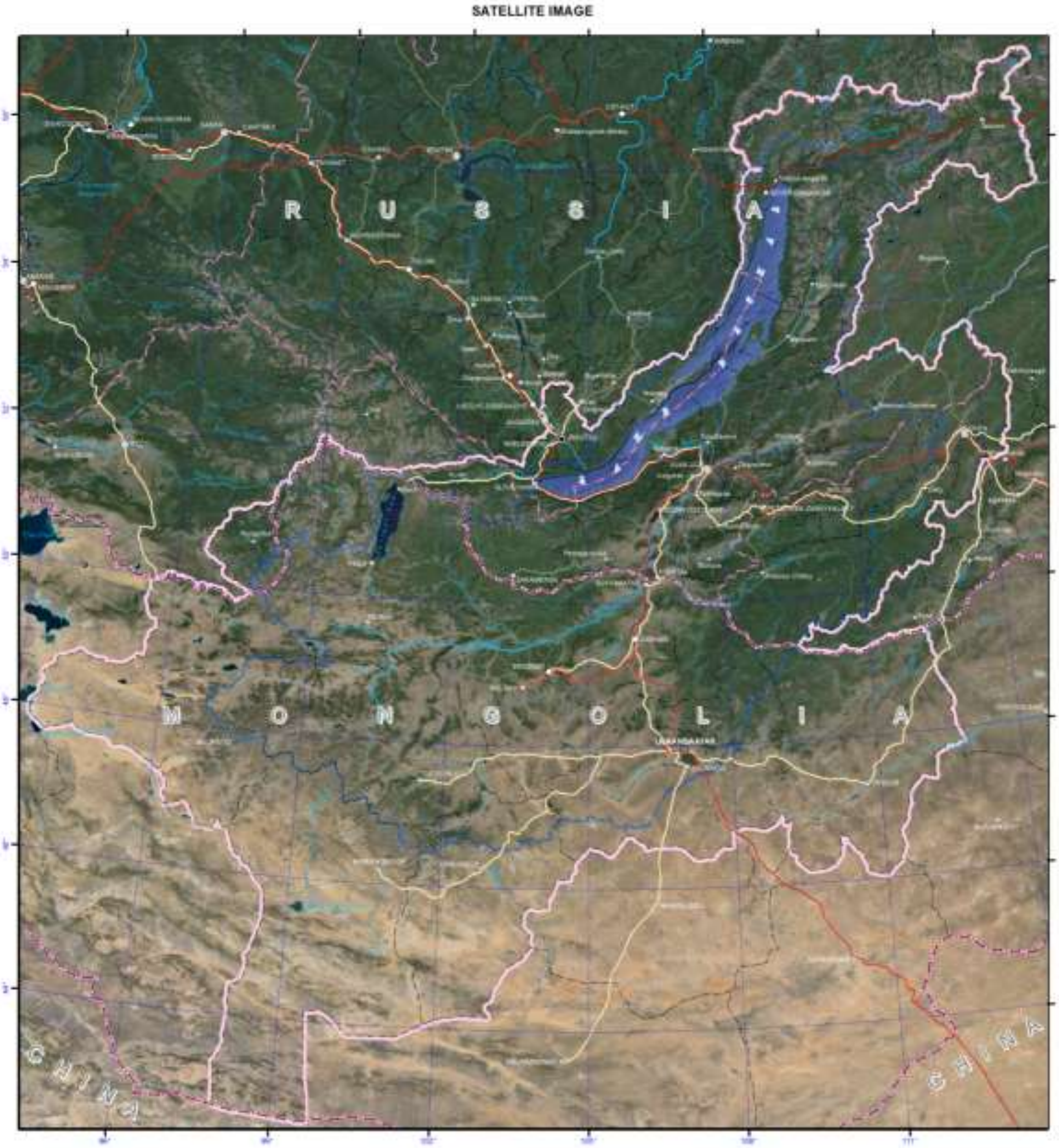
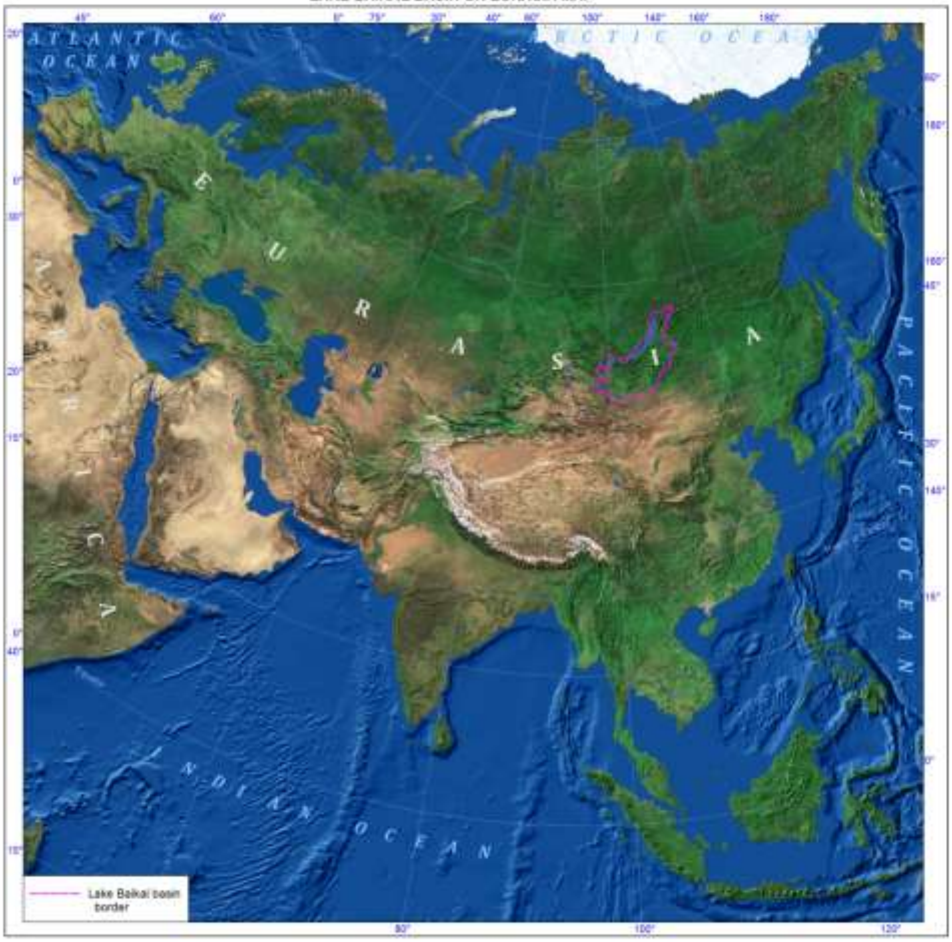
INTRODUCTION

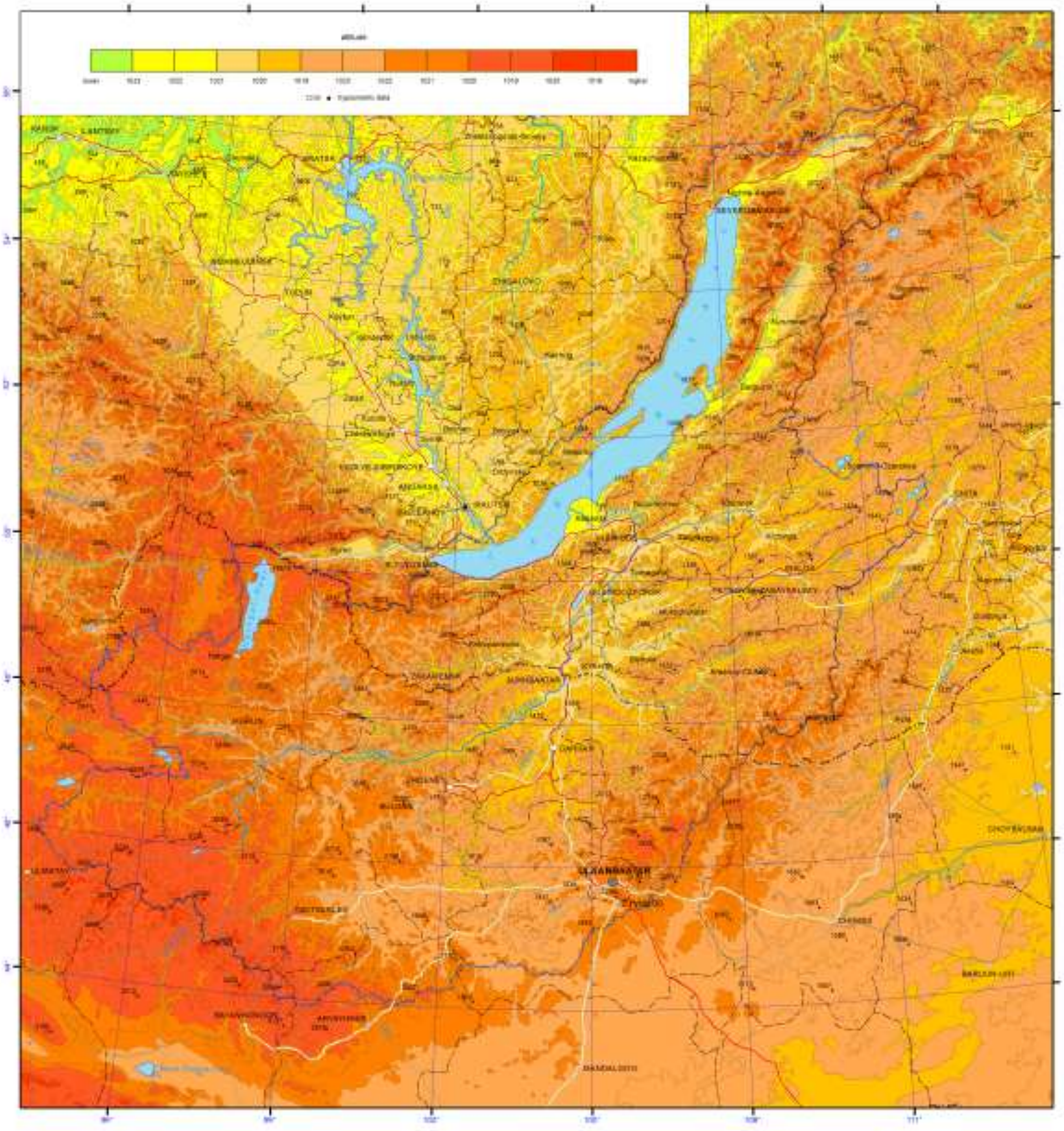


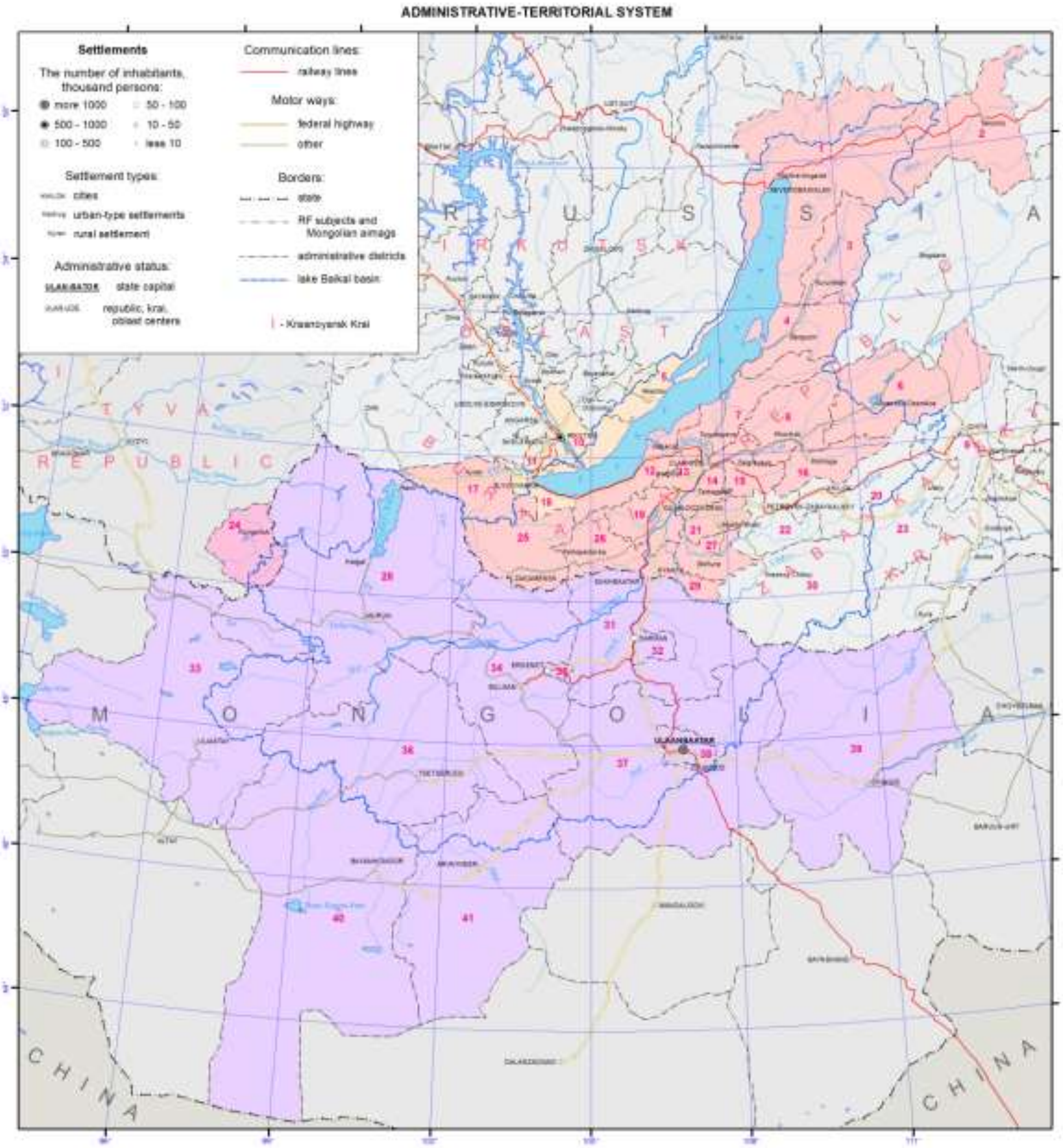
LAKE BAIKAL BASIN ON EURASIA MAP



LAKE BAIKAL BASIN BORDERS AND STRUCTURE

HYPSOGRAPHIC MAP





Russian administrative rayon (district) and Mongolian aimag located in lake Baikal basin and its number on the map

Buryatia Republic
the administrative center – Ulan-Ude

4 Barguzinsky
27 Bichursky
26 Dzhidinsky
13 Ivolginsky
12 Kabansky
8 Khorinsky
16 Kizhinginsky
3 Kurumkansky
29 Kyakhtinsky
21 Mukhorshibirsky
2 Muysky
7 Pribaykalsky
19 Selenginsky
1 Severo-Baykalsky
14 Tarbagataisky
17 Tunkinsky
6 Yeravninsky
15 Zaigrayevsky
25 Zakamensky

Tyva Republic
the administrative center – Kyzyl

24 Tere-Kholsky

Zabaykalsky Krai
the administrative center – Chita

9 Chitinsky
20 Khiloksky
30 Krasnochikoysky
22 Petrovsk-Zabaykalsky
23 Uletovsky

Irkutsk Oblast
the administrative center – Irkutsk

10 Irkutsky
5 Olkhonsky
11 Shelekhovsky
18 Slyudyansky

Mongolia
the capital – Ulan-Bator

38 Ulaanbaatar
36 Arkhangai
40 Bayankhongor
34 Bulgan
32 Darkhan-Uul
39 Khentii
28 Khövsgöl
35 Orkhon
41 Övörkhangai
31 Selenge
37 Töv
33 Zavkhan

NATURAL CONDITIONS OF FORMATION OF ECOLOGICAL SITUATION INTHELAKEBAIKALBASIN

Explanatory notes for the geological map of the Baikal watershed basin

Many features inherent in the geological structure of the territory of the watershed basin are due to the fact that the territory lies at the interface between the two main lithospheric plates of East Siberia, namely the old Siberian platform, and the younger Central-Asian mobile belt. Formation of the geological structure of both Russian and Mongolian parts of the territory began in the Early Precambrian. For this reason, the geological structures, presented on the map, preserved traces of both Precambrian and Phanerozoic eras of tectogenesis.

Precambrian formations have been ascertained essentially within the mountains surrounding the Baikal hollow and to the south and south-west of it, within the north-west of Mongolia.

The sedimentary-metamorphic complexes of Archean age are separated into three series differing in the set of rocks composing them, the degree of metamorphism, the type of magmatic manifestations, and in the pattern of fold structures: the Sharyzhalgai, Khamar-Daban and Olkhon series.

The occurrence area of rocks of the *Sharyzhalgai series* on the south is clearly delineated – it is a near-rectilinear shore of Lake Baikal between the source of the Angara river and the settlement of Kultuk, and on the south-west – by the zone of the Main Sayan Fault. Its composition includes rocks of two types: biotite, biotite-garnet and biotite-hypersthene migmatizated gneisses among which there occur, in the form of separate interlayers and thicker bedsets, amphibolites, pyroxene and amphibolite-pyroxene schists as well as granites differing in composition and structural-textural characteristics.

The complex of sedimentary-metamorphic formations of the *Khamar-Daban series* is of widespread occurrence along the southern shores of Lake Baikal and within the confines of the Khamar-Daban mountain range. The composition of the series is notable for the Slyudyanka and Kharangul subseries. The Slyudyanka subseries is comprised of thick terrigenous-carbonate layers (carbonate bedsets, and specific silicious-dolomite apatite-bearing rocks), while the Kharangul subseries is dominated by flyschoid deposits (homogeneous aluminous slates, and gneisses with rarely occurring interlayers and bedsets of carbonates).

Deposits of the *Olkhon series* occur widely in Priolkhonie and in Olkhon Island; they are represented by marbles, pyroxene-plagioclase schists, amphibole-biotite gneisses, and magmatites with interbeds of amphibolites and quartzites.

The Precambrian ophiolitic complex, confined to the suture zones of the fold belt, is registered in the north-western part of Mongolia.

The Lower-Proterozoic deposits of the Muya series are exposed on the watersheds of the Primorskii ridge along the coastal stripe of Maloe More and are represented by quartzites, slates and metamorphized effusive.

The Upper-Proterozoic (Riphean) deposits occur mainly within the Baikal mountain region. The Patom series occurs in the north of the region and divides into the Ballaganakh, Kadalikan and Bodaibo subseries which, in turn, subdivide into formations. In Western Cisbaikalia there occurs the Baikal series of the Upper Proterozoic consisting of three formations: the Goloustnoe, Uluntui and Kachergat formations. On the south, within the Olkha−Goloustnoe plateau there occur deposits of the Ushakovka formation of the Moty series.

Cambrian rocks occur widely in the Middle-Vitim and Angara-Barguzin mountain regions as well as within the Uda river basin. The composition of Cambrian deposits is quite varied, ranging from conglomerates and sandstones to very fine carbonate differences. The

Devonian deposits are represented by a rather broad spectrum of separate isolated areas; they are arbitrarily subdivided into two stratigraphic complexes. The lower Devonian layers are dominated by carbonate deposits, while the upper level is comprised of terrigenous and volcanogenic-terrigenous deposits. The Carboniferous deposits occur in many isolated areas. The Carboniferous is represented largely by terrigenous deposits (sandstones, aleurites, gravelites and conglomerates, and calcareous clay slates). The Permian deposits are also very much isolated. The largest field of Permian deposits is the Borzya deposit; it lies in Eastern Transbaikalia, and in Western Transbaikalia in the Khilok area. They are represented by relatively uniform terrigenous (and very rarely, carbonate) rocks of a marine and continental origin.

The Triassic deposits include widely occurring volcanogenic formations that are assigned to the Dzhida-Khilok series occurring with scouring on Paleozoic granitoids and other rocks. The lower layers are comprised of the Chernoyarovo formation consisting of major effusive, tuff conglomerates and tuff sandstones. The upper layers include the Tamirskaya formation consisting of acid effusive and tuffs, and aleurites. Sedimentary and sedimentary-volcanic deposits of the Triassic occupy large areas in the western part of Mongolia, where they are interrupted in some places by the Jurassic sediments.

The Lower-Jurassic formations are dominant in the eastern part of Transbaikalia. Starting largely in the Mid-Jurassic period, the western and northern parts of Transbaikalia had been accumulating layers of conglomerates, sandstones, aleurites and argillites with interbeds of bituminous coal. The upper division includes covers of acid effusives. Such effusive-sedimentary formations also extend over the Vitim upland. The syncline cores, usually with their north-eastward strike line, occur in the area of Cretaceous freshwater-continental deposits. The lower part of these deposits refers to the Jurassic, while the upper part corresponds to the Cretaceous. The lower Cretaceous layers are comprised of conglomerates, sandstones, aleurites, slates and strata of brown coal, whereas the upper layers include boulder beds, shingle, sands and clays of the Mokheiskaya formation. In the central parts of Mongolia Cretaceous deposits are somewhat controlled spatially by deep faults and unconformably lie on the Devonian and Cambrian deposits.

Paleogene deposits occur very fragmentarily and are most commonly regarded as Upper Cretaceous−Paleogene deposits, because their detailed partition is unfeasible to date. They are represented by covers of red and variegated-red clays, sandy-shingle deposits and lacustrine clays.Paleogene deposits are characterized by successive link of their composition with the laterite-kaolinite weathering crust. Miocene deposits of the Tankhoi formation are of widespread occurrence on the south-eastern shore of the lake; they were also found at different depths in the course of drilling in the sediments of the Ust-Selenginskaya depression, within the Barguzinskaya depression, and in intermountain depressions of Northern Pribaikalie. In the Dzhida mountainous area and on the Khamar-Daban range, basalt covers, overlaying the watershed areas, belong to the Miocene. On Olkhon Island, deposits of the Tagai formation, which are overlapped with an angular unconformity by deposits of the Sasinskaya formation (Upper Miocene - Lower Pliocene), are referred to the Lower-Middle Miocene. The Upper Pliocene and Eo-pleistocene in most cases compose a single rock mass, which resists dissection. Deposits of this age are registered in South Baikal (Shankhaikhinskaya formation), and in a number of areas of the eastern, western and southern surrounding of the Baikal hollow. On Olkhon Island the Upper Pliocene is represented by clays of the Kharantsy formation. Quaternary formations are characterized by a diversity of lithogenetic and facial types and occupy different geomorphological positions. Most often, the lower half of the profile of the quaternary system clearly shows a thick, complicated sandy layer, while the upper layers of the Pleistocene and Holocene are dominated by rudaceous deposits, including morainic.

The Siberian block of the Eurasian plate and adjoining spaces which, as a result of a long-lasting development, had transformed to the Sayan-Baikal orogenic belt, were characterized by the differing trends of geological events.

In the Early Precambrian, the sialic masses that merged together to form a single block, i.e. Siberia, comprised several Archean blocks with the well-developed continental crust. They were separated by proto-oceanic basins. Toward the end of the Early Proterozoic, the proto-continental blocks had formed a massif with a mature continental crust, i.e. a fragment of the Siberian platform. As a result of the Early-Proterozoic orogeny, the marginal zone of the continent developed the mountain terrain which had been destroyed by the beginning of the Riphean. The Mid-Riphean stage started to accumulate the proper sedimentary cover of the Siberian platform. At the close of the Riphean−Vendian time, most of the paleocontinent was covered by the sea. On the other hand, orogenic movements resulted in the formation of elevated blocks of the Barguzin and Bokson−Hovsgol microcontinents. They produced a discontinuous chain of mountain ridges separating the Siberia paleocontinent from the Paleo-Asian Ocean. In the late Vendian−early Cambrian, the mountain massifs underwent substantial planation.

Starting in the early Cambrian and during the Ordovician−Silurian, the eastern and southern margins of the basements of the microcontinents were represented by shelf zones, and by the upper parts of the continental slope of the oceanic basin. In the latter half of the early Paleozoic and at the beginning of the late Paleozoic, the collision of the Barguzin microcontinent with the Siberian platform triggered the formation of Barguzin granitoids.

The latter half of the Paleozoic witnessed the collision of the Barguzin, Bokson-Hovsgol and other microcontinents with the margin of the Siberia paleocontinent. The Paleo-Asian Ocean stretched out southward of the Siberia paleocontinent.

In the Hercynian era, the active processes in the Mongol−Okhotsk belt were responsible for the tectonic-magmatic intensification of the Sayan region and the southern part of the Siberian platform.

At the beginning of the Mesozoic, an attenuation of the vertical tectonic movements led to peneplanation with the formation of a thick weathering crust. The subsequent Mesozoic intensification was responsible for a growth of the mountains in the Sayan-Baikal region, and for an intensification of intrusive magmatism.

The end of the Cretaceous−Paleogene was marked by a long-lasting period of peneplanation and crust formation which preceded directly the Cenozoic riftogenesis and the formation of the morphostructural plan of the Baikal Rift Zone and Lake Baikal watershed basin.

The distinguished tectonic stages are very clearly registered in three tectonic blocks in the territory of Mongolia, namely: western – Caledonian; central – Early Caledonian, with numerous outthrusts of rocks of the crystalline basement and Hercynian and Mesozoic structures overlaying them, and southern – Hercynian. In general, the modern overlapped-folded structure of the Mongolian territory outlines certain spatial and temporal patterns, consisting in a directional change of more ancient structures, located in the north and west, by younger ones, clearly manifested in the south.

The territory of the Lake Baikal watershed basin is unique as regards the occurrence range and the diversity of granitoids which occupy more than 70% of the area, while the formation of acid magmas was taking place from the Archean to the early Cretaceous. They tend to occur within the Mongol−Okhotsk mobile belt, having a complex long-lasting history. The following stages of magmatism are identified:

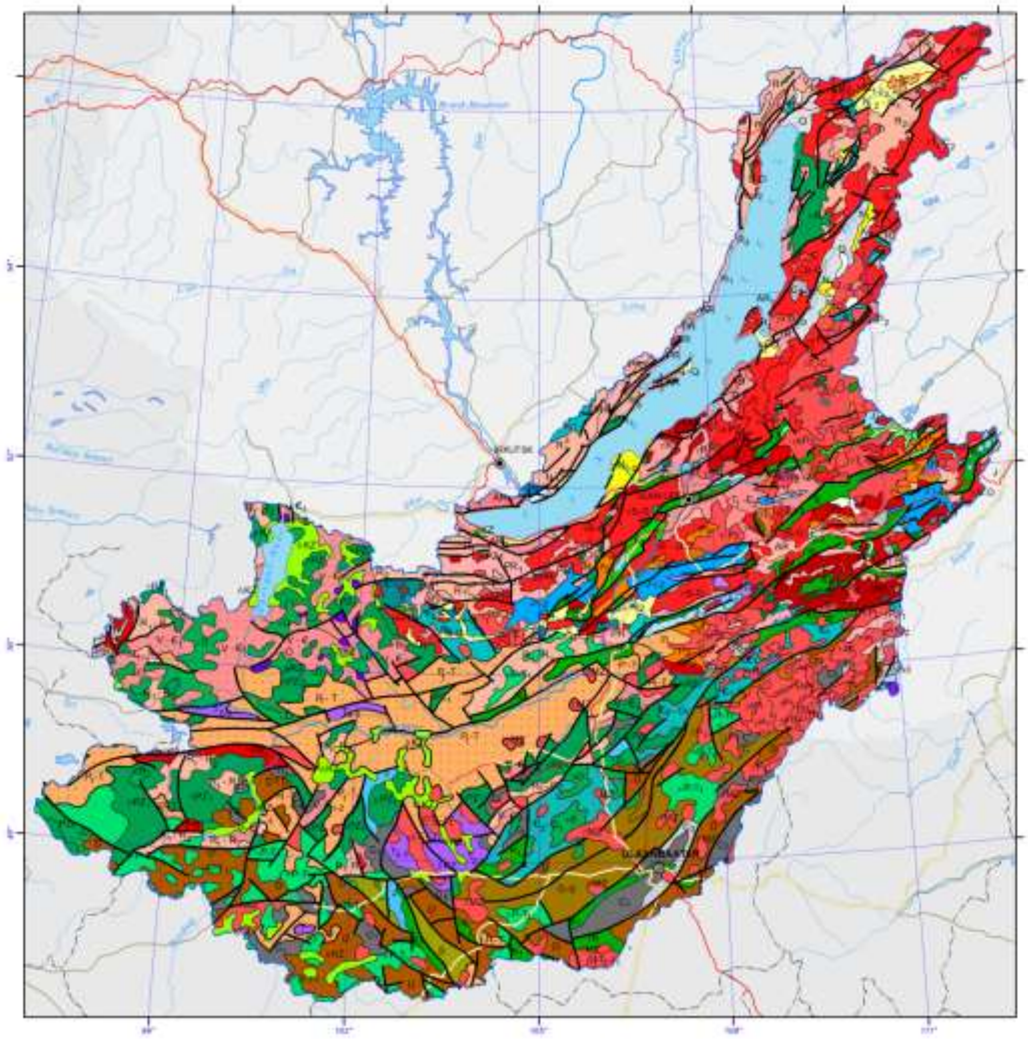
1. Archean early-orogenic – formation of migmatites and lenticular concordant bodies of gneissogranites and granites.Archean late-orogenic – intrusive bodies of pink and red leucocratic significantly potassic granites and alaskites.
2. Early Proterozoic late-orogenic fissure intrusions of the seaside granite complex.
3. Late Baikalian−early Caledonian (Vendian−early Cambrian) – basic volcanism, ultrabasic intrusions.
4. Late Caledonian (Cambrian−Silurian) – formation of granitoids on a mass scale.
5. Early Hercynian (Devonian) – local occurrence of acid and mixed volcanism. Intrusions of alkali-earth syenites, granites and alaskite granites.

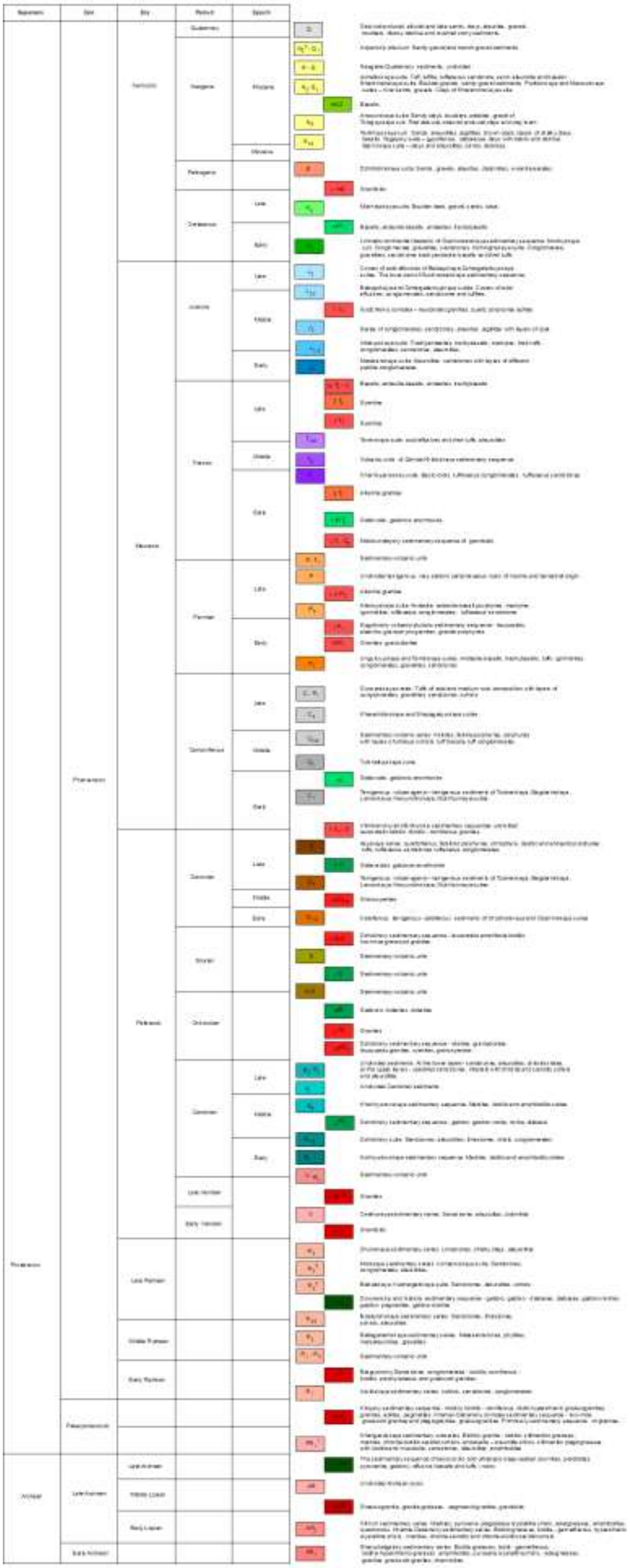
6. Late Hercynian (Carboniferous−Permian) – intrusive series of gabbro-monzonite-syenite, alkali-syenite and alkali-granite composition.

7. Cimmerian (Triassic−Cretaceous) – series of tectono-magma activations with the establishment of volcano-tectonic structures, intrusion of normal and alkali-earth granodiorite−leucogranite series and effusion of basaltoids.

8. Quaternary period – riftogenesis and effusion of alkali basaltoids.

GEOLOGY





Seismic zoning

Seismic zoning implies mapping of seismic risk due to maximum seismic impact, whichmightoriginateoverthisareaandbeexceededwithacertainprobabilityduringtheassignedtimeinterval [Ulomov, Bogdanov, 2013].

Total seismic zoning (TSZ) is implemented on the basis of studying regional and global seismicity-generating structures (SGS), determining recent geodynamics, seismicity and seismic regime over territories of states. TSZ serves the foundation for a rational land use and securing the anti-seismic construction. The scale of basic maps for TSZ should not be larger than 1:2.500.000. Tospecifythedegreeofseismicriskinappropriateregionsandoverlocalareasthe supplementary field surveys are performed, i.e. instrumental survey is carried out for detailed seismic zoning (DSZ) at scale 1:500 000 and larger, as well as seismic micro zoning (SMZ) at scale 1:50 000 and larger.

The map of seismic zoning over the territory of the Baikal watershed depicts the materials collected through a systematic study of active faults within the Baikal region and Mongolia, where the strongest earthquakes might be the case. This type of mapping is methodologically based on the geological and geophysical evidence specifying the features of seismic and tectonic development of the territory including the elements of historic-structural, tectonophysic and paleo-seismic approaches applied for recognizing the zones of probable earthquake foci (PEF). The main goal of identified zones PEF is a maximally reality - approached reflection of projections of future focal zones of earthquakes of varying magnitude (M) occurring with a certain repeatability. Construction of PEF zones also includes extrapolation of possible quakeM occurring in known geologic-geophysical environs onto the morphology-structural fault complexes with similar conditions, but in which the respective earthquakes have not taken place yet. This seismotectonic approach proposed by Gubin I.E. (1950) is applicable so far. On the map of seismic zoning from PEF zones with a certain seismic potential (Mof earthquake), according to a decay of seismic waves from quake epicenters, seismic zones are outlined following the intensity scale units MSK-64 [New map …., 1996; Recent geodynamics…,1996].

The map of seismic zoning may be regarded as the long-term prognosis of strong earthquakes during 1000 years. The map was founded on seismic statistical data on the seismicity recorded over the regional territory for over 100 years period of observations, as well as seismogeological evidence and maps of active faults [Smekalin et al., 2011].

The main goal of the map of seismic zoning is to reflect the realistic level of seismic risk as a magnitude in each point of the surveyed territory considering the quantification of the boundaries of regions with different seismic risk measured in probabilistic values.

Themaprepresentingmodernconceptsofseismogeologicalanalysisdeveloped by seismologists of Irkutsk [Seismic zoning…, 1977] distinctly displays a linear elongated mode of isolines with different seismic risk expressed in magnitude. This is because configuration of all these lines lies upon seismic lineaments. They represent the axes of the upper edges of 3D seismically active fault structures, related structured seismicity and framework of the lineament-domain-focal (LDF) model applied in this study.

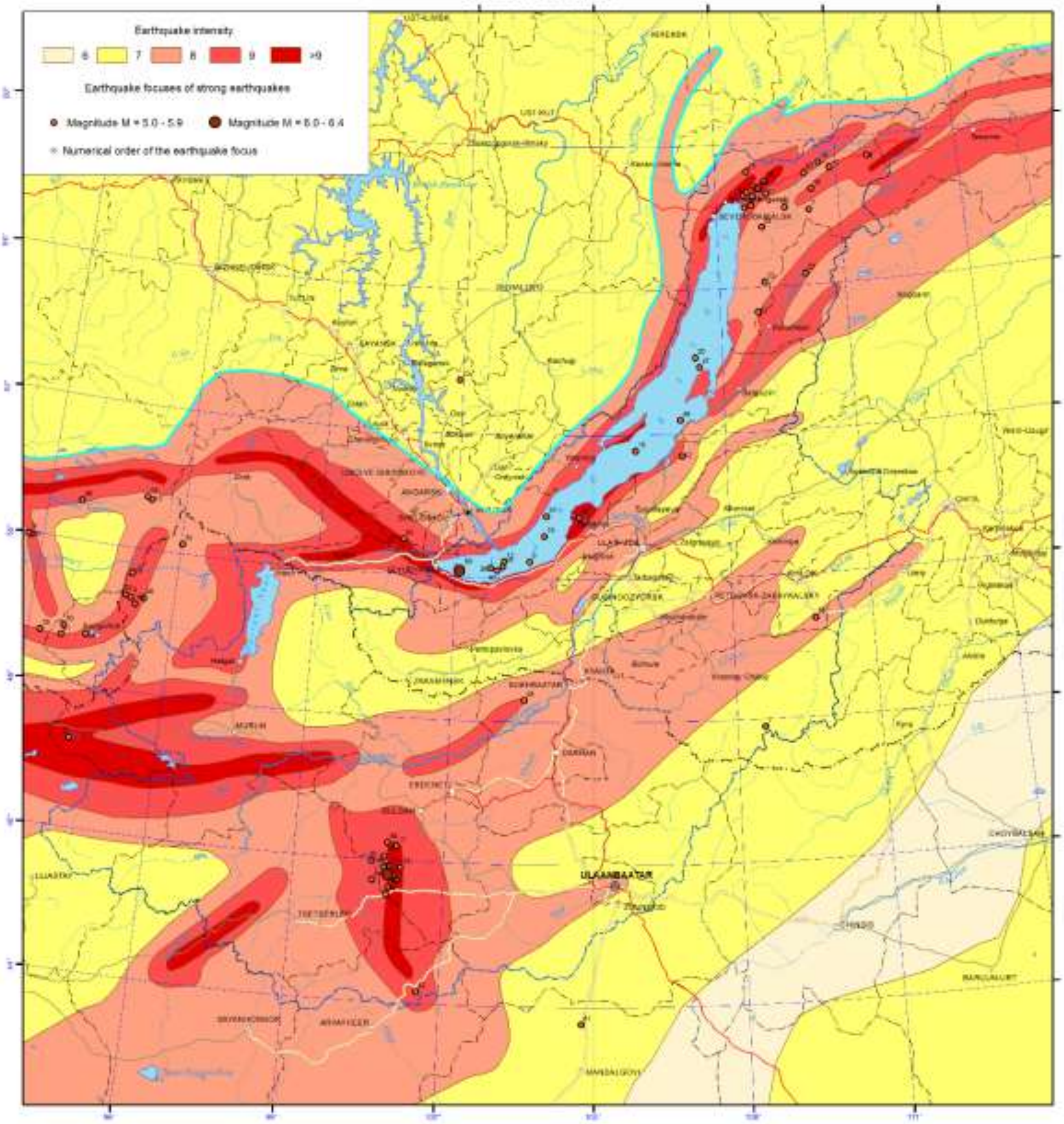
The entire area of the Baikal watershed is outlined by the intensity 7 to 9 isolines of seismic risk. As this takes place, the narrow linear zones of possible quakes with intensity 10 (on the map intensity >9) are common for the southern termination of the lake basin, and they are associated with the Main Sayan fault and numerous paleo-seismic dislocations located nearby. The paleo events, they are related to, could generate quakes with intensity 10 to 11. The other similar spot of quakes with intensity 10 is located in the north of the lake, in the region of the Kichera paleo dislocations occurring within the Kichera seismically active faults capable to generate earthquakes with magnitude M= 7.0 – 7.5. The third spot in the Selenga River delta is linked with the Delta seismically active fault, its plane comprising the focus of the catastrophic

Tsagan-Zaba earthquake of 1862 withM=7.5 (with the M=10 effects observed on the surface). All the water area of Lake Baikal is contoured by the M=9 isoseism.

The isoline of M=8 intensity turns over M=9 isoseisms and extends in the north-eastern direction on both sides from Lake Baikal. This area involves large populated localities like cities Irkutsk, Ulan-Ude and Ulan-Bator. Over Mongolia territory, south of the Khubsugul Lake there is a sublatitudinal zone of M=10 quakes (on the map intensity> 9), associated with the area of two faults, in which planes the foci of the Bolnay and Tsetserleg earthquakes of 1905 occur. These seismic events are referred to the strongest intra-continent earthquakes on the Earth of instrumental period(M=8.5, intensity 11-12).The Khubsugul Lake and adjacent territories lie within the zone of intensity-9quakes.

Ulan-Baatar city sits within the zone with seismic effect of intensity-8 quakes. Thiszoneiscontouredonbothsideszoneareaofpossibleintensity-7 quakes extends from Ulan-Ude city in the north to Sukhe-Baatar (Mongolia) in the south.

SEISMIC RISK ZONING



Geomorphology

The Lake Baikal watershed basin is located in the center of Eurasia, and this determines its specific traits as well as its main features. Paleogeography and geology of the region governits peculiar landforms. Vertical tectonic movements of the Late Mesozoic and the Cenozoic developed a mountain-and-basin type of topography.

The orographic structure of the Baikal watershed basin is rather complex. The topography as a whole is a unified Pliocene-Quaternary formation[Ecosystems, 2005]. Significant subsidence of individual blocks in the midst of general uplift developed grabens of two types. The first type (the Baikal type)is associated with the intensification of tectonic activity in the inland Baikal Rift Zone. The amplitude of vertical neotectonic movements, as well as the thickness of loose deposits reach the maximum here. Crustal movements in this area are still quite intense; they cause a high seismic activity with frequent and sometimes strong earthquakes. The second type (the Zabaikalsky type) of grabensis represented by wide intermountain lowlands, which are very common in the Selenga river watershed basin. They formed as a result of recent deep-seated tectonic dislocations superimposed on the rejuvenated Mesozoic depressions.

Intermountain basins are separated by mountain ranges varying in height and geological structure. They are notice ably dissected by exogenous processes of erosion.

In the Quaternary the highest orographic units (the Baikal, Verkhneangarsky, Barguzinsky, Khamar-Daban, Khangai and other mountain ranges) especially their north-western and northern slopes were exposed to glaciation, which is indicatedby the presence of the Alpine landforms (cirques, avalanche chutes, through valleys, morians, etc.)

Both positive and negative land forms within the Selenga river watershed basin and up to the Uda river mouth are generally directed northeastward with a dominant altitude lowering northward. The mountains surrounding three Baikal intermountain basins (Barguzin, Verkhneangarsk and Khubsugul lowlands) are characterized by a higher absolute altitudes and deeply cut river valleys. These factors predetermine a wide range of elements typical of mountain landform, or plain landform in the wide intermountain basins.

According to the geomorphological analysis[Highlands…, 1974; National Atlas of the Mongolian People’s Republic, 1990] the area of the Baikal watershed basin is made up of the following features: Khangai and Khentei-Dauria Highlands, Prikhubsugul Mountains, Orkhon-Selenga middle mountains and its continuation in the north - Selenga (Selenginskaya Dauria) middle mountains, the Dzhidinsky mountain system, mountain ranges of Khamar-Daban, Ulan-Burgasy, Ikatsky, Barguzinsky, Verkhneangarsky, Severomuysky, Baikalsky, and Primorsky, and the western side of the Vitim Plateau. Minimum absolute altitude is the lake Baikal waterline; since it is regulated, it is subject to slight fluctuations at around 460m a.s.l. Maximum absolute altitude is 3,539m a.s.l. (the Khangai Highland).

The highest mountain range in the areais the ***Khangai Highland*** located in the south-western part of the watershed basin; it has generally subdued delineationand slight changes of relative altitudes. The mountains become more prominent towards the central part of the watershed basin due toAlpine landforms. Tarbagatay and Telin-Tsagan are the largest northern spurs of Khangai Highlands with individual peaks reaching 2,500m.

The maximum altitudes of the ***Khentei Highlands*** mountains go up to 2,200-2,400m a.s.l. Their wide and longspurs stretch westward and eastward, forming a large highland, gradually descending to low hills in the west and in the south, and joining the Zabaikalye Mountains in the north. Generally, this is a gently sloping landscape with wide-spread residual hills, rocks, scattered stones. Traces of ancient glaciation are preserved to a limited extent.

The Orkhon-Selenga middle mountains are located in the central part of the watershed basin between the ranges of the Dzhida river basin in the north and the Khentei Highlands in the south. It features aflattened relief and its spatial configuration resemblesa huge amphitheater descending towards the northeast.

The Selenga middle mountains consist of sublatitudinal medium-altitude mountain ranges with rounded summits (Tsagan-Daban, Borgoysky, Chikoysky, Tsagan-Khurteisky, Zagansky, and others) separated by wide intermountain valleys distinctly stretching along the main riverbeds. The valley bottoms are drained by the Selenga tributaries (Chikoy, Khilok, Uda, Dzida) and composed of alluvial and proluvial deposits of different age arranged in terraces and wide piedmont plains. The Selenga river valley lies among low hills with granite residuals, rocks, and cliffs.

Prikhubsugul relief has a complex structure. Its west side features sharp-crested, steep-sided, and hard to access ridges of Bayan-Ula and Khoridol-Saryag. The outlines of the mountains to the east of Lake Khubsugul resemble those of the northern Khentei with altitudes over 2,000m. Extensive Late Cenosoic lava plateaus are specific features of these mountains.

The Dzhida and Khamar-Damban Mountain Ranges have a lot in common. They stretch from southwest to northeast. In the west, they are relatively flattened and marked by bald peaks, gradually turning into the Alpine middle mountains of the Big Khamar-Daban Mountain Range, which ends with the cliffs, dropping steeply to the shores of Lake Baikal. In the east, the mountain shave a lower altitude. The Selenga River cuts through their spurs.

The northern part of lake Baikal and the ***Verkhneangarskaya basin*** are surrounded by Alpine landforms with harsh outlines of the axial and piedmont parts of the ***Baikalsky, Verkhneangarsky, Severomuysky,*** and***Barguzinsky*** mountain ranges. In spite of the relatively moderate elevations, there are many glacial traces here, and in some places there are small vanishing mountain glaciers (e.g. the Chersky Glacier – 0.4 sq.km.) The Vekhneangarsky basin relief shows little elevation changes at the bottom. It is formed by the alluvial deposits of the Verkhnyaya Angara (the Upper Angara) River, and by lacustrine alluvial deposits of paleo basins. Extensive proluvial and fluvioglacial piedmont plains are typical of the basin.

The structure of ***the Barguzinskyabasin***is typical of the Baikal-type depressions: large swampyplain areas at the basinbottom, relatively uplifted ancient alluvial lacustrine terraces made of sandstonedeposits. The presence of large areas of sand stone deposits predetermine high eolian activities.

In the south, the Barguzinskaya depression is framed by massive, but relatively flat landforms of the ***Ikatsky*** range. The highest summits of the Ikatsky range as well as those of the ranges lying further south ***(Ulan-Burgasy and Kurbinsky ranges)***are treeless and flat with mountain terraces.

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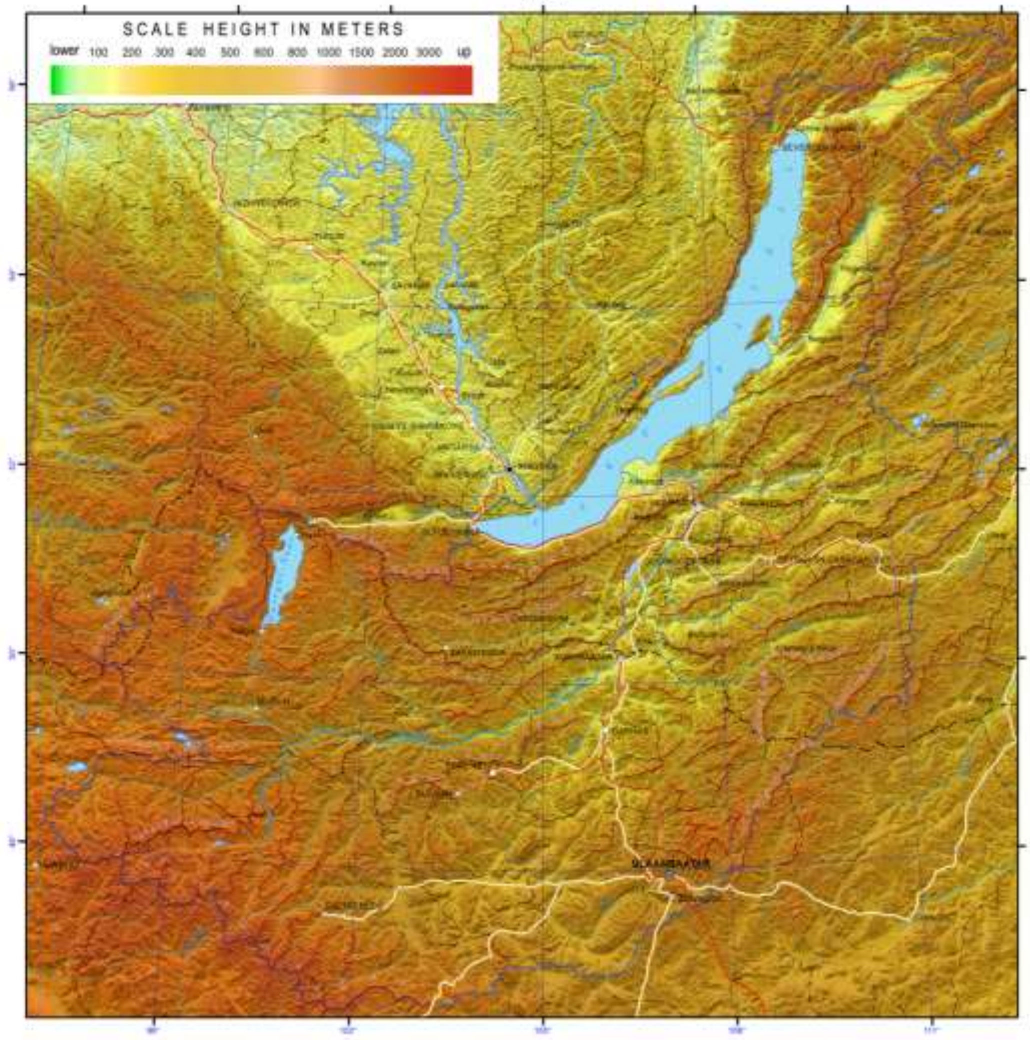
RELIEF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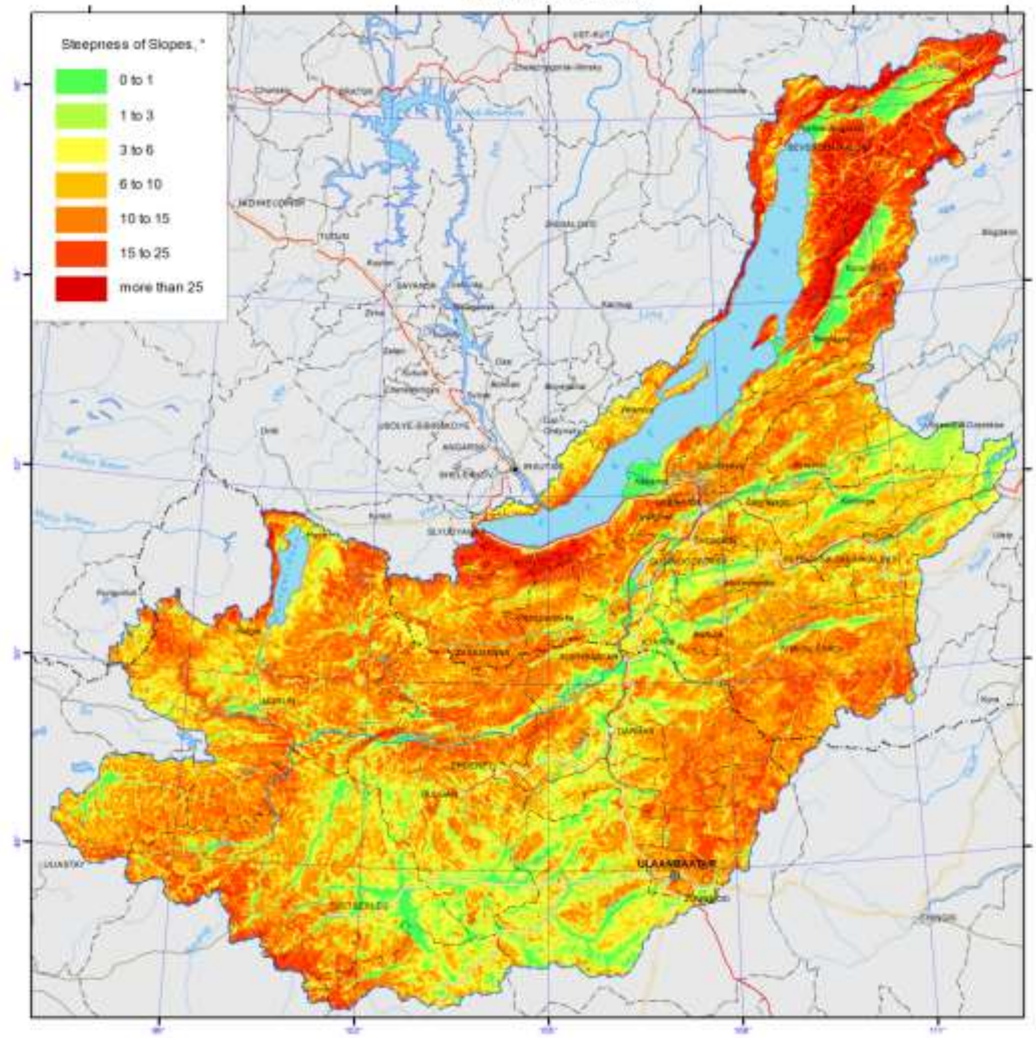
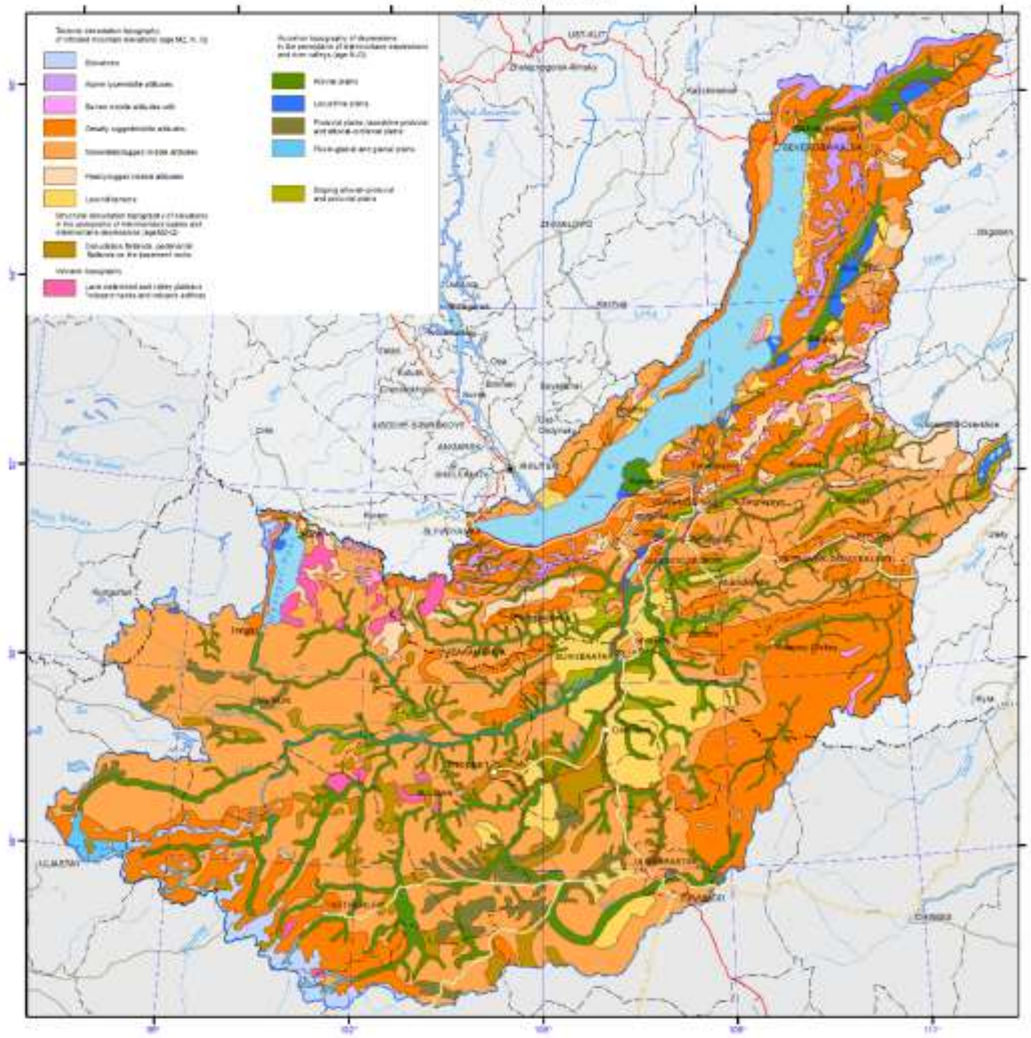
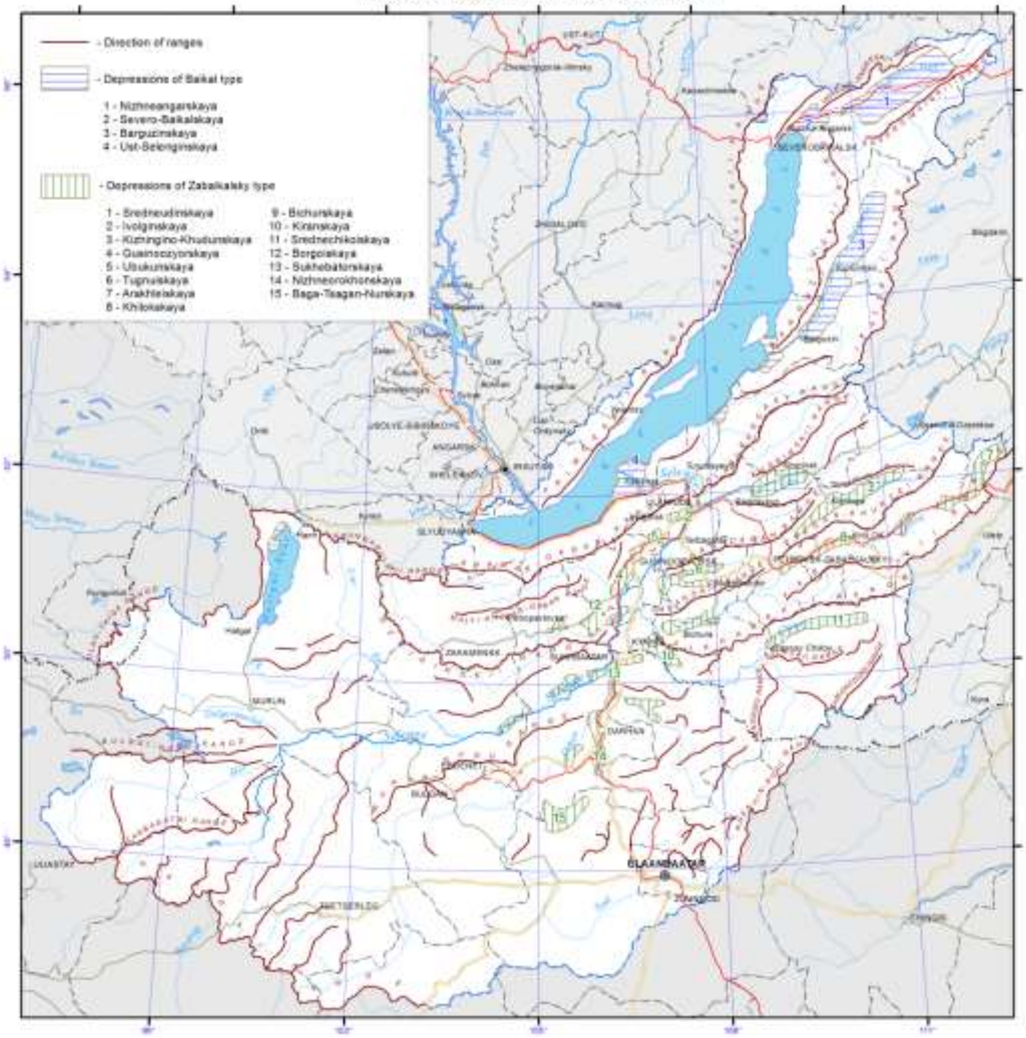
STEEPNESS OF SLOPES



GEOMORPHOLOGY



OROGRAPHIC SCHEME OF LAKE BAIKAL BASIN



Contemporary exogenous processes of morphogenesis

For purposes of mapping, the leading processes were identified on the basis of a classification of the exogenous processes of morphogenesis of land, suggested by V.G. Vyrkin [1986], from taxonomic geomorphological units in accordance with the scale. At a small scale, the objects of geomorphological mapping are the types, subtypes and complexes of topography which are basic to identifying classes and groups of leading processes. The legend is based on identifying one leading process (the one exception to this rule is represented by the display of areas on the map where the contemporary morphogenesis is due to a combination of two leading classes of processes). Identification of the leading processes of the territory took into account their three main parameters: the coverage area, the duration of a continuous occurrence, and the intensity of development.

The process is identified through a process interpretation of the relief, deposits, landscapes, vegetation and other natural formations. The procedure brings to the fore the interpretation of the relief, its morphology, genesis and age, and the identification of the genetic types of deposits. Only an integral investigation into the landforms and correlative deposits, complemented with station-based observations of the intensity of processes, does make it possible to identify in the mapping procedure the leading processes, and of paramount importance is a knowledge of the geomorphological structure of the region being mapped. Vital to the generation of small- and medium-scale maps of the processes, especially for poorly explored spaces of Siberia and Mongolia, are space images. In Siberia's remote regions difficult of access, 1 : 1 000 000 space images provide the main information base for map compilation.

Thus the methodological framework for mapping the contemporary exogenous processes of morphogenesis involves determining and depicting the leading processes. Maps as produced by such a method offer a means of investigating the structure and functioning of the processes of contemporary exogenous morphogenesis. They can be used in developing and generating regionalization schemes for contemporary exogenous processes of morphogenesis.

The map as created on the basis of the aforementioned principles constitutes a wealth of information which can be employed in dealing with issues relating to rational management of natural resources, assessments of the relief and contemporary morphogenetic processes, and to implementation of measures for the protection of land surface against hazardous and adverse geomorphological processes.

These materials were used as the basis to construct the new map of seismic zoning over the RF territory OCP-2012, which in the future will become the normative and reference materials for all research and design project organizations of Russia [Ulomov, Bogdanov, 2013].

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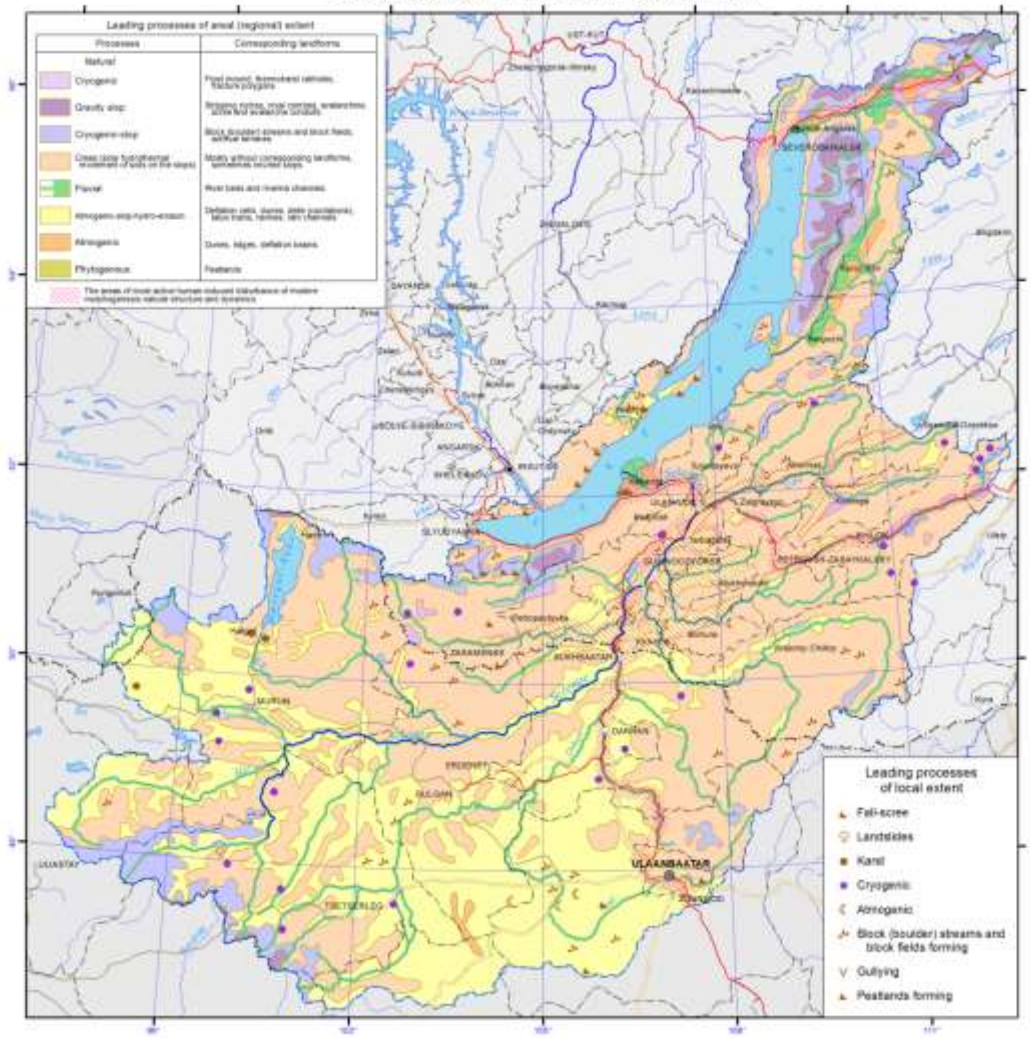
MODERN EXOGENOUS PROCESSES OF MORPHOGENESIS



Climate

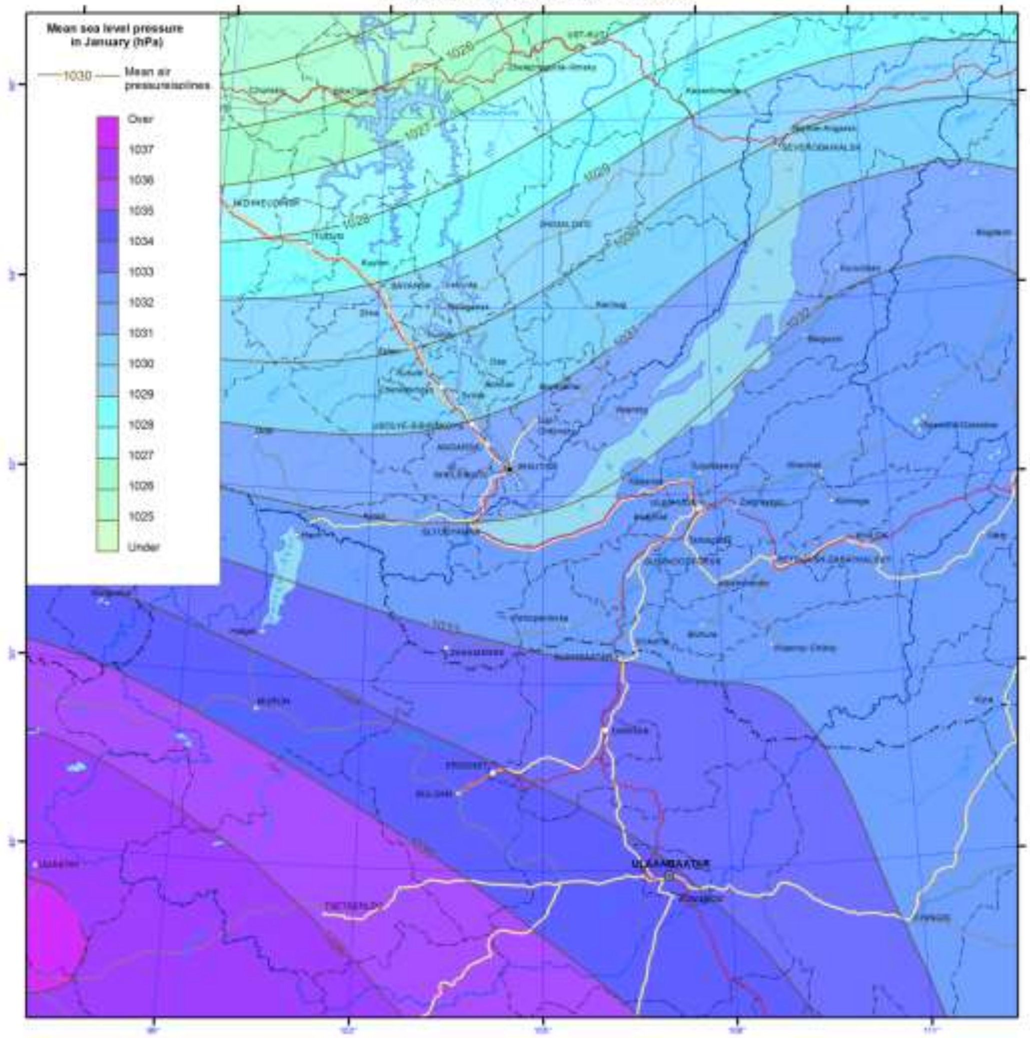
Observational data of meteorological stations on the air temperature and precipitation in the period 1961 to 2008 serve as initial data for climate maps here. Mean monthly and annual values are considered.

Atmospheric pressure

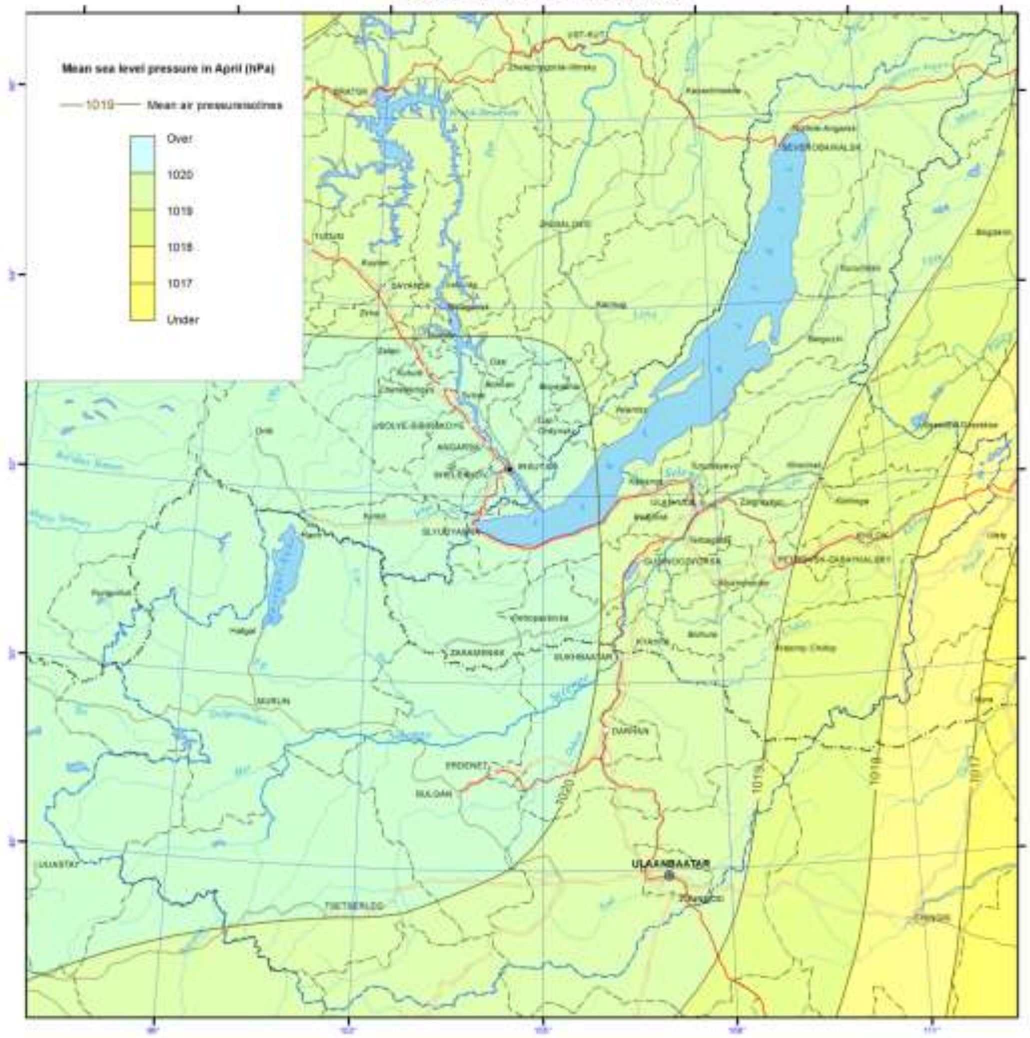
A primary role in shaping climate is played by atmospheric circulation - one of the main climate factors. Atmospheric circulation is presented in the maps of pressure fields in the central months of the season. The maps are compiled on the monthly mean pressure values reduced to sea level (reanalysis base NCEP / NCAR). In winter, the main pressure system at the surface is Asian (Siberian) anticyclone centered on the north-west Mongolia, reaching maximum development in January. In spring the action of Asian maximum weakens. Differences in the properties of the underlying surface of the continent and ocean is dramatically reducing, thereby the zonal circulation factors begin to dominate, that determine the west-east transport. Together with the transfer of pressure formations from west to east the cyclones outputs from Central Asia and Kazakhstan are observed in spring. Summer circulation processes are characterized by the weakening of west-east transport. The pressure field of low pressure dominates at the earth's surface.

Circulation processes are characterized by the weakening of west-east transport. At the earth's surface the pressure field of low pressure with light winds dominates. When the blocking warm anticyclone locates over the central regions of Yakutia, south cyclones from Mongolia move to the Baikal region and then they slowly travel to the west or northwest. Central forms of summer circulation, which are characterized by blockage of the zonal flow and split of planetary altitude frontal zone (PAFZ) of temperate latitudes, occur conditioned upon intensive development of the typical summer tall crests and troughs. Circulation conditions of the autumn period characterized by the development of general west-east transport, which is interrupted by meridional invasions of cold air masses from the north. Siberian anticyclone is in its formation stage. Compared with the spring season the autumn west -east movement of pressure systems are slower. Final transition to winter conditions circulation is carried around the middle of November, when the Siberian anticyclone is sufficiently stable.

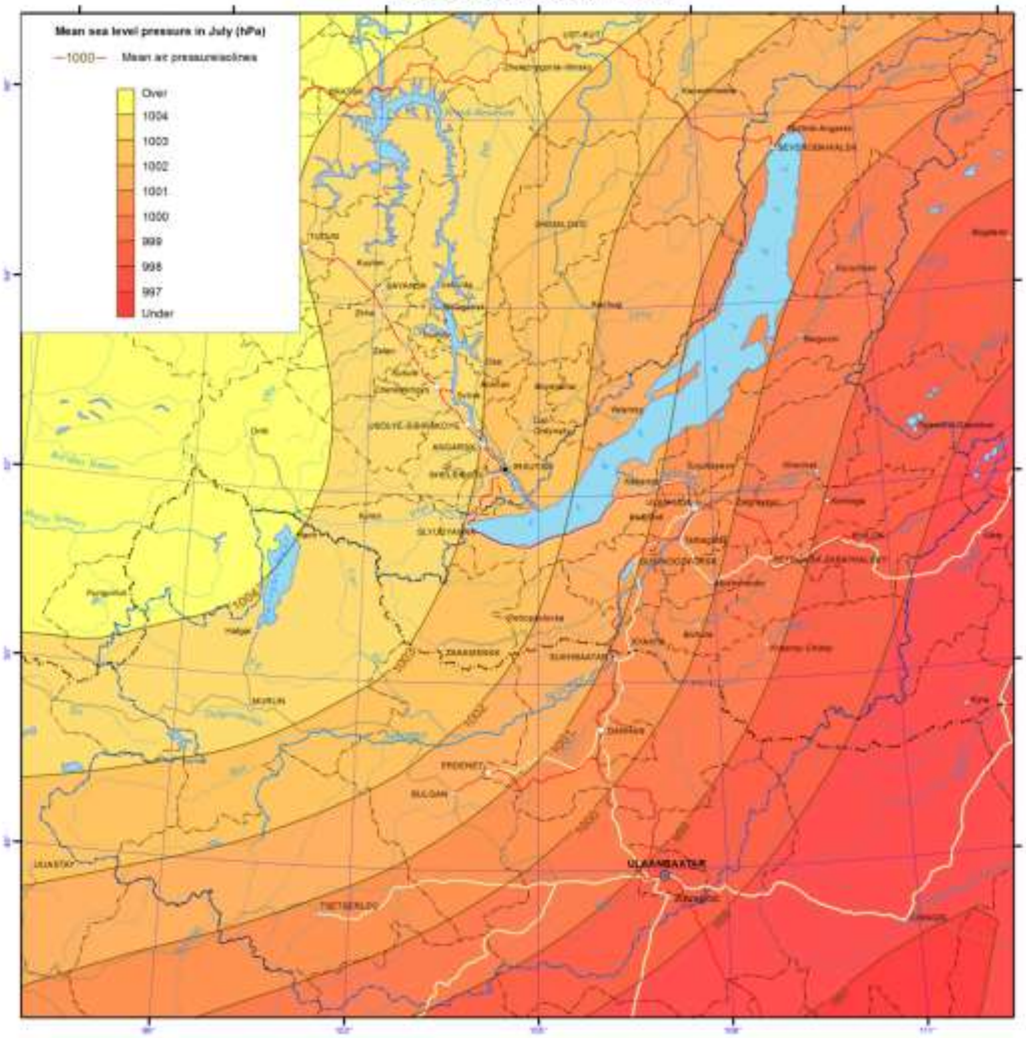
MEAN SEA LEVEL PRESSURE IN JANUARY



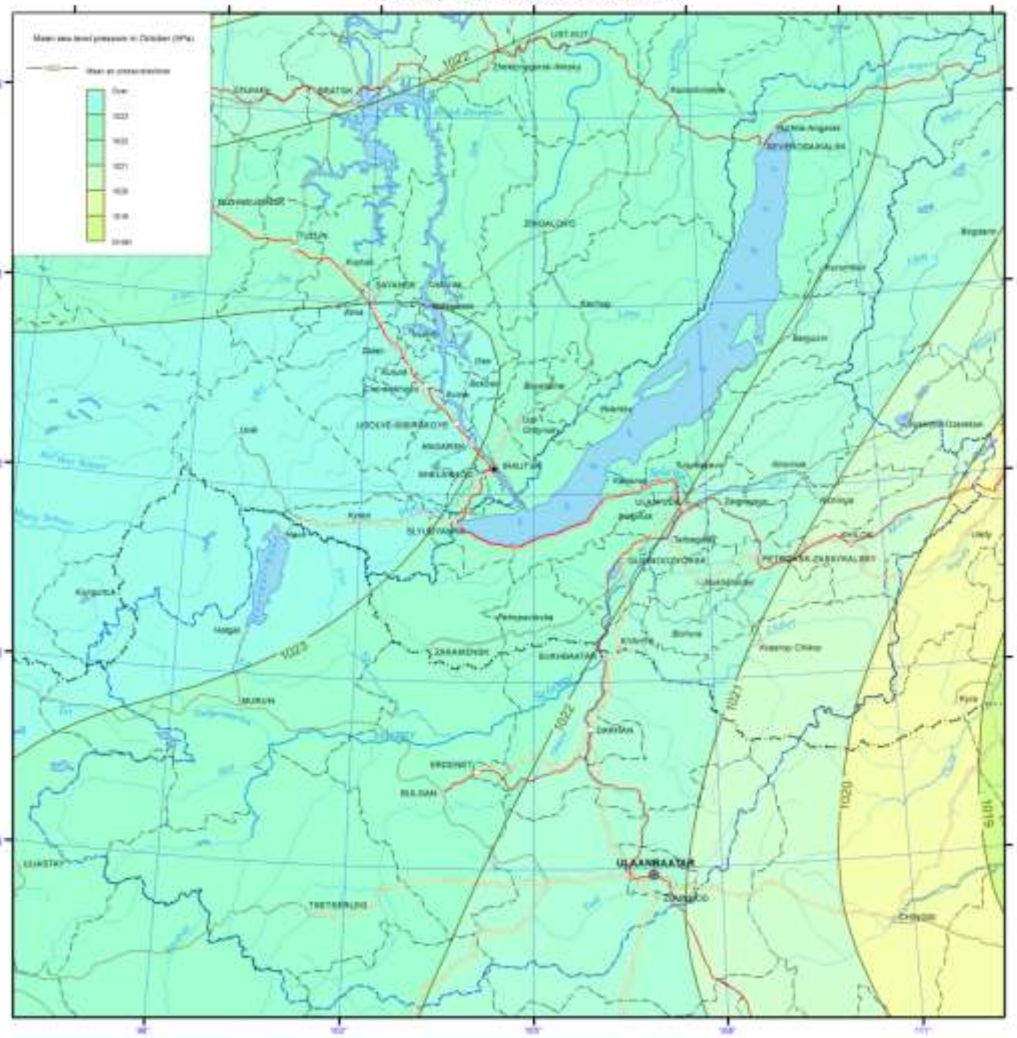
MEAN SEA LEVEL PRESSURE IN APRIL



MEAN SEA LEVEL PRESSURE IN JULY



MEAN SEA LEVEL PRESSURE IN OCTOBER



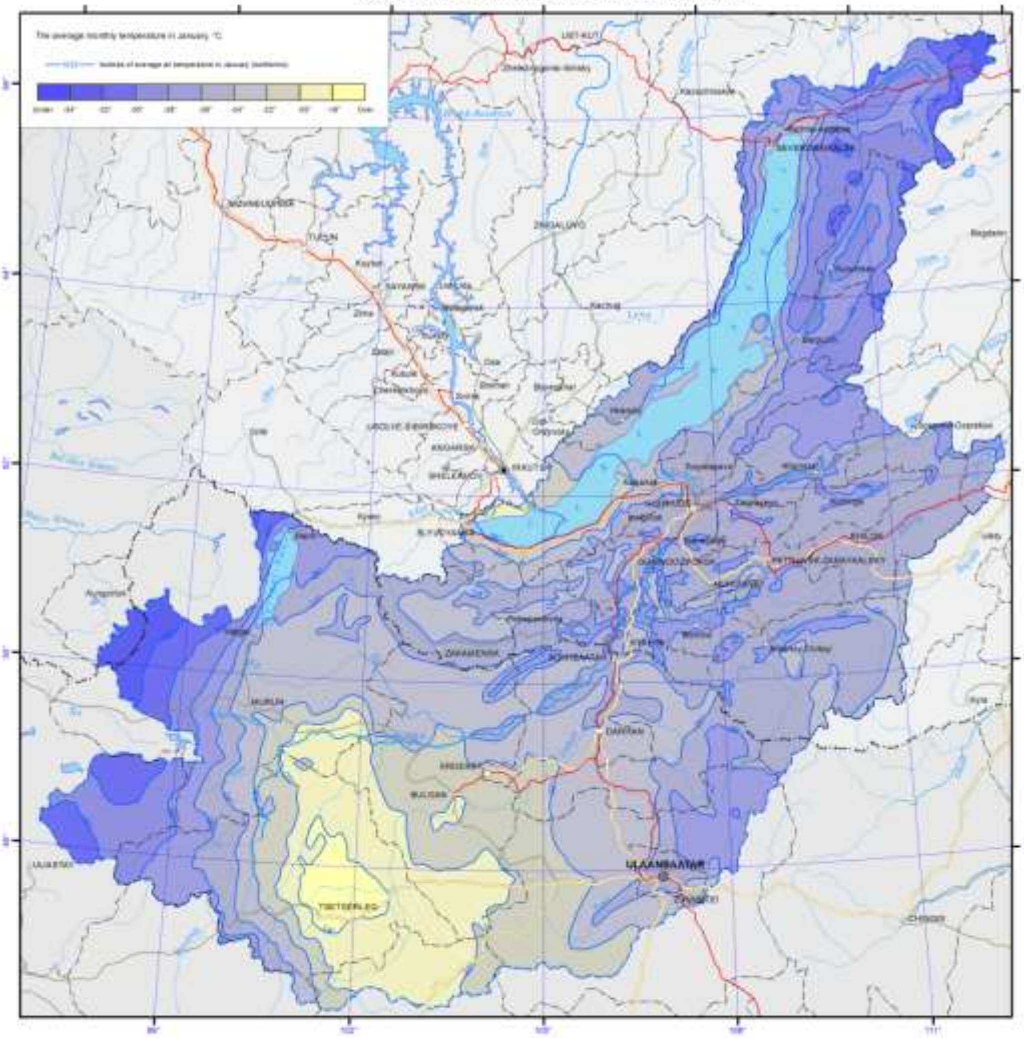
Air temperature

Lake Baikal influences the climate of the surrounding area within the watershed. When the climate of inland areas of Irkutsk region, the Republic of Buryatia, Trans-Baikal Territory, Mongolia may be called sharply continental, and the climate of the coast of Lake Baikal is close to the coastal. Winter month’s temperature on the shores of southern Baikal is on average 5°C higher than in the central areas, and summer month’s temperature is lower at the same rate. In summer temperature inversions are observed over the cold lake surface that impedes upward motions. Additional radiation and circulating factors and local conditions determine the features of the thermal regime.

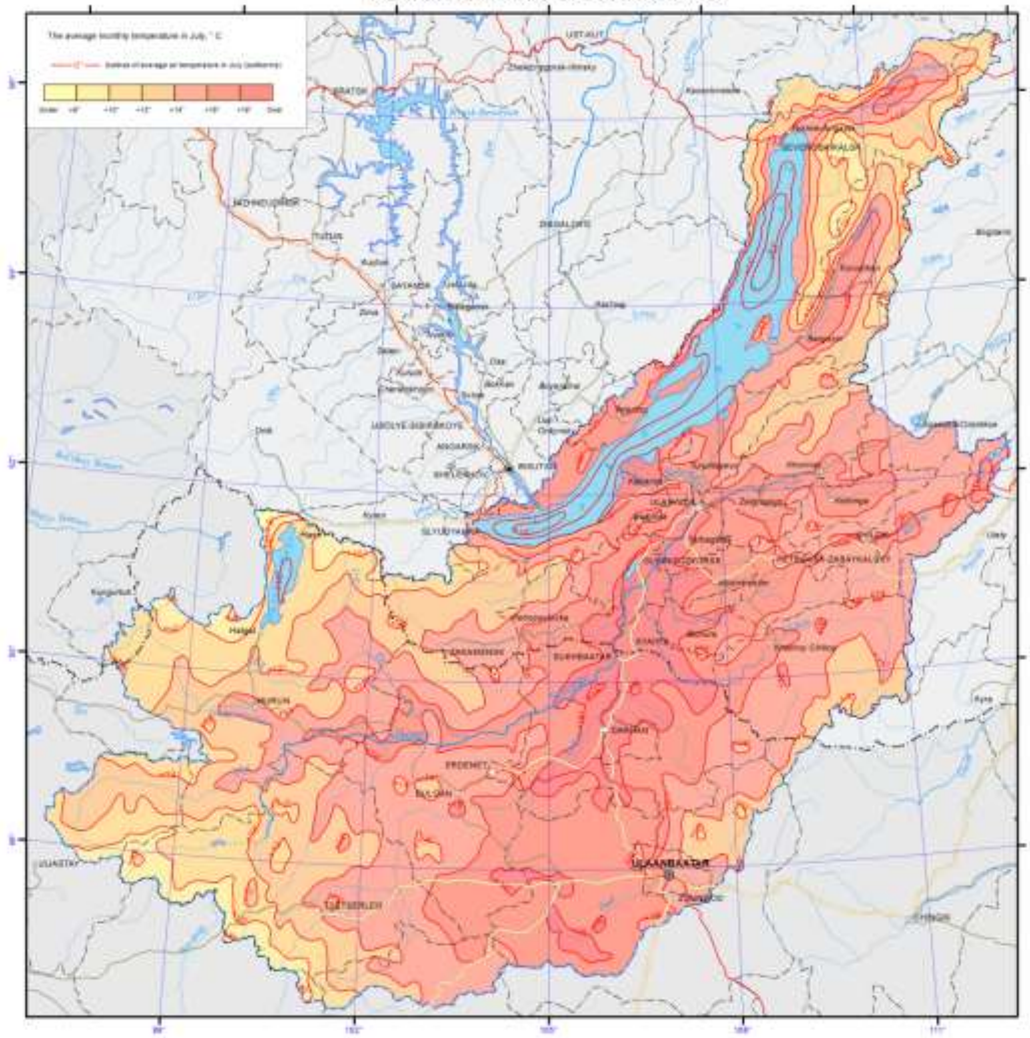
In winter, due to the predominance of anticyclonic weather, the air temperature depends mainly on the radiation environment and the air cools over the underlying surface. In summer radiation factors also play a role in the temperature formation.

Long-term mean annual temperature is almost everywhere negative. At stations located on the shores of Lake Baikal, air temperature is higher than on the continental stations located at the same latitude. The coldest month is January and the warmest is July.

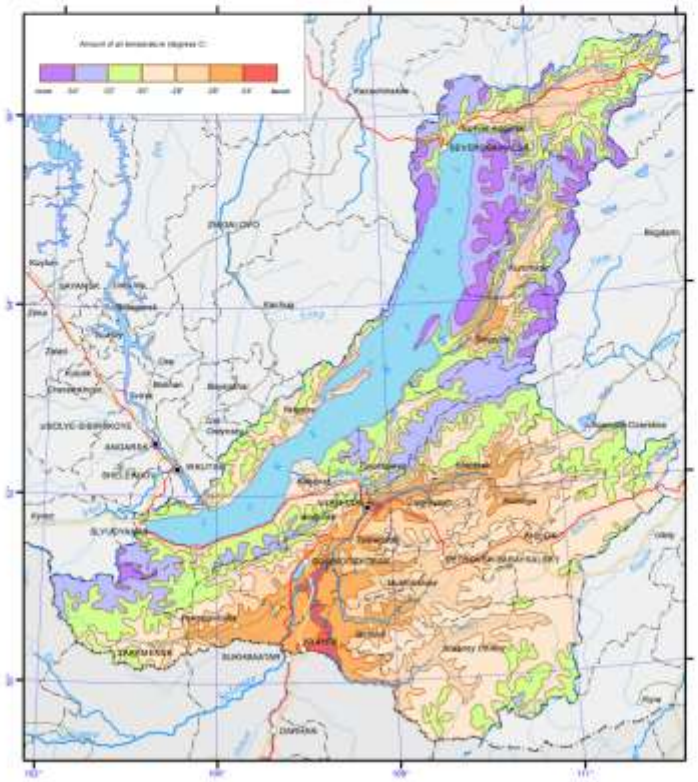
THE AVERAGE MONTHLY TEMPERATURE IN JANUARY



THE AVERAGE MONTHLY TEMPERATURE IN JULY



AMOUNTS OF AIR TEMPERATURES FOR THE PERIOD WITH TEMPERATURES ABOVE 10 ° C



Precipitation

Particularly mountainous topography has a significant impact on the formation and distribution of precipitation over the study area. The altitude of the mountain and especially the situation with respect to moisture air flow lead to the uneven distribution of precipitation. At the same altitude of mountain ranges different rainfall is observed. The greatest amount of precipitation characterizes the north and western slopes of the primary ridges bordering Lake Baikal relative to the prevailing air flow- up to 1400 mm on the windward slopes of the secondary ridges and within the plateau area in the hinterland up to 400-700 mm. In the steppe of the western coast of Lake Baikal and its islands 200-250 mm precipitation occurs in the intermountain basins and up to 300 mm in the river valleys of the Selenga and Uda rivers.

Annual rainfall of 250-300 mm falls in the mountains of Khentei at altitudes above 1000 m, in the mountains of Khubsugul at altitudes above 1500 m, and in the mountains of Khangai - at altitudes above 2,000 m. Summer rainfall predominate, which constitute 60-70 % of the annual amount .

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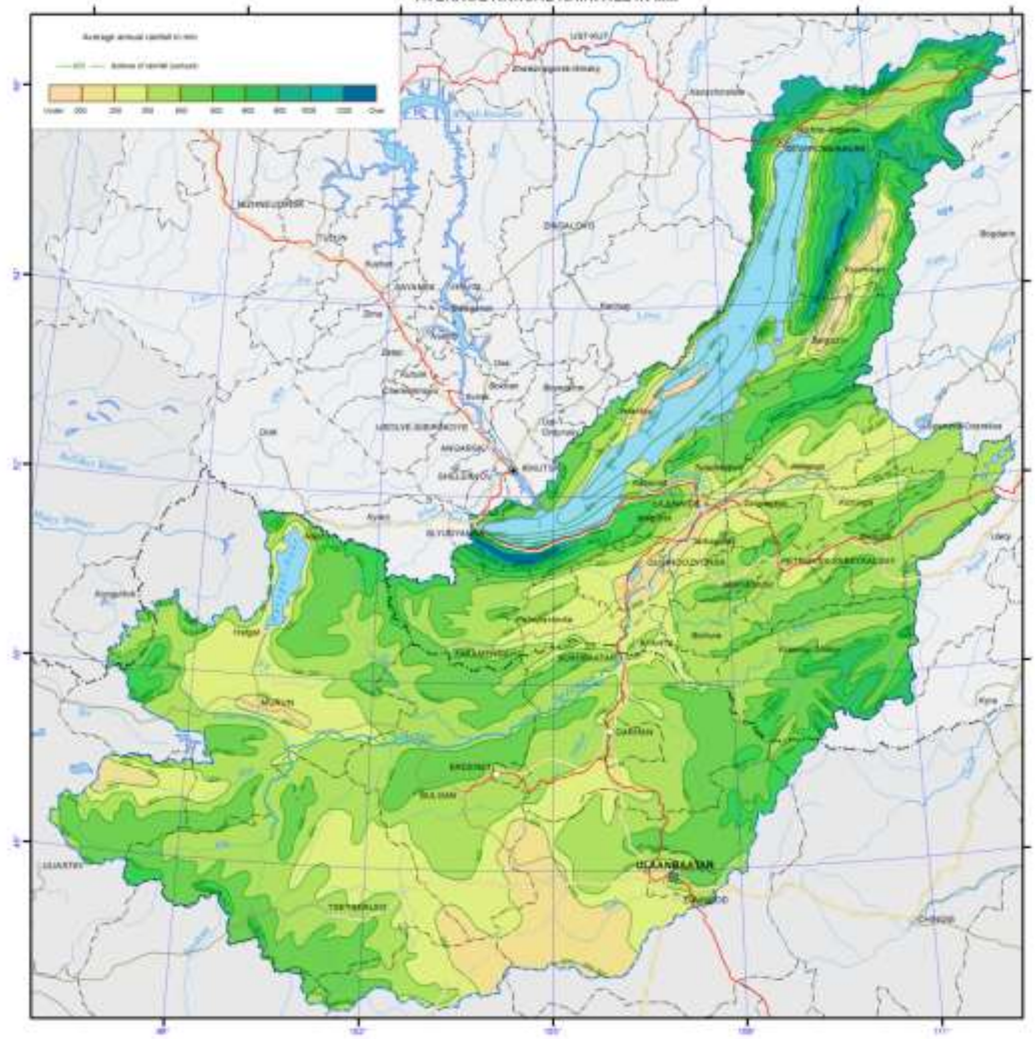
AVERAGE ANNUAL RAINFALL IN MM



UNOPS

Snow cover

Mapping fields of snow, as well as any geographical field, are characterized by their spatial and temporal patterns on topological, regional and planetary levels. Information about the snow cover is mainly represented by measurements at meteorological stations located in homogeneous standard locations. Snow covers countless diverse landscapes, the characteristics of which are not reflected in meteorological information. Therefore, the primary issue of snow cover mapping is substantiation of its spatial and temporal changes. This goal was achieved by the search of further information through the real data links with better known characteristics of geospace. This approach is implemented on the principles of geographical similarity of processes and statistical regularities.

There was a need to solve a number of other key issues. The first is dictated by climate warming. We have complete information on snow cover only till warming according references representing measurement for the period up to 1968. [... References...1968)]. Other publications include maps of individual components of the snow cover of the late twentieth century [Atlas of the Irkutsk region, 1962; Pribaikalie and Transbaikalia, 1965, Atlas of Transbaikalia, 1967]. At the same time, thanks to the field work within the Baikal- Mongolia region and personal contacts of the authors, there was an opportunity to familiarize themselves with climate data of 1951-2010 and of 1976-2010 in Transbaikalia and Mongolia and, accordingly, to fix a tendency of temporarily parameters change of snow cover in the up-to-date period.

The snow cover of the Baikal watershed basin is formed inhomogenously. Its height decreases from the northeast of the Lena- Angara plateau (50-80 cm) to 10.5 cm in the vast plains of Mongolia and Transbaikalia. This is caused by the interaction of powerful northeastern airflows with weakened Pacific ones, as well as by increasing rainfall with the altitude and increasing share of their solid constituents. Therefore, in the valleys the snow depth is small, and in the mountains of Pribaikalie and Stanovoy Highlandsit increases up to 60-100 cm.

Continuous snow cover is typical for the whole Baikal watershed basin, but due to wind transport within basins with inversions, on the windward and leeward slopes it occurs unevenly. These factors make it difficult to reflect its spatial and temporal state, which is traced by measurements of the snow cover. So, on the shores of Lake Baikal within 460-500 m there are about 70 meteorological stations, and on its slopes - not more than 5 stations. This factor defined the search of data correlations of snow depth with better known factors: cold period with precipitation, with altitudes areas. While the snow cover was analyzed at least on 900 meteorological stations in the entire Baikal- Mongolian region and adjacent territories. At the same time, a geographic and functional approach to spatial and temporal analysis of the snow cover was developed. Particular attention was given to determining the height of the snow on the slopes of different exposures. On the windward slopes the snow depth increase up to 70 cmat1500 m of true altitude and up to 125 cmat2000 m. Within the golets zone on the leeward slopes the snow cover is constantly reducing up to 7-12 cm at 2000 m. On the plains its average height fluctuates from 30-40 cm. The exception is provided by the Mongolian Plateau, where in February and March, the snow depth does not exceed a few cm. It should be emphasized that in the snowy winters the snow occurrence over 23-35 cm is covered by ice coating: due to lack of food in 2010 the number of livestock in Mongolia decreased from 40 to 28 million.

All contemporary background information is presented in references on climate, published at the end of the last century, after that the planetary warming came. Therefore a map of snow depth on the measured data of the year1968 was compiled. Further, a correlation between the components of the snow cover of the last century with contemporary data for the warming period (1976-2010) is revealed. Using this approach, the opportunity to evaluate the past changes in snow cover over recent decades presented itself.

Since 1975 to 2010 in extremely arid deserts of southern Mongolia, the average annual temperatures increased by 2C, and in the northern mountain Transbaikalia by 1C. However, in Northern Transbaikalia the growth $\Sigma T \geq 10$Cturned out more - 600C, in arid deserts - only 200C.

In the mountain- taiga landscapes the precipitation remained intact and in arid decreased. Consequently, the height of the snow cover in mountain taiga landscapes decreased, the avalanche danger became less threatening. At the same time more active Mongolian ice coating at Dauria became more active. Livestock deaths increased. Thus, according to the identified correlations the snow cover map, made according to the 1968 can be considered as basic.

Regional peculiarity of snow depth forming should be emphasized. First of all, it is dictated by the meeting of wet air masses with the surface of slopes. It is possible to distinguish graphically the snow accumulation on the windward and leeward slopes. Air masses, transporting over the water surface of rivers and lakes, are saturated with water and enhance the amount of snow on opposite slopes. These are the locations of weather stations near Vydrino, Snezhnaya, Tankhoy, Vorontsovka and other. The effect of windward and leeward slopes is leveled by depression inversion and generally irregular dynamics of air masses. The data of meteorological stations are more reliable. On its base the countdown of snow changes according to the generalized spatial and temporal altitudinal gradient is carried out. So, in the north-western slope, at the levels of 1000 and 1500 meters, the snow depth is 58 - 90, and in the south-east - 56 - 86 cm, respectively.

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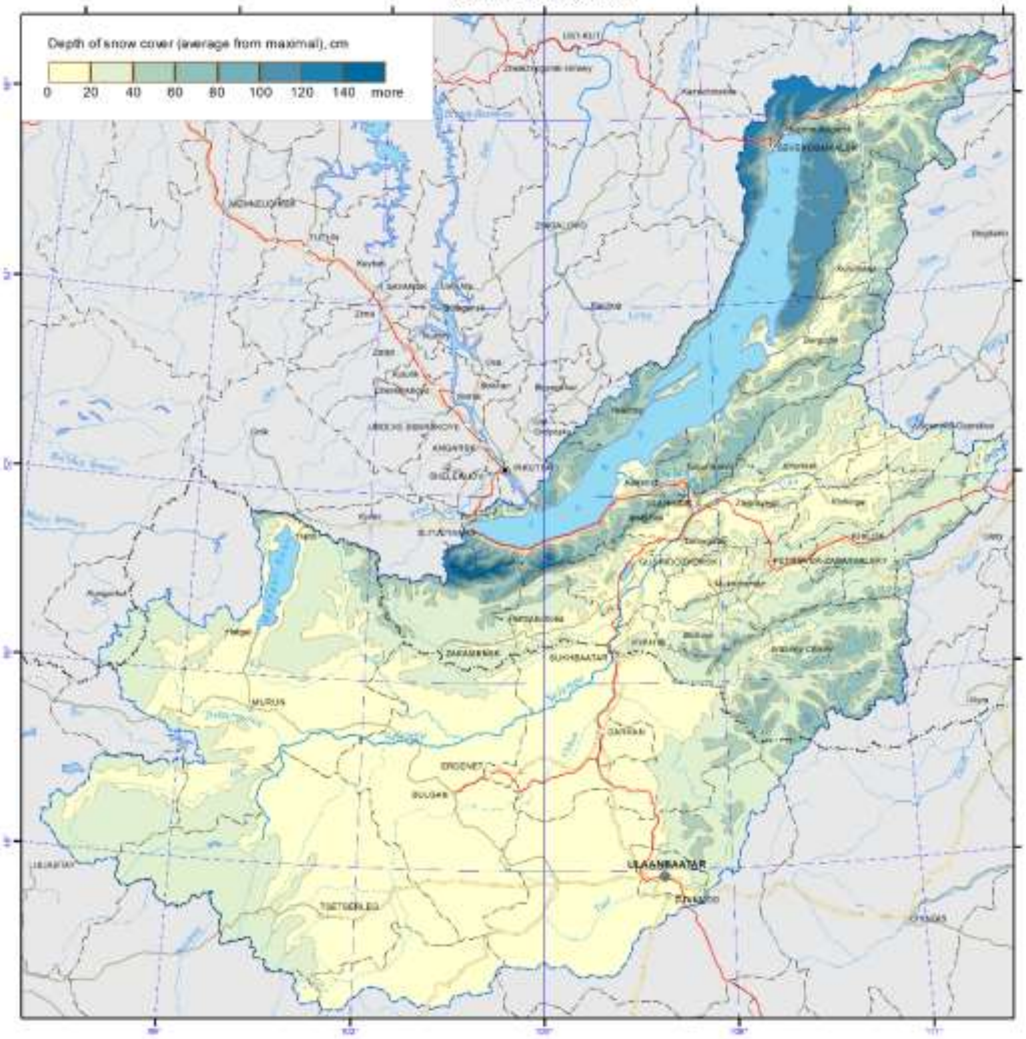
DEPTH OF SNOW COVER



Discomfort of climate

The influence of climate on human beings manifests itself in a variety of fashions, primarily through man's thermal state governed by external effects as well as by internal physiological processes. A comfortable perception of heat occurs when the input of heat and the thermal discharge in human body are at equilibrium. With an enhancement in heat or cool, there is an increase in tension of the physiological systems, which ensures this equilibrium. The intensity and duration of the impact from significant environmental parameters are responsible for the level of expenditures connected with the attainment of physiological comfort of the human life.

The number of days with normal-equivalent-effective temperature (NEET) above 8 °C is said to characterize indirectly the degree of comfort of a warm period for sensibly dressed people. The duration of periods with daily mean air temperatures below −25 °C and the sums above 10 °C represent the territory's resources of heat and cold. The contrasts of the frost-free period determine the need for and the reliability of covering materials used in vegetable farming. In addition, a combination of low temperatures with wind velocity acts to enhance heat output from open surfaces of human body. The risk of cold weather injuries when the values of reduced temperatures are below −32 °C serves as a forewarning in the case of arranging recreation and working in the open air [Khairullin and Karpenko, 2005]. The duration of the heating period makes it possible to calculate the future expenditures of heat necessary for heating vari8ous premises.

The spatial differentiation of the indices under consideration is important within the confines of the basin [Scientific-Applied…, ; http://www.meteo.ru]. The mean daily temperature in the high mountains does not reach 10 °C, and its sum varies from 2400 °C in the southern part of the basin to 500 °C along the northeastern shores of Lake Baikal. The mean monthly NEET do not reach 8 °C in separate sections of the shores of Hovsgol and Baikal, and across the remaining territory they vary from 40 to 110 days. The frost-free period varies between 0 to 110 days. The smallest spatial fluctuations correspond to the duration of the heating season (230−305 days). The number of days with the mean daily air temperature below −25 °C is largest in the bottoms of closed depressions and valleys of the western part of the basin. With the wind taken into account, the differentiation of the severity of climate is enhanced. The mean values of reduced January temperature drop below −37 °C in Tosontsengel and Khatgal. In the former case, this is due to low air temperatures, whereas the increased wind activity is responsible for this in the latter case.

The combined effect of climatic resources has a substantial influence upon the aggregate volume of expenditures connected with the provision of physiological comfort for humans and the manufacture of products. The background characteristic features of the combined effect of the meteoparameters under consideration on humans and of their duration upon the degree of discomfort of habitation were revealed by using the resource-assessment approach [Bashalkhanova et al., 2012].

Throughout most of the basin's territory, as shown on the map, the level of climatic discomfort is moderate, whereas it is strong on the northern, northwestern and western margins. The circle diagrams show the volume of the most differentiated parameters of climatic discomfort. The six respective axes are graduated in points from 1 to 5, including the limits of their possible variation. The diagrams The diagrams corresponding to the most contrasting locations display the leading attributes of climatic discomfort of these territories.

A strong level of discomfort in the northern and western parts of the basin is due largely to the preceding low air temperatures, while on the shores of Hovsgol and in Tarnat it is, to a larger extent, caused by a low heat availability in the summertime and, in the aggregate, by increased wind activity. The life of the population on such territories is more expensive and involves a limitation of the kinds of economic activities, shorter periods of stay in the open air, the requirement for a higher energy value of food, heat insulation of clothes and rooms, and a necessitous adjustment of production technologies, equipment and systems to low temperatures. On the other territory, the total duration of impacts of the parameters under consideration lies within moderate limits. The low duration of the period with NEET <5 °C (within 40−70 days) in the middle mountains is compensated by favorable winter conditions.

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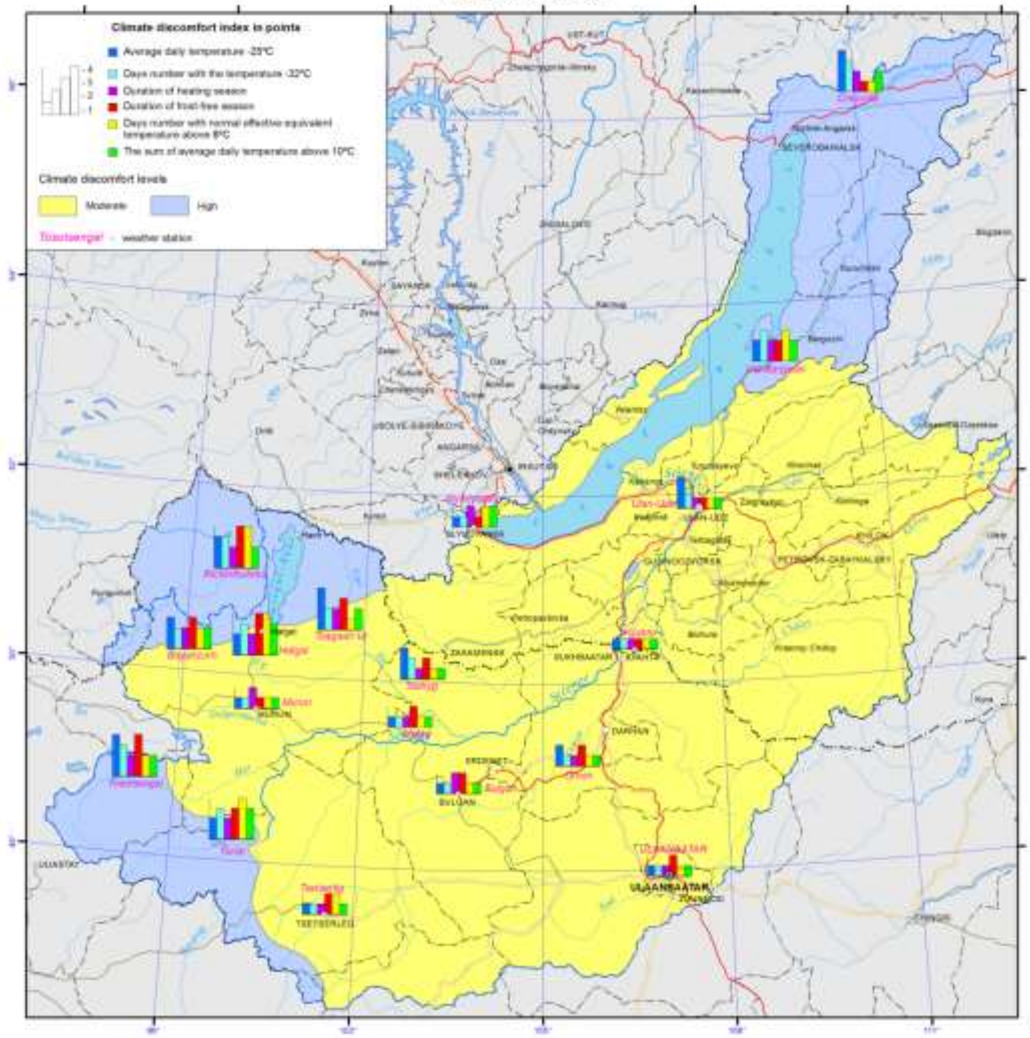
CLIMATE DISCOMFORT



Self-purification capacity of the atmosphere

The self-purification capacity of the atmosphere (SCA) over the continental part of the Asian mainland is largely determined by a combination of the interaction of its general circulation with the underlying surface. Because of the influence of regional characteristics of orographic systems, such as an alternation of dissected depressions, large mountain ridges and narrow valleys, this area is characterized by the formation of seasonal local baric centers. In winters, it is the Asian anticyclone centered over the north of Mongolia, whereas regions of closed thermal depressions are typical of summers. In water-filled depressions (such as the Baikal hollow), because of the influence of the water masses, the local field of increased and decreased pressure is observed in summer and winter, respectively. The strength of local baric centers determines the processes of energy and mass exchange with neighboring territories.

Under anticyclone conditions, a standard decrease in air temperature with height (vertical gradient 0.65 °C/100 m) is distorted, and its rise is observed. Over the narrow valleys of the Russian part of the Baikal watershed basin, the inversion intensity is largest in January, and the temperature difference at the station's level and the 850 mb surface reaches 10−11 °C. With an enhancement in ruggedness of relief, there is an increase in the thickness of recurrence frequency of the number of days with inversion [Zhadambaa, 1972; Sevastyanov, 1998; Beresneva, 2006]. Thus, the average and the largest thicknesses of inversions over Ulaanbaatar and over the depressions in Western Mongolia can differ by a factor of 1.5 to 2. The highest recurrence frequency of inversions (about 50%) is observed when its thickness ranges from 500 to 1000 m in the former case, and from 1500 to 2500 m in the latter case. In the latter case the temperature difference on its upper and lower boundaries can reach 15−20 °C. Also, the deepest inversions with their high recurrence frequency, and the lowest temperatures in the ground layer of atmospheric air are observed in stagnant locations. In such a situation, the quality of the atmospheric air in the ground layer will, to a significant extent, depend on local conditions, namely the recurrence frequency of calms and weak wind velocities, the precipitation amount, and on the amount of incoming impurities.

The SCA was assessed following the technique reported by V.V. Kryuchkov [1979] in which it is assumed that almost no self-purification of the atmosphere occurs in the event of the mean annual wind velocity and the recurrence frequency of calms characterizing stagnant phenomena, and with the smallest precipitation amount (*table*). The SCA manifests itself with an enhancement in wind velocity, a decrease in recurrence frequency of calms, and with an increase in precipitation amounts.

Table

Indices of self-purification capacity of the atmosphere

Indices	SCA		
	Extremely low (1 point)	Moderate (2 points)	High (3 points)
Recurrence frequency of calms, %	75−50	30−50	< 30
Wind velocity, m/s	< 3	3−5	> 5
Precipitation amount, mm	< 300	300−450	> 450

In real situations, the indices show broader combinations. The use of the points-assessment approach makes it possible (by summing up the points of the indices) to take into account the diversity of the existing combinations of SCA: 3−4 points – extremely low, 5 – low, 6−7 – moderate, 8 – good, and 9 – high [Bashalkhanova et al., 2012]. With reference to the mountain territories, allowance was made for the known regularities inherent in changes of climatic indices depending on the location of orographic systems relative to the main transport of air masses. We assumed that with the slope thickness varying from 6 to 20° and the altitude of the location in the range 1500−2000 m, average conditions are created for the atmosphere's self-purification. With an increase in slope steepness>20° and with altitudes>2000 m, the probability for a good SCA increases.

What has been outlined above was used in analyzing material reported in [Scientific-Applied…;VNIIGMI-WDC Data Archives, http://www.meteo.ru] thus making it possible to identify in the study area four SCA levels that are displayed on the map. A good SCA is characteristic for open steep-slope summit planes. The moderate SCA is intrinsic in elevated locations, slope surfaces, and in the shores of Lake Baikal and Lake Hovsgol. In the last case, however, the maximal activity of the local forms of circulations most often occurs in the zone below the height of the surrounding mountain ridges; therefore, the removal of pollutants beyond the depressions will be made difficult. A low SCA corresponds to gently rolling interfluves, river valleys, and to the lower parts of slopes. An extremely low SCA is set up in closed inter montane depressions and in the river valleys of the southwestern part of the basin nearby the anticyclone core, and along its periphery – in the areas of river valleys perpendicular to the base flow of air masses.

By taking into consideration the mesoclimatic conditions, it is possible to obtain a more differentiated assessment of SCA. Furthermore, the seasonal differences in SCA across the study territory will be substantial because of the characteristic features of the atmospheric circulation. Therefore, when planning the siting of production facilities in a particular territory, it is necessary to assess the mesoclimatic potential of SCA.

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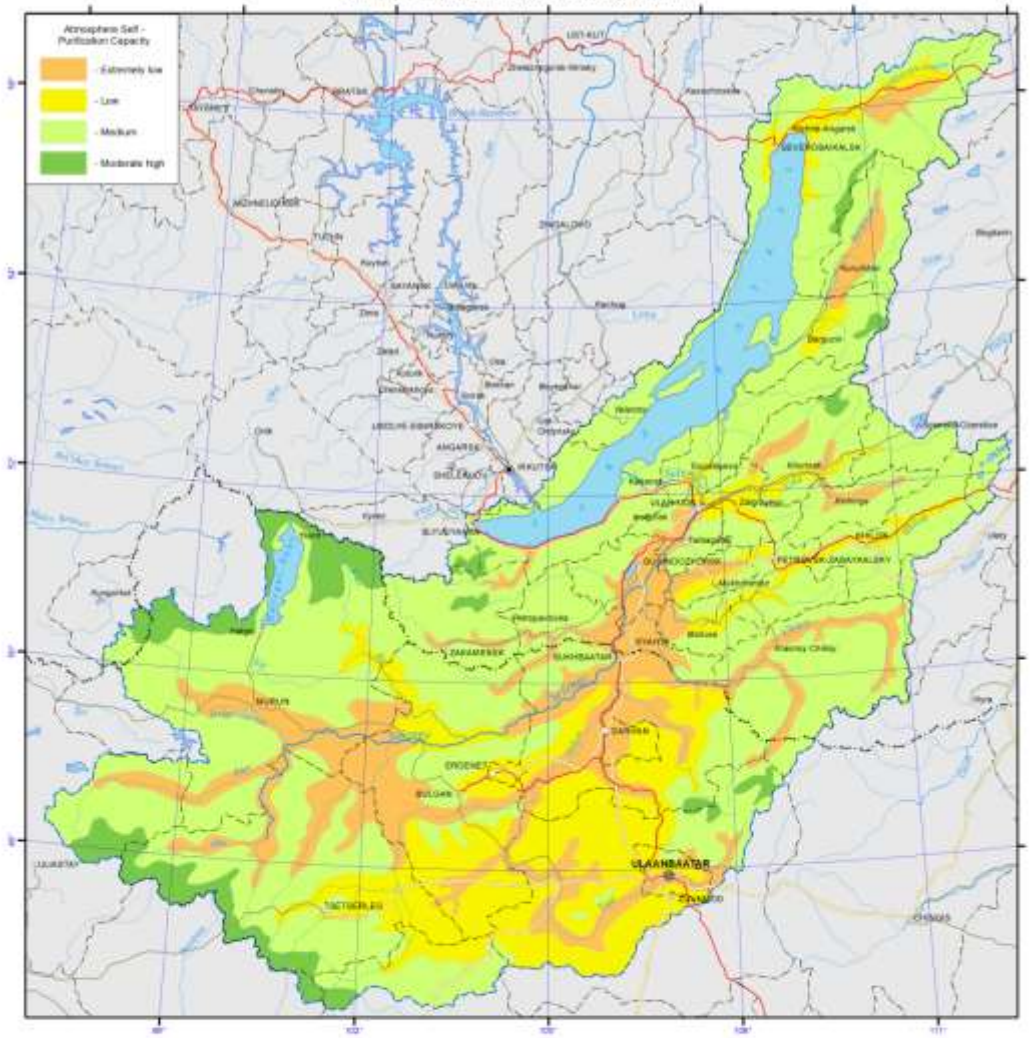
ATMOSPHERE SELF-PURIFICATION CAPACITY



Surface waters

The main rivers of the Baikal Lake basin - Selenga, giving about a half of the river flow into the lake with its tributaries Chikoi, Khilok, Orkhon, Uda and others, as well as the Upper Angara, Barguzin, Turka, etc.

Diversity of natural conditions of the Baikal Lake basin causes large fluctuations in water availability in the territory. The norm of the annual runoff varies from 0.62 to 27.8 l/s km^2. Its value decreases from north to south, in accordance with the general decrease in rainfall and an increase in amount of evaporation. Maximum water content (from 12.7 to 27.8 l/s km^2) are characterized most northern rivers (the Upper Angara with tributaries, Rel, Tyya, Kholodnaya), as well as rivers that originate on the slopes of the ridge Khamar-Daban (Big River, Snezhnaya, Khara-Murin, Utulik). The rivers of the ridge Ulan-Burgasy - Turka and Kika allocate more water content. The increased water content of 5.63 l/s km^2 (r. Eroo) to 9.70 l/s km^2 (r. Chikoi) have rivers of the Khentei- Chikoi highlands.

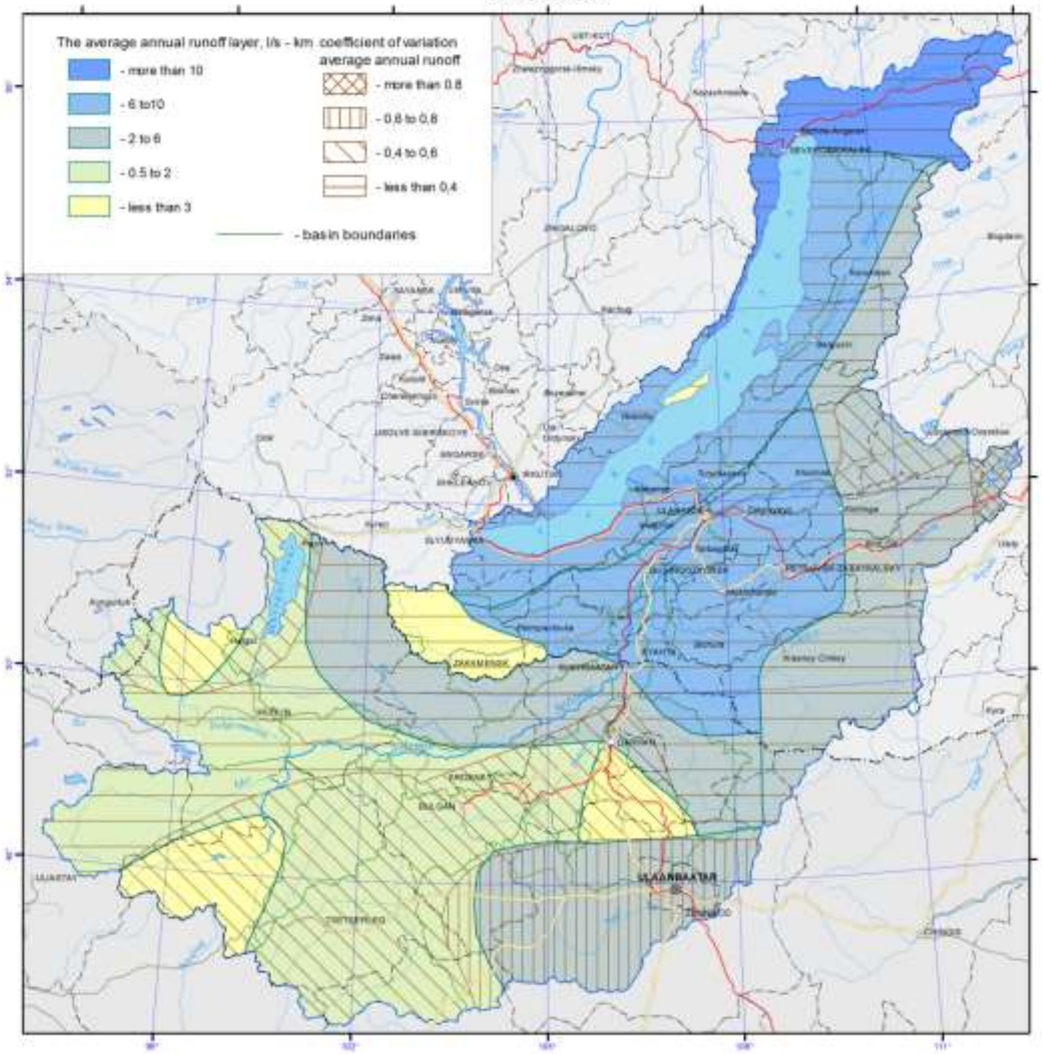
In the rivers of the Barguzin basin and in the watershed of the rivers Temnik and Tsakirka, carrying its waters from the northern slopes of the Khamar-Daban, is distinguished the increased water content in the same range.

Lowest water levels are different the rivers of the Selenginsk midlands and watercourses of the Mongolian part of the Baikal basin (except for the mentioned r. Eroo relatively high conductivity stands out the Tuul River - 4.65 l/s km^2, which originates in the mountains Khentei). For all other river basins the norm of annual flow rate ranges from about 1 to 3 l/s km^2. In the same range is the average annual flow of the highly located rivers watersheds of Khangai and Khovsgol region, mainly because of the limited access of carrying the moisture air masses. The greatest differences in carrying the moisture are characteristic of the Orkhon River basin - due to combined effects of orography, terrain height, latitude, and soil and geological conditions.

The magnitude of the variability of annual runoff has a general tendency of increasing from north to south and varies within this territory from 0.15 to 0.65. Exceptions are areas of the rivers Khilok and Tuul upstream, where the values of the coefficient of variation are much higher. For example, in the alignment of the river Khilok-st. Sokhondo (A= 1900 $км^2$) C_v = 1,32. The annual runoff module at this point varies from 0.01 (1978) to 5.84 l/s km^2 (1984).

In winter, the river freezes over every year, and dries out in the summer low water years, and in some years do not happen a river flow during 9 months (1965, 1967). In the alignment of the r.Tuul - Ulan Bator (A = 6300 $км^2$) C_v= 0, 82; and this is explained by often observed here drying and freezing over, as well as significant anthropogenic load. In this alignment the average water consumption vary within wide limits and their values can vary up to 13 times. For example, in 1972, *Qmiddle* was equal 5.00 m^3/s, and in the following 1973 - 60.5 m^3/s, in 1993 *Qmiddle* = 65.3 m^3/s, and in 1996 - 7.76 m^3/s; winter runoff was not in 60% of cases of the observation period.

ANNUAL RIVER



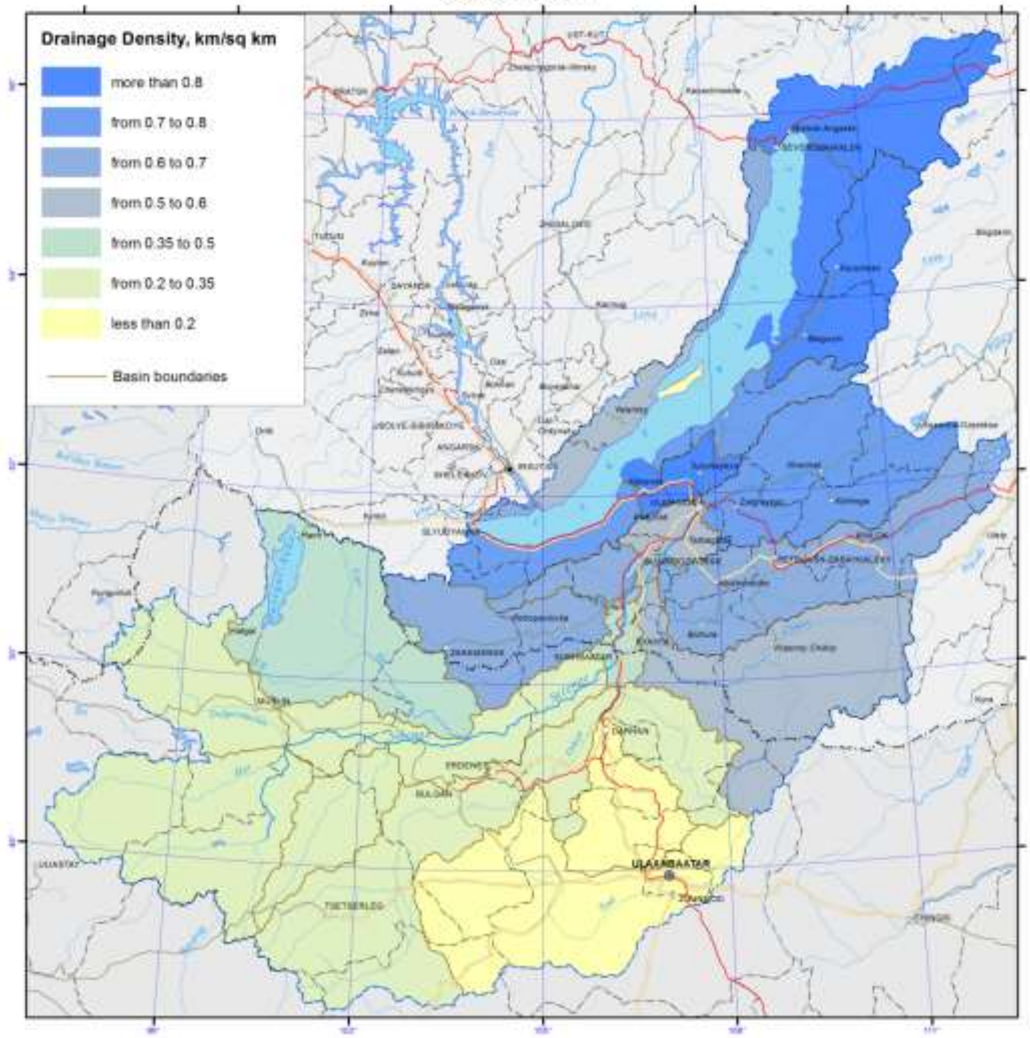
River network density

Differentiation of the river network density of the Lake Baikal basin has a clearly pronounced zonal nature: from 0.1 km/km^2 at the south-eastern boundary to 0.9 km/km^2 on the coastal ridges and in the northern territories. A high river network density is characteristic of the taiga zone, especially of ridges and valleys immediately adjacent to the lake. In general, the northern part of the basin is characterized by favorable conditions of flow. Mountainous terrain, steep slopes and the presence of permafrost contribute to a rapid discharge of water into the main water streams, namely, the Upper Angara and the Barguzin, and to the development of the river network. The highest density is specific to the western slopes of the Barguzinsky (0.92 km/km^2) and Khamar-Daban ridges (0.69 km/km^2). Among the plain territories, the most watered areas are the Barguzinskaya valley (0.89 km/km^2) and the area of the Selenga river delta (0.68 km/km^2).

The middle part of the basin represents a border of forest and steppe, and is characterized by the mid-mountain terrain and a high occurrence of sandy and sandy loam soils. The presence of these factors provides for the average river network density ranging from 0.35 km/km^2 in the middle reaches of the Selenga river and 0.55 km/km^2 for the Chikoi river basin to 0.61 km/km^2 for the Khilok and Dzhida river basins.

In physical-and-geographical terms, the south-western part of the basin, i.e. the area of Lake Hovsgol, represents a forest-steppe with the high-mountain depressions terrain, and is characterized by a lower river network density ranging from 0.32 km/km^2 for the Delger-Muren river basin to 0.34 km/km^2 for the Egiin-Gol river basin. In the southern dry steppe part of the basin a low river network density is registered. This is especially typical for the Tuul and Kharaa river basins; here this index is below 0.2 km/km^2.

DRAINAGE DENSITY



Flow

The map "Mean annual flow in the Baikal region" reflects the formation laws of the water regime of the territory, which are determined by the properties of landscapes to transform atmospheric moisture to drain.

The surface runoff is the total amount of water loss from the watershed landscape for the pool of a water body. The runoff rate from landscapes is determined by solving the inverse problem – identification of the connection of flow at the main stream station with the runoff from landscapes, occupying its area, and is calculated based on the equation $Q_j = \sum q_i f_{ij}$, where *j*- is the index of the river basin ; Q_j–its runoff, l/s; q_i–modification of flow from the i-th landscape complex, l/s km^2; f_{ij}–the square of the j- th basin occupied by the i-th landscape, km^2. Calculation of mean annual runoff data for small and medium-sized rivers of LakeBaikalwere used for the map construction [Perennial…, 1986, http://www.r-arcticnet.sr.unh.edu]. Characteristics of landscape components were obtained on the basis of the landscape of the Baikal region [... Landscapes…, 1977, Natural .., 2009 , Landscapes…, 1990, Lysanova and others , 2009]. In accordance with a regional dimension, generalization degree is chosen at the geoms level and their average annual flow modules are determined. The territory on the map is divided into regions according to the five gradations module - from less than 1 to more than 10 l/s km^2.

The catchments area of the lake covers a variety of landscape zones and high-rise waist ,that makes a great contrast between the runoff rates. The highest annual flow modules are formed within the alpine tundra belt and mountain taiga landscapes. Steppe and forest-steppe areas are distinguished by the minimum runoff characteristic, and in the desert regions of Mongolia (the basin of the Selengariver) flow formation does not take place.

The maps of minimum and maximum flow in the basin of Lake Baikal are based on typological classification of landscape represented on the map [Landscapes… , 1977]. In the course of investigation landscapes of different kinds were generalized by identifying the most informative regarding the hydrological properties (morphological characteristics, vegetation structure, high-altitude zone, etc.). As a result, more than 200 landscapes are combined into sixteen types of natural systems, runoff rates were determined for them. The modification of maximum snow flow and minimum summer flow were calculated as described above.

Areas with the highest runoff floods are confined to the mountain ranges and systems with alpine tundra woodlands and mountain taiga landscapes. The main areas, distinguished by formation of frequent and high floods are Baikal Mountains on the north- eastern end of the lake; Barguzinsky Range, located in the south- eastern part of the catchment , and the Khamar -Daban, covering the south- west coast of Lake Baikal. The rates of the flow modification on the map are shown in three gradations - less than 25, 25-70 and more than 100 l/s km2.

Features of the formation of the minimum summer flows in the Baikal basin are associated with the regime of atmospheric moisture, as well as with the effects of high altitude and exposition. The calculations and analysis of the minimum summer flows have shown a relatively high filtration in the low-flow period from high- taiga landscapes and extremely low river flow formation in central catchment of the Selenga river and in Preolhonje which are covered with steppe landscapes and light coniferous complexes on the slopes and plains. The map shows the magnitude of the minimum flow in three gradations - less than 1.5, 3.0 - 5.0 ,and more than 5.0 l/s km^2.

Landscape and hydrological mapping based on the quantitative characteristics of filtration of landscapes objectively reflects the hydrological organization of the territory.

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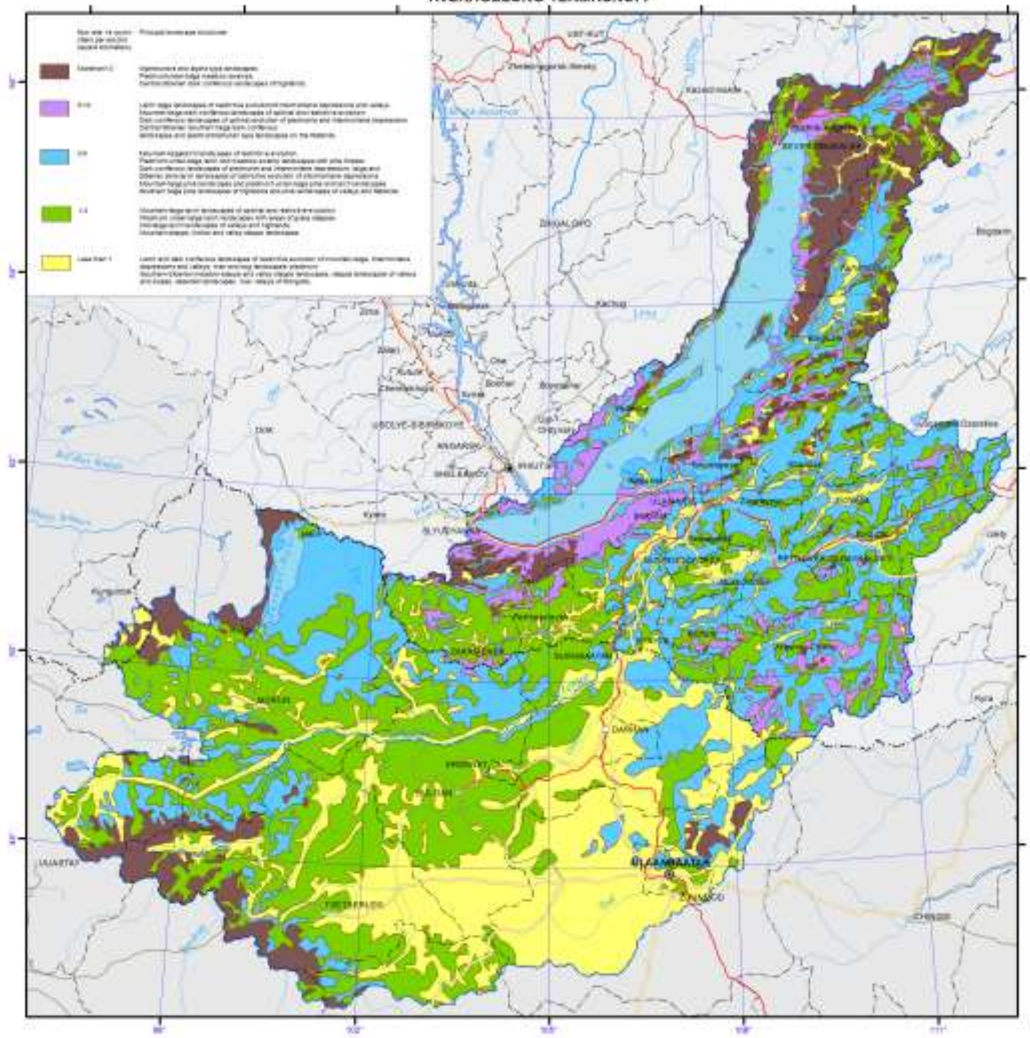
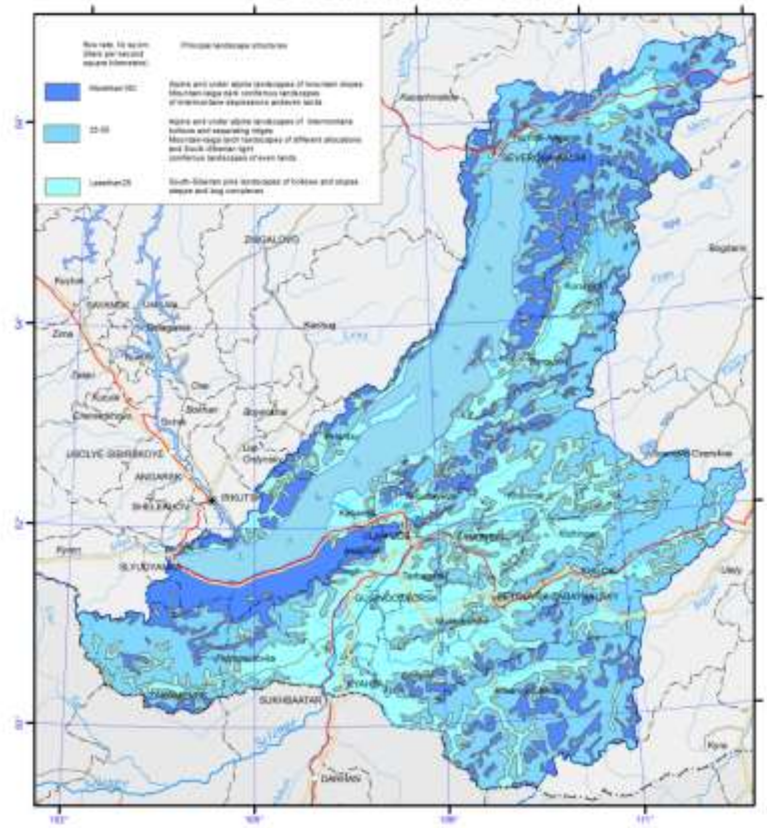
AVERAGELONG-TERMRUNOFF



MINIMUM SUMMER RUNOFF

MAXIMUM RUNOFF DURING THE FLOOD



Floods

The aim of the flood map is to give insight of distribution of flooding risk on the territory and level of its danger to human activity and facilities of national economy. The map was compiled on the basis of reference material of the national water resource inventory [Long-term …, 1986; Resources …, 1973], data on the flooding damage and archival and cartographic materials.

Severe floods take place at the Rivers Selenga, Khilok, Uda, Upper Angara, and Barguzin. The depth of floodplain is 0.5-1 m during common floods and 1.8-3 m during severe floods. The height of the water layer increases downstream the rivers: for example its height at the Selenga River near the settlement Ust-Kyakhta is 1 m and near the city of Ulan-Ude increases up to 3 m. The longest floods (30-90 days) are observed in the valley of the Selenga River and downstream the Chikoy River. Shorter floods (up to 25 days) are recorded in the basins of the Rivers Barguzin, Upper Angara, Uda, Dzhida, and others. The duration of floods at small rivers, the tributaries of Lake Baikal is, as a rule, 3-7 days.

The increase of water level and intensity of flow in the rivers under study are observed during spring floods caused by thawing of snow cover and glaciers and during summer rain floods. High water floods are not characteristic of rivers located in the southern part. Spring floods are observed in the rivers of the Selenga basin, as well as in the streams running from the Khamar-Daban and Primorsky Ridges. The rivers with spring-summer floods are located in the northern part of the territory (Upper Angara, Barguzin, Turka, Tyya, Rel, Goudzhekit, and others).

Rain floods usually start from the decrease of spring flood and are observed during the entire summer period. The highest water levels are usually recorded in July-August. The highest intensity of water level increase is registered at the Rivers Argoda, Snezhnaya, and Dzhida. Fluctuations of water level in the Selenga River and in the lower course of its tributaries are smoother, which is attributed to the spreading of floods and regulatory influence of the plains. However, the damage from the floods in this area is the most severe as the floodplains are the deepest and flooding is the longest. Moreover, this territory is highly developed and densely populated.

Maxima of rain floods on the territory under study significantly prevail over the maxima of spring floods in both absolute value and their number of the total annual maxima [Kichigina, 2000]. The first ones are the most dangerous for the flood formation. The exception is some rivers in the northern regions (Upper Angara, Barguzin, Rel, and Tyya) where the spring flood is the main water regime phase. The map represents the distribution of cross-sections with the dominance of rain flood maxima and with comparable contribution of spring and rain flood maxima. Rain floods cause huge damage as they are widely spread, repeat many times and form fast. They can flood both separate small basins and vast territories. Their timely and precise forecast is, as a rule, low. For example, the destructive rain flood that happened in July of 1966 caused a 3 m water increase in the Tuul River, and for several hours the city of Ulaanbaatar submerged and 130 people drowned.

On the southern coast of Lake Baikal (from the Mysovka River mouth to the Angara River outlet), on the south-eastern slope of the Baikal Ridge and in a number of the Selenga River tributaries, floods are often aggravated by mud flows [Makarov, 2012]. Mud floods are caused by heavy rains at the sites with significant slope steepness and easily washed-away loose soil. Mud flow processes mostly develop in the near-mouth areas of the rivers of the northern slope of the Khamar-Daban Ridge and along the Circum-Baikal railway. Mud flows have very destructive force, and they are able to cause significant damages. The increase of water level in such small rivers as Pokhabikha, Tiganchikha and others can be caused by thawing of ice crust formed as a result of freezing of their river beds.

Floods are assessed from their genesis, recurrence, impact strength, damage magnitude, possibility and appropriateness of the dangerous situation. T. Borisova and A. Beshentsev determined the integral risk of floods from the territorial assessment of risk caused by floods [Borisova, 2013] using private maps of disturbances of land of different category and population (from the estimation of physical, economic and social risks). Flood danger for the rivers of Southern Baikal flowing from the Khamar-Daban Ridge is determined through an expertise as there are noappropriate calculated data.

The list of settlements on the territory of the LakeBaikal basin, which were at risk of flooding, was compiled using summarized archival and reference data. In total, 75 settlements were included into the flood zone. The settlements with the highest risk of flooding are marked on the map.

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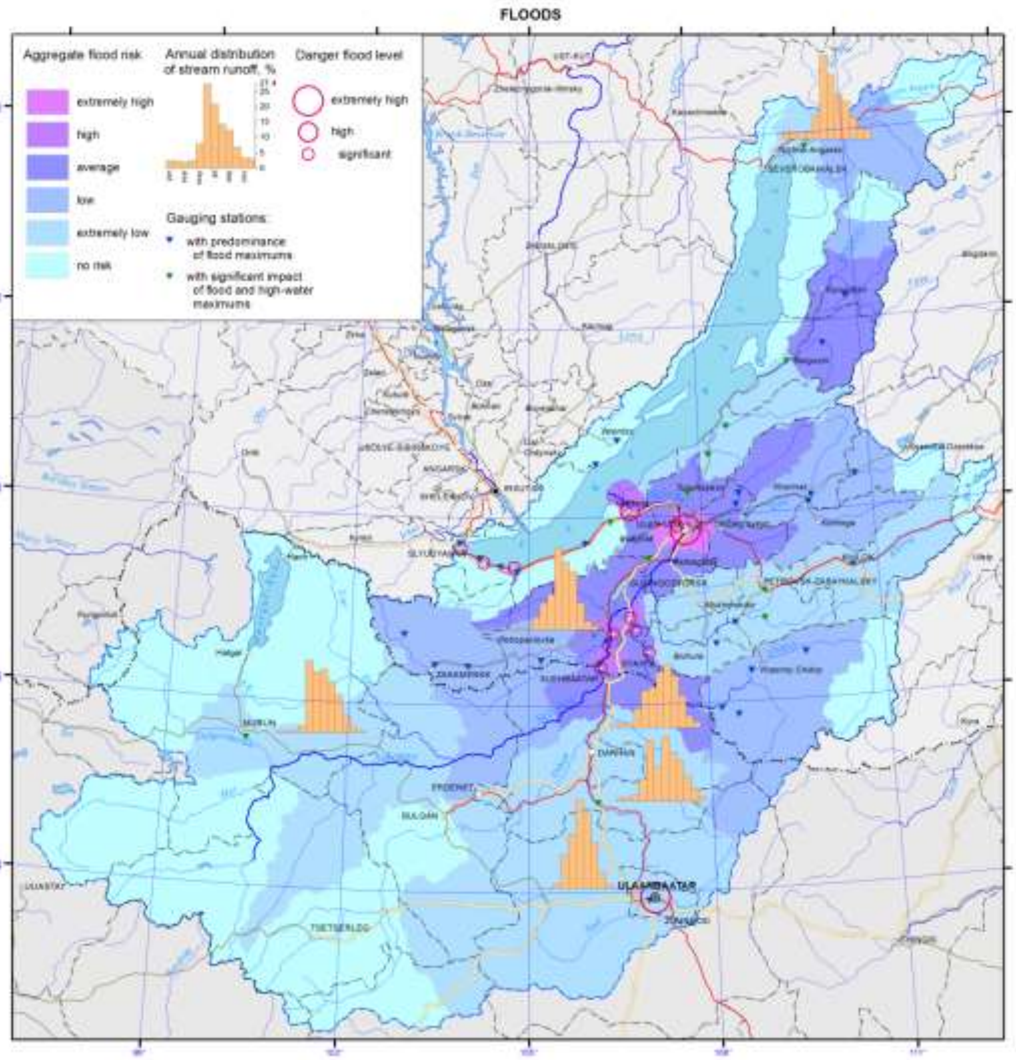
FLOODS
Aggregate flood risk
extremely high
high
average
low
extremely low
no risk
Annual distribution of stream runoff, %
Danger flood level
extremely high
high
significant
Gauging stations:
with predominance of flood maximums
with significant impact of flood and high-water maximums
ULAANBAATAR

Self-clarification condition of surface water

The map "Self-clarification condition of surface water" reflects the potential of natural waters of the territory to neutralize the introduction of pollutants into water bodies and to restore the original properties and composition of water. The self-clarification ability of water bodies is formed by chemical, physical and biological processes; the dominant role here is played by dilution and oxidation.

The process of dilution of pollutants with the waters of rivers and water bodies is directly dependent on the amount of water weight, and it can be characterized by the influx of water into the reservoir and the water flow in the rivers during the minimum flow (the largest environmental stress conditions). Given the lack of material on the flow for the majority of the lakes, the evaluation of diluting ability was carried out by of the average annual water volume in the reservoirs.

The oxidation of organic substances depends on the amount of oxygen from the atmosphere, and is determined by the conditions of mixing and temperature control of water bodies. The amount of oxygen required for oxidation of the process is specified as the biochemical oxygen demand (BOD_5 and COD) and standardized for various substances at the water temperatureof20C. Because of insufficient data for BOD_5 and COD, the oxidative reactions were assessed indirectly based on the average temperature within the warm period and the intensity of water overturn.

The water overturn in the reservoirs is influenced by the differences of density and dynamic parameters, such as churning, surge phenomena etc. The data on churning observations (as well as the inflow observation) for the waters of the Baikal region are not sufficient, that is responsible for indirect assessment of dynamic performance. Here, morphometric parameters are used as an indicator of overturn intensity - the ratio of depth and area of the mirror, which characterizes the potential churning power. In watercourses the channel slopes are criterial for the overturn degree, the flow velocity depend on them.

As a result, the assessment criteria of self-clarification condition of surface water are temperature, flow rate and volume of water, slope streams and morphometric parameters of reservoirs. According to the regional dimension of the territory the analysis was performed for medium and large catchment areas of the rivers (4 – 6^{th} according to Strahler’s stream order) and lakes.

The parameterization of these characteristics is carried out with the help of statistical methods and comparative analyzes with the development of special scales and matrices. The inventory data on more than 200 waterways and 12 lakes and reservoirs of Lake Baikal were used for the map construction [Perennial , 1986; Resources .., 1972, 1973] . For most of rivers on the territory the overturn intensity was determined by the plots, according to a longitudinal gradient. The range of slopes is divided into four groups - from the minimum values (0-2%) for lowland areas to the maximum (over 15 %) in the mountainous areas. The water temperature during the warm period was calculated as the average for four months (June - September), as on the rivers of the region's the water temperature transition over 0 ° C is marked in May and October. The temperature scale is divided into three intervals - less than 10, 10 to 15 and above 15C. The water volume required to dilute pollutants was determined on the basis of the minimum 30-daysriver flow (seven gradations - from less than 10 to more than 800 m^3/s) and the average annual water amount in water bodies (four gradations - from less than 10 to more than 500 m^3)

Determination of the self-clarification conditions of rivers and water bodies was carried out in stages. Primarily, transformation of pollutant by biochemical processes was estimated, and then pollutant dilution conditions were analyzed. As a result, 4 categories of self-clarification degrees of water bodies were defined.

On the map the self-clarification conditions of water bodies are shown with colored along-shore linear curves and with shadings. The most favorable self-clarification conditions within Lake Baikal watershed is in some areas of the Selenga River. Most of the water bodies of the territory are classified as having the satisfactory conditions.

The self-clarification capacity can be regarded as the criterion of sustainability (preservation of properties) of aquatic ecosystems to anthropogenic impact, and the map as an element of environmental potential assessment of the area.

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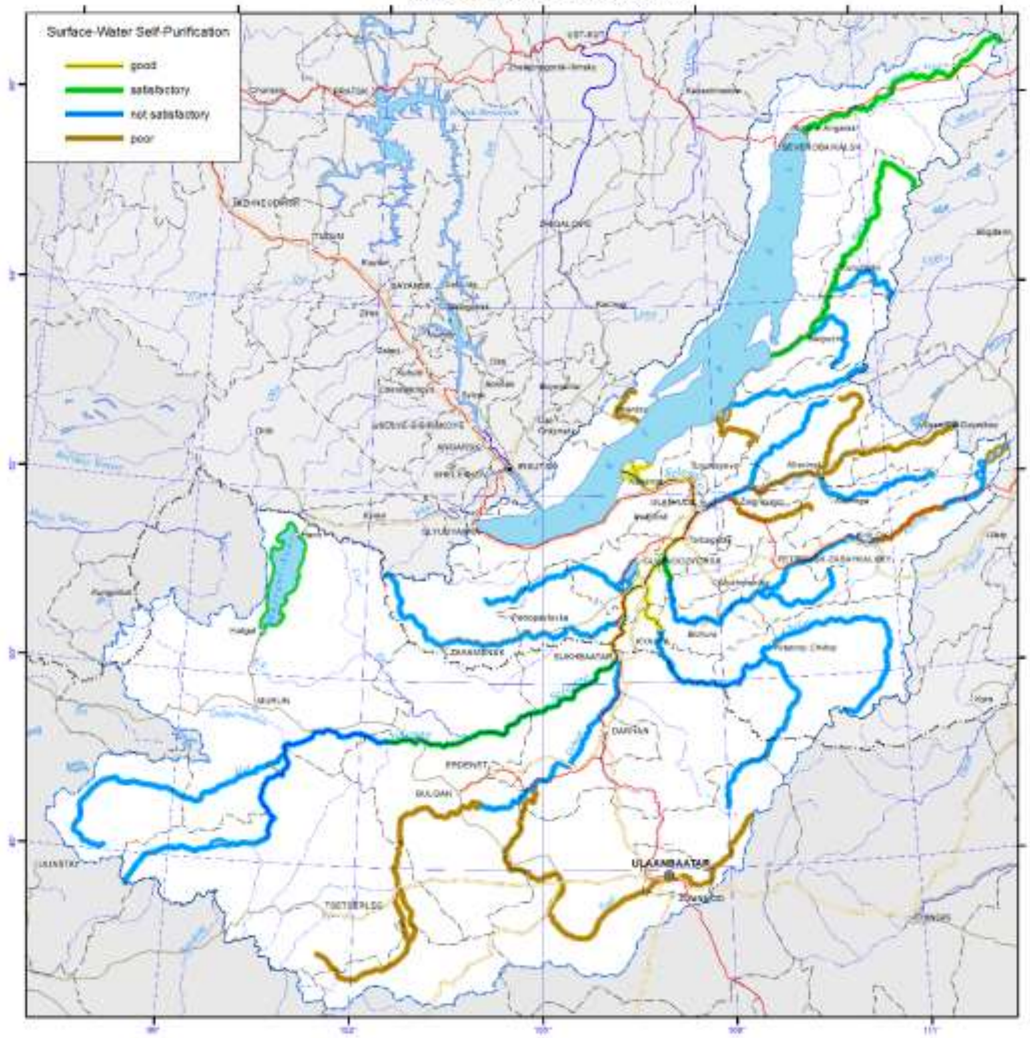
SURFACE-WATER SELF-PURIFICATION



Groundwater

The map is based on generalizing materials of the Institute of Earth's Crust, of Buryatia, Chita and Irkutsk geological services using hydrogeological maps of scale 1:5000000 [Atlas ..., 1983] and 1:4500000 [National Atlas ..., 1990].

During mapping a method of mapping of the main aquifers is applied (hydrogeological formations). Aquifers are distinguished on structural and hydrogeological features, the prevailing type of water permeability and reservoir properties of rocks.

In the Baikal watershed basin pore and produced waters, confined to loose unconsolidated sediments of Mesozoic and Cenozoic age, have a wide distribution, as well as crack waters in all lithified metamorphic, igneous and sedimentary rocks of different ages from the Archaean to the end of the Paleozoic - Mesozoic inclusive.

Hydrogeologically the Baikal watershed basin is a complex system of artesian basins and hydrogeological arrays. Artesian basins occupy intermontane depressions composed of loose rocks of the sedimentary cover and crystalline basement rocks. They are characterized by pore and produced waters of the zone of active water exchange and crack waters, often water strikes, and foundation waters. Hydrogeological arrays are composed with crystalline rocks of mountain-folded frame and can accommodate crack waters of exogenous fracture. Thickness of the zone of active water exchange does not exceed 100-150 m

Most watered are karst carbonate rocks, as well as zones of tectonic dislocations, intersecting the cropping-out foundation or spread along the contacts of sedimentary-metamorphic rocks with igneous and metamorphic rocks. They are often traced by upward unloading both of cold and thermal waters.

References

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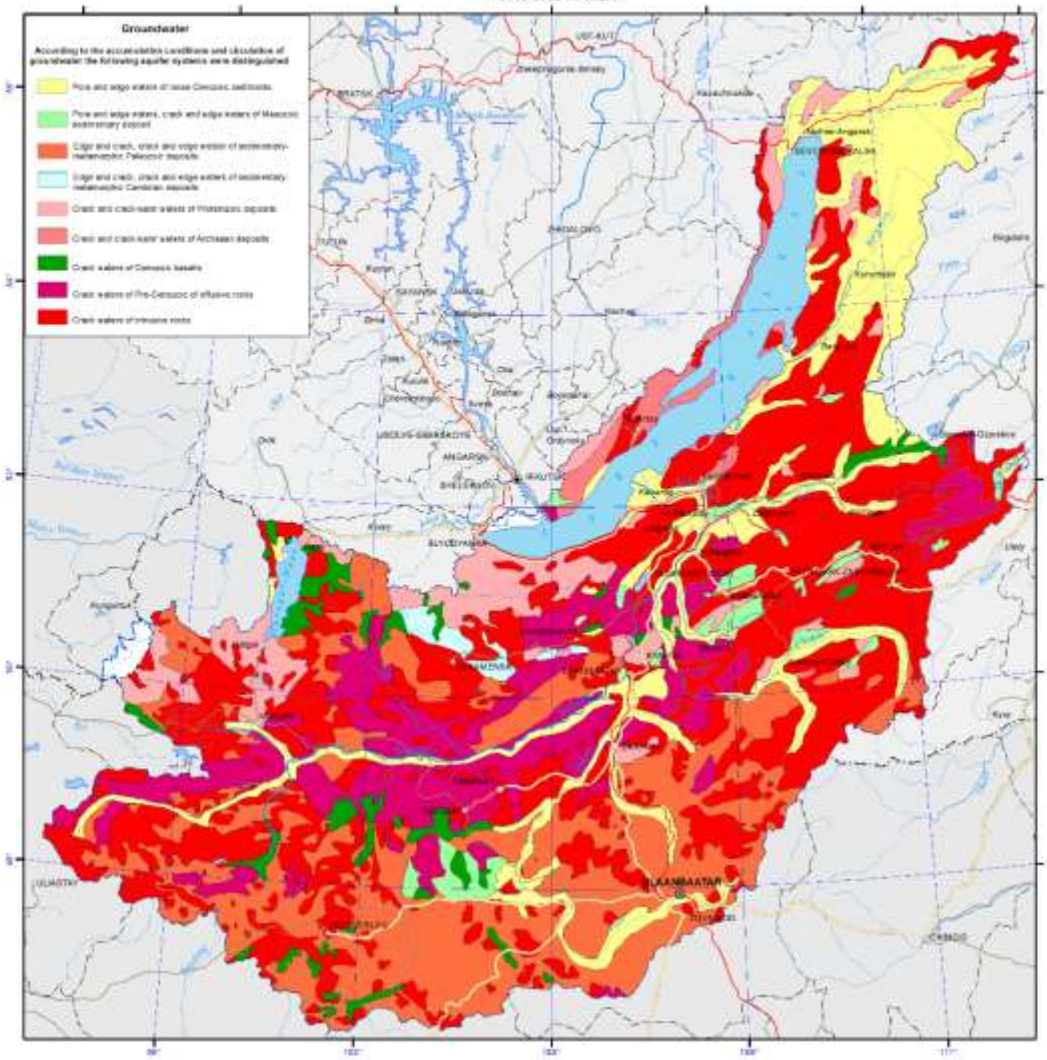
Empowered lives.
Resilient nations.

GROUNDWATER



Permafrost

Permafrost occurs in abundance within the Lake Baikal basin. According to the extent of spreading, thickness of a permafrost section and its temperature, the following five types of areas of permafrost distribution are distinguished: 1) continuous and discontinuous, 2) insular, 3) sparsely insular, 4) sporadic, and 5) without permafrost.

Continuous and discontinuous permafrost is developed on all relief features in the mid- and high-mountain and golets areas. Unfrozen rocks occur only under large rivers, lakes and in the zones of tectonic faults with the discharge of subsurface water, along the fissures of exogenous weathering, as well as on sands, gravels and karsted rocks. The permafrost thickness reaches 100-300 m, andup to 500-600 mon watersheds.The average annual temperature ranges from -0.5 ºC to -3 ºC. Frost mounds, thermokarst, frost weathering, aufeis formation, kurum (rock stream)formation, and solifluction should be mentioned among the prevailing cryogenic processes and phenomena.

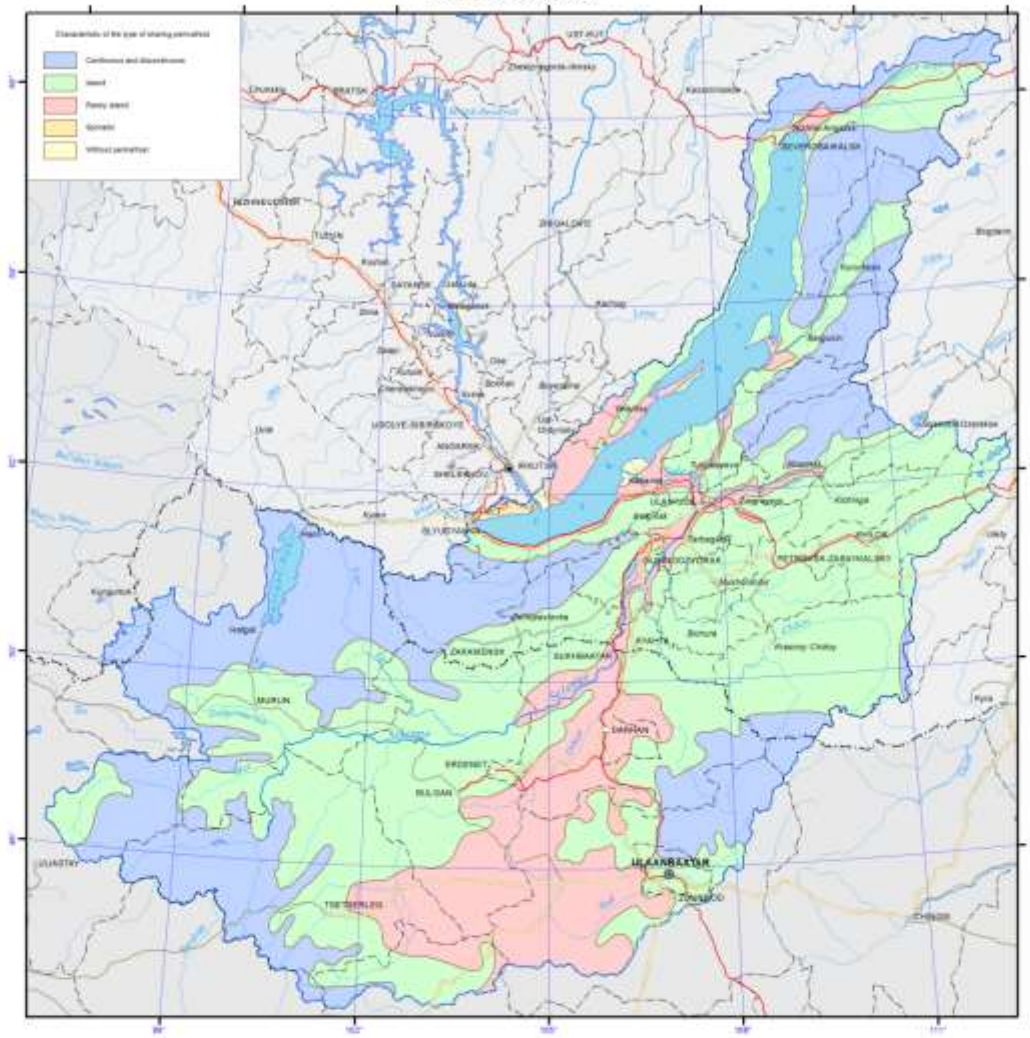
Insular permafrost. The permafrost thickness reaches 50-80 m. Islands of permafrost occur on all relief elements, but usually only in wet, waterlogged or shaded areas, and in mountains above abs. alt. of 1000-1200 m. Sand massifs and karsted rocks are usually unfrozen. The average annual temperature of permafrost ranges from -0.2 ºC to -1ºC.Thermokarst, frost mounds, aufeis formation, solifluction, and frost fracturing of soil are distinguished among the prevailing cryogenic processes and phenomena.

Sparsely insular permafrost occurs in waterlogged areas in valley bottoms, and at the bottom parts of northern slopes of hills, composed of peaty from the surface clay rocks. The permafrost thickness reaches 20-30 m. The average annual temperature of permafrost ranges from -0.1ºC to -0.5ºC.

Sporadic permafrost. Individual islands and lenses of permafrost occur only in wet lowlands, composed of peaty from the surface clay loams and sandy loams. The permafrost thickness reaches 10-15 m. The average annual temperature of permafrost varies from 0ºC to -0.2ºC. Seasonal frost mounds, relic thermokarst, and frost fracturing of soil are distinguished among the prevailing cryogenic processes and phenomena.

The area of *only seasonal* soil freezing has become of widespread occurrence in the Angara river valley and the Selenga river delta. Permafrost patches and neoformations are possible when developing a territory, composed of clay rocks. The depth of winter freezing of rocks ranges from 2-2.5 m in clay loams to 2.5-3 m in sands. Soil heaving, frost fracturing of soil, and relic thermo karst should be mentioned among the prevailing cryogenic processes and phenomena.

PERMAFROST ZONING



Vegetation

The map “Vegetation of the Lake Baikal Basin” is an overview-reference geobotanical map. All available different-scale cartographic materials on the vegetation of southern East Siberia of the Russian Federation, literary and archival sources, and forest inventory data were used when compiling the map. For the territory of Northern Mongolia, basic cartographic and literary materials on the vegetation of this region of Central Asia were involved. For the entire area of the Lake Baikal basin modern satellite images from the Internet resources (Google Earth) were used. Their processing was carried out with the use of GIS-technologies.

When creating the legend of the vegetation map of the Baikal region, well-tested geographical-genetic and structural-dynamic principles of a multi-dimensional and multi-stage vegetation classification, developed by Academician V.B. Sochava, were applied. Accordingly, the legend of the map has a multi-stage structure.

All higher subdivisions of vegetation of the map legend are united by specific taxa of plant communities, typed according to the flora-coenotic and dynamic features of their structure. When typing an epitaxon principle was followed, according to which on the basis of structural-dynamic and topological similarity indigenous communities are joined together with derivatives into common epitaxa. The lowest unit of indigenous communities being mapped is a class-group of associations. On the total the map legend contains 96 numbers of epitaxa of indigenous and derivative vegetation. Each taxon singled out in the legend has a detailed floristic, structural-coenotic and ecological-topological characteristics. Due to the complexity of the spatial structure of the vegetation cover, combinations and complexes of plant communities, which are the most characteristic of a particular type of vegetation or area, are almost universally used.

The highest level of the legend is formed by the following vegetation types: golets (alpine), taiga (boreal) and steppe, communities of which form the modern vegetation cover of the Lake Baikal basin. Each type of vegetation is presented by its set of communities of genetically close phratries of formations and their regional groups of formations.

Taiga (boreal) vegetation covers the main areas of the Lake Baikal basin both in the plains and high plateaus, and in the mountains, forming a high-altitude mountain-taiga belt and a belt of subgolets sparse forests. According to the landscape features of the region, taiga (boreal) vegetation is represented in the legend and in the map by several groups of formations, namely: subgolets sparse forests with thickets of shrubs, mostly of Siberian dwarf pine, mountain-taiga forests, piedmont-hollow forests, and forests of plains and plateaus.

The first three groups are the high-altitude zone structure of vegetation of mountain ranges. High-altitude zone groups of formations of taiga (forest) vegetation are represented by communities of different origin and territorial confinedness.

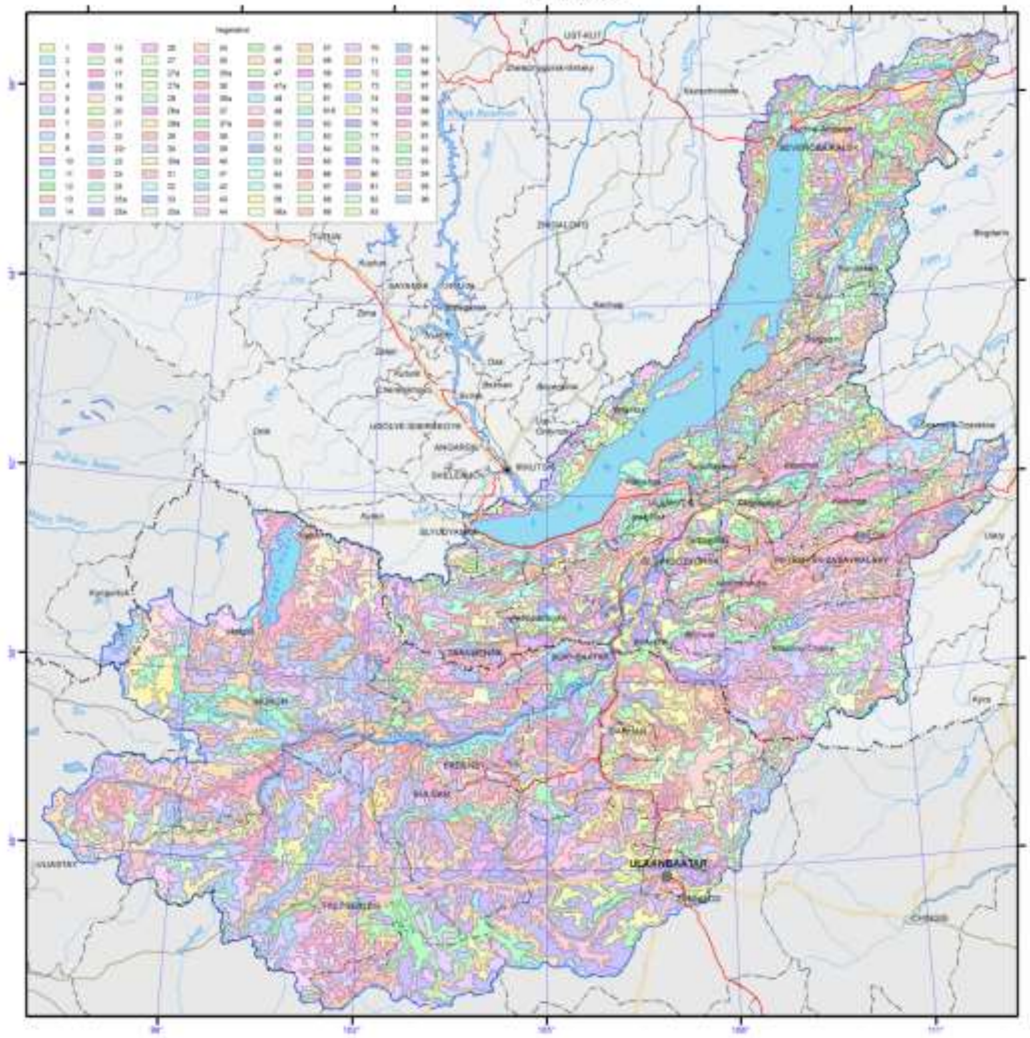
In the contact zones of the taiga and steppe (in the form of islands) vegetation forest-steppe complexes are formed; they are mostly of expositional-conditional nature. Southern warm and dry slopes of mountains and hills are occupied, as a rule, by steppe groups, while northern and eastern cold slopes are covered with forest taiga and in some places steppificated communities. In accordance with the terrain features, these complexes are represented by three groups, namely: mountain, plains and plateaus, and piedmont ones.

Steppe vegetation occupies large areas in the south of the Lake Baikal basin and in northern Mongolia. Here there is an important biogeographical barrier that separates two large flora-coeno-genetic groups of western North Kazakhstan and eastern Central Asia steppes, representing Trans-Volga-Kazakhstan and Mongolia-China phratries of formations, respectively.

Two groups of formations are clearly distinguished; they are mountain steppes and steppes of foothills, elevated plains and hummocks. In each of them, large ecological-morphological groups – meadow and dry steppes – are distinguished according to the nature of steppe vegetation. For each of these groups within the respective phratries of formations independent regional steppe complexes are identified, namely: southern Siberian, northern Mongolian and Central Asian formations. The main areas, both in the mountains and on the plains and hummocks, are occupied by dry steppes of the Mongolian-Chinese phratrie of formations.

In general, the map reveals in details the spatial flora-coenotic structure of the vegetation cover of the Lake Baikal basin in its evolutionary-genetic and dynamic dependence. Regional-geographical features of the coenotic diversity are well identified, taking into account their zonal-subzonal or high-altitude zone development conditions.

VEGETATION



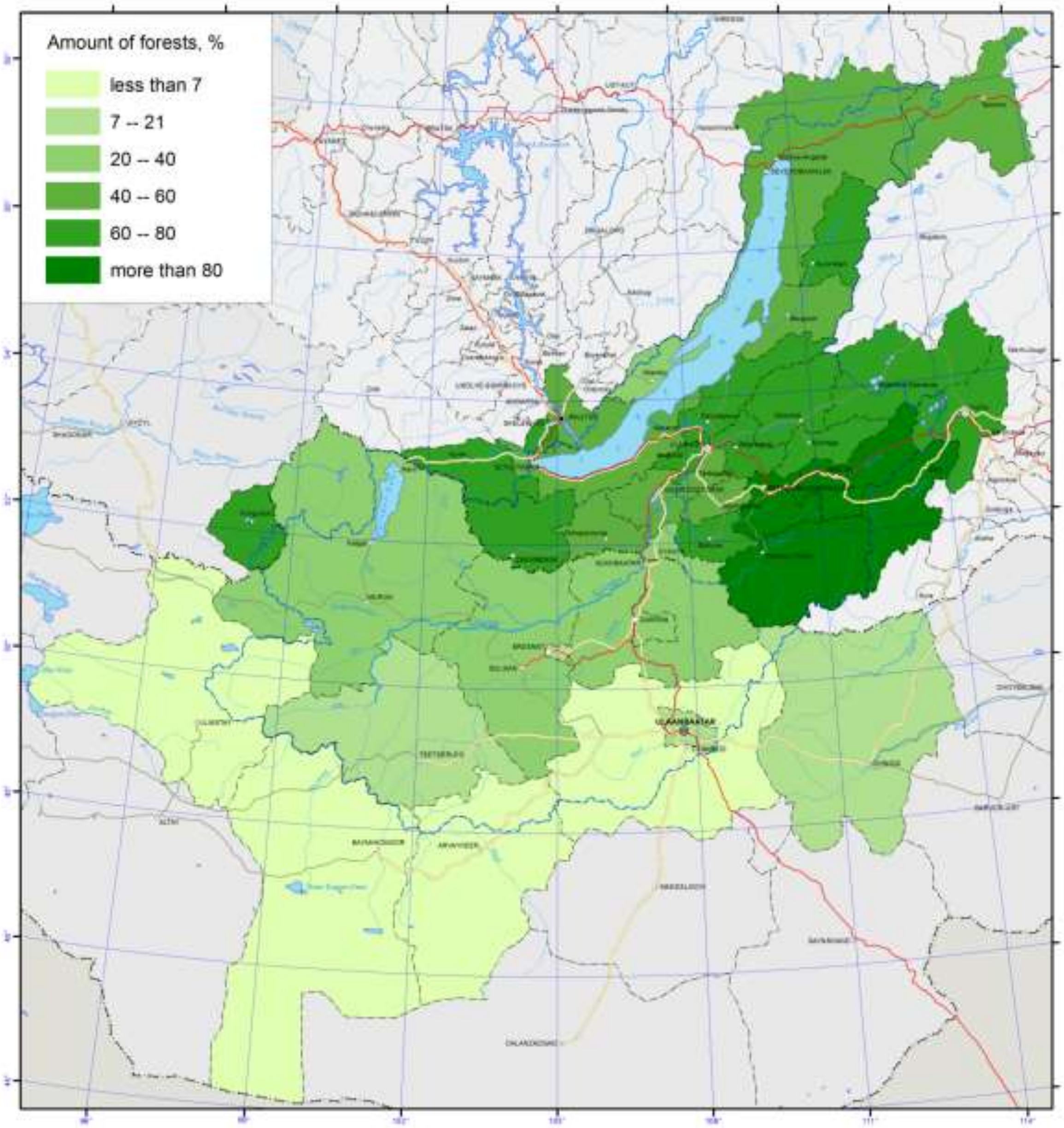
Forest cover

Forest cover is the size reflecting the ratio of the total forested area (on forest land and other land areas where forests are located) to the area of the municipality (district or aimag). Forest cover is an important parameter characterizing the forest availability, and, consequently, the ecological security and the features of the socio-economic development.

Average forest cover of the Baikal watershed basin within the Russian territory is 62.5 %. Forest cover is fluctuating here from 26.4% in Kyakhtinsky district, located in the steppe of the Republic of Buryatia, to 82-89 % in Krasnochikoisky, Petrovsk Zabaikalsky, Uletovsky, Khiloksky districts of Transbaikalia. In Mongolia the average forest cover is significantly lower than in the Russian part of the basin -11.5 % - and it is fluctuating from 0.75% (Uverkhangay aimag) to 35.0 % (Darkhan aimag).

Over the last decade (2000-2010) a decrease in forest cover in the most developed parts of the Baikal watershed basin is registered. This is due to the withdrawal of the forested land of areas, subjected to fire, cutting, and harmful insect.

AMOUNT OF FORESTS



Soils

Soil associations are presented in the contours on the map. Combinations of soils, united in a contour, are associated with the altitudinal and expositional differentiation, and are determined by the character of mesorelief (combinations) and microrelief (complexes), and by the heterogeneity of the soil-forming material (mosaic). The predominant soil is the first in the legend, followed by accompanying and occurring soils. Most soils are distinguished at the type level, rarely at the subtype level.

The great extension of the territory of the Lake Baikal basin from south to north determines latitudinal variations of the thermal factor and the associated land cover. In addition to these basic regular patterns, the influence of exposure and latitudinal arid mountain zonality is manifested here. The role of permafrost and heterogeneity of parent rocks, complicated and insufficiently clear evolution of landscapes in the past, and their changing as a result of the human impact are essential.

Within the mountain taiga, independent contours are distinguished in the south-western and north-eastern parts of the Pribaikalie. They are represented by combinations of soils with the eluvial- illuvial and undifferentiated profile. The Baikal Ridge and the North-Baikal Highland are dominated by podzols and podburs, involving peat-podburs and sod-podzols. They are characterized by a thin profile, which averages 30 cmin the podzols of the highland, while in the mountains of the Pribaikalie it is about 40 cm. Thickness of the profile of podburs, which can be regarded as being in the early stage of soil formation, is even less.

Soils of piedmont dry steppes of the Pribaikalie are common in the Priolkhonie region and on Olkhon Island. Formation of dry steppe landscapes with chestnut soils is due to the arid mountain zonality (location in the rain shadow). The lack of atmospheric moistening is compounded here by a high water penetration capacity of woody-loamy soils. The territory is similar to that of the dry steppe of Kazakhstan in the nature of moistening, and to the middle taiga of Yakutia in heat supply. A consequence of the extreme soil-climatic conditions is a low biological productivity. Agro- ecosystems here are in a state of crisis; the land cover undergoes degradation.

In the high-mountain part of the Khamar-Daban, and Muisky, Verkhne-Angarsky and Barguzinsky ridges the basic soils are petrozems, peat-lithozems, and coarse humus lithozems. Coarse humus, humic and humic-dark-humus soil sare formed under the sub-alpine meadows. On the northern slopes, in relatively low relief elements, and in areas composed of parent rocks of heavier particle-size distribution, gley podbursare formed.

Cryo-lithozems, petrozems and cryo-carbo-lithozems accompany nival dissected landscapes of the Khangai region of Mongolia. Cryozems (coarse humus) and peat-cryozemsare developed in the sub-golets altitudinal belt, locating in a relatively narrow band near the forest line. In soils of taiga massifspermafrost areasare of frequent occurrence;moreover, seasonal frost is longstanding, andcryoturbation phenomena and solifluction are usual.

The structure of the soil cover of the mountain-taiga zone of the Transbaikalia is heterogeneous andis largely associated with the manifestation of vertical zonality, slope exposure, and permafrost. The main soil background comprises podburs, podzols, sod-podzols, sod-podburs, gray-humus, humic, humic-dark-humus soils and coarse humus burozems. The main background of the soil cover of taiga territories of Mongolia includes cryozems, podburs and dark-humus soils. Soils of podzolic type are rare here. In the upper part of the taiga belt cryozems and podburs are formed; higher there are peat-lithozems. In mountainous taiga there occur steppe "islands" with chernozem-likesoils. They can be found on steep parts of the slopes of southern exposure, facing the broad areas of intermontane depressions.

The natural-climatic zone of forest-steppe is dominated by gray metamorphic soils, which are formed on the foothill areas of depressions and on the northern slopes of hills inside inter montane lows or at the bottom part of the forested slopes of ridges, facing the steppe depressions. These soils occupy the largest areas in the forest-steppe of the southern part of the

Trans-Baikal midland. In the forest-steppe landscape belt of Mongolia of light-coniferous and mixed subshrub and herbaceous facies there occur dark-humus metamorphosed soils, located mainly along the southern slopes of ridges and hills. Gray humus soils formed under woody communities with forbs on carbonate rocks. This combination of soils, characteristic of different environmental conditions, is the main feature of the soil cover at the junction of taiga and steppe.

In steppe landscapes of the Transbaikalia the main background of the soil cover is comprised of chernozems. They are formed under meadow and true steppes. The main massifs of these soils are located in the Tugnui-Sukharabasin:onthe Tugnuisky ridge and on the southern slopes of the Zagansky ridge, on the northern slopes of the Kudarinskaya range andthe Small Khamar-Daban, Monostoisky, and Borgoiskyridges. In the more northern part of the territory, chernozems are formed in individual spots on the north-western slopes of the Unegeteisky ridge and along the Uda and Itantsariver valleys.

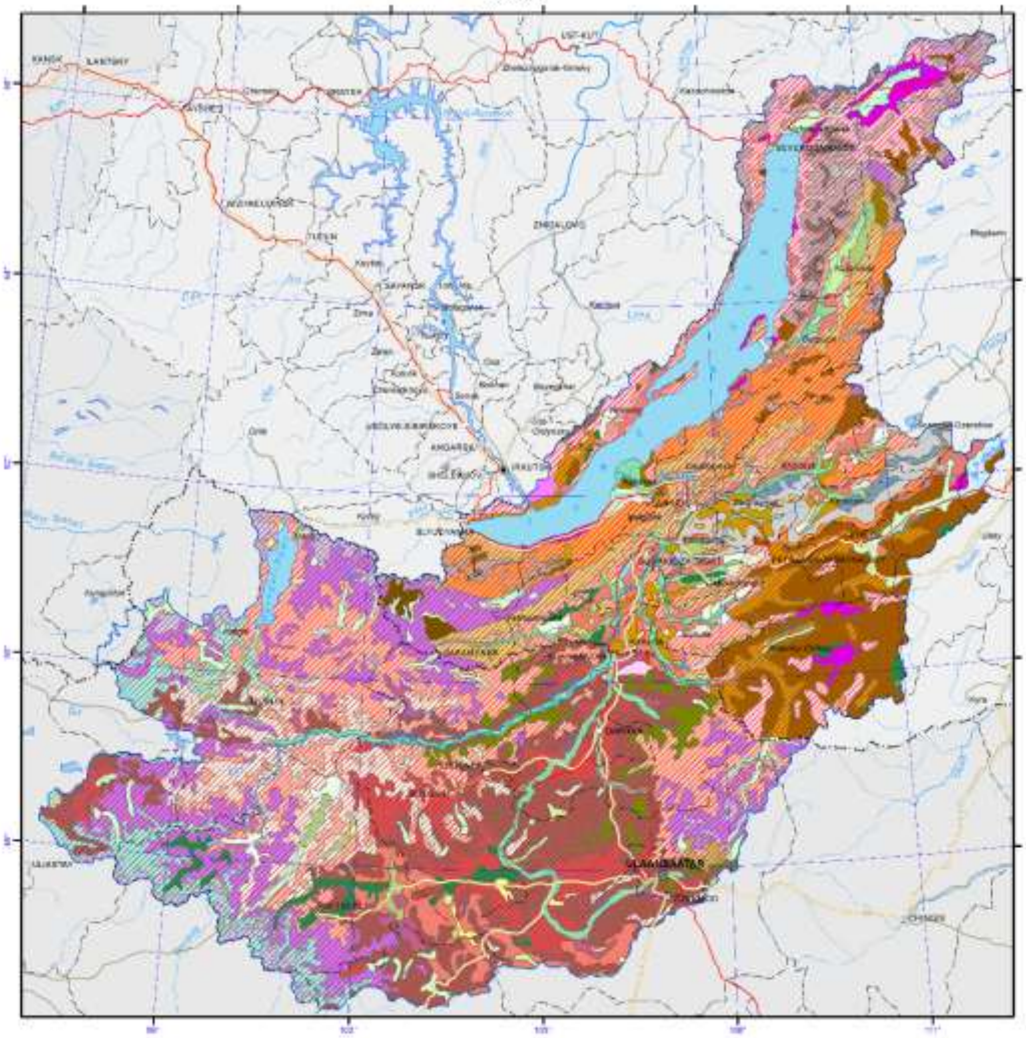
The soil cover of dry steppe is dominated by chestnut soils. They occupy vast tracts in the Udinskaya, Priselenginskaya, and Borgoiskaya steppes, and wide gently sloping terraces in the valleys of large rivers; they are common on the southern slopes of the ridges. On the watersheds of high ridges there occur soils of the lithozem group. Humus psammozems are formed on aeolian sand deposits of the dry steppe zone, especially in the Selenga-Chikoi and Chikoi-Khilok interfluves, on pine-forest sands.

Soils of the river valleys of the Pribaikalie and Transbaikalia are represented mainly by alluvial humic-gley, peat-gley, dark-humus, gray-humus, and dark-humus quasi-gleysoils. In the structure of the soil cover of the flood plains of the upper and middle reaches of the rivers stratified alluvial soils are of frequent occurence. In the steppe and especially in the dry steppe zones of the Transbaikalia solon chaks and less frequently solonetzic soils are formed in the river floodplains. They occupy mostly lacustrine deprssions and lower parts of gentle slopes, generally adjacent to the river floodplains, where there is a zone of accumulation of waters of the valley runoff enriched with soluble salts or a discharge of mineralized ground waters. The most common types of salinization of solonchaks and solonetzic soils are sulfate-soda, soda-sulfate, sulfate, and chloride-sulphate. Large massifs of saline soils are widespread in the Borgoiskaya steppe and lacustrine lows of Lakes Verkhnee Beloe and Nizhnee Beloe. Their proportion in the Ivolginskaya depression is quite substantial. Solonetzic soils and solonchaks also occur in lacustrine depressions of the Bichursky district and the Tugnuiskaya steppe. In the Selenga river delta, in the Barguzin river valley, and in some other regions relatively large massifs are covered with bogs, where mainly peat eutrophic and peat eutrophic gley soils develop.

Soils of waterlogged meadows and lacustrine-boggy complexes of Mongolia are widespread in the near-shore zone of Lakes Hovsgol and Doot-Nur, in the Dzhargalant-Gol and Mungaral-Gol interfluve, in the northern and southern part of the Darkhatskaya depression, and along river valleys. Alluvial dark-humus soils are formed in river floodplains on elevated areas, in deltas, and on alluvial fans of temporary streams. Alluvial humic gley soils are formed under the conditions of additional inflow of moisture. In elevated locations of the riverbed floodplain of mountain rivers on sandy-gravel deposits gray-humus alluvial and stratified soils were formed. Alluvial peat-gley (peat-mineral) soils are formed in relatively low locations of river floodplains with the conditions of long-term surface and subsurface moistening, as well as on the edges of water bodies overgrown with bog vegetation. Humus-hydrometamorphic seasonally freezing for a long time soils are formed in the central floodplain of the rivers. In the lacustrine part of the depressions humic-hydrometamorphic (silty-humic) cryogenic soils are developed.

In the territory of Mongolia a series of relatively small contours of saline soils occurring in different parts of the country was distinguished. Processes of erosion and deflation are widespread, which is due to the shower precipitation pattern, and periodic occurrence of dust storms and strong winds, especially in spring when soil is dry and vegetation grows poorly.

SOILS



	Основные почвы	Сопутствующие (около 15-20 % к площади контура)	Встречающиеся (около 5-10 %)
	Почвы горных территорий		
	литоземы, петроземы	криоземы, подбуры	глееземы, подзолы
	литоземы	петроземы	подбуры
	крио-литоземы грубогумусовые	глееземы, подбуры	петроземы
	крио-литоземы перегнойно-темногумусовые	глееземы	крио-карбо-литоземы темногумусовые
	литоземы темногумусовые	литоземы серогумусовые	крио-литоземы темногумусовые
	глееземы	торфяно-глееземы	торфяно-литоземы
	торфяно-глееземы	торфяно-литоземы	торфяно-подбуры глеевые
	карбо-литоземы темногумусовые	карбо-литоземы перегнойно-темногумусовые	карбо-литоземы перегнойные
	карбо-литоземы перегнойные	карбо-литоземы темногумусовые	карбо-литоземы перегнойно-темногумусовые
	перегнойно-темногумусовые	перегнойно-криометаморфические	перегнойные
	криоземы	подбуры	торфяно-литоземы
	торфяно-криоземы	торфяно-подбуры	торфяно-глееземы
	подбуры типичные и грубогумусированные	дерново-подбуры, торфяно-подбуры	буроземы грубогумусовые
	подбуры оподзоленные	подбуры иллювиально-железистые	подбуры иллювиально-гумусовые
	подбуры, буроземы грубогумусовые	дерново-подбуры оподзоленные	подзолистые
	подбуры, подзолы	дерново-подзолы	дерново-подбуры
	буроземы грубогумусовые	темногумусовые остаточно-карбонатные	подбуры
	дерново-подзолы и подзолы	дерново-подзолистые	подзолистые
	дерново-подбуры	дерново-подбуры оподзоленные	темногумусовые остаточно-карбонатные
	темногумусовые типичные	темногумусовые метаморфизованные	темногумусовые глееватые
	темногумусовые метаморфизованные	темногумусовые глееватые	темногумусовые остаточно-карбонатные
	светлогумусовые	каштановые	серогумусовые
	темногумусовые остаточно-карбонатные	черноземы дисперсно-карбонатные	темногумусовые метаморфизованные
	горные черноземы дисперсно-карбонатные маломощные щебнистые	черноземы маломощные щебнистые	черноземы гидрометаморфизованные
	горные темно-каштановые маломощные щебнистые	темно-каштановые	темно-каштановые гидрометаморфизованные
	горные каштановые маломощные щебнистые	каштановые	каштановые гидрометаморфизованные

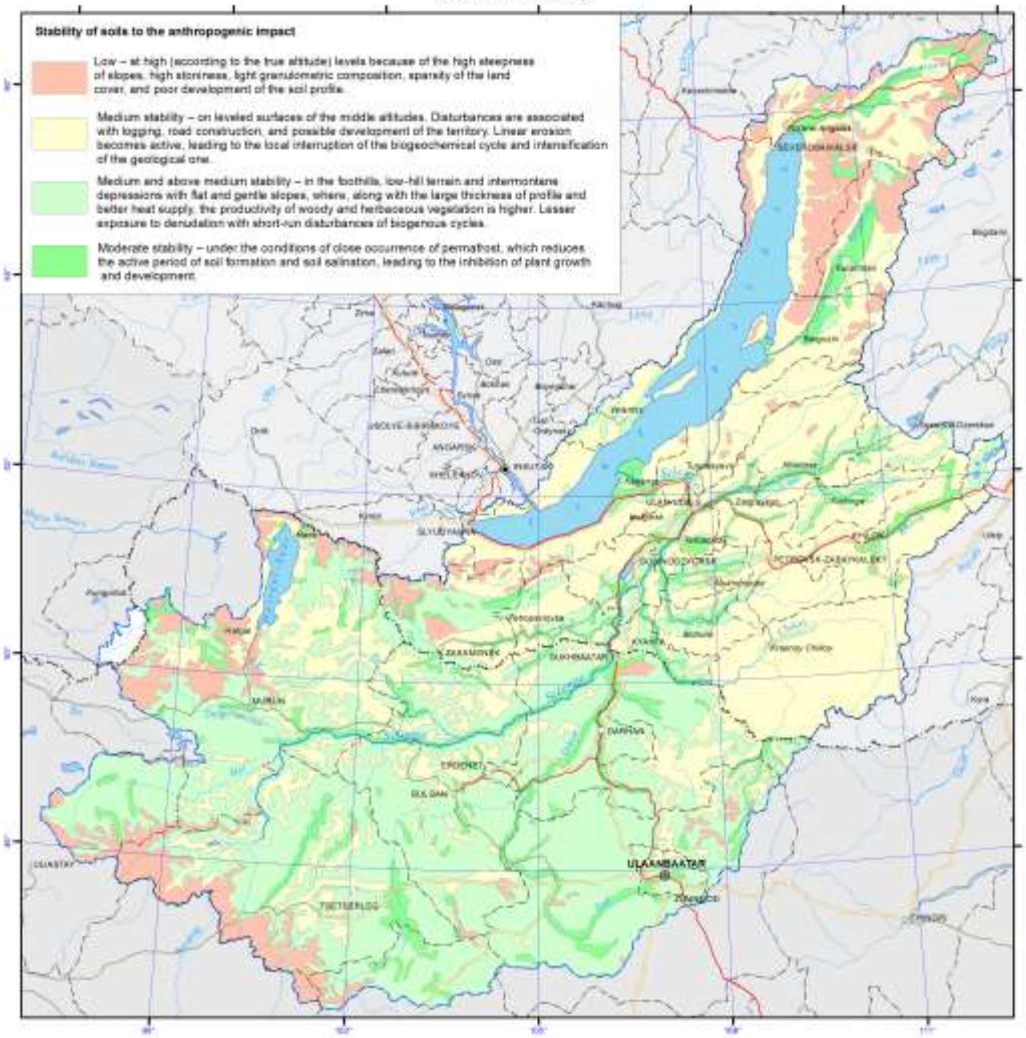
	Основные почвы	Сопутствующие (около 15-20 % к площади контура)	Встречающиеся (около 5-10 %)
	Почвы высоких равнин и межгорных понижений		
	подзолы	дерново-подзолы	подзолистые
	дерново-подзолистые	подзолистые	дерново-подбуры оподзоленные
	слабо-подзолистые боровых песков	слабо-оподзоленные песчаные	дерново-подзолистые песчаные
	дерново-подзолы глеевые	дерново-подзолисто-глеевые	дерново-подзолы глееватые
	дерново-подбуры и серые метаморфические	подбуры грубогумусированные	серые
	дерново-подбуры и псаммоземы гумусовые	подбуры	псаммоземы
	темно-серые	темно-серые метаморфические	темно-серые глеевые
	серые метаморфические	серые	темно-серые
	гумусово-гидрометаморфические	темногумусовые	перегнойно-темногумусовые
	перегнойно-глеевые	перегнойно-квазиглеевые	перегнойно-гумусовые глеевые
	черноземы квазиглеевые	черноземы гидрометаморфизованные	черноземы глинисто-иллювиальные квазиглеевые
	черноземовидные	темногумусовые метаморфизованные	черноземы текстурно-карбонатные квазиглеевые
	черноземы дисперсно-карбонатные	черноземы гидрометаморфизованные	черноземовидные
	темно-каштановые	темно-каштановые турбированные	темно-каштановые гидрометаморфизованные
	каштановые	каштановые маломощные	каштановые гидрометаморфизованные
	каштановые гидрометаморфизованные	каштановые турбированные	темно-каштановые
	торфяные эутрофные (глеевые)	гумусово-гидрометаморфические, перегнойно-гидрометаморфические	торфяно-криоземы
	аллювиальные серугумусовые и темногумусовые	аллювиальные темногумусовые глеевые, слоистые, перегнойно-глеевые	аллювиальные торфяно-минеральные, торфяно-глеевые, торфяно-криоземы глееватые
	солончаки, солонцы	светлогумусовые засоленные, каштановые засоленные (солонцеватые)	черноземы засоленные (солонцеватые)
	гумусово-гидрометаморфические засоленные, перегнойно-гидрометаморфические засоленные	гумусово-гидрометаморфические солонцеватые	перегнойно-гидрометаморфические солонцеватые
	пески		

Soil stability

A qualitative assessment of the soil stability (i.e. the resistance to external effects and the ability to restore the disturbed properties)was made with regard to the external and internal factors. In general, the stability decreases from low leveled surfaces or gentle slopes with an increase in an altitude and steepness of slopes. In the same direction a change from loamy deposits to stony deposits with small thickness of the loose mass takes place, and heat supply changes for the worse. In total, four large subdivisions of soils were distinguished according to different degrees of stability: low, medium, medium and above medium, and moderate. In the legend to the map of the soil stability to the anthropogenic impact, their characteristics is given.

The map of the soil cover can be used as an independent scientific work, characterizing the soil cover of the area, which is an important component of the landscape, also as a starting material for the soil (land) resources accounting, as a support material for planning the chemicalization of the agricultural production, agroforestal and erosion control measures, development of forest resources, environmental protection, as a basis for various types of zoning, and as a manual for students of higher education institutions.

STABILITY OF SOILS



Soil-ecological zoning

The principles of "Soil-ecological zoning of Irkutsk oblast" [Kuzmin, 2004], "Soil zoning of the Baikal region" [Kuzmin, 1993], and "Soil-geographical zoning of Mongolia" [Dorzhgotov, 2010], the map of the soil cover, information on soils, their connections with the natural conditions, obtained as a result of the in-house long-term research, and materials on geology, topography, and other natural components were used when developing the zoning.

In the map of the soil-ecological zoning, nine provinces are singled out, reflecting the peculiarity of the surface topography, since the ratio of the heat and moisture balance, which serves as the basis for zoning, manifests itself against the background of the complex orography. Here bioclimatic factors play a key role. Twenty-eight districts are distinguished in the provinces according to the lithologic-geomorphological features. From the standpoint of the structural approach, the districts are regarded as territories with a specific regular change of several types of the soil cover structure, associated with the features of terrain and soil-forming rocks.

The complex of all natural conditions that influence the formation of the soil cover is taken into consideration in the soil-ecological zoning. Connections of soils with other components of the landscape are identified. It is necessary to consider regional features of the soil cover when planning the distribution of agricultural production, while knowledge of the interrelations of soils with the natural conditions is essential to develop the measures aimed at avoidance of negative consequences of the anthropogenic impact.

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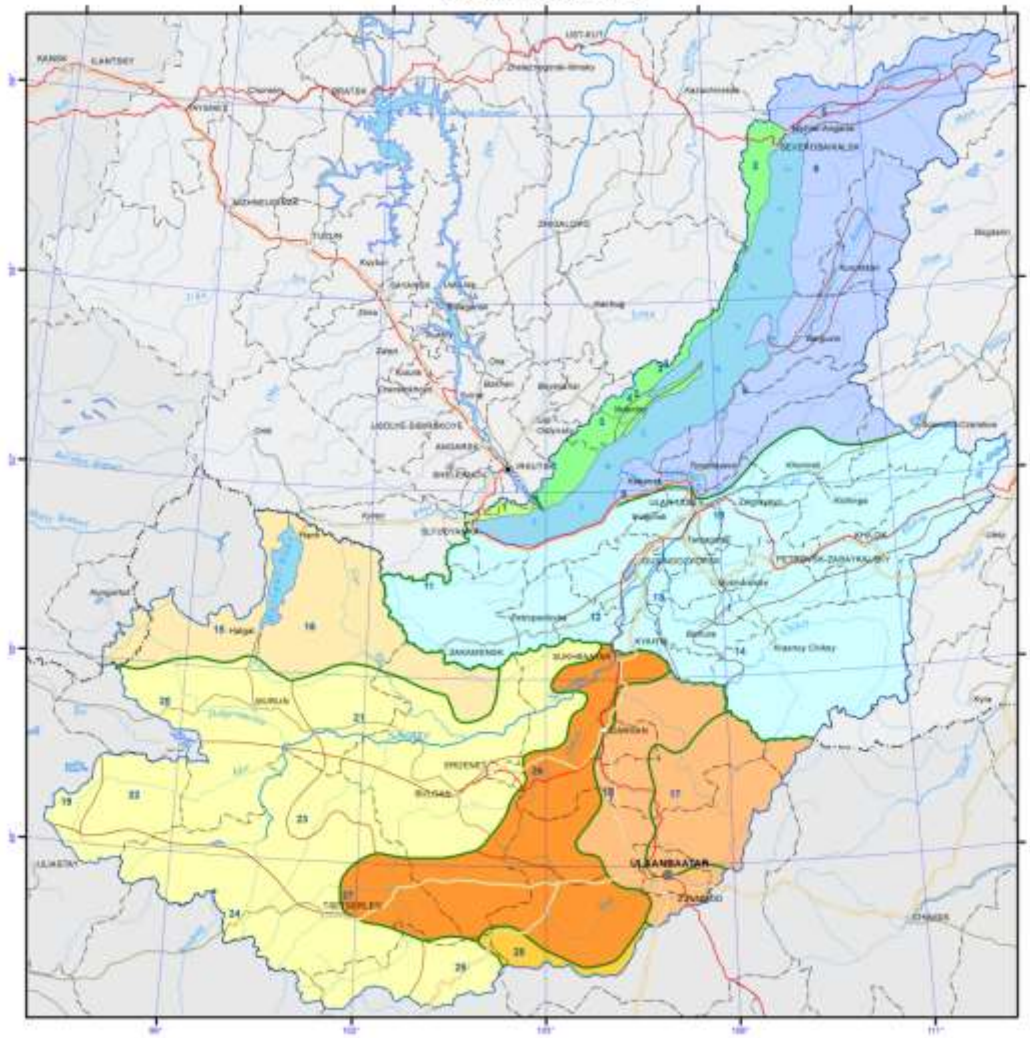
SOIL-ECOLOGICAL ZONING



I - Eastern-Sayanskaya high- and mid-mountain province

of medium thick, loamy, acid, slightly acid soils with a high absorption capacity, moderately and weakly moistened, cold, freezing for a long time, providing the growth of forests of medium and high productivity
1 – mid-mountain district of the South-Western Pribaikalie of podzols, podburs and sod-podzolic soils

II – Pribaikalskaya piedmont, high-, mid- and low-mountain province

of predominantly medium thick, loamy, slightly acid, neutral and slightly alkaline, moderately and regularly insufficiently and weakly moistened, cold, freezing for a long time soils of medium and low natural fertility
2 – high- and mid-mountain Baikal district of peat-podburs, podburs and coarse humus burozems;
3 – mid- and low-mountain Primorsky district of podzolized podburs, sod-podburs, coarse humus burozems, and sod-podzolic soils;
4 – piedmont and low-mountain district of Olkhon Island and the Priolkhonie of chestnut soils, locally sod-podburs and podburs

III – Baikalo-Dzhugdzhurskaya high-, mid-mountain-taiga, depression -valley province

of shallow to relatively thick, predominantly loamy acid, neutral and slightly alkaline, moderately moistened, very cold and freezing for a long time soils, providing from low to medium biological productivity of vegetation
5 – depression-valley Verkhneangarsky district of podzolic, peat eutrophic and alluvial soils;
6 – high-mountain Barguzinsko-Verkhneangarsky district of lithozems, petrozems, humic carbo-lithozems, sod-podzols, podzols, gleyzems, and typical and coarse humic podburs;
7 – depression-valley Barguzinsky district of chestnut, alluvial, peat eutrophic and podburs;
8 – mid-mountain Ulan-Burgassko-Ikatsky district of podburs, coarse humus burozems, sod-podzols (gley), and podzols;
9 – valley district of the Selenga river lower reaches of alluvial, peat eutrophic soils, sod-podzols, sod-podburs and gray metamorphic soils.

IV – Khamardabano-Southern-Transbaikalskaya mid-mountain-taiga, forest-steppe and mountain-depression-steppe province

of medium and relatively thick, predominantly loamy, acid, neutral and slightly alkaline, insufficiently and temporarily excessively moistened, moderately cold and moderately freezing for a long time soils with vegetation of medium and high productivity
10 – mountain-valley Udinsko-Khiloksky district of sod-podburs, podburs, coarse humus burozems, alluvial, chernozems, chernozems-like, quasi-gley chernozems, chestnut soils, and a complex of saline soils;
11 – high- and mid-mountain Khamar-Dabansky district of podburs, coarse humus burozems, sod-podzols, podzols, cryozems, lithozems, and humic carbo-lithozems;
12 – depression and low-mountain Dzhidinsko-Chikoisky district of chestnut, chernozems, light-humus, alluvial, solonetzes, and solonchaks;
13 – low-mountain-valley Chikoisko-Khiloksky district of sod-podburs, sod-podzols, podzols, gray metamorphic, alluvial, chestnut and chernozems, and a complex of saline soils;
14 – mid-mountain Verkhnechikoisky district of sod-podburs, podburs, sod-podzols, podzols and coarse humus burozems.

V – Khubsugulskaya high-mountain-depression province

of shallow and medium thick, predominantly sandy-loam, sandy, rank, slightly acid, neutral, slightly alkaline and alkaline, moderately and weakly moistened, cold, freezing for a long time soils of low natural fertility
15 – high-mountain South-Western Prikhubsugulsky district of coarse humus cryo-lithozems, humic-dark-humus cryo-lithozems, sod-podburs, dark-humus, and locally peat eutrophic and humus-hydrometamorphic soils;
16 – high-mountain and depression-valley Eastern-Prikhubsugulsky district of coarse humus cryo-lithozems, dark-humus lithozems, cryozems, sod-podburs, dark-humus, and locally mountain dark-chestnut shallow rank, alluvial and peat eutrophic soils

VI – Khenteiskaya high-, mid-, low-mountain, mountain-valley province

of predominantly medium thick, sandy-loam, rank, slightly acid, neutral, slightly alkaline and alkaline, moderately and weakly moistened, cold, freezing for a long time soils, providing medium productivity of vegetation
17 – high- and mid-mountain Northern-Khenteisky district of sod-podburs, cryozems with coarse humus cryo-lithozems, dark-humus, mountain dark-chestnut shallow rank, mountain dispersive-carbonate shallow rank chernozems;
18 – low- and mid-mountain-valley South-Western Khenteisky district of mountain dark-chestnut shallow rank, dark-humus metamorphized, dark-chestnut with dark-humus typical, alluvial, and locally peat eutrophic soils.

VII – Khangaiskaya high-, mid-mountain-taiga, mountain-valley, patchy forest-steppe province

of shallow and medium thick, predominantly sandy-loam, rank, slightly acid, neutral, slightly alkaline and alkaline, moderately and periodically insufficiently and weakly moistened, cold, freezing for a long time soils of low to medium natural fertility
19 – high- and mid-mountain-taiga Telmensky district of mountain dark-chestnut shallow rank, dark-chestnut, dark-humus lithozems, locally with sod-podburs;
20 – mid-mountain-valley Delger-Murensky district of cryozems, sod-podburs, mountain dispersive-carbonate shallow rank chernozems, mountain dark-chestnut shallow rank, dark-humus, chestnut hydrometamorphized and alluvial soils;
21 – mid-mountain-taiga and forest-steppe Selenginsky district of sod-podburs, cryozems, mountain dark-chestnut shallow rank, mountain dispersive-carbonate shallow rank chernozems, chestnut hydrometamorphized, and dark-humus soils;
22 – high- and mid-mountain Northern-Khangaisky district of cryozems, humic-dark-humus cryo-lithozems, sod-podburs, mountain dark-chestnut shallow rank, mountain dispersive-carbonate shallow rank chernozems, dark-humus, dispersive-carbonate chernozems, peat eutrophic, humus-hydrometamorphic saline, and humic-hydrometamorphic saline soils;
23 – mid-mountain-taiga Khanuy-Orkhonsky district of mountain dark-chestnut shallow rank, mountain dispersive-carbonate shallow rank chernozems, dark-chestnut, dispersive-carbonate chernozems, locally sod-podburs, cryozems, peat eutrophic, humus-hydrometamorphic saline, humic-hydrometamorphic saline, and dark-humus metamorphized soils;
24 – high-mountain Khangaisky district of cryozems, sod-podburs, coarse humus cryo-lithozems, humic-dark-humus cryo-lithozems, dark-humus lithozems, mountain dispersive-carbonate shallow rank chernozems, mountain dark-chestnut shallow rank, dark-humus, locally dark-chestnut, humic-hydrometamorphic and peat eutrophic soils;
25 – low- and mid-mountain Eastern-Khangaisky district of mountain dark-chestnut shallow rank, chestnut, chestnut hydrometamorphized, humic-hydrometamorphic, peat eutrophic, with cryozems in places.

VIII – Orkhon-Tuulskaya forest-steppe province

of medium and relatively thick, predominantly sandy-loam and sandy, neutral, slightly alkaline and alkaline, periodically insufficiently moistened, moderately cold and moderately freezing for a long time soils with vegetation of medium and high productivity
26 – forest-steppe valley Orkhon-Shaamarsky district of dark-chestnut, mountain dark-chestnut shallow rank, humic-hydrometamorphic, peat eutrophic, alluvial, solonetzes, solonchaks, and chestnut saline soils.
27 – forest-steppe Tuul-Dashinchilensky district of dark-chestnut, chestnut, mountain dark-chestnut shallow rank, chestnut hydrometamorphized, dark-humus, humus-hydrometamorphic saline, humic-hydrometamorphic saline, peat eutrophic, alluvial, eolian sands, locally solonetzes and solonchaks.

IX – Burdskaya steppe province

of shallow and medium thick, sandy and sandy-loam, neutral, slightly alkaline and alkaline, periodically and insufficiently moistened, cold, freezing for a long time soils of low to medium natural fertility
28 – steppe Burdsky district of chestnut, mountain dark-chestnut shallow rank, mountain dispersive-carbonate shallow rank chernozems, dark-humus soils, locally eolian sands.

Taxonomic diversity of soil biotic communities

Cartographic analysis of the spatial distribution of taxonomic diversity of invertebrate communities was carried out on the basis of the vegetation map of the Lake Baikal basin.

The object of the analysis is the species (taxonomic) diversity of terrestrial invertebrates, forming community and having systemic and functional relationships. Focused on the mesopopulation (supraspecific taxonomic level), i.e. on relatively large invertebrates habiting in the soil and on its surface.

The data are obtained as a result of a detailed study of the quantitative characteristics of invertebrate communities on key ranges in taiga, mountain taiga and steppe geosystems of the Lake Baikal basin. Numerous literary and cartographic materials, information on land cover and vegetation conditions are analyzed, data on the thermal conditions of soil and moisture are taken into account. In formulating and carrying out a method of soil-zoological and biogeocenotic studies with comparative geographical approach is used. Opportunities of landscape indication, based on theoretical concepts about the relation and interdependence of all natural components within a certain genetically homogeneous space are used to compile a map model of distribution of soil and biotic patterns communities.

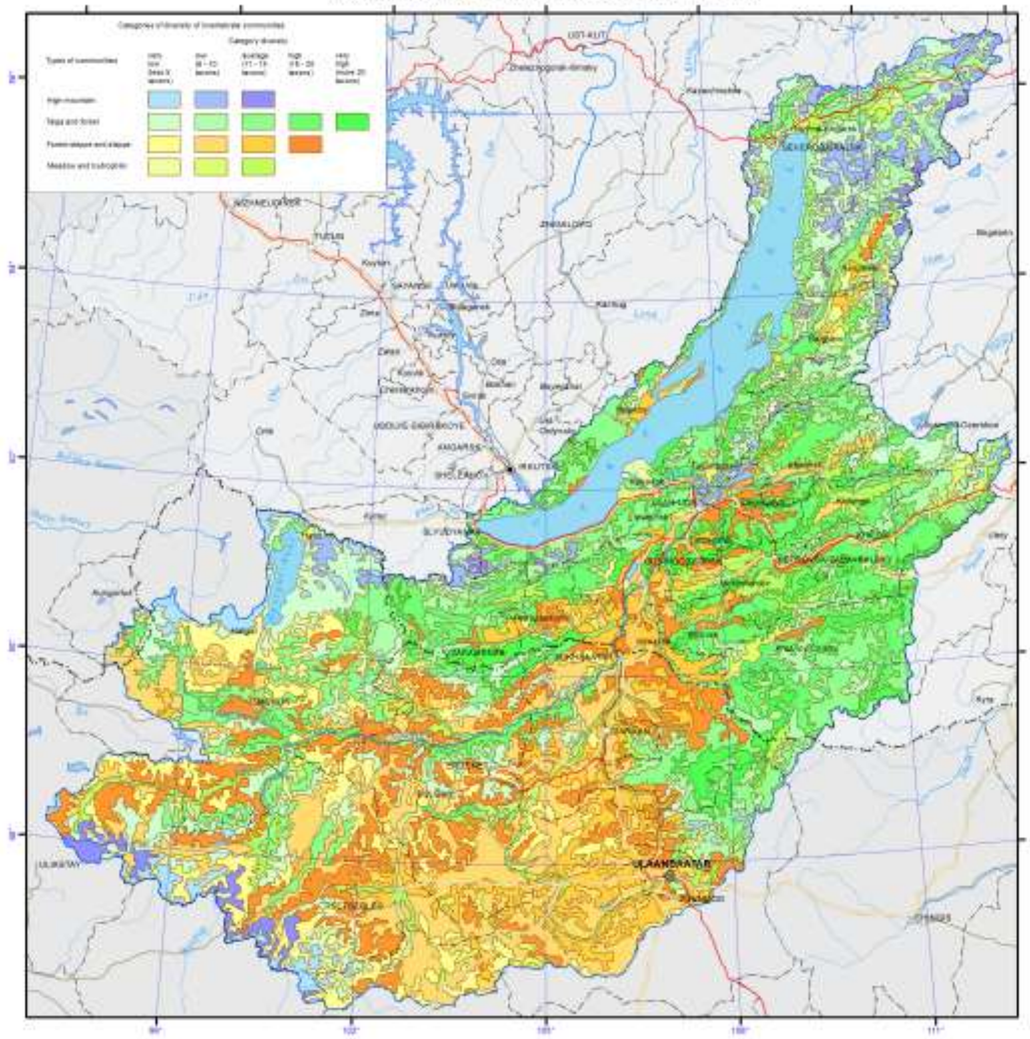
The structure of the animal population according to the specific range of edaphic conditions ensuring normal functioning of soil organisms, was interpreted from the standpoint of our landscape- typological approach, i.e. correlation and subsequent identification (experimentally) of soil invertebrates in specific conditions of their habitat .

Spatial patterns of change in species diversity in gradients of environmental factors such as high-altitude zone, temperature and soil moisture are identified on the most well-studied model groups of invertebrate in the Baikal region, the members of the families Lumbricidae, Carabidae, Staphylinidae, Elateridae.

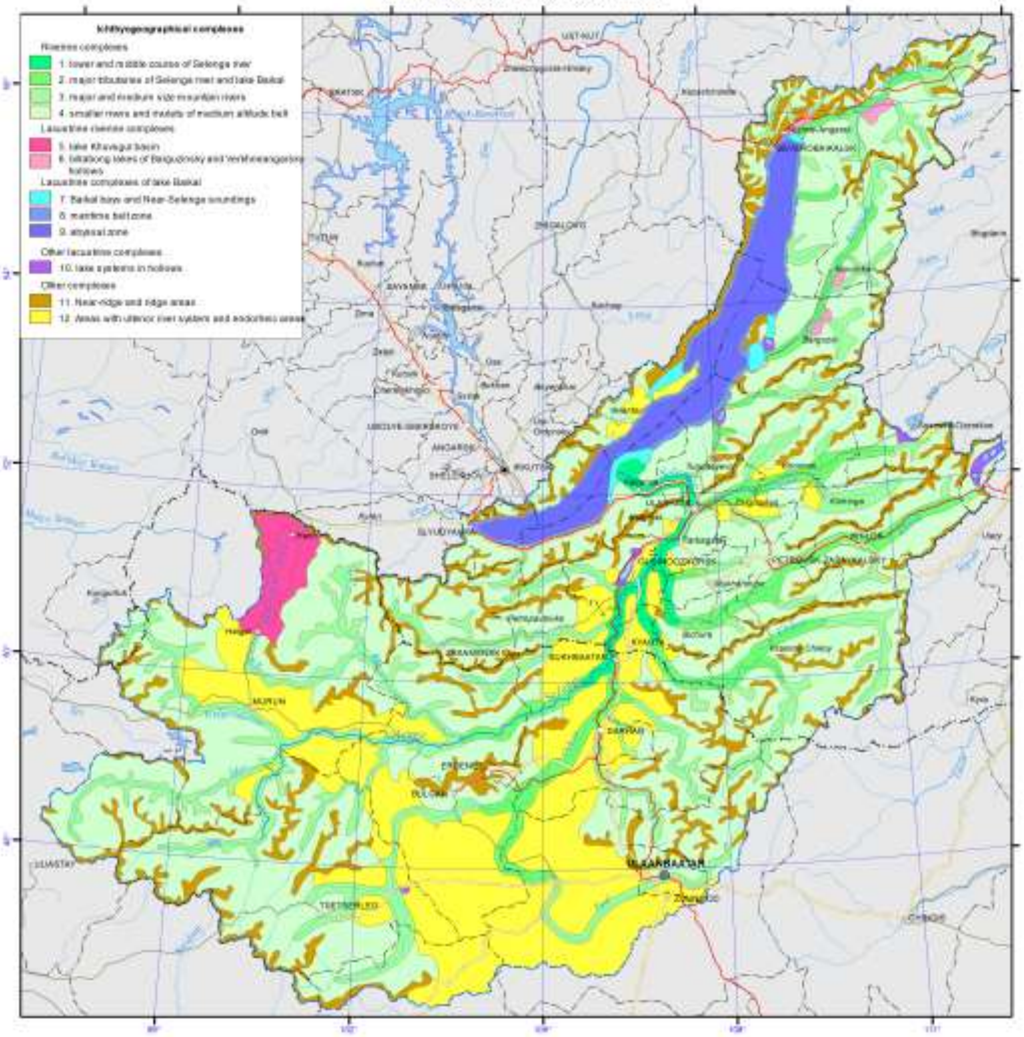
As a result of a unified research methodology the communities of terrestrial invertebrates were grouped into four groups: alpine, taiga and forest, forest-steppe and steppe, meadow and hydrophilic. Five categories of diversity structure were identified of each group by the number of taxonomic units in the community: 1 - very low diversity (less than 5 taxons), 2 - low (6-10 taxons), 3 - medium (11-15 taxons) , 4 - high (16-20 taxons) , 5 - very high (more than 20 taxons) .

On the basis of structural and dynamic analysis of differences in habitat and their invertebrates' complexes on the macrogeographical level two main types of community structure are distinguished: mesothermohygrophile with a relatively small fraction of insects and a large fraction of annelids, and xeroresistant with significant participation of the class of insects. The first type includes zoocomplexes of taiga, forest and meadow biogeocenosis, represented mainly by moisture-loving forms, the second includes steppificated, steppes and radically anthropogenically disturbed, dominated by insects with relatively short development cycles and largely adapted to moisture deficit. This corresponds to two main types of natural environment: excess moisture- taiga with humid climate and insufficient moisture - steppe with semihumid climate.

TAXONOMIC DIVERSITY OF INVERTEBRATE COMMUNITIES



ICHTHYOGEOGRAPHICAL COMPLEXES



Species of pisciforms and fish	Ichthyogeographical complexes											
	1	2	3	4	5	6	7	8	9	10	11	12
Order – **STURGEONS - *ACIPENSERIFORMES*** Family **- Sturgeons –*Acipenseridae*** Genera**- Sturgeons –*Acipenser***												
Baikal sturgeon –*A. baeriibaicalensis*	+	+					+	+				
Order – SALMONIDS –*SALMONIFORMES* Family – **Salmonids–*Salmonidae*** Genera **Brachymystax–*Brachymystax***												
Lenok –*B.lenok*	+	+	+	+	+		+	+				
Genera **Taimen–*Hucho***												
Taimen –*H. taimen*	+	+	+				+	+				
Genera**Salvelinus –*Salvelinus***												
Арктический голец (даватчан) –*S. alpinus (erythrinus)**			+	+								
Family **Coregonidae–*Coregonidae*** Genera **Coregonus–*Coregonus***												
Humpback whitefish –*C. (lavaretus) pidschian*	+	+	+				+	+				
Baikal whitefish (Sig) –*C. (lavaretus) baicalensis*							+	+	+			
Arctic cisco (Baikal omul) –*C. (autumnalis) migratorius*	+	+			+		+	+	+			
Family **Graylings –*Thymallidae*** Genera **Graylings –Thymallus**												
Black Baikal Grayling –*Th. (arcticus) baicalensis*	+	+	+	+	+		+	+				
White Baikal Grayling –*Th.(arcticus) brevipinnis*	+	+					+	+				
Baikalolensky Grayling –*Th. Baicalolenensis***			+	+								
Kosogol Grayling –*Th. (arcticus) nigrescens*					+							
Suborder **Esocoidei (Pikerels) –*ESOCOIDEI*** Family **Esocidae–*Esocidae*** Genera **Esox –*Esox***												
Northern Pike –*E. lucius*	+	+	+			+	+			+		
Order **Cyprinid fishes–*CYPRINIFORMES*** Family **Cyprinid fishes–*Cyprinidae*** Genera **abramis –*Abramis***												
Bream –*A. brama*	+						+			+		
Genera **Leuciscus –*Leuciscus***												
Ide –*L. idus*	+					+	+			+		
Siberian Dace –*L. leuciscusbaicalensis*	+	+	+			+	+	+		+		
Genera Alay **Diptychus –*Oreoleuciscus***												
Dwarf Altai Diptychus –*O. Humilis****		+	+	+								
Genera **Phoxinus–*Phoxinus***												
Phoxinus Chekanovsky –*Ph. czekanowskii*			+	+							+	
Phoxinus Lyagovsky, Amur Phoxi *Ph. Lagowskii*****				+							+	
Lake Phoxinus –*Ph. perenurus*	+									+		

Phoxinus (Eurasian minnow) – *Phphoxinus*	+	+	+	+	+	+	+	+		+	+	+
Genera **Rutilus –*Rutilus***												
Roach –*R.rutilus*	+	+			+	+	+			+		
Genera **Gudgeons –*Gobio***												
Siberian Gudgeon –*G. gobio cynocephalus*	+											
Genera **Carassius –*Carassius***												
Crucian –*C. auratus*	+					+	+			+		
Genera **Cyprinus –*Cyprinus***												
Amur carp –*C. carpiohaematopterus*	+						+			+		
Genera **Tinca –*Tinca***												
Tench –*T. tinca*						+						
Family **Balitoridae–*Balitoridae*** Genera **Barbatula –*Barbatula***												
Stone loach –*B. toni*	+	+			+		+	+				
Family **(Loaches) Cobitidae–*Cobitidae*** Genera **Cobitis –*Cobitis***												
Siberian spined loaches –*C. melanoleuca*	+	+			+		+			+		
Order Siluriformes–*SILURIFORMES* Family **Siluridae–*Siluridae*** Genera **Parasilurus –*Parasilurus***												
Amur catfish –*P. azotus*	+	+					+			+		
Order Anacanthinse –*GADIFORMES* Family **Lotidae –*Lotidae*** Genera-**Lota –Lota**												
Burbot –*L. lota*	+	+			+	+	+	+				
Order Rerciformes–*PERCIFORMES* Family **Percidae–*Percidae*** Genera **Perca –*Perca***												
River perch –*P. fluviatilis*	+	+	+		+	+	+					
Family **(Loachgobies) Eleotrididae–*Eleotrididae*** Genera **(Sleepers) Perccottus –*Perccottus***												
Amur sleeper –*P. glenii* Dybowski	+						+	+		+		

Species of pisciforms and fish	Ichthyogeographical complexes											
	1	2	3	4	5	6	7	8	9	10	11	12
ORDER (SCORPION FISHES) SCORPAENIFORMES–*SCORPAENIFORMES* Family **(bullheads)–*Cottidae*** Family **(bullheads) – Cottidae–*Batrachocottus***												
Baikal big-headed sculpin –*B. baicalensis*							+	+	+			
Spottedfin sculpin –*B. multiradiatus*								+	+			
Nikolsky sculpin –*B. nikolskii*									+			
Talievsculpin –*B. talievi*									+			
Род **Желтокрылки –*Cottocomephorus***												
Yellowfin Baikal sculpin –*C. grewingkii*								+	+			
Nothern Baikal yellowfin Baikal sculpin –*C. alexandrae*								+	+			
Longfin Baikal sculpin –*C. inermis*								+	+			
Genera **Stone (sculpins) Paracottus –*Paracottus***												
Stone sculpin –*P. knerii*								+	+			
Genera **(sand sculpins)–*Leocottus***												
Sand sculpin–*L. kesslerii*	+	+					+	+	+	+		
Family **(Baikal oilfishes)–*Comephoridae*** Genera **Baikal oilfishes –*Comephorus***												
Big Baikal oilfish –*C. baicalensis*									+			
Small Baikal oilfish –*C. dybowski*									+			
Family**(abyssal Baikal sculpins) Abyssocottidae–*Abyssocottidae*** Genera **abyssal Baikal sculpins–*Abyssocottus***												
Elokhinsky sculpin –*A. elochini*									+			
White sculpin –*A. gibbosus*									+			
Small eye sculpin–*A. korotneffi*									+			
Genera **Rough sculpins –*Asprocottus***												
Abyssal sculpin –*A. abyssalis*									+			
Rough sculpin –*A. herzensteini*									+			
Koryakov sculpin –*A. korjakovi*									+			
Small Koryakov sculpin –*A. korjakovi minor*								+	+			
Shielded sculpin –*A. parmiferus*								+	+			
Flatheaded sculpin –*A. platycephalus*								+	+			
Sharpnosedsculpin –*A. pulcher*								+	+			
Genera **Humpbacksculpins –*Cyphocottus***												
Widefin sculpin –*C. eurystomus*								+	+			
Humpback sculpin –*C. megalops*								+	+			
Genera **short-headed sculpin–*Cottinella***												
Short-headed sculpin–*C.boulengeri*									+			
Genera **Neocottus –*Limnocottus***												
Berg's abyssal sculpin –*L. bergianus*									+			
Marble sculpin –*L. godlewskii*								+	+			
Dark sculpin –*L. griseus*									+			
Narrow sculpin –*L. pallidus*									+			
Genera Neocottus –*Neocottus*									+			
Crumbly sculpin –*N.werestschagini*									+			
Warm water sculpin –*N.thermalis*									+			
Genera **Red sculpins –*Procottus***												
Red sculpin –*P. jeittelesii*								+	+			

Ghotos' sculpin –*P. gotoi*								+	+			
Dwarf red sculpin –*P. gurwici*									+			
Big red sculpin –*P. major*									+			

*In the basins of Frolikha and Svetlaya rivers

**In the basins of Verkhnyaya Angara and Barguzine rivers

***In the basins of Orkhon, Tuul, Selenga (within Mongolia) rivers

****In the basins of Khilok and Uda rivers

Empowered lives.
Resilient nations.

Natural regionalization of the Landscape- typological structure

In the presented materials natural regionalization and the landscape typological structure of the Baikal watershed basin is uniformly considered. Maps compilation is based on the idea of geosystems classification and the resultant action, including cartographic work on physical and geographical differentiation of the territory of the Russian Federation and Mongolia, which are presented below.

Physiographic structures' boundaries (individual and typological) were integrally positioned on the same topographic base in the environment Map info and verified according to the multispectral satellite images Landsat 7 (2000).

The natural regionaization map reflects individual heterogeneous regional natural formations. The featured physiographic regions and provinces characterize the territory with a similar geographical location, manifestation of morphotectonic geological and geomorphological features, latitudinal, vertical and bioclimatic zonation. Physiographic region, country and province are comparable across researches. Within this territory mountain areas of North Asian mountain megalocation on the edge of the sphere continent (Baikal-Dzhugdzhurskayai and South Siberian - Khangai - Khentey) and their contact with the Central Asian desert and steppe region of the Central continental mega-location are presented. Intraregional differentiation into provinces related to the specific manifestations of mountain-belt differences and geological and geomorphological features in mosaics of geosystems types and mobile components of soils and vegetation. The map shows three physiographic areas and 12 provinces.

Landscape-typological structure shows the features of spatial mosaic of individual physicographic units, the internal structure of a relatively homogeneous combination of physical and geographical conditions. In accordance with the small scale 39 geoms groups are shows. The geoms are distinguished according to the indicators of topological order, but generalized to the regional level [Sochava , 1978]. They combine topo-geosystems of the certain zonal or belt (within physiographic region) accessories characterized by similar structural features of soil, vegetation and hydrothermal regime. The vegetational component of a geomis adequate to formation: the soil one is close to the subtype of soils, the climate regime to the modification of climate subzone, which arose under the influence of the structural properties of the other components.

Geosystems specific to North and Central Asia form the regional classification band. Their location, interpenetration and unicity of landscape situations in the Baikal watershed basin is presented. Regional interpretation of landscape- typological units –the geom groups (A. NORTH ASIAN, GOLETS AND TAIGA: A1. Goletsand subgolets of taiga highlands East and South Siberian, A2.Mountain taiga Baikal-Dzhugdzhursky; A3.Mountain taiga South Siberian; B. NORTH ASIAN STEPPES: B1. Plains (piedmont and intermountain depressions) meadow-steppes and steppificated meadows, B2.Mountain-steppesNorth Mongolian Khangai; C. CENTRAL ASIAN STEPPES: B1. Mountain depressions West Transbaikalia/ West Mongolian of Dahurian type B2. High Plains and denudation remnants East Mongolian) characterizes their latitude, altitude and clarify the difference, as well as its relation to the various regional and typological range of natural conditions that may be disclosed in detail on a larger scale display of landscape structures and geosystems components.

Multiscale mosaic natural-territorial structure determines the complexity of the landscape area, the local "contrasts" of economic use and development of different local options.

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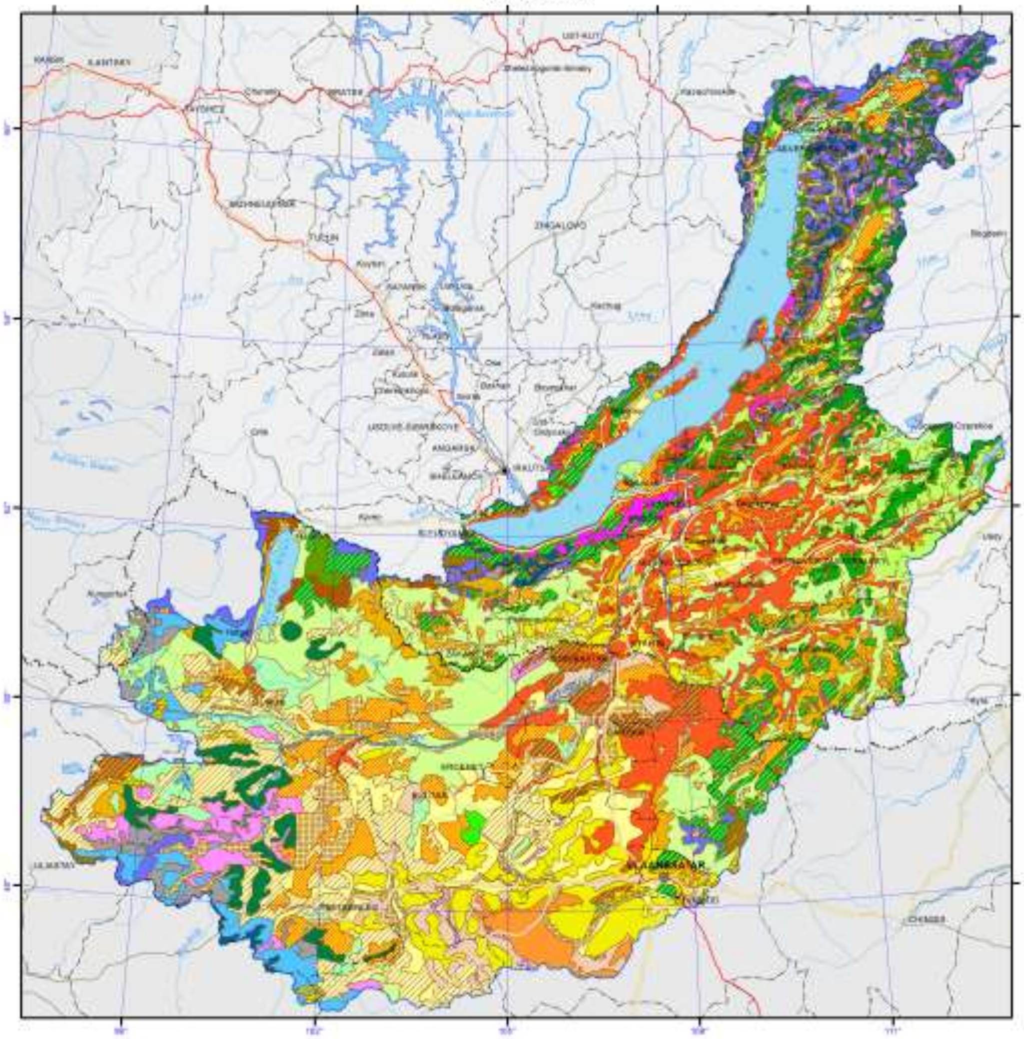
GEOSYSTEMS



A NORTHERN ASIAN ALPINE TUNDRA (GOLTSY) AND TAIGA

A1 ALPINE TUNDRA (GOLTSY) AND UNDER ALPINE TUNDRA SOUTHERN SIBERIAN AND EASTERN SIBERIAN TAIGA GEOSYSTEMS

1. Alpine tundra (goltsy) and alpine type geosystems
2. Alpine tundra (goltsy) geosystems
3. Subalpine tundra high-altitude-meadow and meadow-tundra geosystems
4. Under alpine tundra (under goltsy) high-altitude-shrubby geosystems with fragments of tundra
5. Under alpine tundra (under goltsy) sparse larch geosystems
6. Under alpine tundra (under goltsy) sparse dark-coniferous geosystems

A2 MOUNTAIN-TAIGA BAIKAL-DZUGDZURSKY

7. Medium-altitude larch geosystems of reduced development conditions
8. Intermontane depressions' and hollows' taiga larch geosystems of reduced development conditions
9. Intermontane depressions' and hollows' taiga dark coniferous geosystems of reduced development conditions
10. Medium-altitude taiga larch geosystems of limited development conditions
11. Intermontane depressions' and hollows' taiga larch geosystems of limited development conditions
12. Low-altitude taiga larch geosystems of optimal development conditions
13. Piedmont and intermontane depressions' and valleys' taiga geosystems of optimal development conditions
14. Piedmont under taiga larch steppificated geosystems

MOUNTAIN TAIGA SOITHERN-SIBERIAN

15. Medium-altitude larch-dark coniferous geosystems of reduced development conditions
16. Medium-altitude larch geosystems of reduced development conditions
17. Medium-altitude larch-dark coniferous geosystems of limited development conditions
18. Medium-altitude larch geosystems of limited development conditions
19. Piedmont and intermontane depressions' and valleys' taiga dark coniferous geosystems of limited development conditions
20. Piedmont and intermontane depressions' and valleys' taiga cedar-larch geosystems of limited development conditions
21. Low-altitude taiga dark coniferous geosystems of optimal development conditions
22. Low-altitude taiga larch geosystems of optimal development conditions
23. Mountain taiga light coniferous geosystems
24. Piedmont and intermontane depressions' and valleys' taiga dark-coniferous geosystems of optimal development conditions
25. Piedmont under taiga light coniferous geosystems in combination with mountain steppe

B NORTHERN ASIAN STEPPE

B1 PLAIN (PIEDMONT AND INTERMONTAN DEPRESSIONS) MEADOW-STEPPE AND SPEPPIFICATED MEADOW

26. Piedmont plains and piedmont hollow meadow steppe
27. Lowland valleys' and intermontane depressions steppificated –meadow, occasionally swamped geosystems

B2 MOUNTAIN-STEPPE NORTHERN-MONGOLIAN KHANGAISKY

28. Mountain mixed herb- bunchgrass and bunchgrass geosystems
29. Piedmont and intermontane depressions' bunchgrass geosystems
30. Lowland (hollow base and hollow)meadow-steppe shrubby occasionally swamped geosystems

C CENTRAL ASIAN STEPPE R

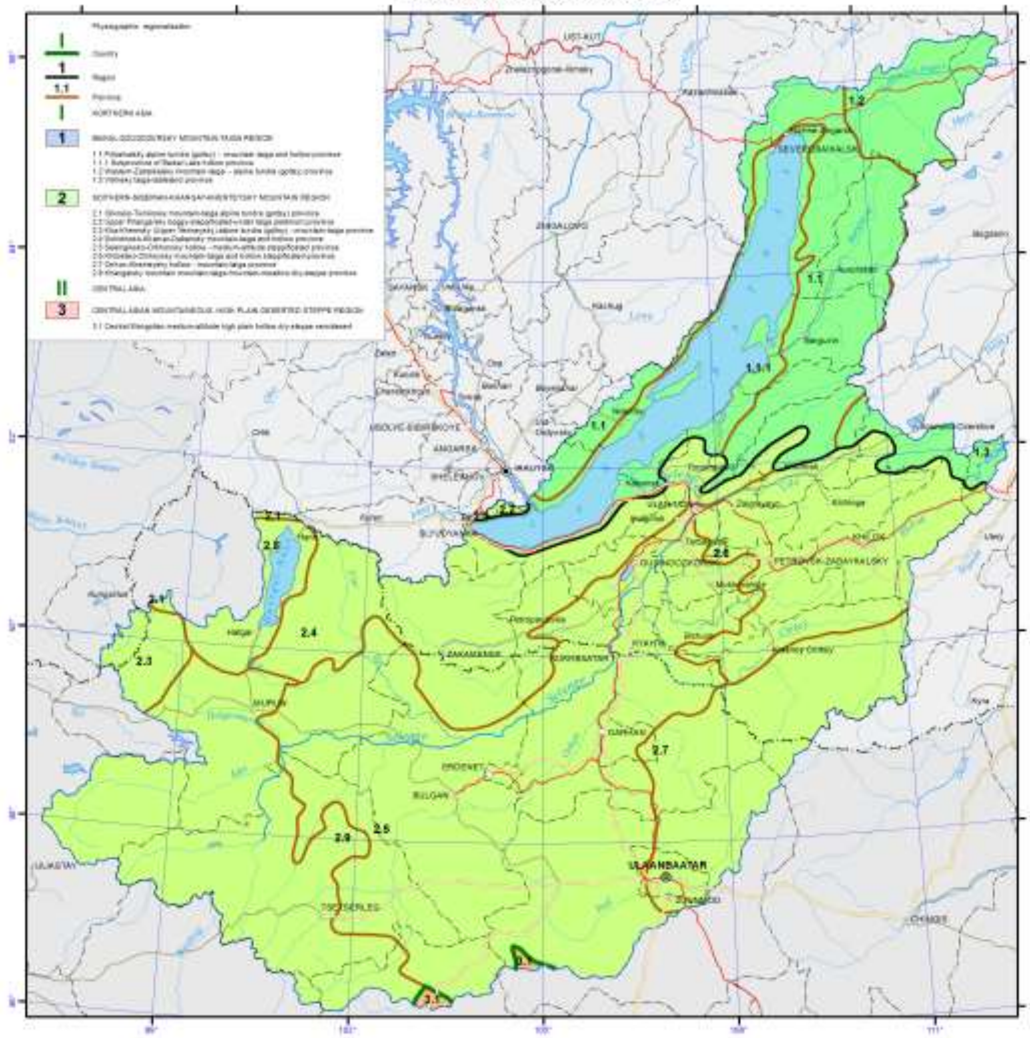
C1 MOUNTAIN-HOLLOW WESTERN SIBERIAN WESTERN MONGOLIAN DHAURSKY TYPE

33. Lowland (hollow base and hollow)short-grass steppificated-meadow cryosolic and meadow boggy geosystems
31. Mountain steppe (bunchgrass- gramineous- Volga fescue) geosystems
34. Mountain dry-steppe bunchgrass geosystems

HIGH PLAINS AND DENUDATION ISOLATED HILLS'DRYSTEPPE EASTERNMONGOLIAN TYPE

32. Piedmont and intermontane dry-steppe (tall grass-feather-grass and low-bunchgrass) geosystems
35. High plains dry steppe (Filifolium sibiricum-mixed herb and low-bunchgrass feather-grass geosystems)
36. Lowland meadow - solonetz-saline geosystems

PHYSIOGRAPHIC REGIONALIZATION



Landscapes stability

Landscapes stability is one of the most important parameters determining the state of the environment and changes occurring in it under the influence of natural and anthropogenic factors. The nature of landscape changes depends on the location in the geographical environment, their properties, and type and extent of the anthropogenic impact. Of particular importance is the estimation of landscapes stability of the Lake Baikal catchment area, which is a territory of high environmental responsibility.

Landscape stability is a property of a geosystem to maintain its structure and the mode of functioning under changing conditions of its environment [Protection of landscapes..., 1982]. An assessment and mapping of landscapes stability are made according to the complex of natural and anthropogenic factors of influence. The natural factor is mainly determined by the influence of climate (indicators of heat-moisture supply) and the properties of lithological-and-geomorphological basis. The anthropogenic influencing factor is associated with the background nature management, which is based on spatially extensive use of natural resources, and lands, closely related to the zonal-belt features of natural landscapes. The background types of nature management in the study area include agriculture, mainly in steppe landscapes, forestry in taiga landscapes, as well as recreation.

Stability is considered in relation to landscapes of two levels: regional (geoms) and topological (groups of facies). A landscape map, compiled by the authors on the basis of landscape maps of the territory under consideration [Landscapes..., 1977; Landscapes..., 1990], was used for its mapping.

Stability of landscapes of the regional level – geoms – is determined based on the level of *natural ecological potential of a landscape* (EPL), the main indicator of which is the *index of biological effectiveness of climate* (TK) according to N.N. Ivanov [Ecological..., 2007, Ecological..., 2007]. Characterization and comparative assessment of this indicator is based on two determining factors, namely, the ratio of heat and moisture, on which the biological productivity of a landscape and ecological capacity primarily depend. At the same time, the influence of latitudinal and altitudinal zonality on their distribution is traced. A single and continuous process of moisture and heat exchange not only forms the spatial differentiation and a type of a landscape, but also determines their stability. Landscapes with high values of TK and EPL are the most stable, while low values of these parameters characterize unstable landscapes.

Twenty-two geoms are represented in the landscape structure of the territory under consideration. Mountain terrain predominates in the catchment area of Lake Baikal. Therefore, this territory is characterized by the high-altitude belt differentiation of landscapes, which determines the degree of their stability.

At the regional level, according to the values of these indicators, landscapes are subdivided into five ecological groups of geoms, to which the corresponding values of stability, ranged on a five-point scale, are assigned. These values are considered as the starting point, or background stability.

A geom unites groups of facies similar in structural-dynamic characteristics [Sochava, 1978]. This taxonomic unit is important in generalization of geotopological works. Inside a geom, stability was readjusted in respect of groups of facies with different dynamic categories. A set of variable states of these categories includes indigenous, pseudo-indigenous, serial and derivative geosystems under one epifacie. The highest natural and anthropogenic stability characterizes indigenous landscapes with well-established intrasystemic and external relations; many of them are notable for durability. Pseudo-indigenous landscapes, unlike indigenous ones, are modified as a result of hypertrophy of one of the components of the system. Serial facies in most cases are nondurable, quickly alternating with each other spontaneous geosystems, formed under the significant hypertrophy influence of various natural factors. In a range of transformation of geosystems they are characterized by the greatest variability and are prone to damage, and therefore they are classified as landscapes unstable to anthropogenic impacts. Derivative landscapes are variable states of geosystems caused by human influence. They are characterized by different degrees of stability.

The highest values of stability, considered as the initial point corresponding to the background rate of stability of a geom, are set for indigenous facies. Further on, the initial point is reduced to three gradations, namely, for pseudo-indigenous, serial and derivative facies. For pseudo-indigenous facies a decrease in the stability by 1 point in relation to the initial point is possible; for serial facies it can amount to 1-2 points. For derivative facies deviations from the norm can reach 1-2 points towards an increase or decrease in the stability depending on the type of succession, namely, progressive stabilizing or digressive destabilizing.

To assess the anthropogenic stability of landscapes an analysis was made of disturbances of natural environment, arising under the influence of various types of human activities related to the background land use. According to the predominant nature of the background land use, the following types of functional load on the environment were distinguished: agricultural arable and grazing (mainly for steppe and forest-steppe landscapes), and forestry (for taiga landscapes) and recreation.

Stability of arable lands was largely determined by the intensity of erosion loss, soil deflation and pesticide pollution, and natural self-purification potential of soils. Stability of natural-forage lands was determined in respect of plant communities to grazing and haymaking and was assessed according to the degree of degradation of hayfields and pastures, susceptibility to erosion and deflation, and recoverability of vegetation and soils.

The most significant impact on the state of forests is made by commercial logging using the clear felling approach. Stability of forest landscapes was determined according to the degree of disturbance of forests by felling and fires, recreation, and agricultural use. Reforestation is influenced by changing temperature conditions, hydrophysical properties of soils, evolving erosion and cryogenic processes, deflation and waterlogging in felled and burnt areas. An important criterion for stability, i.e. forest bonitet, is an indicator of productivity and environmental growth conditions, evaluated by richness (trophicity) and moisture content of soil. Environmental factors, spontaneous and associated with the human activity, prevent natural reforestation; their progressive successions do not reach the original state. Such landscapes fall in the category of the most unstable.

Recreational stability is assessed referring to the mass recreation and tourist-excursion activities. Indicators of the degree of recreational digression of landscapes, depending on the type and intensity of recreational influence, sensitivity and recoverability of landscapes, which together define their recreational potential, served as stability criteria. Stability of landscapes is a key indicator, based on which the regulation of recreational loads is made.

The compiled map reflects the territorial diversity of landscapes stability, characteristics of which is presented in the table.

The lowest and low (I-II points) stability characterize golets and sub-golets landscapes presented in major mountain ranges in the north-eastern and south-western parts of the territory. In the north-east, they are golets and sub-golets landscapes of the Baikalsky, Verkhne-Angarsky, Barguzinsky, and Ikatsky ridges in the framing of the Severo-Baikalskaya, Verkhne-Angarskaya and Barguzinskaya depressions. In the Hovsgol region and in Southern Pribaikalie they include the Eastern Sayan mountain structures. In the south-west, alpine meadows, and subalpinotype and subgolets landscapes of the Khangai and Khentei uplandsare characterized by low stability.

Ecological potential of these landscapes is very low; TK is less than 8. The structure of geoms is dominated by serial groups of facies. They are characterized by severe climatic conditions and dissected mountainous terrain, active development of exogenous geological processes, and lack of heat and excess of moisture. The same values of stability are assigned to steppe landscapes of depressions and valleys bottoms, characterized by excess heat together with the lack of moisture, with manifestations of cryomorphism, waterlogging, water erosion and deflation, and soil salinization.

In general, the Lake Baikal basin is dominated by moderately stable and stable landscapes (III-IV points), distributed mainly in the central part of the territory. They are characterized by medium and relatively high ecological potential; the index of biological effectiveness of climate amounts to 8-16. Pseudo-indigenous geosystems with a relatively stable landscape structure predominate.

Landscapes of reduced development of mountain-taiga and taiga intermountain depressions and valleys, having dispersed distributional pattern and occurring in the Selenga-Vitim interfluve and to the north of the Khangai upland, are referred to the stability of III points.

The stability of III points also characterizes piedmont and plain relatively dry and arid steppes. They are located in the Barguzinskaya depression, in hollows of the Trans-Baikal type, to the north of the Khangai upland, and in the surroundings of the Khentei upland.

The group of geoms with the stability of IV points includes mountain-taiga landscapes of restrictive and optimal development, taiga piedmont landscapes of intermountain depressions and valleys of restrictive development, mountain low-bunchgrass and forb-bunchgrass, and mountain dry steppes. The main areas of development of taiga landscapes of this stability group are low- and midlands to the south of the Eastern Sayan,the Primorsky ridge, Selenginskoe midland, Vitimskoe plateau, Olekminsky Stanovik, Khentei-Chikoiupland, and others. Mountain steppes with IV points of stability are most commonly found in the Selenge-Orkhon interfluve.

Landscapes with the highest ecological potential for the region, and TK amounting to 16-20, are classified as the most stable (V points). In the Russian part of the territory, they are landscapes of piedmont and intermountain depressions of optimal development, as well as piedmont subtaiga landscapes. They are found in the Verkhne-Angarskaya and Barguzinskaya depressions, in the Selenga river delta, and in depressions of the Trans-Baikal type. In Mongolia they are represented by mountain subtaiga landscapes, the large areal of which is midlands and lowlands lying to the north of the Khangai upland in the central part of the basin of the Selenge and Orkhon rivers. The structure of geoms is dominated by pseudo-indigenous and indigenous geosystems. They are the nuclei of the ecological stability and reproduction of the environment [Mikheev, 2001]. In the landscape structure of the region their distribution area is in the transition zone between taiga and steppe landscapes with low background stability.

The conducted mapping of landscapes stability is the basis for the assessment of the anthropogenic impact on the environment, and for substantiation of environmentally acceptable nature management in the Lake Baikal basin.

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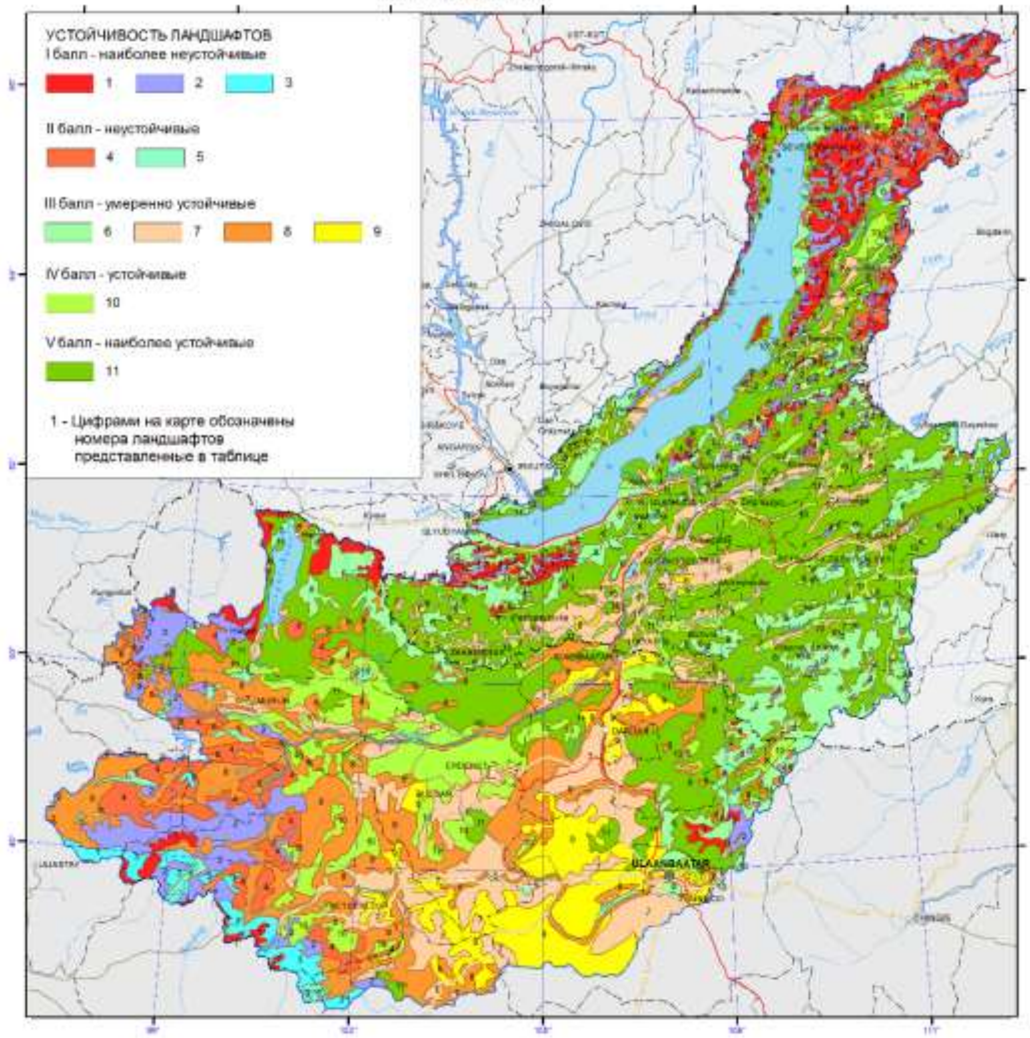
LANDSCAPE STABILITY



СЕВЕРОАЗИАТСКИЕ ГОЛЬЦОВЫЕ И ТАЕЖНЫЕ		ЦЕНТРАЛЬНОАЗИАТСКИЕ СТЕПНЫЕ			
ГОЛЬЦОВЫЕ И ПОДГОЛЬЦОВЫЕ БАЙКАЛО-ДЖУГДЖУРСКИЕ И ВОСТОЧНО-САЯНСКИЕ	ГОРНОТАЕЖНЫЕ БАЙКАЛО-ДЖУГДЖУРСКИЕ И ЮЖНОСИБИРСКИЕ	ГОРНО-ЛУГОВЫЕ СЕВЕРО-МОНГОЛЬСКОГО ТИПА	ГОРНО-СТЕПНЫЕ ЗАПАДНО-ЗАБАЙКАЛЬСКИЕ ДАУРСКОГО ТИПА	ГОРНО-СТЕПНЫЕ СЕВЕРО-МОНГОЛЬСКИЕ ХАНГАЙСКОГО ТИПА	ВЫСОКИХ РАВНИН И ДЕНУДАЦИОННЫХ ОСТАНЦОВ СУХОСТЕПНЫЕ ВОСТОЧНО-МОНГОЛЬСКОГО ТИПА
I балл*, наиболее неустойчивые, экологический потенциал очень низкий, индекс биологической эффективности климата 4-8					
1. Гольцовые и моховостепные и тундровые 2. Субальпийско-таежные горно-луговые и подгольцовые кустарниковые, лиственничные и темнохвойные редколесья и каменно-березовые		3. Высокогорные луговые и гольцовые			
II балл, неустойчивые, экологический потенциал низкий, индекс биологической эффективности климата 8-12					
	4. Горные и межгорных понижений и долин таежные лиственничные и темнохвойные регрессивного развития		5. Долинные и днищ котловин остепненно-луговые мерзлотные и лугово-болотные		
III балл, умеренно устойчивые, экологический потенциал средний, индекс биологической эффективности климата 12-16					
	6. Горные, подгорные, межгорных понижений и долин таежные лиственничные и темнохвойные ограниченного развития		7. Горные, подгорные, межгорных понижений степные относительно сухие	8. Горные, подгорные и днищ котловин степные относительно сухие	9. Горные и равнинные опустыненные и солонцово-солончаковые
IV балл, устойчивые, экологический потенциал относительно высокий, индекс биологической эффективности климата 16-20					
	10. Горные и подгорные подтаежные лиственничные и сосновые и лесостепные				
V балл, наиболее устойчивые, экологический потенциал высокий, индекс биологической эффективности климата 20 и более					
	11. Горные, подгорные межгорных понижений и долин таежные лиственничные и темнохвойные оптимального развития				

*Исходный балл фоновой устойчивости геомов присваивается по коренным ландшафтам, для которых расчетная устойчивость соответствует исходному баллу фоновой устойчивости. Для мнимокоренных ландшафтов при определении расчетной устойчивости возможно снижение фоновой устойчивости на I балл, для серийных – возможно снижение на I-II балла, для производных – возможно снижение или увеличение устойчивости на I-II балла, в зависимости от восстановительной, либо регрессивной сукцессии.

RESOURCE FACTORS OF FORMATION OF ECOLOGICAL SITUATION IN THE LAKE BAIKAL BASIN

Fuel and energy resources and their development

Fuel and energy resources of the Lake Baikal basin are represented by deposits of solid fossil fuels (black and brown coals of different ranks), oil shales and uranium.

Coal deposits are confined to the Upper-Mesozoic depressions of the Transbaikalian type, the most significant of which are Tugnuiskaya, Gusinoozerskaya, Udinskaya, Chikoiskaya and others. The main reserves of black coals within the territory under consideration are focused in the Erdem-Galgataiskoe, Krasnochikoiskoe, Nikolskoe, Olon-Shibirskoe, and Zashulanskoe deposits; reserves of brown coals are localized in the Gusinoozerskoe, Zagustaiskoe, Taseiskoe, Sharyngol, and Ulaan-Ovoo deposits. The largest deposits are located in economically developed regions with an extended infrastructure, including the presence of traffic arteries in the form of railways and auto-roads. Among 33 coal deposits, located within the territory of the Lake Baikal basin, sixteen are currently under development.

To date the largest coal producer not only of this area, but in general of Eastern Siberia and the Far East is the Tugnuisky open-pit coal mine, which develops the Olon-Shibirskoe deposit (97% of the reserves occur within the Petrovsk-Zabaikalsky municipal district of Zabaykalsky Krai, and 3% are deposited in the Mukhorshibirsky district of the Republic of Buryatia). Due to the adaptation of the most up-to-date high-efficiency equipment of the world-renowned manufacturers, the production here has more than doubled for three years and reached about 13 million tons in 2012. To enhance the competitiveness of the coal produced, a concentrating mill with the use of unique technological developments was built. Currently, the capacity of this processing plant has reached 9 million tons. Coal is mainly exported to Japan, Korea, China and other APAC countries.

The coal industry of Buryatia experienced a significant decline after closing of the major coal producers of that time in the early 1990s, namely: the Kholboldzhinsky open-pit mine and the Gusinoozerskaya mine (Selenginsky district). Currently, JSC “Coal Company Bain-Zurkhe” holds licenses for the Bain-Zurkhe and Kholboldzhinsky sites of the Gusinoozerskoe deposit. This company has resumed the coal feed from the deposit to the Gusinoozerskaya state district power plant. A radically new development technology is applied, i.e. a complex of deep extraction of seam; there is a gradual growth in coal production (in 2012 - 932 thousand tons).

In recent years, LLC “Ugolny razrez”, that develops the Okino-Klyuchevskoe brown coal deposit in the Bichursky municipal district of the Republic of Buryatia, has been expanding production capacities. It is expected to increase the capacity of the enterprise to 5 million tons per year and to continue the construction of the railway spur as far as the Khoronkhoy station to transport coal to the Gusinoozerskaya state district power plant. Moreover, to provide the thermal energy facilities of the Republic of Buryatia with the coal of its own, a construction of a large Nikolsky open-pit mine along with a processing plant on the basis of the balance reserves of the same-name coal deposit is planned. In the Selenginsky municipal district nowadays LLC “Buryatugol” develops the Zagustaiskoe deposit. It produces more than 200 thousand tons of brown coal per year.

The remaining coal producers of Zabaykalsky Krai and the Republic of Buryatia within the territory of the Lake Baikal basin mine in small volumes (10-50 thousand tons per year), mainly for housing and utilities needs; they are the Daban-Gorkhonsky, Khara-Khuzhirsky, Zashulansky, and Burtuisky open-pit mines. An exception is LLC “Razrez Tigninsky”, which develops the Tarbagataisky deposit in the Petrovsk-Zabaikalsky district. In 2012, 260 thousand tons of brown coal were produced here, which significantly exceeded the level of 2010-2011. All coal is mined by open-pit operation.

Mongolia's oldest coal producer is the “Nalaikha” mine, extraction at which was launched in small volumes in 1912. After the reconstruction in the 1950s the capacity of the producer increased up to 600-800 thousand tons of brown coal per year. The mine is the town-forming enterprise of the town of Nalaikh and was originally the only source of fuel for thermal power plants under construction in Ulaanbaatar. After the official closure of the mine due to the impossibility of its safe operation, artisanal mining of the deposit by efforts of former professional miners started.

The Sharyngol brown coal deposit was discovered by Soviet geologists in the 1930s, but the development of the deposit began only in 1961, after additional exploration. In the 1980s, the the open pit capacity reached the maximum values of 2.5 million tons per year. Currently, the company is privatized; in 2010 the production was about 1 million tons; mining is open pit.

In the Selenge aimak, the Ulaan-Ovoo high-energy brown coal deposit is being developed. Currently, the Canadian company «Prophessy coal» holds the development license of this deposit, having begun its exploitation in 2010.

In small volumes coal is produced in the Zhulchig bulag, Nuurestein am (Khuvsgel aimak), and Saikhan ovoo and Ereen (Bulgan aimak) deposits.

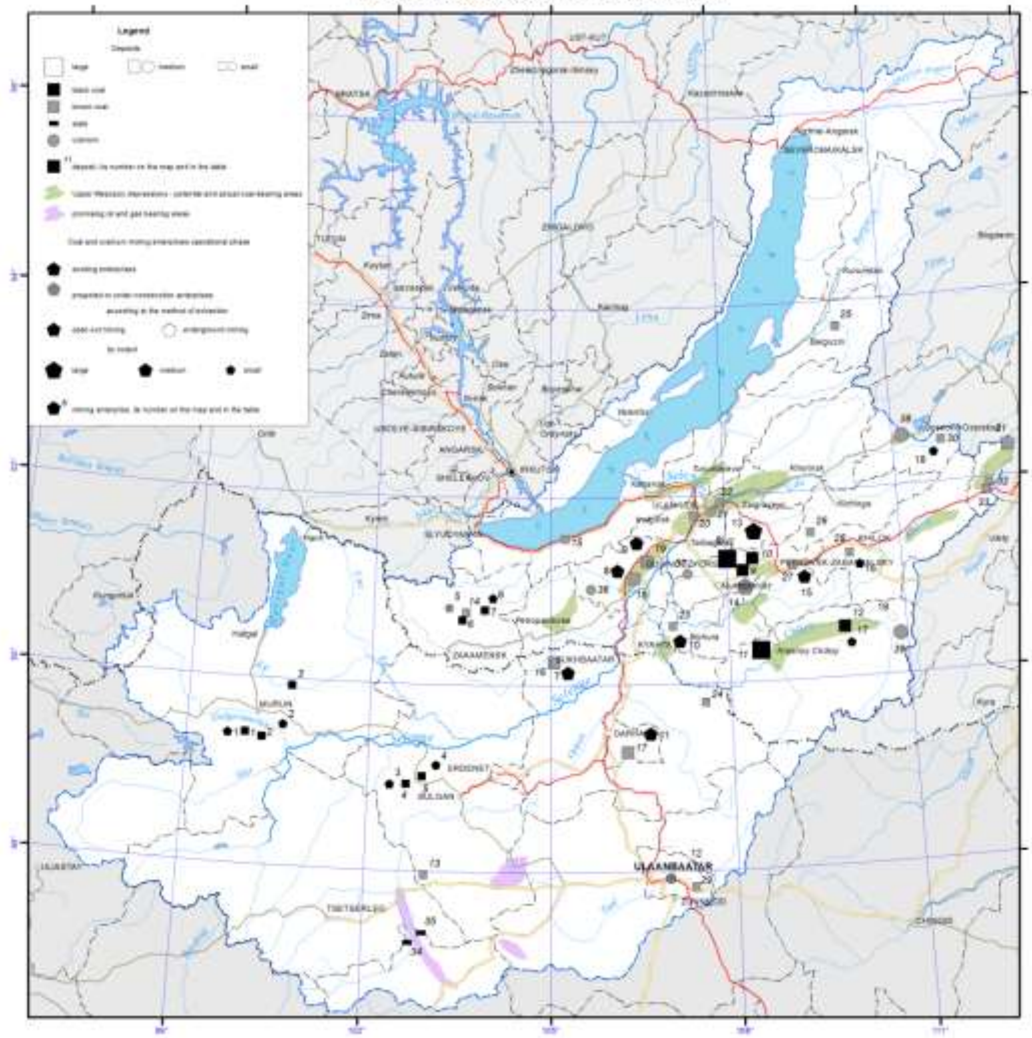
At present two small (in respect of reserves) deposits of *uranium raw material* (Slantsevoe in the Dzhidinsky municipal district and Zhuravlinoe in the Mukhorshibirsky municipal district of the Republic of Buryatia; both deposits belong to the Selenginsky uranium ore region; a preliminary exploration was conducted at the deposits), and two medium ones, namely: Buyanovskoe in the Eravninsky district of Buryatia (Eravninsky uranium ore region; the deposit is in the state reserve) and Gornoe in the Krasnochikoisky municipal district of Zabaikalsky Krai (Chikoisky uranium ore region) are known within the Lake Baikal basin. The last deposit is being prepared for industrial development to produce natural uranium concentrate. It is planned to construct an underground mine and a heap leach pad for processing uranium ore mined.

The territory of the Lake Baikal basin, except for solid fuel, was recognized as promising for the discovery of commercial deposits of *raw hydrocarbons*, especially natural gas within the Selenginskaya and Ust-Barguzinskaya rift troughs. According to the results of the prospect evaluation survey carried out in the Ust-Selenginskaya depression in 1955, 1962, and in the 1990s, its prospective hydrocarbon resources were estimated for oil amounting to 364 million tons, and for natural gas – 520 billion m^3 (category C3). Works on estimation of the prospects of the Barguzinskaya depression are in progress.

Oil shale deposits in view of the small sizes and low resin content (8-10%) are of no commercial interest.

The map “Fuel and energy resources and their development” shows deposits of solid fossil fuels (black coal, brown coal and uranium) using different symbols. The symbol size is determined by the size of a deposit. Mining companies are also shown using symbols. The symbol size is dependent on the average production output for the last 3-5 years (for operating enterprises), or on the design capacity (for companies being designed and constructed). The following ranking of enterprises was adopted: large ones with the production of over one million tons, medium ones – from 100 thousand tons to one million tons, and small ones – less than 100 thousand tons per year for coal mining enterprises; the projected uranium mining company “Gornoe” is a small one with the production of less than one thousand tons of uranium per year. Circled symbols show underground mining, and color shows the exploitation stage of an enterprise (operating or being designed and constructed). Upper-Mesozoic depressions are shown with areals: potential and actual coal-bearing regions and prospective oil and gas areas.

ENERGY RESOURCES AND THEIR DEVELOPMENT



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Resources of ferrous, nonferrous and rare metals and their mining

The exploration work has discovered more than 150 deposits of metal minerals within the Lake Baikal basin.

Ferrous metals are presented by a number of iron ore deposits of different genetic types, including two small (in terms of reserves) magnetite deposits, namely, Balbagarskoe in the territory of the Khorinsky municipal district of the Republic of Buryatia and Baleginskoe in the Petrovsk-Zabaikalsky district of Zabaikalsky Krai. In the 18th-19th centuries, the Baleginsky mine supplied the Petrovsky plant with iron ore to provide iron and steel for the mines of the Nerchinsky district. In the Olkhonsky municipal district of Irkutsk oblast iron ore deposits of small reserves are known; they are mainly represented by brown iron ore deposits (Borsoiskoe, Kuchelginskoe, etc.). In the first half of the 18th century, ore of these deposits was used for the needs of the Anginsky (Laninsky) ironworks. The most promising iron ore deposits of Mongolia are deposits of the skarn type, namely, Tumurtolgoy, Bayangol, and Tumurtey, which form the Bayangolskaya iron ore zone in the north of the country. Currently, iron ore deposits in the region are developed only in the territory of Mongolia: ore is mined in small amounts in the Zakhtsag and Tamir gol deposits; in recent years, the production at the deposits of the Bayangolskaya iron ore zone has been more than 5 million tons, primary processing of ore is performed at the concentrators near the deposits; iron-ore concentrate is exported to China.

The Oldakit manganese deposit, medium in terms of reserves, is located in the North-Baikal municipal district less than 30 km from the Baikal-Amur Mainline road. Given the fact that Russia is currently experiencing shortage of this raw material, the deposit may be of some interest. Moreover, several small deposits of manganese are known within the Lake Baikal basin, including the Ozerskoe deposit (the Olkhonsky district), which was developed in the 19th century for the needs of the Nikolaevsky ironworks.

Nonferrous metals. Almost all reserves and resources of copper ores of the region are concentrated in complex copper-molybdenum and molybdenum-tungsten deposits of Mongolia, located within the Selenginsky volcanic belt. From 1978 till now a large deposit Erdenetiyn ovoo has been developed; on its basis a joint Soviet-Mongolian venture, namely, Erdenet Mining Corporation was established. The company is engaged in open-pit mining and primary processing of copper-molybdenum ores and is one of the world leaders in the production of copper concentrate. Currently, the production is more than 25 million tons of ore, and the production of copper concentrate is about 350 thousand tons. In a globalizing world economy, the company faces the challenge of competitiveness of their products, which necessitates the construction of a copper-smelting plant. At present, Erdenet Mining Corporation includes a pilot plant for the production of pure cathode copper from off-balance and storage ore dump piles of LLC “Erdmin”, which is a joint venture of Erdenet Mining Corporation and American company RCM.

Within the Lake Baikal basin, the largest Kholodninskoe deposit of lead-zinc sulfide ores is explored and prepared for industrial development; its reserves amount to 11.2% of the lead reserves and 34.1% of the zinc reserves of the Russia's total reserves. Based on the economic indicators of development, the deposit corresponds to the best world analogues. According to the feasibility study of final mining parameters, the annual production of the underground mine at the deposit should amount to 3 million tons of ore, 504 thousand tons of zinc concentrate, and 60.3 thousand tons of lead concentrate. In order to ensure environmental safety of production, provision is made for a circulating water supply system, transportation of wastes of the concentrating mill outside the catchment of Lake Baikal using pipelines, and a number of other environmental measures. However, due to the fact that the deposit is located in the Central Ecological Zone of the Baikal Natural Territory (BNT), where mining activity is banned, the production license, owned by LLC “InvestEvroKompaniya”, was suspended until 2015. Among other objects of polymetallic raw materials in the region, the Davatkinskoe deposit (medium in terms of reserves), discovered and assessed in the Khorinsky municipal district of the Republic of Buryatia, should be noted.

In Buryatia there are two large deposits of molybdenum ores, namely, Zharchikhinskoe and Malo-Oinogorskoe, and small Pervomaiskoe (abandoned) and Dolon-Modonskoe (undeveloped) deposits. There is a project for the construction of the Pribaikalsky mining and concentrating mill on the basis of the Zharchikhinskoe deposit, located 40 km to the south of Ulan-Ude in close proximity to the highway and railway, with the molybdenum content in the ore of more than 0.1% and high technological and technical-economic indicators. Its effective development is possible, provided that all necessary environmental requirements are followed.

Tungsten in the region belongs to the widespread elements. In the territory of the Zakamensky municipal district there is the Inkurskoe deposit of the stockwork geological-industrial type, which is comparable to the largest analogous deposits of the world with respect to the reserves and tungsten content. The Kholtosonskoe deposit, located to the west of the Inkurskoe one, is the largest deposit of the vein type in Russia, and according to its characteristics is considered to be unique not only in Russia but also in the world. The Dzhidinsky tungsten-molybdenum mill operated from 1934 to 1996 on the basis of these two deposits as well as the Pervomaiskoe molybdenum deposit. After the closure of the mill, a tailings pond remained over an area of more than 1 km^2, which represents a man-made Barun-Narynskoe deposit, the development of which has been started by JSC Zakamensk since 2010. A concentrator for mill waste recycling was built 1.5 km from the town of Zakamensk; the concentrate production amounts to about 300 tons per year. CJSC Tverdosplav is involved into the reconstruction of mining sites at the Inkurskoe and Kholtosonskoe deposits. It is planned to construct a modern concentrator and hydrometallurgical workshop for processing of tungsten concentrates to produce commercial treated tungsten compounds. In the Petrovsk-Zabaikalsky municipal district of Zabaikalsky Krai the prospectors' artel Kvarts mines using the underground method the medium (in terms of reserves) Bom-Gorkhonskoe tungsten deposit. In recent years, the concentrate production is about 600 tons. Remaining tungsten deposits within the territory of the Russian part of the Lake Baikal basin are temporarily abandoned or are in the state reserve.

A number of tungsten deposits are known in Mongolia. At the Tsagaan davaa deposit a small tungsten ore processing plant was created; the concentrate production amounts to about 40 tons per year; the final products are exported to the United States and China.

Tin deposits located in the Krasnochikoisky district are small in terms of reserves and are currently mothballed.

In the Dzhidinsky district of Buryatia, medium (in respect of reserves) Borgoiskoe (Al2O3 – 19.8% on average) and Botsinskoe (21.44%) deposits of nepheline-bearing rocks are preliminary explored; currently, they are not being developed.

Rare metals. In the Kizhinginsky municipal district of the Republic of Buryatia there is the Ermakovskoe deposit of beryllium ores, which contains 80% of the beryllium reserves of Russia and is unique concerning the grade of ore. From 1978, the deposit was developed by the Zabaikalsky mining and concentrating mill; in 1990, the company was mothballed. Beryllium is a strategic metal, which is essential for the development of nuclear, aerospace, and aviation industry, and instrument engineering; it is used in the manufacture of telecommunications equipment. Currently, the demand of Russia for this metal is met through imports. Taking into account the need to restore the raw-material and production independence of the country in obtaining beryllium, it is expected to resume the ore production at the deposit, and to create production on primary processing of ore, as well as hydrometallurgical production, the final product of which – beryllium hydroxide – will be delivered to the Ulbinsky metallurgical plant in Kazakhstan for processing and producing beryllium alloys and metal. The work on creating the beryllium production is included in the Federal target program for the rare metals of paramount importance.

In the Severo-Baikalsky municipal district within the Central Ecological Zone of the BNT, three subsoil plots of the Federal importance with large prognostic resources of rare earths of the yttrium group are in the state reserve; they are the Chestenskoe, Akitskoe and Pryamoy-Il deposits.

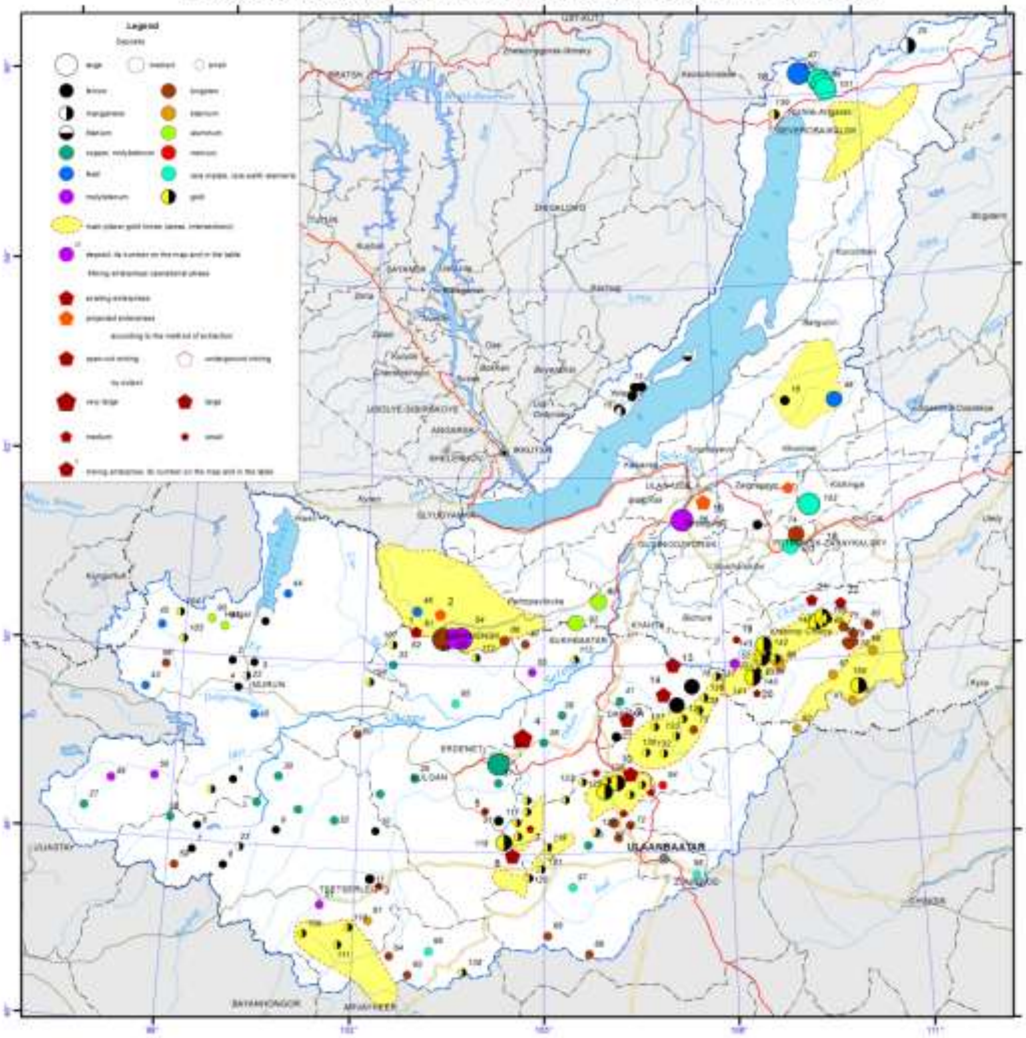
Noble metals. Within the Russian part of the Lake Baikal basin there are no lode gold deposits (except for the woked-out Voskresenskoe one in the Krasnochikoisky municipal district). Placer deposits are small or medium (concerning the reserves) and are grouped into the gold-placer regions, namely: Dzhidinsky, Namaminsky, Yambuy-Tolutaisky, Chikoisky, and Baldzhikansky. In the Republic of Buryatia within the territory under consideration gold practically hasn't been produced for the last three years (economically advantageous deposits are worked-out, and prospecting and exploration works require substantial expenditures); in the Krasnochikoisky district of Zabaikalsky Krai, four prospectors' artels produce 300-400 kg of gold annually using the open-pit hydromechanical method.

Gold is the second significant resource of Mongolia after copper. The industrial mining of gold ores in the country began in the early 20th century by the Russian-Mongolian joint-stock company "Mongolor" in the Iro-Gol river basin, in the Hovsgol region and in the Boroo area. Primary deposits are usually of the vein type, more rarely – mineralized zones. The most significant primary deposits concerning the size of reserves include the Boroo deposit in the Boroo-Zuunmod region and the Bumbat deposit in the Zaamarsky gold field. The metal content in individual layers reaches 10 g/t. The deposits are developed by Canadians with an annual production of 5 and 1.5 tons of metal, respectively. Moreover, gold is currently mined at the Narantolgoy and Nariyn gol deposits.

Among the placers small and medium ones predominate, and only single ones are large placers in terms of reserves. Most placers are shallow single-layer, more rarely double-layer; in rare cases there occur deep-seated deposits. Dredging and separate production techniques are applied at the placer deposits. After mining by large companies, the remaining gold is mined by individual prospectors, whose number has exceeded 10 thousand people, according only to the official data. In river valleys, where it is possible to mine, huge settlements are formed. As a result, in recent years, an intensive shallowing of rivers and their pollution, reduction of grazing lands for cattle, and a process of desertification of the southern territory have been in progress in the country, and there appear problems of lack of drinking water for the population. This is largely due to the large volumes of gold mining in the river valleys, illegal use of mercury and cyanides, and almost total lack of reclamation.

The map shows metallic mineral deposits using symbols, depending on their size and type of commercial minerals. Mining companies are also shown with symbols. The size of a symbol corresponds to the production output. The group of large companies include enterprises producing ferrous, nonferrous and rare metals with the production ranging from 1 to 10 million tons of ore per year, the group of medium ones has the production of 0.1-1 million tons per year, and small ones produce less than 0.1 million tons per year. Erdenet Mining Corporation is distinguished as a very large enterprise with an annual production of more than 20 million tons. The following gradation is accepted for gold mining: large companies are gold mines with the production of more than one ton per year, medium companies producing 0.1-1 ton, and small ones with less than 0.1 tons produced. The color of a symbol corresponds to the exploitation phase of an enterprise: operating or being projected and under construction; additional outline corresponds to the underground mining method. Gold-placer regions of the given territory are shown with areals.

FERROUS, NONFERROUS, RARE AND PRECIOUS METAL RESOURCES AND THEIR EXTRACTION



The main types of nonmetallic raw materials: resources and development

Nonmetallic mineral resources of the region are of great industrial importance. Within the Lake Baikal basin there are deposits of mining-chemical, mining-technical, optical raw materials, construction materials, mineral fertilizers, and semiprecious and precious stones.

Deposits of *raw quartz* belong to strategic types of mineral resources. The region has the largest explored and prepared for industrial development raw material base: there are deposits of especially pure granular quartz (Chulbonskoe, Nadezhnoe, Goudzhekitskoe, and others) and quartzites (Cheremshanskoe and Goloustenskoe). The vast majority of deposits are located in the territory of Buryatia; there are all the prerequisites for creating a large complex of plants for deep processing of raw quartz for high-tech industries. In the long term, the Republic can become the largest producer and exporter of polysilicon and autonomous energy saving systems. Currently, there is a development project of the Chulbonskoe granular quartz deposit in the Severo-Baikalsky municipal district to get the final product in the form of photovoltaic systems.

Quartzites of the mined Cheremshanskoe deposit have exceptionally high quality of raw materials and meet the requirements of industry for production of industrial silicon, silicon carbide and ferrosilicon; in recent years, research has been carried out on the most pure varieties to produce high-purity silicon for solar energetics and growing of single crystals of piezoelectric quartz. The deposit has been mined since 1992 by CJSC “Cheremshansky quartzite” with an annual output of about 200 thousand tons and is a mineral resources base of CJSC “Kremniy” OK RUSAL, which is one of the most modern silicon production facilities in Russia and the country's only producer of refined silicon .

Quartzites of the Goloustenskoe deposit are suitable for the use in metallurgy, and in production of silica brick. Sources of high-quality abrasive raw materials are microquartzites of two large deposits, located in the Olkhonsky municipal district on the eastern slope of the Baikal Range, namely, Srednekedrovoe and Zavorotninskoe. The latter was developed from 1975 till 1993 by “Baikalkvartssamotsvety”; currently, the deposits are in the state reserve.

Significant reserves of raw *fluorspar* were explored in the Lake Baikal basin in the Republic of Buryatia. Currently, one deposit is being developed here, it is a medium Egitinskoe deposit in the Eravninsky district; extracted ore is processed at the concentrator of the Zabaikalsky mining complex. The Naranskoe deposit in the Selenginsky district was prepared for operation and was developed for some time. The Kyakhtinskaya fluorspar factory operated near the settlement of Khoronkhoy from 1966; first it worked using local raw materials, and then using materials imported from Mongolia. Currently, the factory doesn’t function.

The region possesses large reserves of chemically pure *limestones*: in the Olkhonsky municipal district there is the Ust-Anginskoe deposit, and in the Zaigraevsky district there are the Bilyutinskoe deposit being developed for the production of calcium carbide and the Tatarsky Klyuch for the paint and coating industry. Dolomites of the Tarabukinskoe deposit are used as a raw material for glass and metallurgical production.

Deposits of *phosphate* raw materials are known in the Pribaikalie region; they are the Sarminskoe phosphorite deposit in the Olkhonsky municipal district and the Slyudyanskoe apatite deposit in the Sludyansky municipal district; in northern Mongolia large reserves of formation phosphorites in the Khubsugulsky phosphorite basin were discovered and previously explored. The main deposits of the basin are located in the immediate vicinity of Lake Hovsgol, which is an obstacle to their development. The large Oshurkovskoe apatite deposit is prepared for exploitation near the city of Ulan-Ude. On the basis of the approved reserves of the first priority the Zabaikalsky apatite plant was under construction; it was closed at the building phase of a concentrator because of possible deterioration of the environmental situation in the Lake Baikal basin. Currently, there is a project of the deposit development based on environmentally friendly technologies for the extraction and beneficiation of ores. Taking into account a sustained deficit of phosphate raw materials in the country, an increase of the raw materials base for the production of phosphate fertilizers is a matter of economic security of Russia. The planned standard of production of apatite concentrate is 500 thousand tons per year. Breakstone will be produced as a by-product in the same amount of 500 thousand tons per year.

Considering the *ceramic and fire-resisting raw materials*, deposits of Irkutsk oblast should be noted; they are the Naryn-Kuntinskoe microcline pegmatite deposit, developed earlier for the needs of the “Sibfarfor” factory, the Kharginskoe glass sands deposit, on the basis of which the Taltsy plant was established in 1784 and produced a variety of glass products for 170 years, and the Asyamovskoe deposit of wollastonite, a relatively new kind of mineral raw materials with a number of unique properties and a growing range of applications. In the south of Buryatia a sillimanite (high-alumina) shales deposit named Chernaya Sopka is known; its ores have simple mineral composition and are easily dressed. On the basis of the deposit a non-waste production with the release of sillimanite and quartz as commercial products can be created. All the above mentioned deposits are currently in the state reserve.

Phlogopite mica deposits in the south of Baikal have been known since the second half of the 18th century. Its regular commercial production using a ramified system of underground (tunnels, mines) and open (open pits) mine workings began in 1924 with the development of the electrical engineering industry in the country and lasted until 1973. From four to seven thousand tons of high-quality raw materials were mined annually in the Sludyansky district.

Graphite is represented in the region by two large deposits, namely, the Bezymyannoe (the Slyudyansky municipal district) and Boyarsky (the Kabansky municipal district) deposits. Ores of the Bezymyannoe deposit are of high quality and free-milling, according to the data of manufacturer's tests, but the deposit is located in close proximity to Lake Baikal. The Boyarskoe deposit has the largest reserves. Economic efficiency of its development in compliance with all environmental requirements, and despite the low average graphite content in the ore, can be quite high due to the favorable transport and geographical location.

In the past, a considerable part of the Lake Baikal basin experienced an intense volcanic activity, the product of which is *perlite* deposits, among which the largest ones in terms of reserves are Mukhor-Talinskoe, Zakultinskoe, and Kholinskoe. Currently, this raw material is produced by JSC “Perlit” at the Mukhor-Talinskoe deposit with the production for the last three years amounting to 1-10 thousand m^3 of raw material per year. The Kholinskoe perlite and zeolite deposit is located on the border of the Republic of Buryatia and Zabaikalsky Krai; mining LLC “Kholinskie tseolity” develops the deposit. Nowadays, the capacity of the company mining such a valuable kind of mineral raw materials as zeolites is small and amounts to only about 0.8 thousand tons.

Within the region there are a number of deposits of *precious and semiprecious stones*. In Zabaikalsky Krai, CJSC “Turmalkhan” develops a unique deposit of jewelry tourmaline, which is the only one in Russia to date. In the Republic of Buryatia, LLC “Kaskad” exploits the Khargantinskoe deposit with an annual production of 20 tons of raw nephrite; CJSC “MC Holding” started to develop the Khamarkhudinskoe nephrite deposit, where 510 tons were produced in 2012.

To meet the needs of the building complex the region possesses significant resources of *mineral building materials*: numerous deposits of cement, brick, sand and gravel raw materials, building and facing stone, etc. are explored in the area. The raw material base of the Angarsky cement plant is the large Slyudyanskoe deposit of cement marbles, being developed by LLC “Karyer Pereval” with an annual output of about 900 thousand tons. The Tarakanovskoe deposit of cement limestone and Timlyuiskoe deposit of loam supply the Timlyuisky cement plant with raw materials. LLC “Timlyuitsement” produces 250-400 thousand tons of limestone and 20-35 thousand tons of loam annually.

Facing stone deposits are located on the western and south-eastern shores of Lake Baikal; they are Burovshchina and Novo-Burovshchinskoe deposits of pink marbles and Buguldeiskoe deposit of highly-ornamental statuary marble of various color shades: from snow-white to smoky-gray. Currently, stone is not produced at any of these deposits. Among building stone deposits JSC RZhD exploits two, namely, medium Angasolskoe deposit in Irkutsk oblast and large Zhipkhegenskoe one in Zabaikalsky Krai, which are the raw material base of the same-name crushed stone plants. Several deposits of building stone are situated in the coastal zone of Lake Baikal, namely, Baikalskoe, Ermolaevskoe, Dinamitnoe and others, which makes their development impossible.

The following deposits were discovered: deposits of brick and keramzite clays and loams, namely, the Murinskoe and Khuzhirskoe deposits in the Pribaikalie region and Irkaninskoe one in the Severo-Baikalsky municipal district, deposits of sand-gravel mix, including the Utulikskoe deposit of high-quality raw materials, the Pankovskoe deposit of building sands, and others.

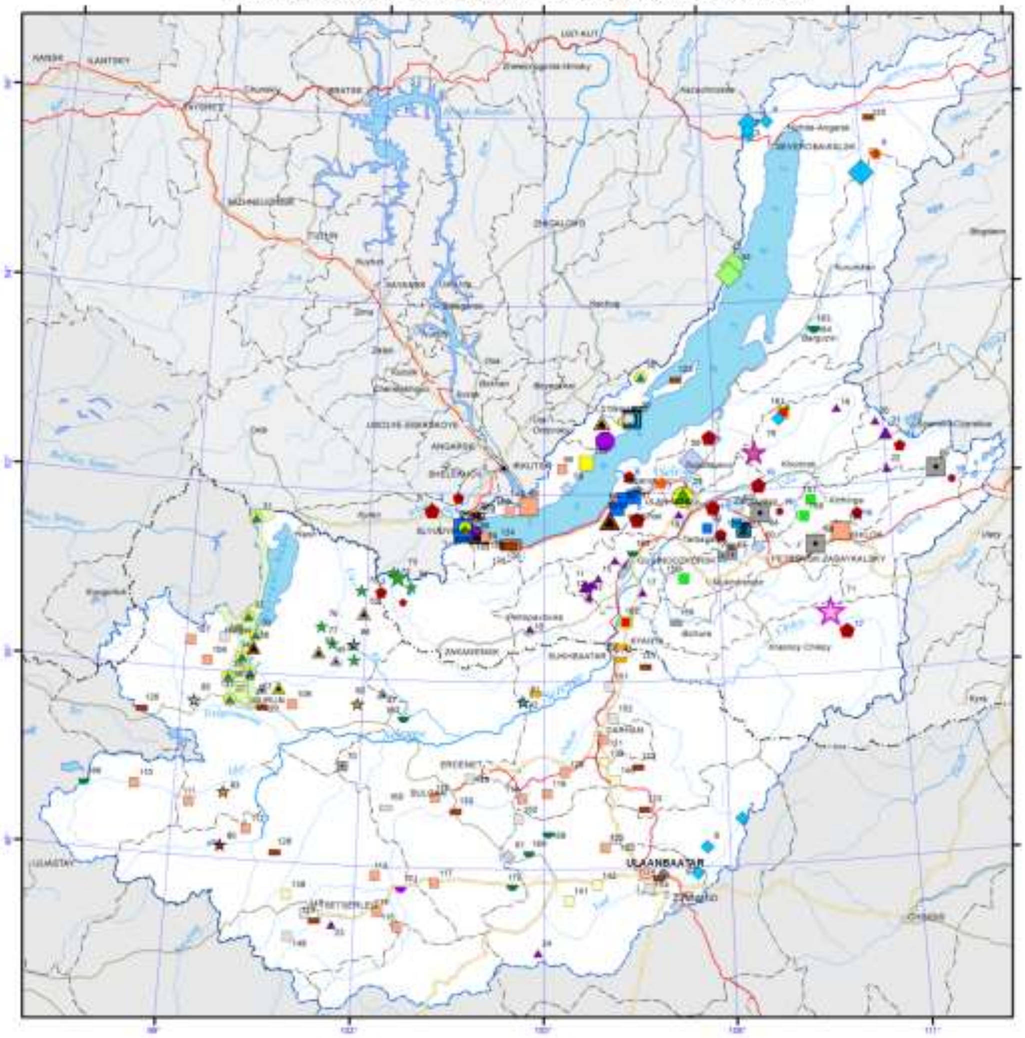
Among *other* mineral resources of the region, the Zangodinskoe and Kalinishenskoe deposits of mineral paints, Khayanskoe deposit of drilling clays, several deposits of raw materials for stone casting, as well as deposits of mineral salts (sodium sulfate) should be mentioned. All deposits of these raw materials are small in terms of reserves and are in the state reserve.

In Mongolia within the Lake Baikal basin small deposits of asbestos, gypsum, graphite, talc, magnesite, bentonite, ornamental stones (nephrite, serpentinite, lasurite, ophicalcite, chalcedony, etc.), raw quartz, and mineral salts are known. Among building materials there are deposits of building sand, brick, keramzite and ceramic clays, sand-gravel mix, building stone, etc.

The map presents the main nonmetallic mineral raw materials deposits, depending on their size and type of a mineral resource, as well as mining companies using symbols. The size of a symbol for a company depends on the average production volume for the last 3-5 years or on the planned capacity of the objects being designed and constructed; gradation is presented in the summary table. The color of a symbol corresponds to the operational phase of an enterprise. The Khubsugulsky phosphorite basin is shown with an areal.

Materials of Regional funds of geological information, maps of mineral resources of the A.P. Karpinsky Russian Geological Research Institute; materials of State Reports “On the state of Lake Baikal and measures for its protection” for 2010–2012; “National Atlas of the Mongolian People's Republic” (1990), “Atlas of Mongolia” in the Mongolian language (2010), “Atlas of Socioeconomic Development of Russia” (2009) were used when compiling the maps. Information on deposits according to the types of raw materials and on mining companies is presented in the summary table.

MAIN TYPES OF NON-METALLIC MATERIALS - RESOURCES AND DEVELOPMENT




Legend
Deposits
large
medium
small
Optical materials
Optical and piezo-optic raw materials
Chemical raw materials
fluorspar
carbonate raw materials
Mineral fertilizer
apatites
phosphorites
Ceramic and refractory raw materials
feldspar
wollastonite
high-aluminous raw materials
Abrasive materials
microsilica
Mine technical raw materials
asbestos
phlogopite mica
vermiculite mica
talc
graphite
magnesite
quartz raw materials
metallurgical dolomite
perlite, zeolites
Precious gems and ornamental stones
tourmaline
nephritis, serpentine
agalmatolite
garnet
lazurite
ophicalcite
chalcedony
obsidian
Construction materials
cement raw material
facing stone
building stone
brick raw material
expanded clay materials
construction sand
sand and gravel
Прочие ископаемые
sand glass
stone casting raw materials
drilling clay
bentonite clay
mineral pigments
Salts
sodium sulfate
sodium carbonate
Khubsugul phosphorite basin
71
deposit, its number on the map and in the table
mining enterprises operational phase
existing enterprises
projected enterprises
by output
large
medium
small
12
mining enterprise, its number on the map and in the table

Water resources and water consumption

The river net of the Lake Baikal basin comprises about 10.4 thousand water streams. The catchment area of Lake Baikal is asymmetrical; large river systems drain the south-eastern and north-eastern parts of the basin. The most significant river systems are the Selenga river and its right tributaries, namely, the Chikoi, Khilok, and Uda rivers, as well as the Barguzin and Upper Angara rivers. About 53% of river waters are formed in the territory of the Republic of Buryatia, 27% - in the territory of Mongolia, 16% - in the territory of Zabaikalsky krai, and 4% - in Irkutsk oblast. About 60 km^3 of water flows annually with water streams into Lake Baikal and through the Angara river out of the lake.

The origins of most rivers are located on slopes of mountain ranges at altitudes of 1200-1400 m. Therefore, in the upper reaches, and for many rivers along the full length, they are of mountain character. Riverbeds with deep erosional incisions are rocky. Within the greater part of their valleys a floodplain is almost absent. Only large rivers in the middle and lower reaches have a character close to the plain one [Hydroclimate… , 2013].

The most ancient river systems drain the western slopes of the Baikal surrounding; they are the Sarma, Buguldeika, and Anga rivers. The class of such systems includes also basins of the largest Selenga and Barguzin rivers. The river systems of the south-eastern and northern macroslopes of Lake Baikal, namely, the Utulik, Tyya, Upper Angara, Turka, etc., are relatively young.

Methods of structural hydrography were used to compile a map of the rate of stream flow. Calculations of the river flow were made for the entire river network of the basin and were based on the close connection between the structure of the river network and its average rate of stream flow at any point of the system [Amosova, Ilyicheva, and Korytny, 2012]. Based on topographic maps, a graph of the river network was constructed, and then structural parameters for each point of the confluence of streams were calculated. Structural modules, representing the ratio of the water flow rate (Q, m^3/s) to the structural measure at the given point, were determined. Data of reference materials of all hydrometeorological sections on the average long-term runoff from 105 gauges served as initial hydrological information [Surface water resources ..., 1972; Hydrological ..., 1977].

The rate of stream flow of river systems is shown as an along-riverbed scale band (curve). This technique is usually called the method of localized diagrams, which is a method of cartographic representation of phenomena that have a continuous or linear (band) distribution. In the present case, the curves are referred to a linear element of the space, i.e. to a riverbed. The curves are drawn on both sides of the riverbed; they are proportional to the stream flow. The width of the curves varies along the length of a river and at the points of confluence with tributaries, depending on their rate of stream flow. Three gradations of the rate of stream flow are distinguished due to the large range of water flow rates (more than 500 m^3/s, 50-500 m^3/s, and 5-50 m^3/s), which largely corresponds to the division of rivers according to their size. The mapping starts with the average long-term water flow rate of at least 5 m^3/s, as values of lower rate of stream flow are difficult to represent [Korytny, 2001].

Within the boundaries of the administrative units, the volumes of local and general streamflow are calculated. Available water supply of the territory with the local stream flow is shown using five gradations. Mountain areas with the river systems of the northern and southern parts of the Baikal depression are characterized by the largest water supply. Administrative units of the Mongolian part of the Selenga river basin are generally poorly provided with local resources of river flow (less than 0.05 and 0.05-0.15 km^3 per year).

The structure of water consumption is displayed using pie charts, the diameter of which corresponds to the volume of water consumption, and the area of sectors – to the water use for various purposes, expressed as a percentage. On the whole, for the Lake Baikal basin water consumption amounted to 502 050 thousand m^3 in 2011, of which 56 440 thousand m^3 were taken for drinking and household purposes, 389 170 thousand m^3 - for production, and 56 440 thousand m^3 – for agricultural purposes. The main share of the river waters is drawn from the rivers of the Selenga basin. The largest consumers in the basin are the cities of Ulan-Ude and Severobaikalsk.

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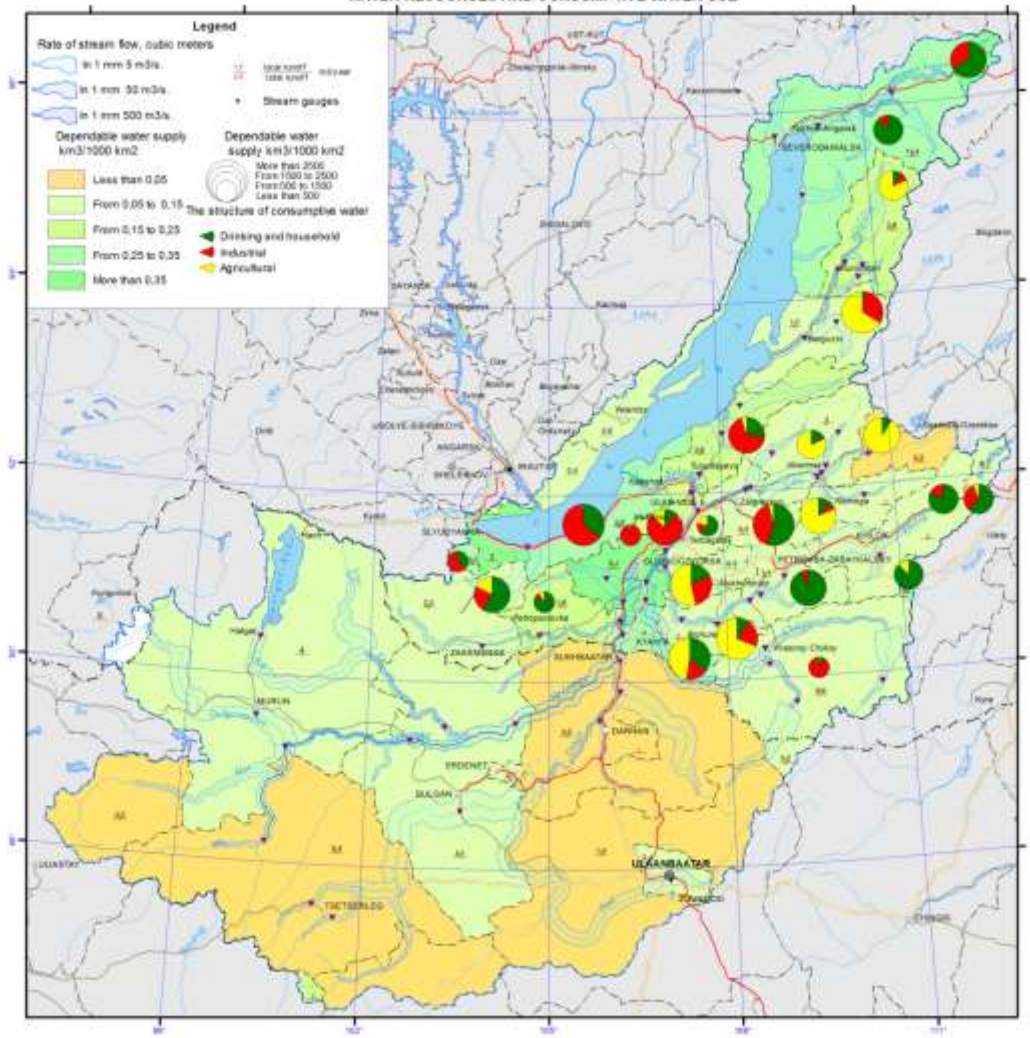
WATER RESOURCES AND CONSUMPTIVE WATER USE



Natural groundwater resources

The map is based on the monograph by B.I. Pisarsky (1987) using medium-scale hydrogeological maps for the Irkutsk Region, the Republic of Buryatia and Tyva, Transbaikalia and Mongolia. Spatial principle of mapping of natural groundwater resources (in units of groundwater flow) was applied, as it was a comprehensive assessment of the main hydrological and geochemical method of partitioning the hydrograph of the total streamflow. Mapping was carried out by the reference catchments, which were located within the same aquifer system and characterized by homogeneity of geological and hydrogeological conditions and sufficiently long series of runoff observations. For part of the territory where information was not available or poor, the mapping method was based on hydrological and hydrogeological analogy.

The color map is based on an energy principle. Cold colours correspond to low values of the rate of subsurface water flow, warm colours to the high. Extremes of the spectrum of white correspond to the extreme values of the intensity of subsurface flow. Ranking of values of natural groundwater resources and gradation is brought into compliance with existing in this area [Natural Resources..., 1976]. A fractional division of classes is caused by low values of rate of subsurface water flow in the territory of Mongolia, occupying a significant part of the Baikal watershed basin.

Distribution of natural groundwater resources in the Baikal watershed basin is extremely uneven; nevertheless it is subject generally to the vertical zonation and latitudinal zones. Anomalous values of the rate of subsurface water flow are confined to the basins with complex hydrogeological conditions.

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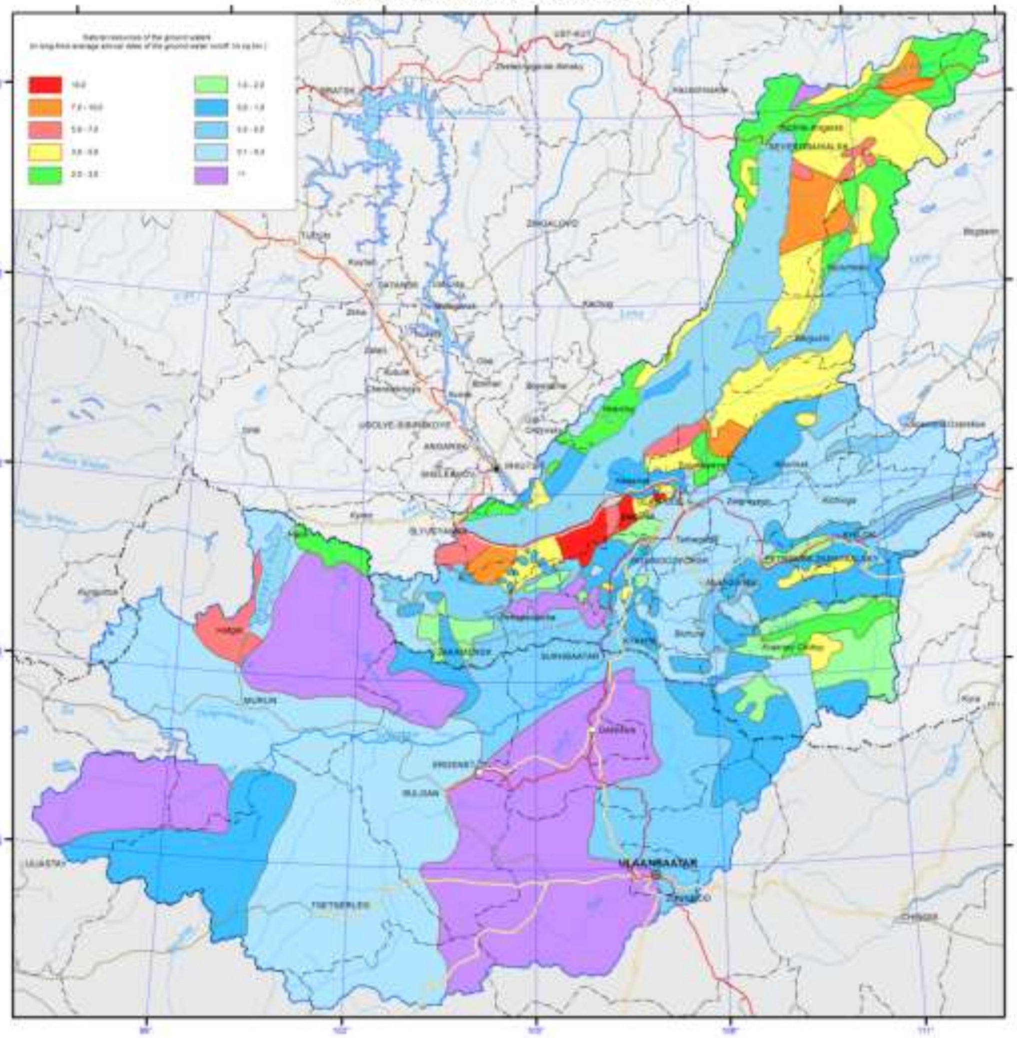
NATURAL RESOURCES OF THE GROUND WATERS



Mineral springs

The map is based on generalizing monographs, maps of mineral waters and the data obtained by the authors in the field investigations.

The map depicts the mineral springs, the water of which can be used for balneological purposes according the physical and chemical properties. These characteristics include: water temperature (hot springs); radon (radon sources cold), content of free carbon dioxide (carbonic cold sources), content of sulphate sulfur (hydrogen sulfide sources cold) and iron (ferrous cold springs).

This card can be used for the organization of sanatorium construction, as well as for planning of underground thermal water use in thermal engineering.

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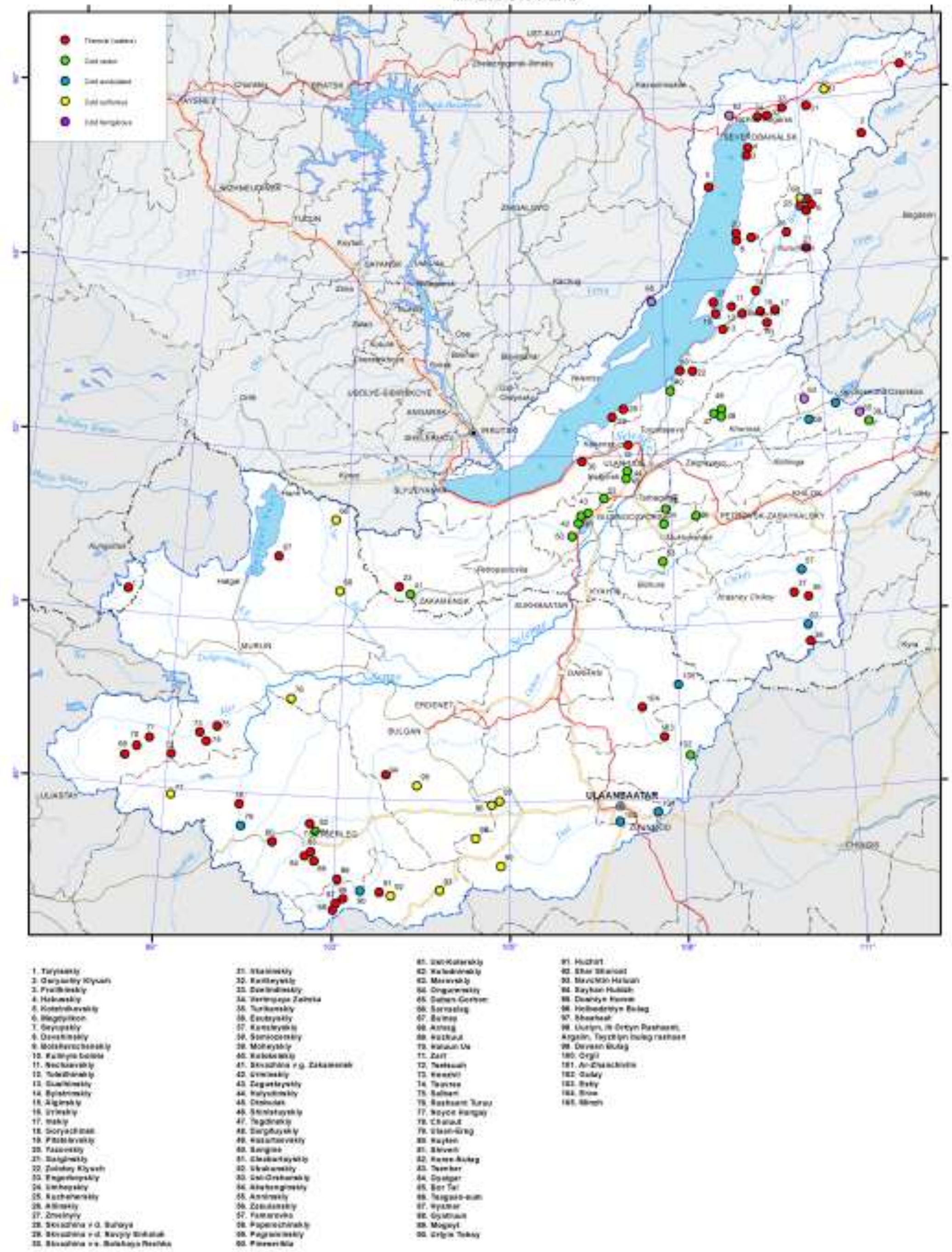
MINERAL WATERS



Recreation resources of climate

The whole complex of climatic factors operating within the Lake Baikal watershed basin promotes formation of local climates, the suitability of which for seasonal recreation is highly differentiated. Their main features in this case are characterized by a number of differently directed indices [Scientific-Applied…, 1991; http://www.meteo.ru], whose combined impact on humans can have a similar effect. The same air temperature has a dissimilar thermal effect on human body in the case of different wind velocities and different air humidity.

Normal-equivalent-effective temperature (NEET) is often used to take into consideration their combined influence upon the thermal state of man. The level of comfortable perception of heat according to the NEET scale varies over a broad range depending on the degree of man's adaptation to ambient conditions. The use of the duration of NEET values above 8 °C for background assessments of contrasting territories demonstrated its validity [Bashalkhanova et al., 2012].

Reduced temperature (Qred) implies heat losses from the open surface of human body in the wintertime under a combined effect of air temperature and wind velocity [Khairulin and Karpenko, 2005]. With Qred below −32 °C, the risk of frostbite increases, so that recreation in the open air is limited. Therefore, in the aggregated form, the set of the most important characteristics of climate resources favorable for recreation is represented by the duration of periods with NEET above 8 °C and those limiting it – by Qred below −32 °C. Seasonal behavior of these indices gives a further insight into the recreation potential of a territory's climate.

In summers, the duration of the number of days with NEET above 8 °C is largest in steppe, steppizated and subtaiga piedmont pine landscapes of slopes, plains and river valleys [Landscapesстепненных, подтаежных подгорных сосновых ландшафтах склонов, равнин и долин рек [Landscapes…, 1977; Mongol…, 2009]. The recreation resources of the climate of the uplands and mountainous territories are substantially lower; they are characterized by a shorter duration of the favorable period. The duration decreases dramatically depending on the latitudinal and altitudinal location of natural complexes, varying from 40 to 70 days. In mountain-taiga landscapes of flat (sometimes slope) surfaces as well as in dark-coniferous landscapes of high slopes and plateaus, this period is less than 40 days. In high mountains with goletz, subgoletz and, partly, mountain-taiga larch forests, the mean monthly NEET do not reach 8 °C.

The low recreation potential of the climate in winters is due to the circulation and astronomical factors. In the subtypes of climates differing weakly in summers, the period of possible limited recreation in the open air in the northern and southern parts of the basin can differ nearly by a factor of two. Meanwhile the stagnant phenomena in orographically isolated intermontane depressions and closed river valleys are accompanied by the longest period of Qred below −32 °C, which reveals the more favorable conditions on their slopes. The severity of winters for open surfaces of slopes and summits obeys the wind regime.

Quite special conditions occur on the shores of Baikal. The warming (in winter) and cooling (in summer) influence of the lake's water masses showed a shift toward a decrease in climatic-physiological comfort of landscapes when compared with their counterparts outsize of the influence zone. This is largely due to the large horizontal temperature gradients between land and the lake which are often the cause for strong winds, the exceptional variety, unpredictability and velocity of which are a matter of common knowledge. For that reason, a dependence of the climatic-recreation potential on the location increases here. In areas of the shores which are relatively favorable in the summer season, the length of the period of reduced temperature below −32 °C differs substantially.

On the whole, the recreation resources of the climate across the territory are relatively varied. Given the availability of mud-bath resources in the depressions and in the broad river valleys with a shorter length of the limiting period, there is a possibility of organizing the facility for sanatorium-and-spa treatment. Of considerable interest are the middle mountains of Khangai and the interfluves of the Selenga and Orkhon. The climatic resources of the other territories are more suitable for an extensive development and promotion of tourism and stationary recreation. Because of the low heat availability and abrupt fluctuations in the temperature-wind regime, the shores of Baikal and Hovsgol are favorable for recreation of healthy humans. It stands to reason that, depending on the characteristics of heat and moisture exchange and on the regime of the local circulation, the period for different kinds of recreation is different. Thus, the slopes of Khamar-Daban on the southern shores of Lake Baikal are most favorable for the winter kinds of recreation owing to an abundance of snow, and to an appropriate combination of the temperature and wind regimes. The shores of Middle Baikal characterized by a long duration of sunshine are more favorable for summer recreation.

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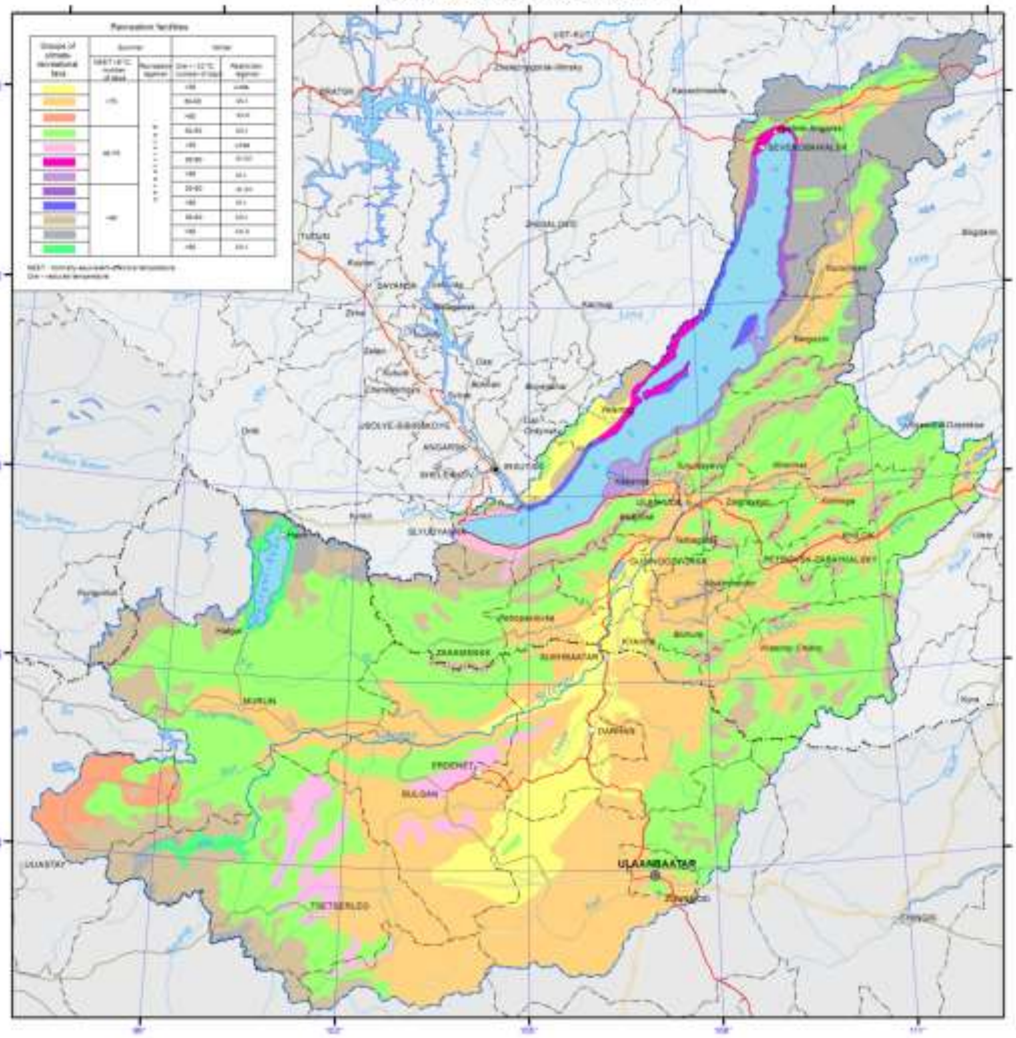
RECREATIONAL RESOURCES OF CLIMATE



Land resources and their use

Land resources are a spatial basis, a store of various types of minerals for many branches of industry, as well as the basic means of production for agriculture and forestry. Land resources and soil fertility are important means of growing crops and forest stands for these branches. For other types of land use (residential, transport, etc.) the role of land resources is reduced mainly to the role of the operational basis for spatial location of specific objects inherent to these types of land use.

Under current law and established practice State land registration in the Russian Federation is carried out on land categories and agricultural lands, forms of ownership and types of land rights, as well as the on use for agricultural production and other needs. Land registration in Mongolia is carried out similarly (with minor changes).

On the basic map of the scale1:5 000000 as a quality background land fund structure on agricultural lands is presented. The latter ones are defined as land, systematically used or usable for specific economic purposes and for differing in natural and historical features. Land carries material properties typical for land use as an economic phenomenon.

The map “Distribution of the land fund on land categories" (Table 1) presents the layout of the land fund on land categories and the index of availability of agricultural land. Land categories are lands distinguished for their intended use (agricultural land, settlements, industry, energy, transport, communication, communication, defense and security, etc., forest, water resources, reserves, etc.). Mongolia is characterized by the absence of the concept of "land reserve". However, a large share of the land fund structure there is occupied by public land for special purposes, which consists not only of lands of defense and security and protected areas, but lands, used uncharacteristic for Russia. Therefore, in the map legend the category "lands of state and special purpose" applies only to Mongolia, excluding the land protected areas and land defense and security. The latter ones are included in the respective categories of land.

The availability index of farmland is the ratio of agricultural land area (in hectares) belonging to the agricultural land to the number of residents living in the municipality. Farmland is an essential part of land, which is a potential resource for the formation of local food base. The average area of agricultural land per capita (within Russian territory, except Tere- Khol district of the Republic of Tyva) takes 3.7 hectares; it ranges from 0.06 ha within Sludyansky district Irkutsk Oblast to 22.9 ha in Yeravninsky district of the Republic of Buryatia. Within Mongolian territory the indicators of the agricultural land per an aimag inhabitant, is on the average significantly higher than in the Russian part of the basin - about 45 hectares. Minimum rates are found in the aimag Ulaanbaatar, Darkhan, Orkhon, that is connected, first of all, with a significant amount of the population in these aimags and relatively smaller area of agricultural land compared to other aimags.

Table 1

Distribution of land fund categories on lands within the Baikal watershed basin on January 1, 2011 , thousand ha

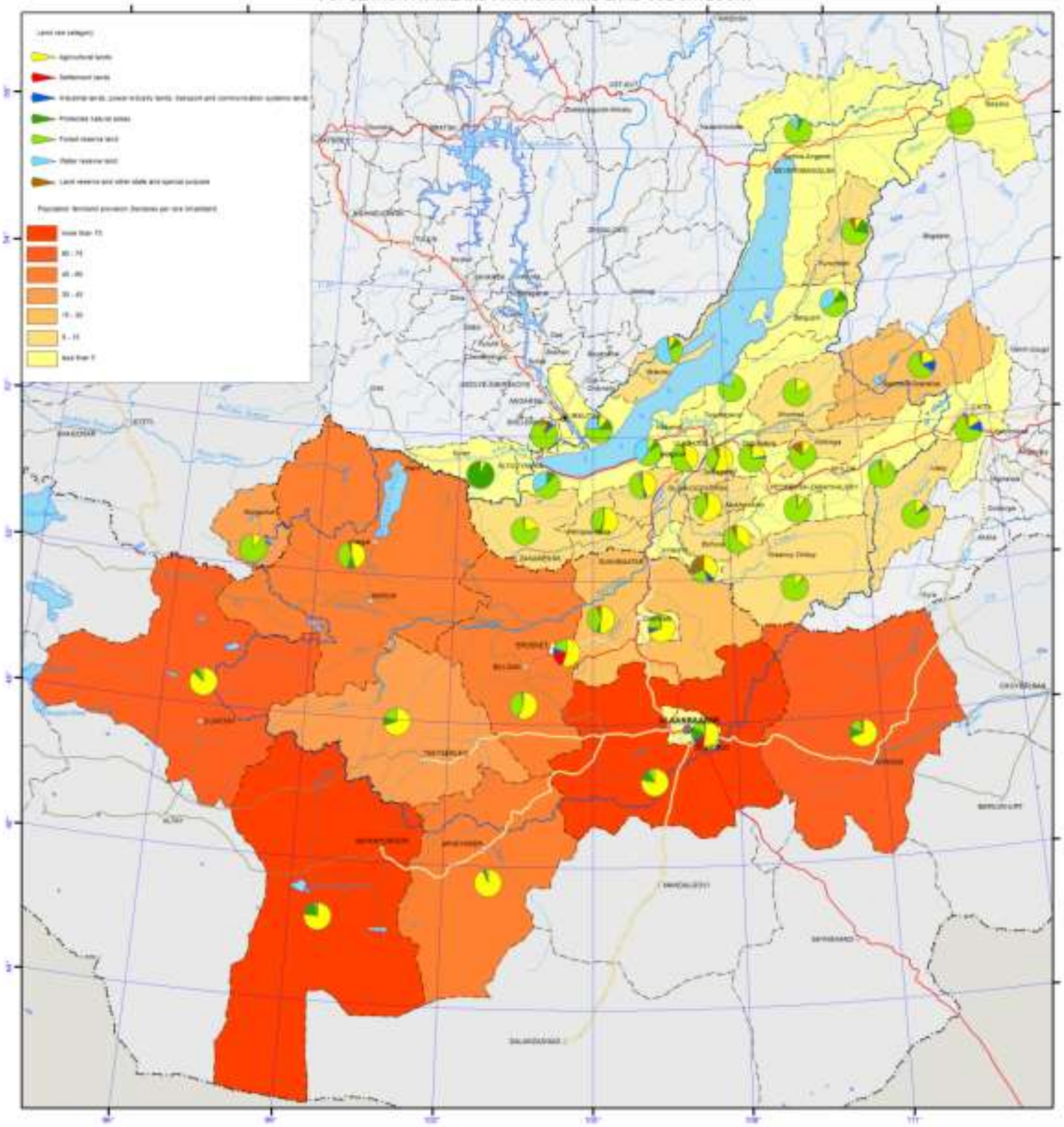
Subjects of the Russian Federation	Total	Agricultural lands	Settlements	Industrial lands	Protected Areas	Forest Fund areas	Water Fund arease	Reserve lands**
Irkutsk region	3584,2	271,6	55,9	21,6	352,9	1554,3	126,4	63,8
Republic of Buryatia	25851,9	3599,6	142,1	485,4	2136,5	16657,6	2124,6	706,0
Transbaikalia	8452,6	974,7	38,1	286,2	90,8	6869,2	15,4	178,1
Republic of Tyva	1005	107.,5	0,13	0,6	0	890,8	3,5	2,4
Mongolia	67034,8	46427,2	25,3	279,8	693,1	1137,4	377,7	1466,0
Baikal watershed basin, totally	105928,5	51273,1	261,53	1073,6	3273,3	27109,3	2647,6	2416,3

Note: * Industrial transport, defense, communications, energy lands, ** for Mongolia instead of this land category the following one should be considered "other lands of the state and special purpose".

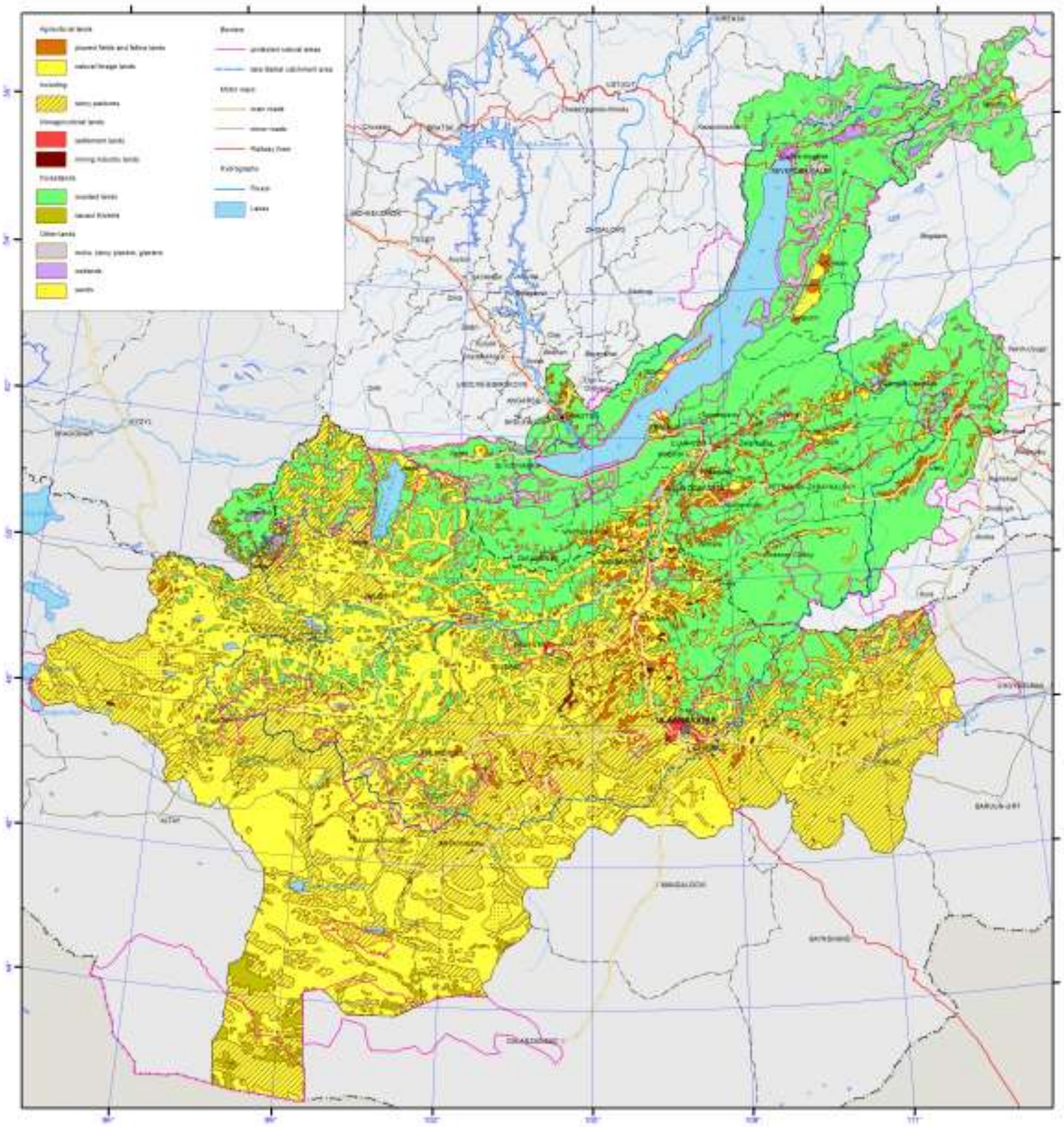
In 1990 - 2010 reduction of agricultural area for most municipalities is registered on the Russian part of the watershed basin, so that it is directly linked to their withdrawal from agricultural use. The main reason of reduction of agricultural area was the termination of many agricultural enterprises, entities, and farms and transfer of the withdrawn lands, for the most part, to fund of land redistribution. Another reason is the expiration of the land leasehold (or temporary use) and nonrenewal of its agricultural productivity. The agricultural land reduction is caused by negative processes became widespread due to the sharp reduction of protection measures of valuable land from water and wind erosion, flooding, waterlogging and other processes. It should be noted that the actual outflow of productive land is much more. Previously transferred farmland reserves are overgrown with shrubs and low forests and lose their agricultural value.

In Mongolia problems of agricultural lands reduction are currently not marked because of their significant amount due to factors in natural and historical features of agriculture.

POPULATION FARMLAND PROVISION AND LAND USE CATEGORY



LAND RESOURCES USE



Forest resources and their use

The Baikal watershed basin is a truly enormous treasury of "green gold". The forest area is 32103.6 thousand hectares in the Russian part of the basin and 10354.3 thousand hectares in Mongolia on January 1 2011. Total timber reserves in the Russian part of the basin are 2,795,800,000 m3, with a stock of coniferous 2,443,000,000 m3 (87.4 %). In Mongolia the total timber reserves is 1,373,100,000 m3.

The basic map shows the forests of nature protective and other preservation patterns, as well as operational and other forests, possible for the operation, and reserve forests. It should be said that the division of forest lands in protection, maintenance and reserve is characteristic only for the Russian Federation. However, in the territory of Mongolia forests of special importance and need of protection are distinguished, such as forest areas up to 100 hectares, forests on the slopes of the mountain areas of more than 30 degrees, etc.

Protective forests in Russia includes the forests subject to reclamation in order to maintain environmental, water protection, safety, sanitation, health and other useful features while using these forests providing compatibility with their intended purpose. Within the Baikal watershed basin there is a high proportion of protective forests, due their ecosystem, environment protection and water protection functions, as well as an important ecological role of mountain forests. Operational forests are these which should be developed with the purpose of sustainable, maximum efficient rate of high quality wood production and other forest resources, their products with ensuring the preservation of beneficial functions of forests. As the reserve forests those are typed which are not planned to be used for logging for next twenty years. These forests are mostly found in the northern part of the region, in the permafrost zone, off-road area and are unattractive for development.

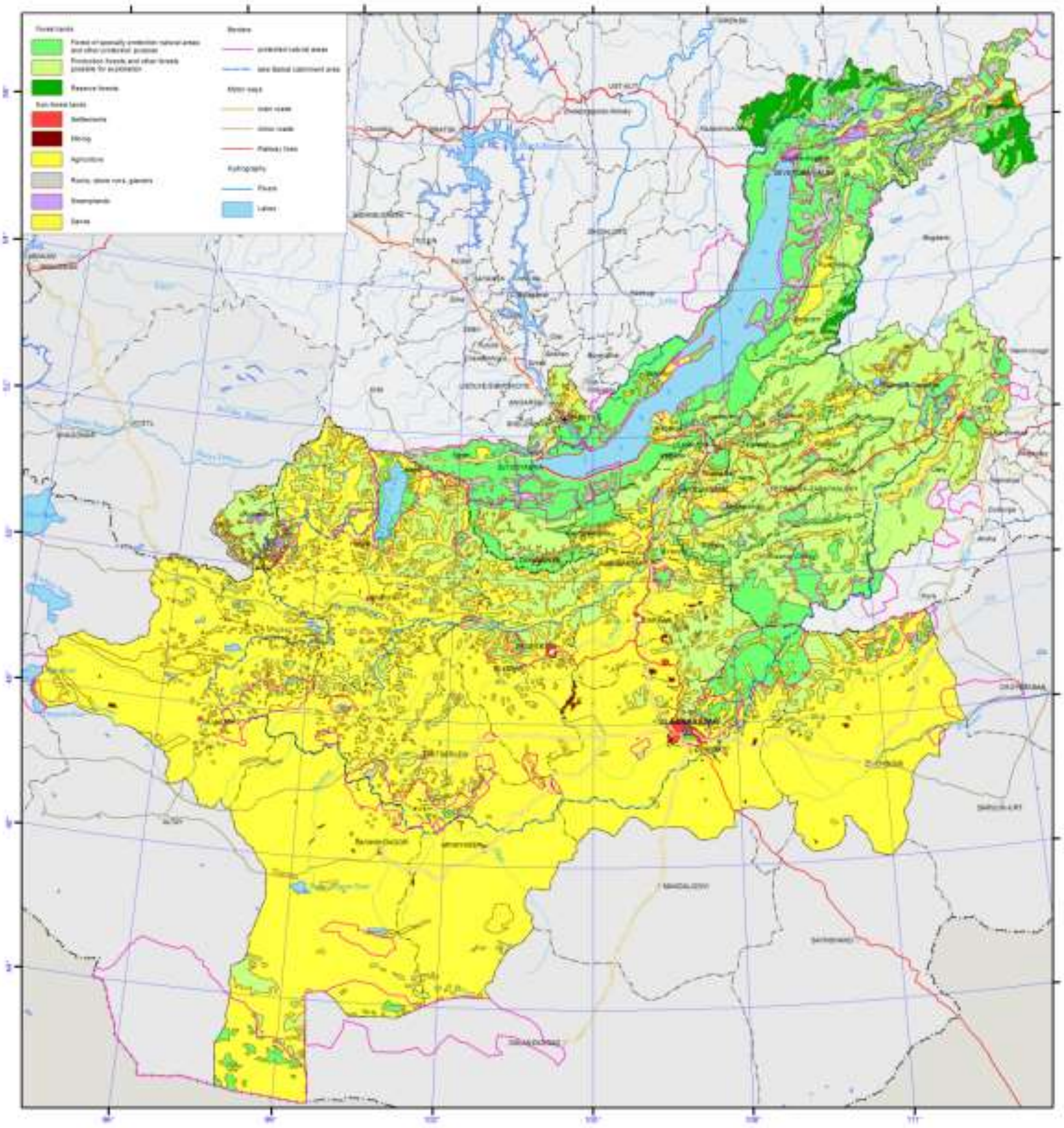
The insert map "Timber reserves by groups of the major forest forming species" shows the average reserves of softwood and hardwood forests (m3) per hectare of land, covered by them. The average timber reserve on a unit of the area is one of the indicators characterizing the productivity of forests, depending on growing conditions of stands, their species, and stands sparsity. The average reserve of coniferous and deciduous per hectare of land, covered by them in the Russian part of the Baikal watershed basin is 132.5 m3 (the global average is 100 m3/ha), and it is fluctuating from 79-82 m3/ha (mostly in the steppe regions of Transbaikalia, the Republic of Buryatia (Zaigraevsky, Chita regions)) to 160 -170 m3/ha and up in the mid- and north areas (Uletovsky district of Transbaikalia, Kabansky and Severobaikalsky districts of the Republic of Buryatia, Irkutsky and Slyudyansky districts of the Irkutsk region). Within the Mongolian part of the basin the average reserve of coniferous and deciduous stands is 126.6 m3 per 1 hectare with fluctuations in aimags from 81 to 205 m3 per ha. The highest average timber reserve per unit of forest area is characteristic for the northern mountainous areas of Mongolia.

Also on this map the total timber reserve distribution by major groups of forest forming species (million m3) is shown with the method of cartodiagram. This index demonstrates forest resource security area, which varies significantly in the districts of the Russian part of the basin and Mongolian aimags (from 1.5 to 481 million m3). A conventional stepped scale for the circular cartodiagram, that simplifies determination of the amount of timber reserve according to the percentage between the major groups of forest forming species (coniferous, deciduous and shrubs) for adequately display of the total timber reserve within municipalities.

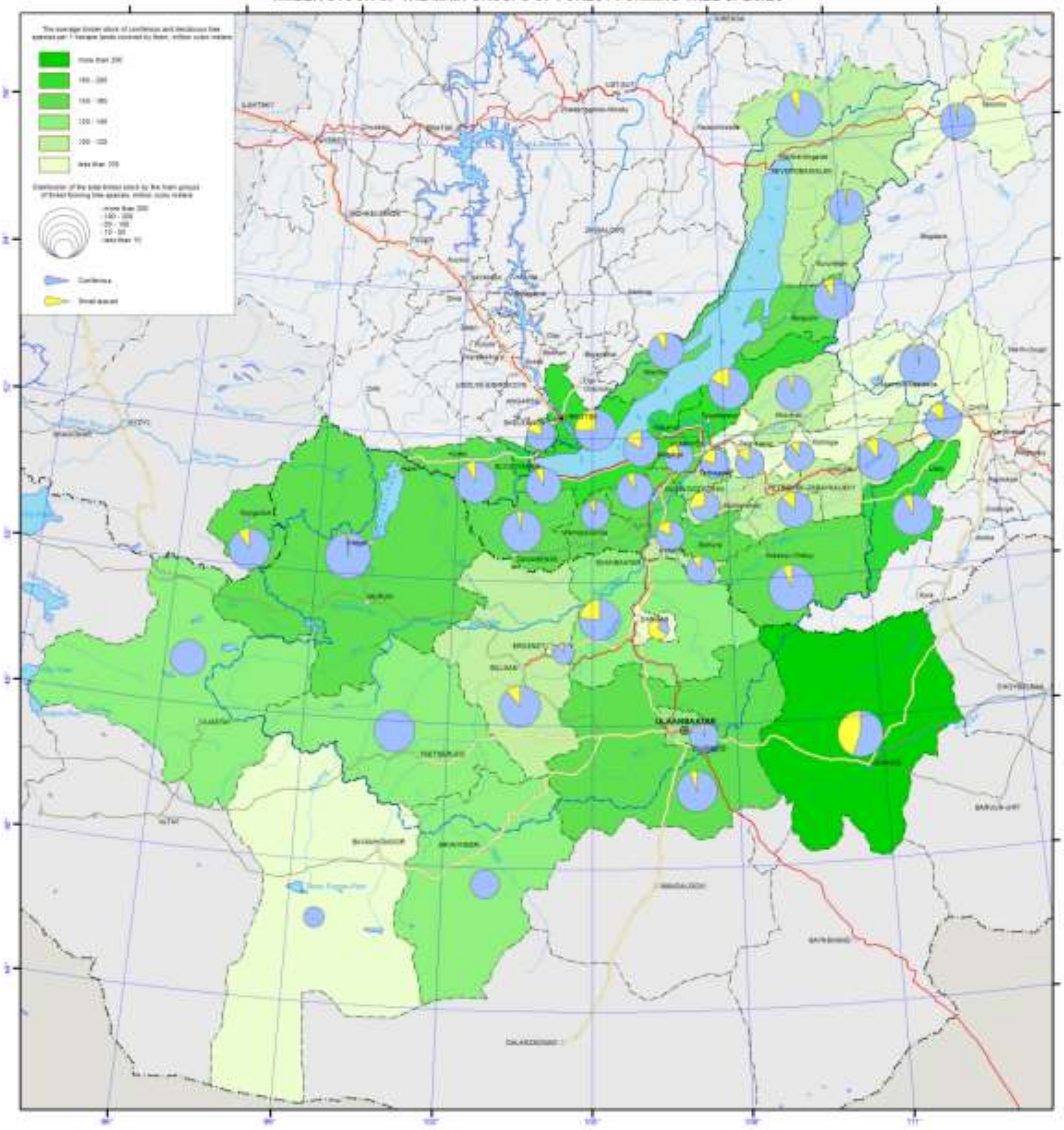
Forest use is determined by the activities that have pre-property development within the silvicultural areas. The most developed of forests type use for the Russian part of the Baikal watershed is the wood procurement which is regulated by wood cutting rates. Forests are actively used for recreation, for hunting activities, etc.

In the analysis of the forests use the following trends for all forests of the Baikal watershed basin are revealed in recent years: are reduction of coniferous stands, mostly maturing and mature stands; replacement of coniferous species by deciduous; widespread illegal logging, reduction of forest area due to fires, forest damage by pests, deforestation, insufficient reforestation.

FOREST RESOURCES AND THEIR USE



TIMBER STOCK OF THE MAIN GROUPS OF FOREST FORMING TREE SPECIES



Game animals

The resource potential of game animals of the Lake Baikal basin has long been characterized by the abundance and high species diversity. This is due to the location of the territory at the intersection of Central-Asian, European-Siberian and East-Asian faunas, where representatives of all of these complexes, including species valuable for hunting, are found. Within the region, there are four typological landscaped complexes, corresponding to the zonal and regional landscape subdivisions, namely: mountain-taiga, golets, forest-steppe, and steppe. Each of them is characterized by a set of habitat types, the quality and quantity of which influence the number of animals.

The wildlife of the ***mountain taiga*** is the most rich and diverse; there manifestations of latitudinal zonality in the distribution of vegetation are complicated by the features of altitudinal zonality of its location in the mountains depending on the steepness and exposure of slopes. This creates prerequisites to spread the spectrum of landscape-ecological diversity of conditions of animal habitats, and possibilities for most of them to choose the most valuable biotopes and, eventually, to increase in number. In the mountain taiga squirrel, hazel grouse, sable, bear, and in some places musk deer are numerous. Far-Eastern red deer and roe deer, which inhabit light slopes, forest openings and woodlots, as well as elk, inhabiting waterlogged intermountain depressions, creek valleys and wide plots of terraces in the coastal area of Lake Baikal, are common. Wolf is numerous in some places; wood grouse and fox are common; lynx and wolverine are less common. Unique populations of reindeer and black-capped marmot survived in high-mountain belts of ridges on both sides of Lake Baikal due to the good protection.

Nerpa (Baikal seal) occupies a special place, being the only representative of the family of pinnipeds on Lake Baikal. Its largest rookery is located on the Malye Ushkan Islands.

The ***golets complex*** is characterized by a significantly lower abundance of game animals. Willow and rock ptarmigan, reindeer and ermine belong to permanent residents. This complex can be roughly considered as a complementing link to the mountain-taiga one, in so much as many of game animals, especially the ungulates, as well as bear, are connected with the highlands by systematic seasonal migrations.

The ***forest-steppe and steppe complexes*** stretch in narrow discontinuous bands in the south of the region. They are represented by the Central-Asian mountain steppes and are not distinguished by the abundance of game animals. Only roe deer in the forest-steppe continues to hold the background position among other species, while tarbagan, which was earlier numerous in steppe, has lost its former significance in consequence of plowing of the Transbaikal steppes and its extermination as a carrier of epizootic plague as a result of measures carried out against the disease. Other species characteristic of the forest-steppe zone, namely, badger and raccoon dog, and of the steppe zone, namely, tolai hare, manul, and dzeren, are small in number. Some of them (dzeren and manul) are protected.

The status of game animals is examined only for the Russian part of the Baikal basin. In connection with the reorganizational measures in the Russian hunting sector over the past two decades, some negative manifestations can be noticed in the usage patterns of species valuable for hunting and in the dynamics of their numbers. There arose a number of problems, related mainly to wild ungulates, especially to red deer (Far-Eastern red deer), roe deer, elk, wild reindeer, and in some places musk deer. Concerning these species an undisputed conclusion was made (as, indeed, for other regions) that “the current dynamics of populations of wild ungulates in Russia is determined mainly by hunters (poachers to a greater extent), large predators, and, locally, snowy winters, and not by a natural cyclicity and changes in the productivity of phytocenoses” [Kozhichev, 2002; Danilkin, 2010].

Among large predators the greatest harm is done by wolves. The wolf problem arose due to the loosening of its control. The damage from this predator to the ungulates (Far-Eastern red deer and, especially, roe deer) in different regions of Buryatia reaches 8-30% of the autumn herd [Noskov, 2008]. In recent years, in consequence of the irregular decrease in number of Far-

Eastern red deer (poaching and death by predators) in conjunction with the legal shooting in Buryatia a crisis situation with the population of this deer was created [Noskov, 2008]. The damage from wolf only in Transbaikalia in 2011 amounted to 11.6 million rubles to agriculture and 70-80 million rubles to hunting [Samoilov, Kayukova, 2013]. Because of the large number of wolves in some areas of Transbaikalia an emergency was declared [Samoilov, Kayukova, 2013].

In the current situation, the negative effects are smoothed to some extent through a network of specially protected natural areas. Thus, in Buryatia, 7-8% of the total livestock of red deer and roe deer are protected within the territories of 13 natural sanctuaries (zakazniks) and 3 reserves (zapovedniks) [Noskov, 2008]. Reindeer is listed in the Red Book of the Republic of Buryatia. Measures to protect the hunting grounds, especially in the areas of concentration of animals, are taken.

Another situation formed with respect to fur-bearing species of hunting. This is due to the fall in world prices for raw fur. Eighteen million fur skins of caged mink from China were put on the market [Romanov, 2008]. Because of low prices for Chinese mink, fur coats of squirrel or muskrat turned out to be more expensive. As a result, squirrel and muskrat are not popular on the market. The same situation takes place with other species, namely: fox, Siberian weasel, and ermine. Fur skins of lynx and wolverine, which are small in number, are used mainly in the domestic market.

The situation is different concerning sable, which has enabled Russia to achieve a dominant position in the world market as an exclusive supplier of sable. Demand and prices for sable fur skins have increased. The price for a skin at an auction averages 220-250 dollars. As opposed to the past years, extermination does not endanger sable as there are less professional hunters. Besides, remote hunting lands are not utilized. They have become a kind of sable reserves, where it multiplies and settle throughout the taiga.

The analysis of the status of hunting fauna in the Lake Baikal basin revealed a number of trends in the features of its use, also characteristic of other regions of the country, the problem of protecting ungulates, in particular. A positive phenomenon is a continued status of sable as the leader in the world fur market, and a removal of the danger of its extermination due to changes in socio-economic conditions, which is important in contrast with previous years.

At the same time, unlike in the majority of Siberian regions, where a trend of rapid increase in the area of publicly available lands is enhanced, in the region under consideration this phenomenon is minimized. This is indicative of targeted optimization of the resources usage of game animals on the basis of improving the forms of hunting management and the prospects for its development in the region. Thus, the calculations [Dambiev et al., 2011] made it possible to estimate the socio-economic significance of hunting nature management in the Republic of Buryatia in 2010 as amounting to 1.1 billion rubles. Among them natural products of hunting (furs, meat, etc.) are estimated at 150 million rubles, while the social impact of tourism associated with hunting reaches 450 million rubles. The remaining portion is accounted for by other socio-economic relevance. Therefore, the current state of game fauna in the study region is characterized as conditionally stable. As a result of satisfactory organization of protection of game animals in the region, their number corresponds to a primitive stage of market hunting management.

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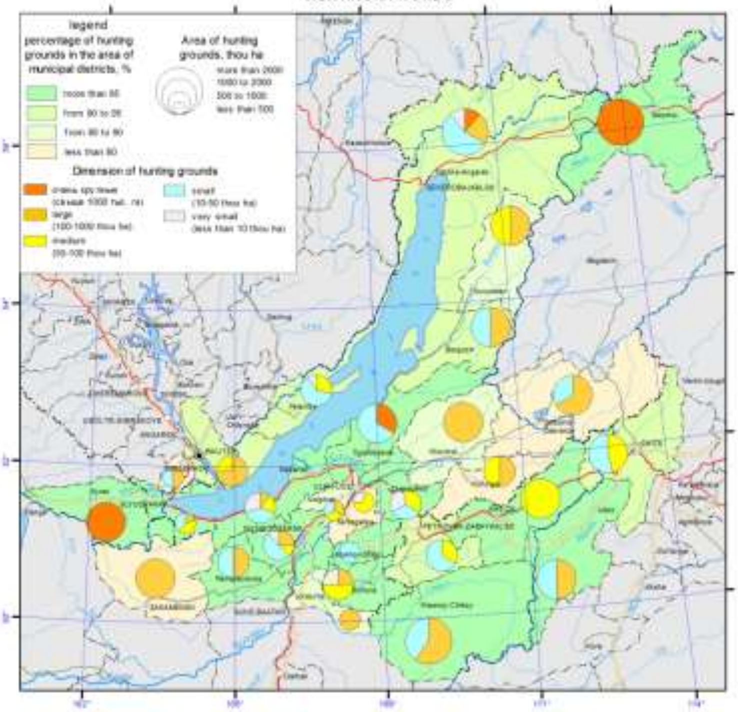
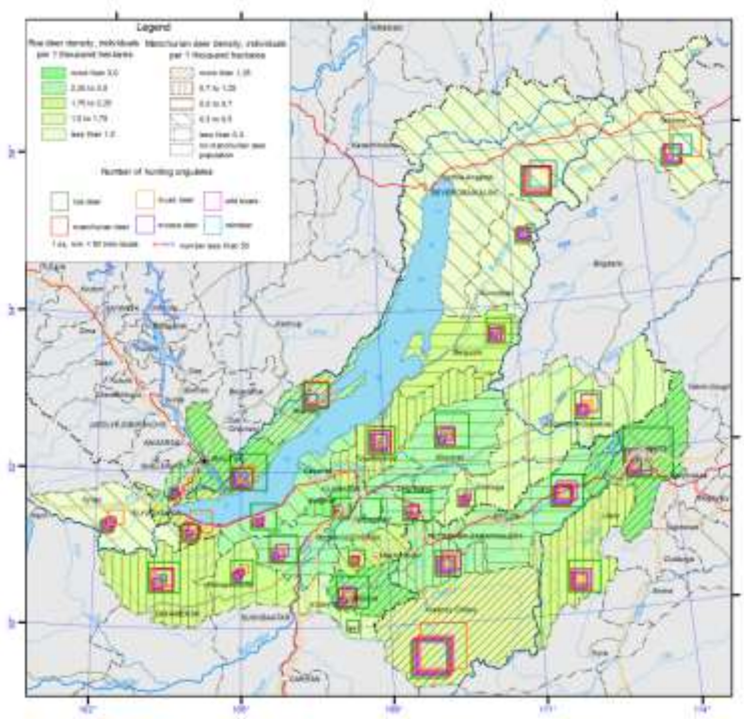
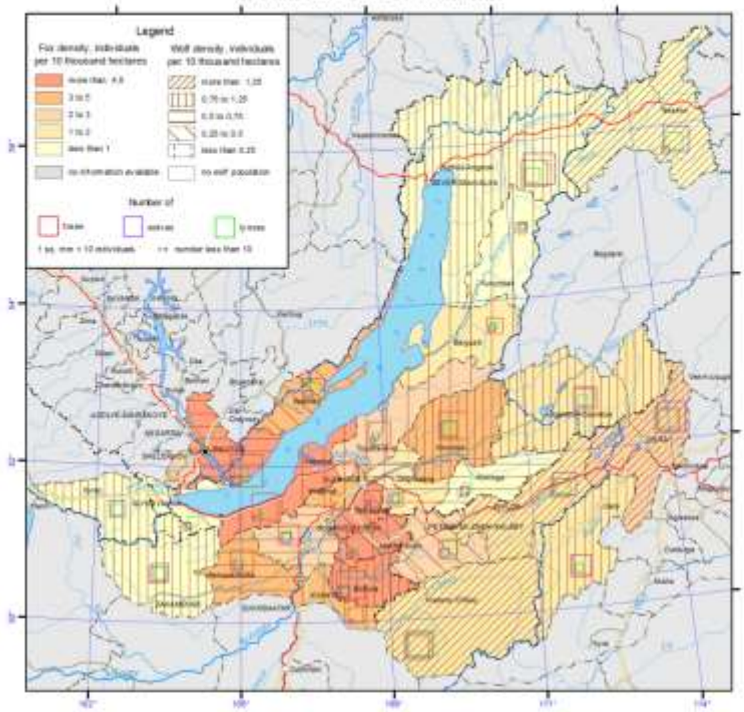
HUNTING GROUNDS

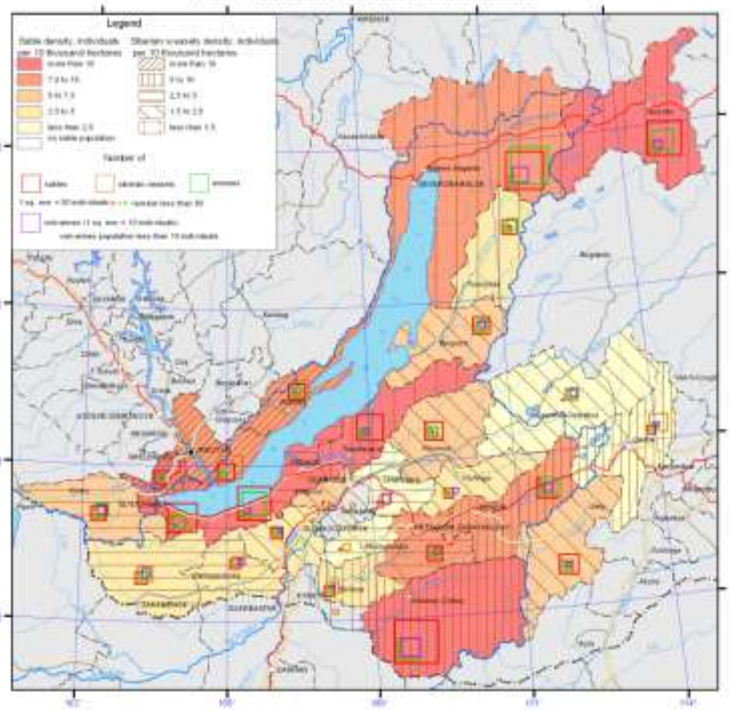



Legend

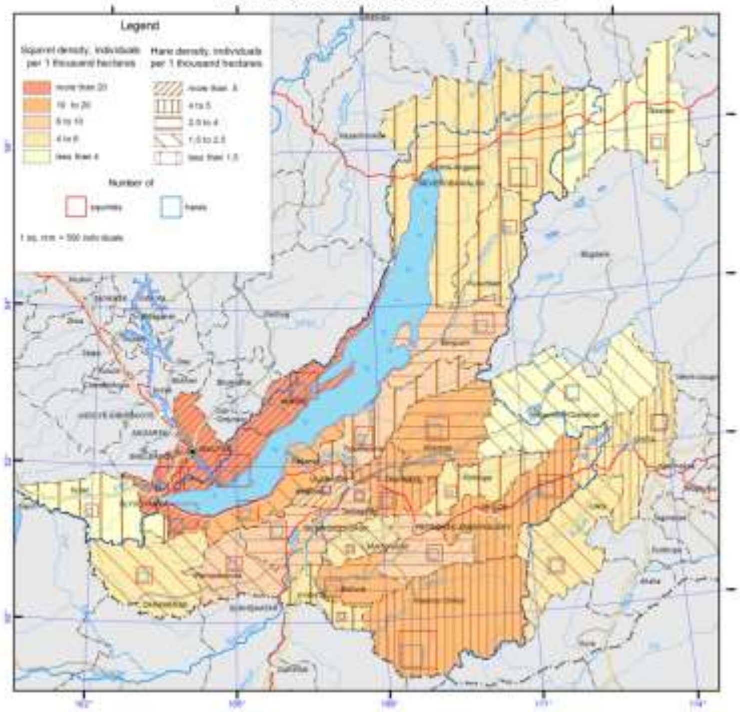
HUNTING RESOURCES. PREDATORS

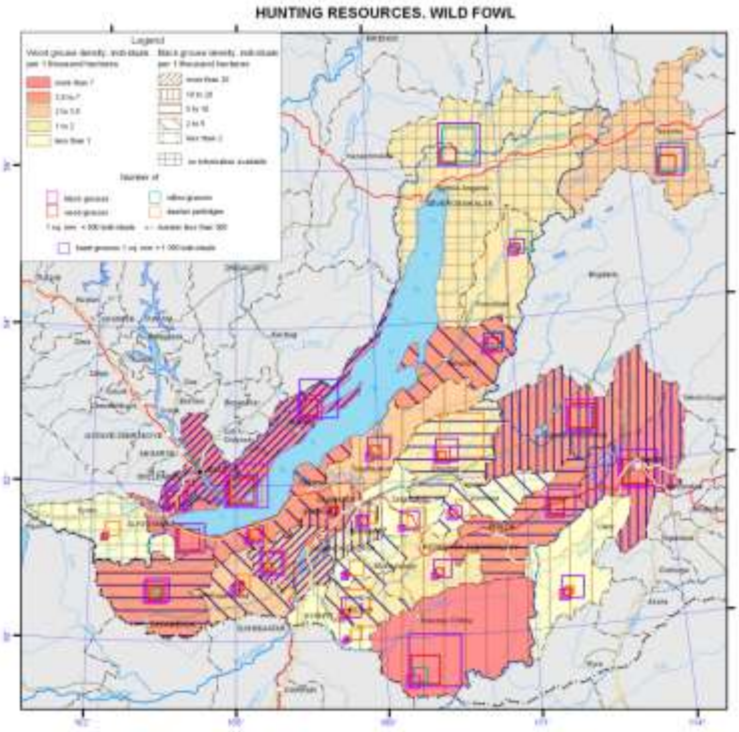


HUNTING RESOURCES. FUR-BEARING ANIMALS



HUNTING RESOURCES. SQUIRREL AND HARE




HUNTING RESOURCES. WILD FOWL

Package of maps “Environment resources: ecological resources of landscapes in the basin of lake Baikal”

This package contains small-scaled overview maps with the most common patterns of ecological resources of landscapes in the basin of Lake Baikal. The definition “ecological resource”, which is identical to the definition “ecological potential”, means the ability of landscapes to provide people with all necessary conditions for existence, i.e. to create specific local environment.

The structure of the map package was developed to solve practical problems and to provide with regional programmes on rational use of natural landscapes and their protection. The information database of the package consists of literature sources [Geosystems …, 1991; Isachenko, 1990; Mikheev, 1987, 1988; Polikarpov et al., 1980; Sochava, 2005], cartographic material [Atlas …, 2004; National Atlas …, 1990; Correlation …, 1977; Landscapes …, 1977; Eco-geographic …, 1996] and Internet resource.

Landscape-ecological map

This map is a mosaic of 16 structural landscape subdivisions belonging to 2 subcontinents (Northern and Central Asia) and 3 types of natural conditions (arctic-boreal, semiarid and arid) [Geosystems …, 1991, p. 52-53].

Typological classification of landscapes (golets, subgolets, uppertaiga, taiga, subtaiga and steppe) represents altitude-zonal differentiation of environment conditions, as well as depression and piedmont effects of their development. Regional classification of landscapes (Baikal-Dzhugdzhurskiye, South-Siberian, Central Asian, Khangaisko-Daurskiye, Srednekhalkhasko-Mongolian) includes sector differentiation of environmental conditions, which is formed under the influence of prevailing air masses of different direction (mainly western and eastern transfer), as well as interpenetration and uniqueness of natural phenomena in the basin of Lake Baikal.

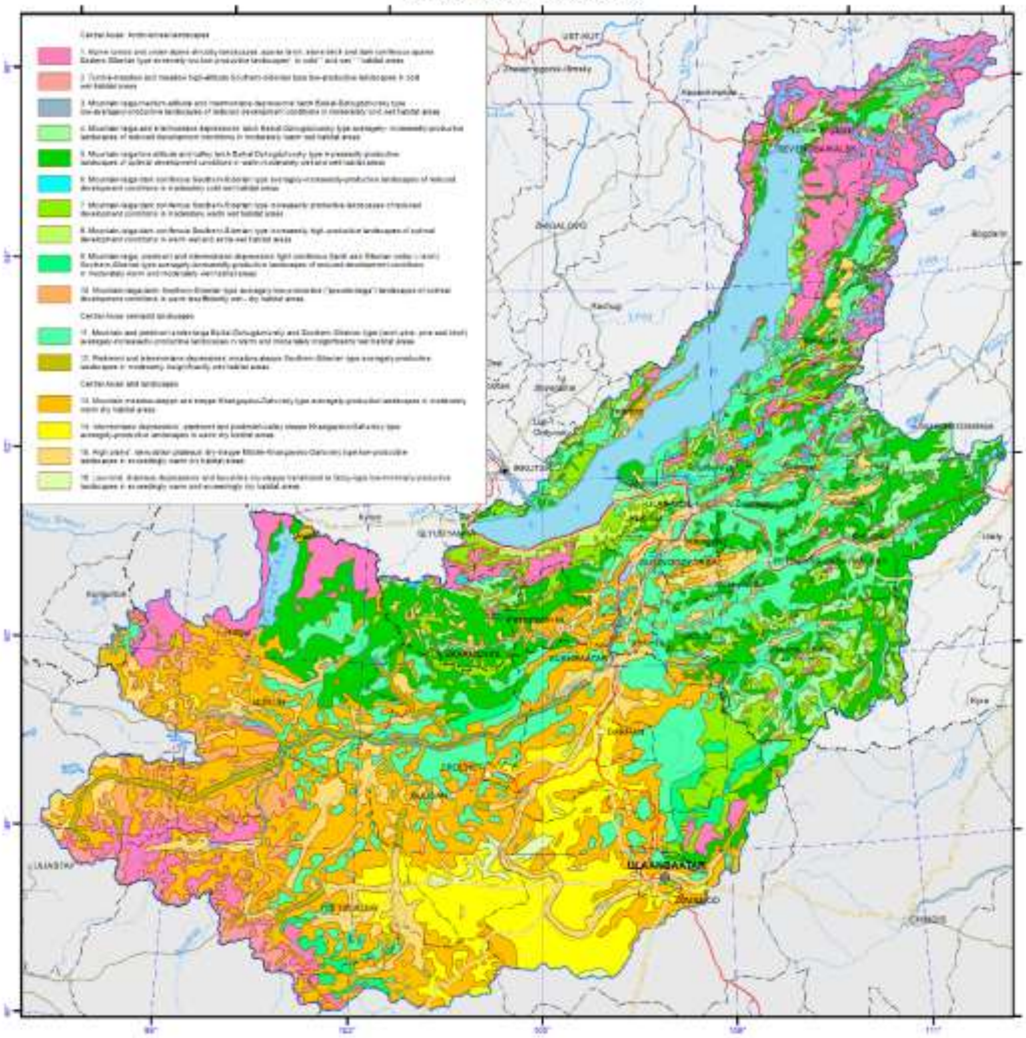
According to the material and energy exchange, the North-Asian golets, taiga and subtaiga landscapes are subdivided into subgroups of natural conditions: extreme, reduced, limited and optimal development. South-Siberian and Central Asian steppe landscapes are subdivided into arid, dry and very dry landscapes depending on moisture supply of these landscapes [Eco-Geographic …, 1996].

The legend of the map also contains numerical values of integral intensity of landscape functioning (heat and moisture supply of landscapes and plant biological productivity) [Eco-geographic …, 1996]:

- heat supply (total mean daily temperatures over 10ºC): cold (600-800ºC), moderately cold (800-1200 ºC), moderately warm (1200-1600 ºC) and warm (1600-2000 ºC);
- moisture supply (radiation dryness index according to M. Budyko): perhumid (less than 0.5), humid (0.5-0.9), subhumid (1.0-1.4), insufficiently humid (1.5-1.9), dry (2.0-2.4), and very dry (over 2.5);
- plant biological productivity (annual growth of plants at appropriate values of heat and moisture expressed in dry mass of organic matter of terrestrial and underground parts of plants): very low (less than 20 cwt/he), low (20-40 cwt/he), mean (40-60 cwt/he), elevated (60-80 cwt/he), and high (over 80 cwt/he).

This map is used as an interpretation basis for development of productive assessment and recommendation maps of the environment.

ENVIRONMENTAL LANDSCAPES



Landscape sensitivity

The map of landscape sensitivity characterises general respond of landscapes to external anthropogenic effect. Landscape sensitivity is determined from “self-regulation” [Sochava, 2005, p. 72] – ability to retain the structure of landscapes within the certain boundaries for a certain period of time.

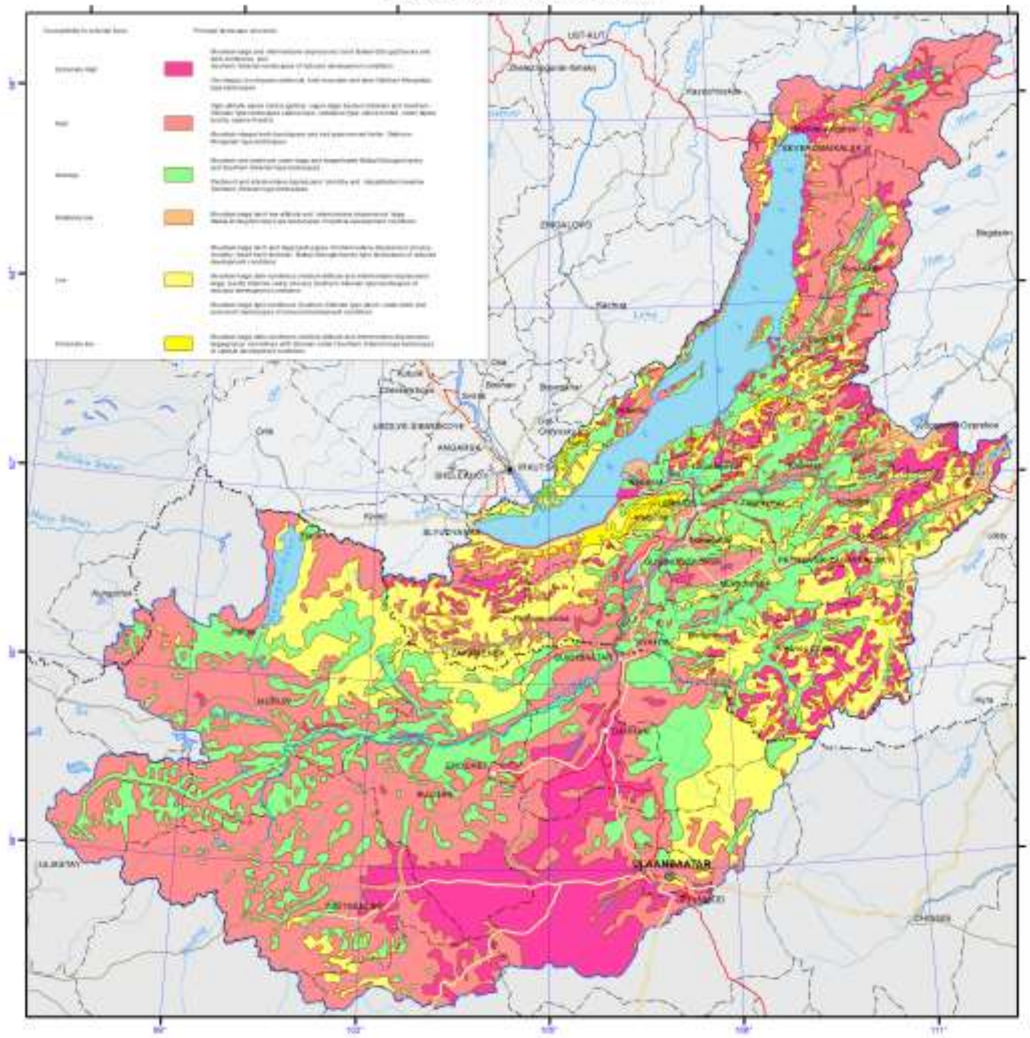
Landscape sensitivity in the basin of Lake Baikal is strongly interdependent on landscape types. “Integral intensity of functioning … and productivity of landscapes” [Isachenko, 1990, p. 7] are indicators of sensitivity. Sensitivity correlates with heat and moisture supply of landscapes “according to the optimality principle”, as well as with plant biological productivity “according to the maximum principle: the more the better” [Sochava, 2005, p. 72].

Sensitivity increases with the increase of deviation from ecological optimum between heat and moisture ratio. Landscapes with optimal combinations of heat and moisture supply and with high biological productivity are less sensitive to anthropogenic pressure. The most sensitive landscapes are with low and very low biological productivity, which develop under extreme conditions.

The sensitivity in the map legend is characterised by relative estimating categories such as “very high”, “high”, “mean”, “low”, and “very low”.

Empowered lives.
Resilient nations.

SUSCEPTIBILITY TO EXTERNAL INPUT



UNOPS

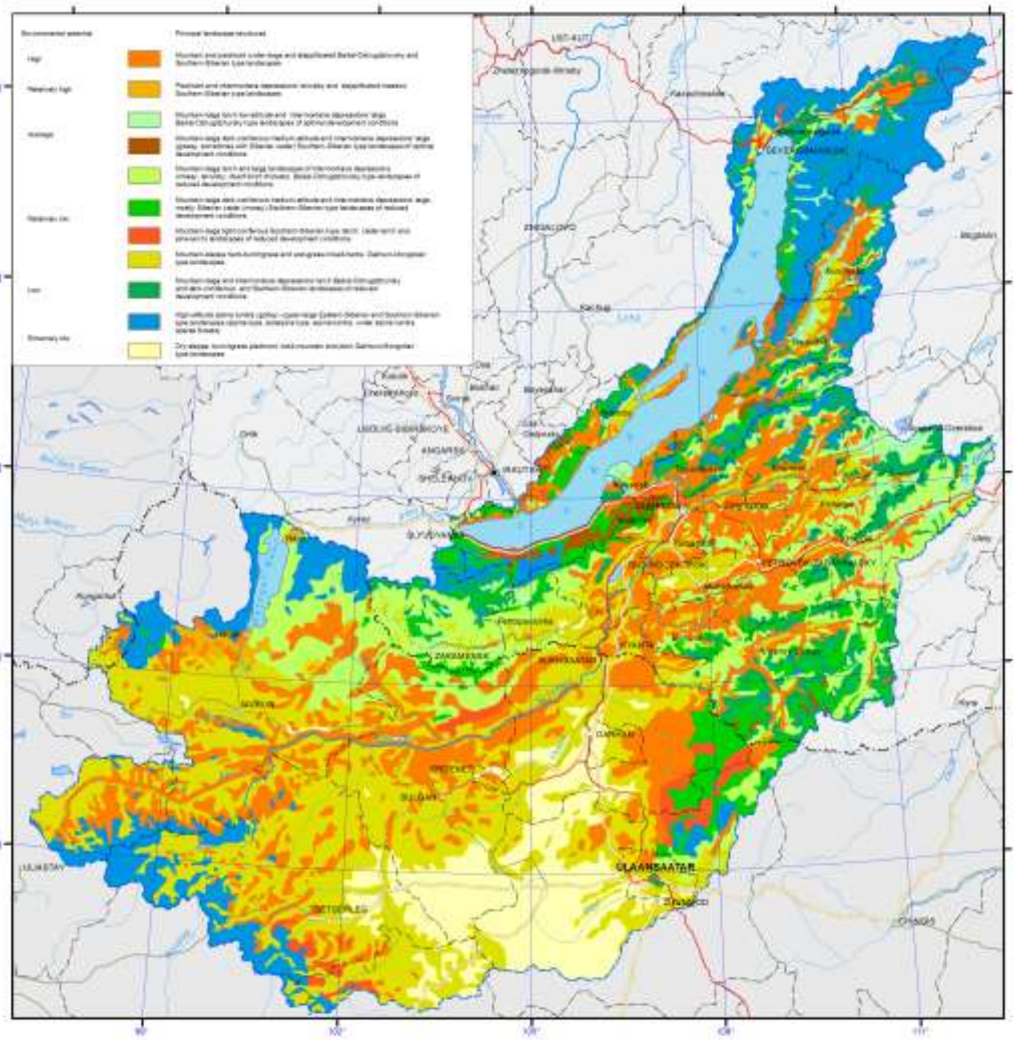
Ecological landscape potential (ELP)

The map characterises the ability of landscapes to create specific local human environment. It was compiled on the basis of ecological interpretation of landscape characteristics and consequent zoning of the Lake Baikal basin taking into account comfort level of landscapes for human activity.

The ratio of heat and moisture supply of landscapes, as well as productivity of their plants (low, mean, elevated, and high), was used to indicate ecological comfort of landscapes (lack of heat, excess of moisture, etc.).

Relative estimating categories (very low, low, mean, high, and very high) are used for ELP characterisation. In the map legend, they are correlated with factors of integral functioning intensity.

ENVIRONMENTAL POTENTIAL



Ecological functions of landscapes

This map represents the groups of landscapes, which have similar nature protected (ecological) functions [Polikarpov et al., 1980, p. 184-194]. They are divided into groups depending on these functions: environment-forming function of geosphere and local significance, environment-regulating, environment-stabilising, and environment-protective.

The landscapes of golets, tundra and sparse wood perform main environment-forming “water-productive” function. Of special significance is their snow and water collecting function. These landscapes experience large hydrological loads as they transform the water and transfer it to the subsurface flow. To date, the production of pure water is the most important ecological function as pure water is becoming the most valuable product on the Planet. The significance of these landscapes increases due to the protection fullness and purity of Lake Baikal water.

The environment-stabilising function is characteristic of all mountain-taiga (moss) landscapes of reduced and limited development – from mountain-taiga shrub-moss dark coniferous and larch communities to shrub and moss-shrub dark coniferous and larch-taiga landscapes in the intermountain depression and valleys with yernik and mixed undergrowth. Their moss cover provides certain ecological conditions. These landscapes are more stable and after external pressure they, as a rule, are recovered fast. Together with golets and upper-taiga landscapes, they play a certain role in internal and external interactions of landscapes.

South-Siberian and Central Asian (Dahurian-Mongolian) steppe landscapes are referred to the group with environment-regulating functions. On the whole, they have insufficient moisture [Geosystem …, 1991; Eco-geographic …, 1996]. Their role in the flow regulation is rather small. However, under conditions of intense water evaporation they have a very important regulating significance: plant components of these landscapes support the existing ecological balance whose changes can cause the disturbance of the moisture regime and, as a result, the landscape structure. This function intensifies under conditions of anthropogenic pressure. As a result, all steppe landscapes fulfil a technogenic barrier function for soil protection.

“Herb” landscapes perform environment-protective function: mountain-taiga larch landscapes of optimal development, piedmont and larch-taiga landscapes of optimal development in intermountain depressions, piedmont sub-taiga larch, mountain-taiga pinewood, piedmont sub-taiga pinewood landscapes. Insufficient moistening is characteristic of these landscapes, and changes of their vegetative component can cause changes in hydrological regime towards aridity and, as a result, disturbances of landscape structure. Their water and soil protective role increases. They are characterised by high concentration of different economic activity. Therefore, these landscapes are of technogenic barrier significance.

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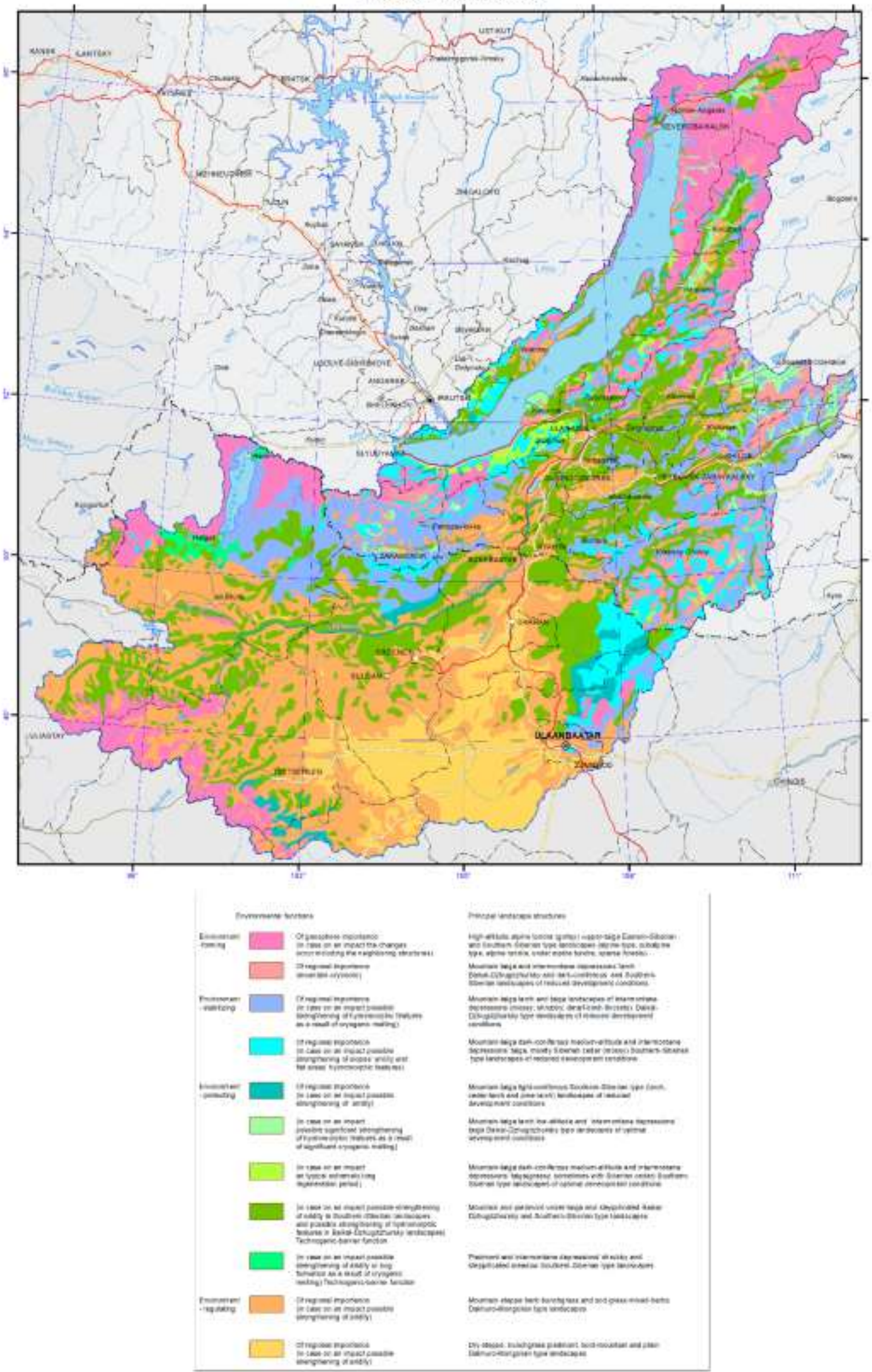
ENVIRONMENTAL FUNCTIONS



UNOPS

SOCIO-ECONOMIC FACTORS OF FORMATION OF ECOLOGICAL SITUATION IN THE LAKE BAIKAL BASIN

Industrial and its impact on the environment

Nowadays economic activity exercises significant influence on the environment, and the main impact factor is industry. The higher is concentration of industrial facilities, the more extensive the area of environmental changes, which can be traced in the Baikal watershed basin. Any change in one of the areas of the environment is reflected in the other (lithosphere disturbance indirectly affects the surface water and groundwater regime, predetermines the dust and gas pollution, etc.).

The research results of the industrial impact on the environment in the Baikal watershed basin are presented on the map "Industry and its impact on the environment". The mapping object is the industrial center, as one of the most common forms of territorial organization of industrial production and as well is a local group of companies (within the boundaries of a settlement).

Industrial centers are displayed on the map with symbols. The symbol's size shows the total population, the inner sectors - industry branches, circled sectors - the dominant impact on the environment components. Besides the areas disturbed by the mining industry (quarries, waste heaps, dumps, etc.) and emissions (for large settlements) are presented. Based on the analysis of the industry impact on the environmental the areas with maximum impact on the environment are distinguished.

The research results make it possible to draw the following conclusions.

The maximum industry impact on the environment is registered in the Republic of Buryatia. The impact is observed in all settlements; the areas of possible negative impacts on all environmental components are Zakamensky, Kyakhtinsky, Gusinoozersky, Nizhne-Selenginsky and Ulan-Udensky industrial centers.

Major industries exercise negative impact, e.g. the fuel and energy complex, mining, pulp and paper and food industries. The main pollutants are Ulan-Ude TPP-1, aircraft factory, car-repair plant, glass factory, Selenginsky cardboard mill; as well as light and food industries. Waste deposits of consumer and industrial waste disturb the environment significantly[Impact...].

On the territory of Transbaikalia local environmental impact of electric power, mining and food is observed. The largest area of the negative impact on the environment is the Chita industrial center, with the main polluters from the fuel-and-energy complex (TPP-1 and TPP -2), mechanical engineering and metalworking, and transportation.

The territory of the Irkutsk region, belonging to the Baikal watershed basin, is presented poorly in the industrial development, except for the towns of Bajkalsk and Sludyanka, the main polluters are mining (marble mining) enterprises, transport and energy companies. In Baykalsk the main source of pollution is the Baikal Pulp and Paper Mill is now shut down, but the consequences of its activities in the form of pollution of the lake and the adjacent part and the huge mass of solid wastes which have been stockpiled remain. The fuel and energy complex and transportation enterprises continue pollution. On the territory of Olkhon district the major source of environmental pollution is recreational activity, resulting in the problem associated with disposal of solid waste.

In Mongolia the main areas of industrial impact on the environment also belong to industrial centers, where population is concentrated, where the enterprises of industrial production are located (Ulaanbaatar, Darkhan, Erdenet, etc.) and local mining areas, as well as objects of light industry (processing of wool and leather). In Mongolia the impact of industry on water resources is particularly acute. In the last 20 years 852 rivers and 1131lakes of five thousand water bodies have dried up due to mining [Sergei Bassayev ...]. In addition, within all selected areas and large industrial centers an intensive water pollution (water quality relates to pollution class 3-4) is observed; the water polluters are mineral oil , phenol, also an increased oxidation is registered.

Uneven economic development of the territory is accompanied by a non-uniform impact on the environment. As a result, the most negative impact is occurred in large industrial centers where there is a high concentration of industrial enterprises, which are characterized by significant emissions of air pollutants and wastewater discharges in large volumes. Natural-resource potential of the area determined the development of the mining industry, which poses the greatest risk of land, surface and groundwater contamination with toxic substances from the tailings dumps.

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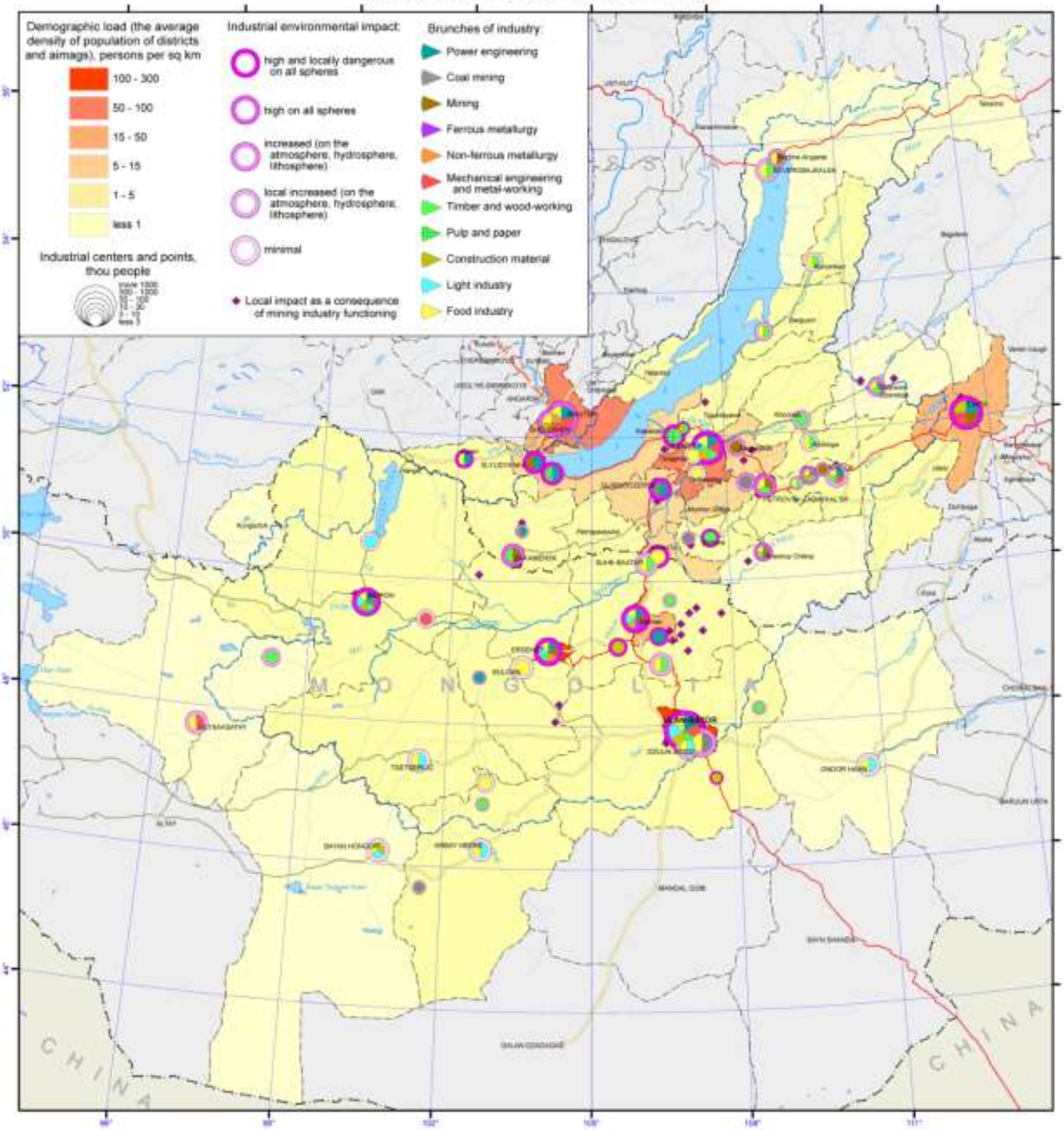
INDUSTRY AND ITS ENVIRONMENTAL IMPACT



Construction

The construction branch over Baikal watershed area is one of the issues in advancing economy and ecological well-being.

The principal indices in construction industry imply the bulk of industry-civil assigned areas, which in general reflect the social-economic status of some regions. The modern characterization of the construction sector, i.e. public residential construction is based on the governmental statistic observation data [Regions …, 2013; Construction in Trans-Baikal region …, 2013; Construction in, 2012; Construction and commissioning …, 2013] attracting the Internet resources [Federal survey …].

In this region for the past three years from 2010 to 2012 the bulk of commissioned housing increased three-fold, e.g. from 0.4 to 1.2 mln. sq. m).As regards the increment of absolute indices (figures) of commissioning residential building, the Irkutsk Region gains a leading position being mostly urbanized. This is where over half of public construction was placed within the watershed area of Lake Baikal (2012). The second position is occupied by Republic of Buryatia (26.2 %), and the third one is taken by the Trans-Baikal Region (Zabaikalie) (19.3 %).

An important feature of the yearly commissioning of housing ($м^2$/person) is the background index of map. Russia occupies the prior to reform level of residential housing in 2007 following the absolute indices. However, the specific volume of commissioned housing both in the country and on the Baikal watershed area is not in excess of 0.5 m^2/person (in developed countries they put into operation no less than 1 m^2 per capita, and the annual increment of commissioned housing makes up 4.5-5.0 %) [Federal Survey …]. The territorial differentiation of municipal formations within the region on this important index is quite contrasting. High specific indices and subsidized housing projects are observed on the entire territory, but Tuva Republic. Nearly twofold predominance of this index is shown by the Irkutsk Region(0.81 m^2/person, with mid-regional index 0.45 m^2/person).

The residential construction sector is distinguished by:

– contrast range of its geography both in absolute and standard specific basic figures;

– the modern center of its growth is Irkutsk and Ivolga in the Republic of Buryatia.

Important tools to improve public housing construction are subsidized housing projects of regional and municipal levels aimed at complex activities on the development of mass public construction in the region. The social-economic planning through various regional programs is capable «to advance» the much-demanded public housing in lower municipalities.

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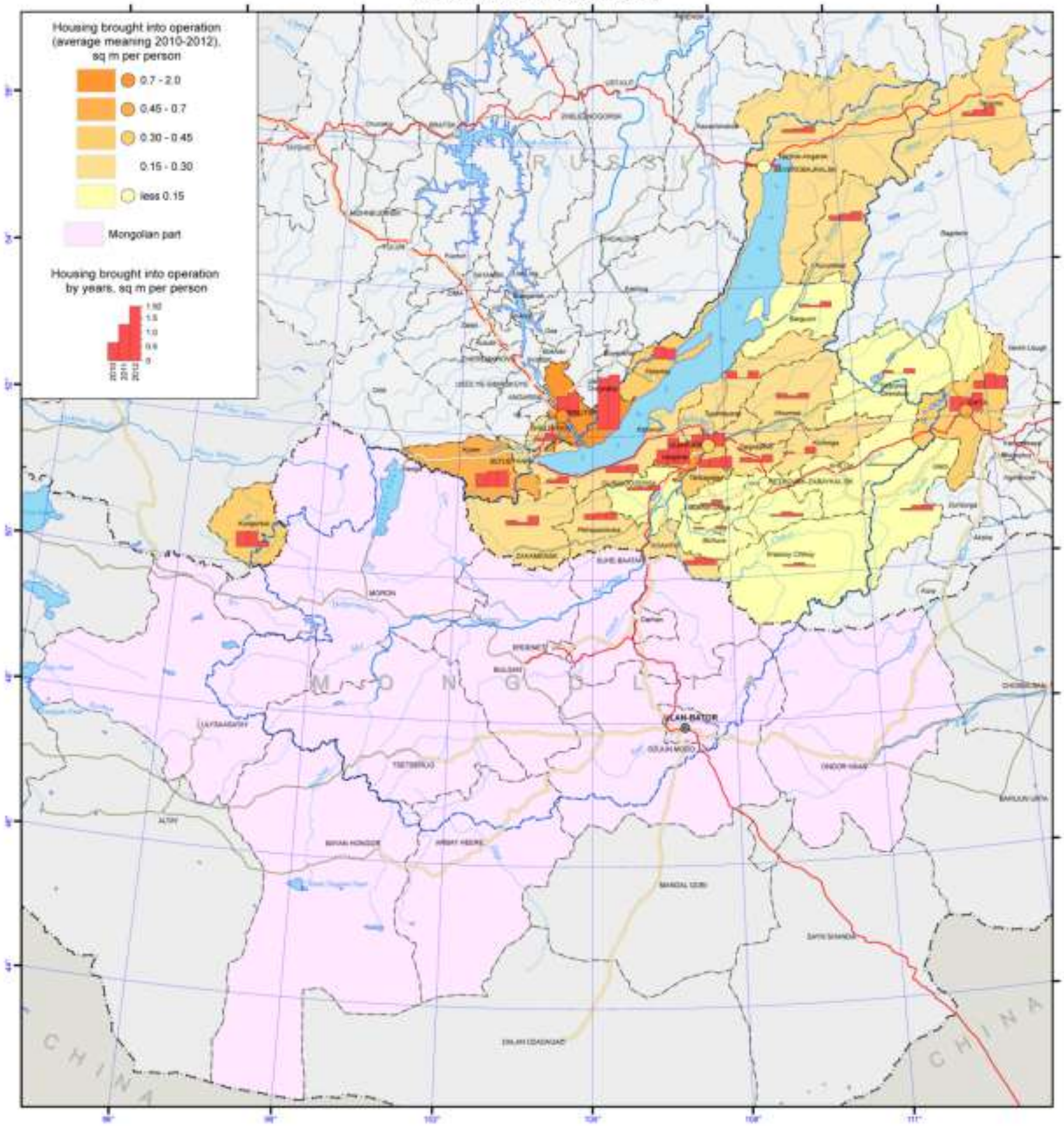
CONSTRUCTION (Russian part)



The use of agricultural lands: livestock husbandry and crop production

The agricultural production is one of the leading sectors of the economic complex of Mongolia. Two branches are traditionally presented in the structure of the gross agricultural production; they are livestock husbandry and crop production. A specific feature of Mongolia is the predominance of livestock products and reliance on the pasture management system. On a national scale, the agriculture of the Baikal region of the Russian Federation holds a modest place: less than 1% of agricultural production. In the East Siberian economic region Irkutsk oblast ranks second in the production of agricultural products after Krasnoyarsk krai; the Republic of Buryatia and Zabaikalsky krai rank third and fourth, respectively. Among the regions, included into the Siberian Federal District, Irkutsk oblast, the Republic of Buryatia, and Zabaikalsky krai rank 5th, 8th and 9thin the agricultural production, respectively. In the economy of Irkutsk oblast the agriculture plays a minor role. Its aim is to meet the needs of the local population in agricultural products. In Zabaikalsky krai and the Republic of Buryatia the agriculture is one of the leading production branches, which plays a key role in the livelihood of the population. The branch accounts for about 8.1% of the gross regional product in Irkutsk oblast, 12% - in Zabaikalsky krai, and 11.5% - in the Republic of Buryatia.

The agriculture develops under extreme environmental conditions: the agricultural territory belongs mainly to an area of low biological activity, andits significant part is characterized by cold climate. Bioclimatic potential of the agricultural zone is 2-2.5 times lower than in the European agricultural zone. Consequently, to get a unit of agricultural production in the region requires more energy expenditures.

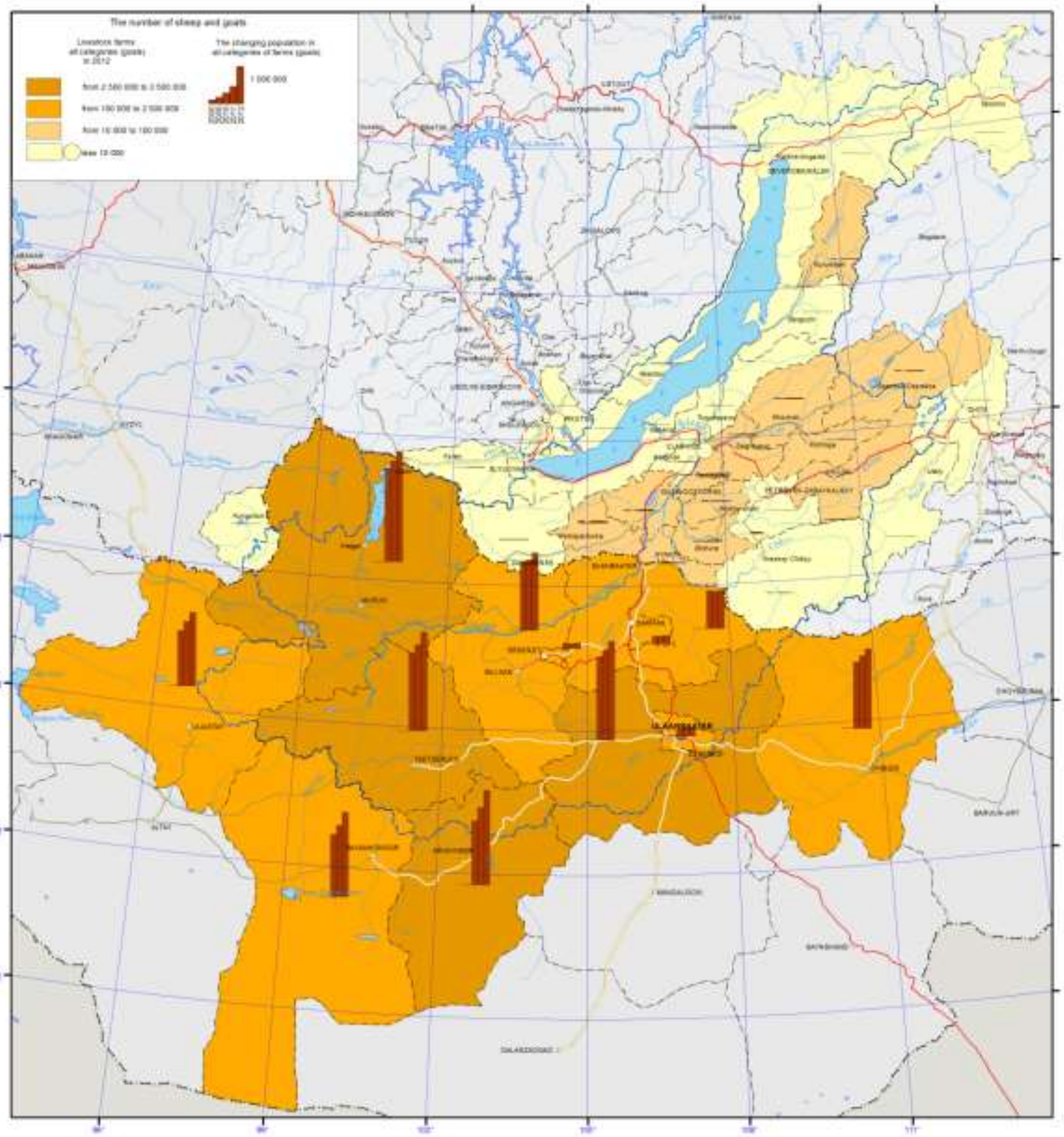
The agriculture of regions within the Lake Baikal basin includes two major branches, namely: livestock hus band dry and crop production, the shares of which in the gross agricultural output vary regionally: in Irkutsk oblast they are approximately equal; in Zabaikalsky krai, the Republic of Buryatia and Mongolia the leading branch of agriculture is livestock husbandry, the proportion of which is over 70%.

Areas of agricultural lands, which are in use by commercial farm units, engaged in the agricultural production, decrease year by year. Disposal of agricultural lands from agriculture is registered in almost all districts of the region. The main reason for the reduction of lands dedicated to agricultural production is the termination of activities of enterprises and organizations, and peasant farms. Another reason is the expiration of the agricultural tenancy (or temporary use) and its non-renewal by agricultural producers.

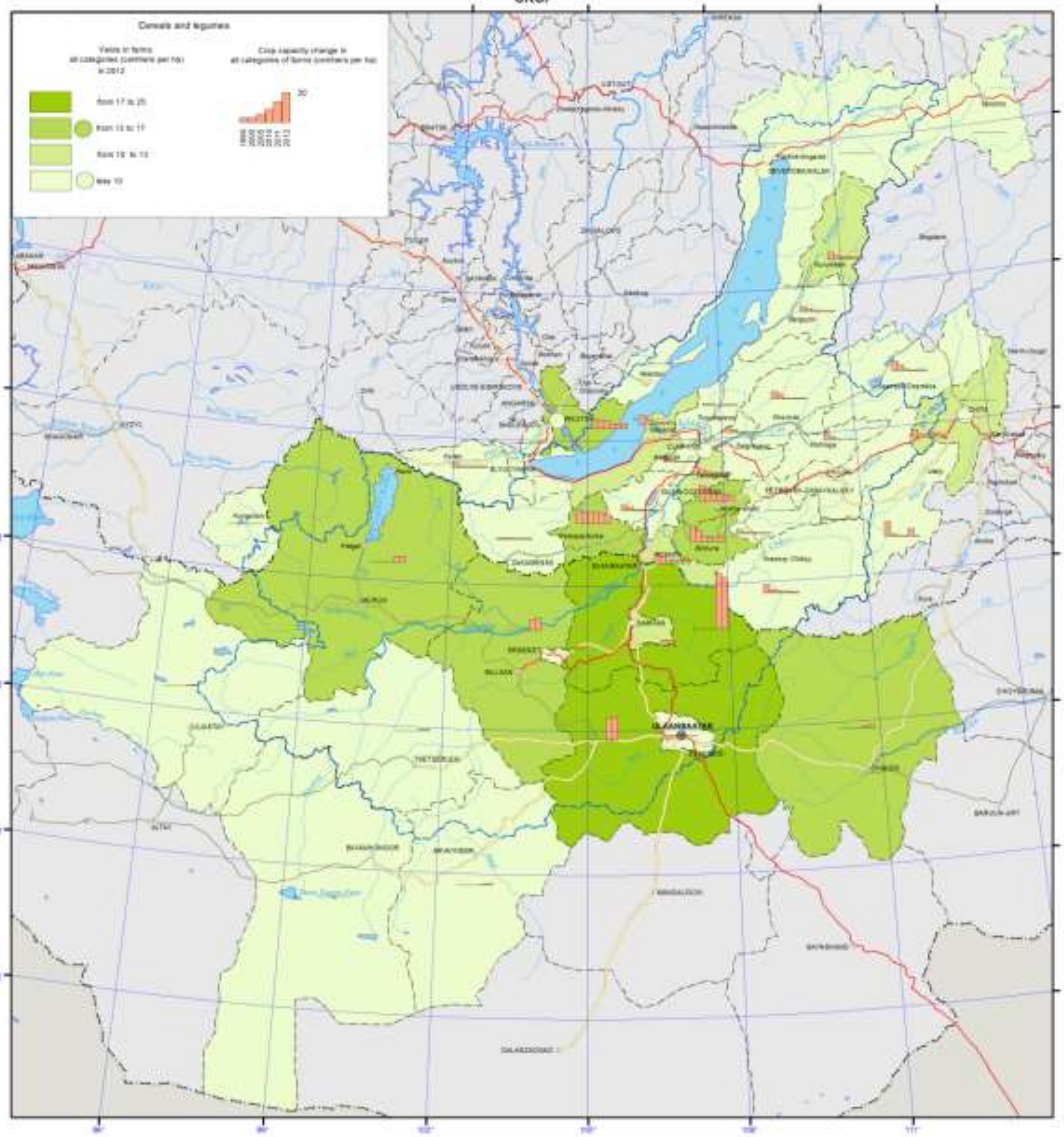
About 1% of agricultural lands of Russia are located within the Baikal region. The main agricultural lands are located in the forest-steppe areas and along river valleys. However, the provision of the population with agricultural lands per capita is sufficient, for example, in Irkutsk oblastit amounts to 1.1 ha, and in Zabaikalsky krai it is 6 ha (average provision index for Russia is 1.5 ha). In the total area of agricultural lands of Irkutsk oblast the share of arable lands accounts for 69%, the proportion of pastures is 20%, and meadows and hayfields cover 10%. In Zabaikalsky krai the largest areas are occupied by forage lands, meadows and hayfields, the proportion of which exceeds 80%. In the structure of agricultural lands of the Republic of Buryatia the share of arable lands is 30%. Sown lands are used mainly for cereal crops (more than 75%), among which wheat occupies more than 45%. The yield of cereals on the average is low (8-9 centners per ha), but in some farms it can reach up to 20 and more centners per ha. Potatoes and vegetables are widely cultivated for one’s own needs. Sown lands under these crops amount to slightly more than 8%, of them under vegetables is 1.0%. Vegetable production is concentrated mainly around cities and settlements. In Irkutsk oblast in the Baikal natural territory lands of four districts, namely, Irkutsky, Shelekhovsky, Slyudyansky and Olkhonsky, are involved into the agricultural exploitation. Furthermore, two districts –Olkhonsky and Irkutsky – are typically “agricultural”, where agriculture is one of the leading sectors of the economic complex. In contrast to the Irkutsky and Olkhonsky districts, in the Sludyansky district the scarcity of land resources does not allow to develop agricultural production, but the district has formed a high-intensity horticultural sector with commercial cultivation of strawberries. Currently, this resource is not included in the turnover of the legal economy of the district; it is not processed on a commercial scale, and it is realized by private buyers, who do not pay taxes. Processing of local horticultural resources is included in the plan of the production diversification in the town of Baikalsk within the framework of the program of the Baikalsk Pulp and Paper Mill conversion. In Mongolia, the total sown areas of cereal crops and potatoes amount to 283.6 thousand ha and 13.6 thousand ha, respectively. Currently, the leaders in the production of cereals and potatoes are the Selenge and Bulgan aimaks.

In the structure of the gross agricultural output a quintessential role belongs to the livestock husbandry. The development of the livestock husbandry, especially sheep and beef cattle breeding, is facilitated by the presence of large areas of dry grazing lands, where valuable forage herbs grow, and by a thin snow cover in winter, enabling year-round cattle grazing along with relatively small quantities of fodder procured for winter. In the structure of the fodder base for all species the proportion of natural coarse and green forage accounts for 75 to 85% of all fodder. The foundation stock of farm animals is managed in the private sector. The livestock husbandry is represented by various branches; in the forest area of the region it is dairy-meat farming, and in the south, including Mongolia, it is distant-pasture beef-dairy and beef cattle breeding, meat-wool sheep breeding, and horse and pig husbandry. Moreover, goat breeding is traditionally represented in the aimaks of Mongolia, and camel husbandry is an auxiliary branch. Most farms produce milk and beef, implementing the so-called full cycle of a herd based on internal specialization of farms, producing milk and breeding young-stock.

ANIMAL INDUSTRY



CROP


Cereals and legumes
Yields in farms all categories (centners per ha) in 2012
Crop capacity change in all categories of farms (centners per ha)
from 17 to 25
from 13 to 17
less 10
30
ULAANBAATAR

Transport

The transport infrastructure of the Lake Baikal basin is a constituent part of the transport systems of Irkutsk oblast, the Republic of Buryatia, Zabaikalsky krai, and the Republic of Mongolia. Almost all modes of transport, namely, rail, road, river, and air transport, are presented within the territory under consideration.

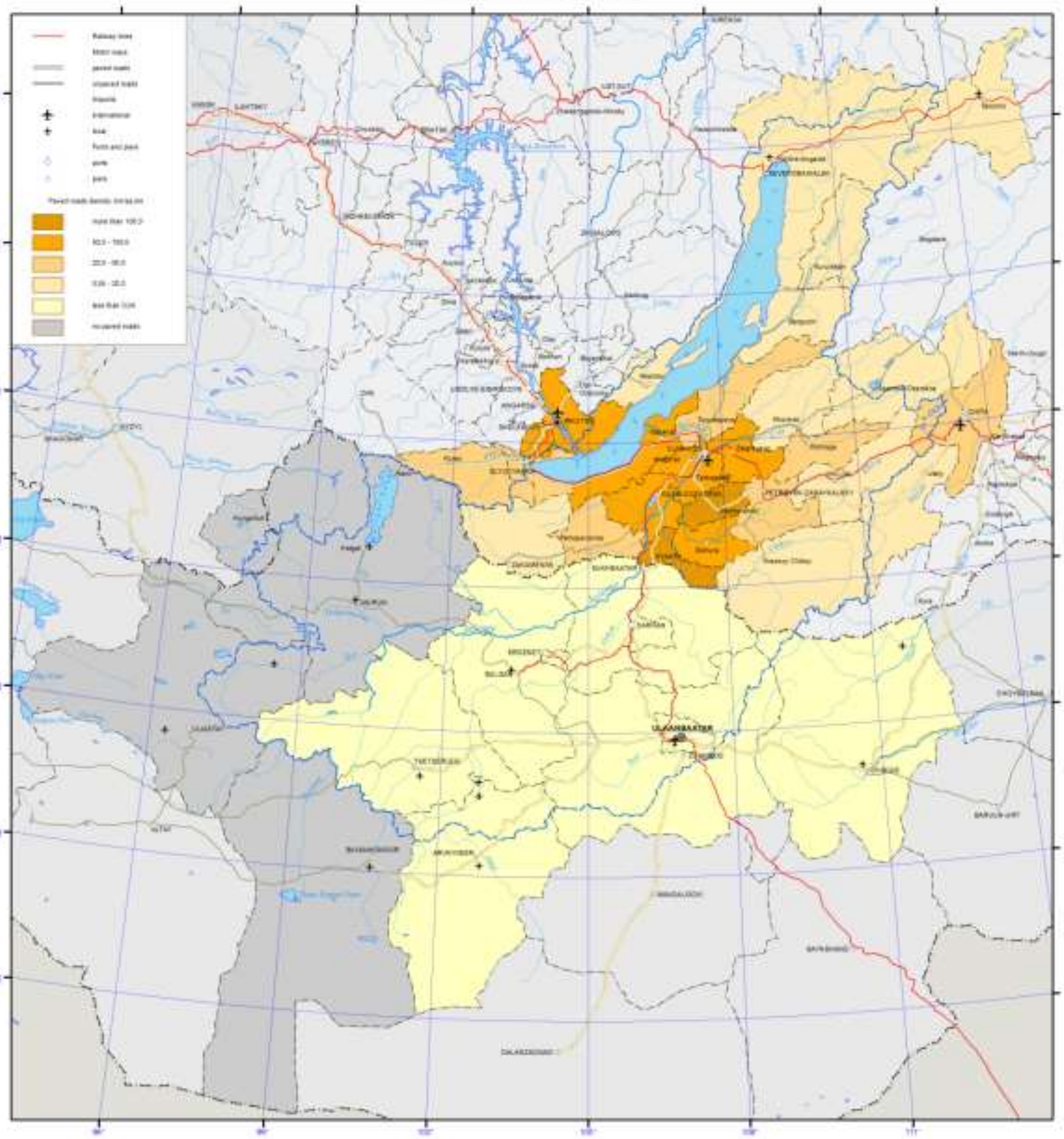
Railways in the given territory within Russia are a part of the East Siberian Railway. The rail transport serves the Southern and Northern Pribaikalie. The Baikal-Amur Mainline runs along the northern shore and further along the valley of the Upper Angara river. A short segment of the Trans-Siberian Railway runs along the southern shore of Lake Baikal and further to the east. Two railway spurs branch off from it, namely: the Circum-Baikal Railway 84 km in length and the railway Ulan-Ude–Naushki (253 km) and further to Mongolia, where it is connected to the Ulaanbaatar railway. In Mongolia, the basis of railways is the section from the Russian border via Ulaanbaatar to the border with China to Beijing. Within the Lake Baikal basin branch lines to Erdenet, SharynGol and Baganuur run away from it.

Among ***highways*** the most significant one is the federal road Irkutsk–Ulan-Ude–Chita (a segment of the Moscow highway),which parallels the Trans-Siberian Railway. Besides the Moscow highway, the segments of the motor roads Kultuk–Mondy, Irkutsk–Listvyanka, Magistralny–Severobaikalsk–Uoyan–Taksimo,Bayanday–Elantsy–Khuzhir, Ulan-Ude–Turuntaevo–Kurumkan, Ulan-Ude–Kyakhta with a branch to Zakamensk, Ulan-Ude–Bichura, Ulan-Ude– Sosnovo-Ozerskoe–Bagdarin, Chita–Bagdarin, Chita–Aginskoe, etc. runwithin this territory. In the territory of Mongolia hard-surface roads are presented by the road from the border with Russia to Ulaanbaatar, with its branch Darkhan–Erdenet–Bulgan. There are two motor roads from Ulaanbaatar to Tsetserleg and Underhaan. The rest of the roads in Mongolia are dirt roads. The highest density of hard-surface roads is observed near Ulan-Ude.

Within the territory under consideration ***navigation*** is realized on Lake Baikal and LakeHovsgol, and in the Angara and Selenga rivers. The fleet, currently involved on Lake Baikal, is represented by drycargo, passenger, expedition, and research vessels, freight and passenger-and-freight ferries, and self-propelled vessels. Passenger serviceis performed from Irkutsk with stops at Olkhon Island and Severobaikalsk to Nizhneangarsk; there are also other routes from Irkutsk, namely, to Ust-Barguzin, Bolshie Koty and Peschanaya bay. There are stretches potentially suitable for navigation on the Selenga (274 km), Barguzin (138 km) and Upper Angara (254 km) rivers.

The major proportion of ***air transportation*** is carried out by four international airports: Irkutsk, Ulan-Ude, Chita, and Ulaanbaatar. Direct traffic is provided through these airports concerning both national interregional (Moscow and other Russian cities) and international (China, Japan, South Korea, and Germany) air transport service. The network of local airports is small. In 2012, about 1.1 million people were transported by air from the Russian airports, while from the Mongolian airports this value amounts to 770 thousand people.

TRANSPORT INFRASTRUCTURE



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Functional types of settlements

The map "Functional types of settlements" shows using symbols the distribution of settlements within the territory of the Lake Baikal basin and their economic significance. The main content of the map is a network of urban and rural settlements with an indication of a number of residents, shown by the size of a symbol (marker) in accordance with the selected scale of 9 gradations of population size. Color of a symbol shows the functional type of a settlement, which is defined on the basis of the structure of employment of population in various sectors of economy.

A dominant role in the settlement network, formed in the Lake Baikal basin, is played by large multifunctional industrial-transport, administrative-cultural and scientific centers of the state (Ulaanbaatar) and regional (Irkutsk, Ulan-Ude, Chita) significance.

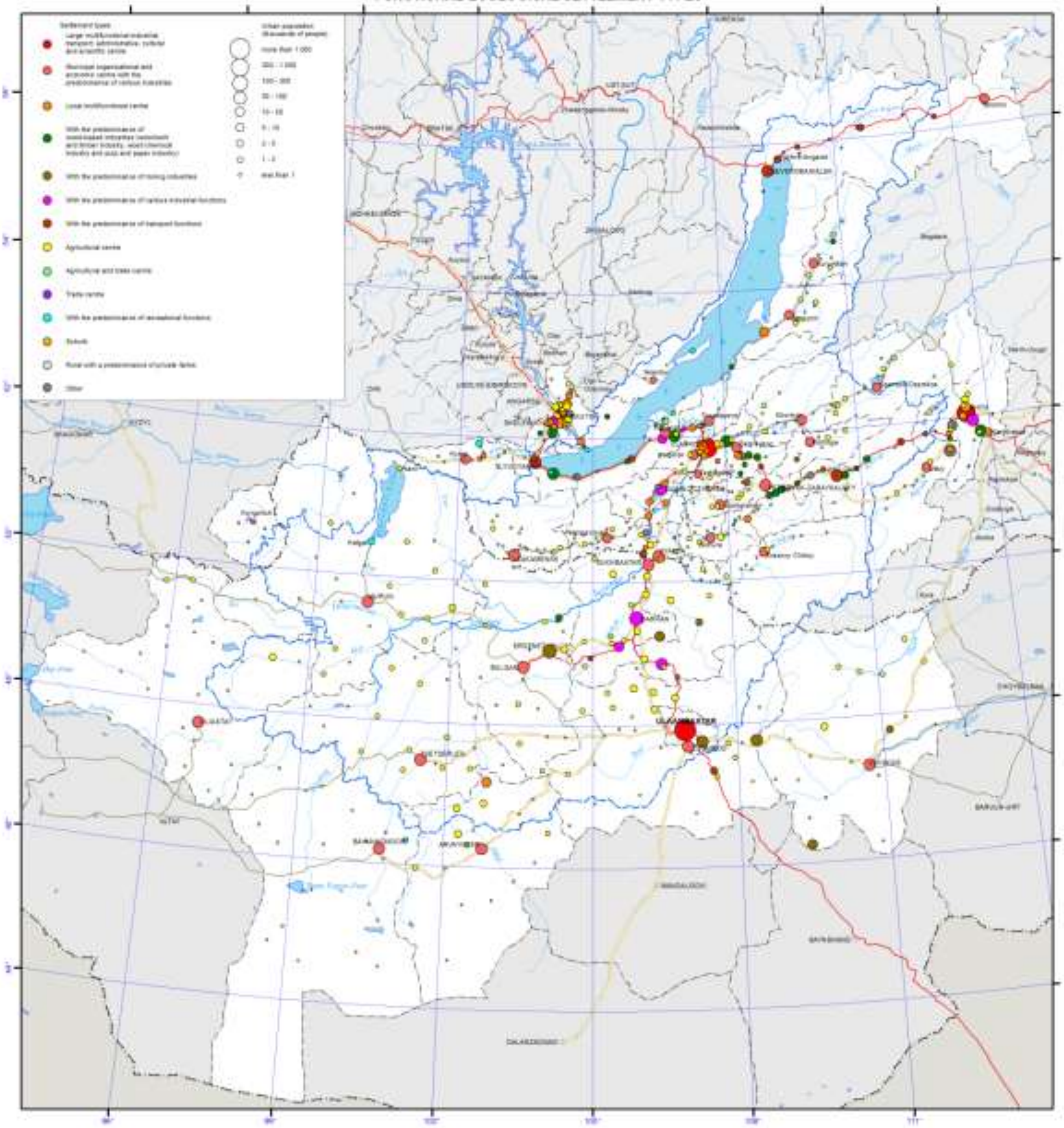
Various specialized industrial and transport centers are almost exclusively confined to the railway lines. Local organizational-economic centers, performing nodal functions of serving their hinterlands, are scattered over a greater part of the territory. Dispersed settlement is especially clearly manifested in the Mongolian part of the Baikal basin, where each aimak is dominated by the corresponding center under the conditions of a sparse network of agricultural settlements.

Quantitatively, the region's territory is dominated by small rural settlements with agricultural functions; their predominance is especially high in Mongolia. They are scattered within the steppe areas and in the southern part of Buryatia, where they are confined to river valleys.

Settlements with predominance of recreational functions are few in number and are mainly confined to the shore of Lake Baikal (Listvyanka, Utulik, Khuzhir), to the shore of Hovsgol (Khatgal), and to the Tunkinskaya valley (Arshan).

Large-scale inset maps "Irkutsk", "Ulan-Ude", and "Chita" demonstrate functional types of settlement in the areas of direct influence of the relevant regional centers, around which features of the suburban type of settlement are clearly manifested.

FUNCTIONAL-ECOLOGICAL SETTLEMENT TYPES



Population

The maps of population disclose the present features of the territorial population density and demographic situation with in the Baikal watershed, associated with a combination of social, economic and ecological factors.

The maps of population are compiled from statistic data of the Federal Survey of the State Policy of the Russian Federation and National Statistical Office of Mongolia [see reference list]. They also include the data on the population census implemented in Russia and Mongolia, as well as data on the current record of demographic events. Statistic sources were used by the authors to evaluate the indices/figures on the territories, referred to the Lake Baikal basin.

Within the Baikal watershed the populated areas are distributed fairly irregularly; amongst them are the four sites of regional concentration of population. In Irkutsk Region the main zone of population extends along the Trans-Siberian Railway from the western boundary of the region up to Lake Baikal. The zone comprises numerous agricultural settlements, majority of large administrative-economic centers with predominance of processing industries. The population settlement group system is headed by Irkutsk, the large multifunctional center. Within the Baikal basin there are low-populated Olkhon and Slyudyanka Districts and part of Irkutsk District. Close to the Baikal basin, within the Angara River basin, Irkutsk city and Shelekhov town are located. In the Republic of Buryatia quite a sizable inhabited center grew up around Ulan-Ude city, with a maximum distribution south off it. The geographic differences in specialization of settlements are the case: whereas along the Trans-Siberian Railway these are the settlements involved in the industry-transportation functioning, the southern Buryatia primarily comprises agricultural areas. In the Trans-Baikal Region three networks are available: (1) industry-transportation settlements confined to the railway track; (2) mining enterprises near developed deposits; (3) agricultural settlements located south of Chita city in the zone of forest-steppes and steppes. In Mongolia the population is mainly concentrated over the territory of central region, i.e. from Ulan-Baatar city in the south to Sukhe-Baatar in the north. This area includes three main cities, in which nearly half of entire population settled. The other territories of the Mongolian part of the Lake Baikal watershed are populated quite irregularly.

The population distribution and the extent of habitation are displayed on the maps *«Density of population by1.01.2013»;* 71*«Density of rural population and population size of urban settlements by 1.01.1989»;* 72 *«Density of rural population and population size of urban settlements by 1.01.2013».*

The Baikal region is referred to low-and irregularly-populated. By density of population the Lake Baikal watershed yields the world average index 17-fold, e.g. 53 persons/km^2. The Russian part of it has the population density 2.9 persons/km^2, i.e. nine-fold lower than in the European part of Russia, e.g. 26 persons/km^2.

The intra-regional differentiation of territory occupancy is stipulated by the presence of some spatial gradients of population density reduction, with the main gradient lying from the center (capitals and administrative centers to the periphery. The other gradients occur on separate territories. Thus, in the Russian part of the basin the population density reduces from south to north and from west to east. The Russian-Mongolian boundary over its larger extent separates, rather than unites the inhabited areas, but the only direction, with the core – the Selenga River delta, where the territory between Ulan-Baatar and Ulan-Ude cities shows a high density of population.

The territories around large cities, like regional centers Irkutsk, Ulan-Ude and Chita, are most densely inhabited. Next to the districts of compact occupancy there are sparsely populated areas of some dozens thousand square kilometers. The rural population is distributed more or less regularly, as compared to the urban one. The main clusters of rural population are located in the forest steppe and steppe zones, where the density of population may achieve 10-20 persons/km^2. Rural population is mainly concentrated in the south of Irkutsk Region (around Irkutsk) and in the central part of Buryatia (south of Ulan-Ude).

Most important cities of the Russian part grew up on the transportation lines. Thus, along the railways 11 out of 13 towns are located. Only towns Zakamensk and Kyakhtas it away from railways. In the Mongolian part the towns are not so numerous near the transportation lines, e.g. 5 out of 12 towns are situated on the railways.

The map *«Dynamics of population number (1989-2013)»* exhibits considerable changes in population number, when its concentration in some largest centers is accompanied by depopulation of vast territories.

On the Russian territory two patterns of population number dynamics in the period 1989-2013 are clearly recognized: (1) the population decreases from the south-west to the north-east; (2) the population dynamics is relatively favorable in the regional centers Irkutsk, Ulan-Ude and Chita and their surroundings. Only in Irkutsk, Shelekhov and Olkhon Districts of Irkutsk Region, Ivolga District in the Republic of Buryatia and in the Chita District of the Trans-Baikal Region there is growth of population. The highest (over 160 %) growth of population was recorded in the suburban Ivolginsk and Irkutsk Districts. Maximum decrease of population occurs in the localities, referred to the districts of extreme North, where the Muysky and Severobaikalsk Districts of the Republic of Buryatia lost over half of population.

In the Mongolian part of the Baikal basin the population is growing over half of the territory, particularly fast growing are the cities Ulan-Baatar, the capital of Mongolia, (244 % to the level of 1989), Erdenet and Darkhan; the Khubsugul and Selenga aimaks (Mongolian district). In four aimaks Arkhangay, Zavkhan, Tov, Khenteythe population decreases due to migration outflow of residents beyond these aimaks.

The contrast of population dynamics within the Baikal basin is distinctly the case:

- the Russian part of the Baikal basin is typified by population dynamics, which implies the migration flow-out, manifold predominating the natural decrease of population;

- the Mongolian part is typified by population dynamics with predominance of the natural increment over migration inflow of population.

The territorial features of demographic development are depicted by map *«Natural increase of population»*.

In the Baikal basin there coexist different modes of population reproduction with a wide variation of quantitative parameters of demographic processes. In total, two types of population reproduction have been revealed. Thus, entire Mongolia, Tuva and part of Buryatia are characterized by a widened type of reproduction with a high birth rate, mean death-rate and a significant natural growth. The Irkutsk Pre-Baikal territory and Trans-Baikal Region and larger part of Buryatia are typified by the reductive model of population reproduction with a low birth-rate, high death-rate and natural decrease or insignificant natural growth. The natural growth of population in Mongolian aimaks annually makes up 17-19 ‰. In the Russian part of the basin the natural movement of population resulted in ambiguous results, when 23 municipalities showed population increase, and 10 municipalities showed population decrease. With the natural population increase counted as 1.4 per mille there were significant variations: from decrease in the range -5 − -6 ‰ (in Petrovsk-Zabaikalsk, Irkutsk and Olkhon Districts) to the increment, exceeding 10 pro mille (in Dzhida District - 10.4 ‰, in Kizhinga District – 12.1 ‰, in the Tere-Kholskykozhhuun– 16.0 ‰). The natural population increase in the Mongolian capital Ulan-Baatar was 17.2 ‰, and in the Russian regional centers Ulan-Ude and Chita it was 4.3 and 3.4‰, accordingly, with decrease in Itrkutsk -2.7 ‰.

The map *«Urbanization of the territory»* displays the proportion of urban population within population of the Russian municipal districts and Mongolian aimaks. The urban population on average exceeds 74 % of entire population, but it is added up due to a small number of territories. If the rate of urban occupancy of population (74 %) is in excess of world average (51 %) nearly half as much again, then this rate is low. The urban territories are primarily those lying close to railway, with the concentration of population in the administrative centers. On the Mongolian territory highly urbanized are Ulan-Baatar, Orkhon and Darkhan-uul, and the rest 9 aimaks having a small proportion of urban population (from 17.5 to 34.9 %).If in

Mongolia every aimak comprises a town being its administrative center, then the Russian legislation does not oblige municipal districts to include urban settlements. As a result, by 2013 on the Russian territory 14 districts do not have urban population at all. Some settlements, like Barguzin, Ivolginsk, Kyrenand Khorinsk were deprived of the urban status after municipal reforms of 2000s. The population of Mongolian towns increased through period 1989-2013 nearly tow-fold, e.g. in Ulan-Baatar from 540.6 to1318.1 thousand people. The population of the largest cities Russian part of the basin of Lake Baikal did not change much: in Irkutsk from 572.4 to 606.1 thousand people, Ulan-Ude from352.5 to 416.1; Chita from 365.8 to 331.3 thousand people.

The migration processes in 2010-2012 are depicted on the map «*Migration increase of population*».

In Russia and Baikal region for the past two decades the migration activity of population decreased markedly. However, the migration flow-out from the region is retained at the high level and is reproduced yearly from the middle of 1990 up to now. The Population Migration Is Basically Intra Regional: the migration turnover covers nearly 2/3 of relocations in the Baikal region. The within-Russia interregional movement causes migration loss, and migratory relationships with FSU countries contribute to a considerable increment of population.

The population is redistributed between the segments of the Baikal region fairly intensively, covering some tens of thousand people annually. In 2010-2012 on average 66.500 people arrived, and 58.600 people left. In the Baikal Region The average annual migration increment is 7.900 people. However, this status was due to attractive cities for migrants Irkutsk with Irkutsk District (+9.300 people), Ulan-Ude (+3.400 people) and Chita (+2.9 people) which population increased in total by 15.600 people. The rest of the region had the flow-out of inhabitants counted as 7.700 people. The migration redistribution of population causes growth of municipal formations had migration growth of population, and the rest 24 show the migration decrease. The intensity of migrant arrival is highest (twice as high as average level) in the suburban Irkutsk and Ivolga Districts, and the intensity of leaving (twice as high as average level) in the depressive Dzhida, Kizhinga and Muysky Districts. On this background in the Russian part of the Baikal region the migration centers (poles) are Irkutsk and Dzhida Districts, with the average annual migration balance being +47.4 ‰ and -46.0 ‰, accordingly.

Most of territories are characterized by a progressive migration flow-out of population, deteriorated by the unfavorable structural features of outflow deteriorated by unfavorable structural features of outflow (due to young and educated groups of people). Theresultsofmigrationmovementareclearlyexpressedincenter-periphery relation: there are three areas of migration increase in the Russian part (Irkutsk, Ulan-Ude and Chita with corresponding suburban districts) and one in the Mongolian part uniting the capital Ulan-Baatar and lying in the north aimaks Selenge, Orkhon and Darkhan.

* * *

The evaluation of the demographic potential within the Baikal basin lets a conclusion to be made on its important factors:

– ultra continental geographic position in severe natural conditions and at a large distance from densely-populated territories in Eurasia;

– low investment activity, that reduces economic development and deteriorates structural shifts in favor of innovation sector of the region;

– low degree of relevance of labor potential of the region with the available economy, indicators being a low earnings of employees and a regular outflow of population from the Russian part of the Baikal basin;

–socio-demographic structures, occupation and quality of life of population between separate localities, that is particularly evident in comparison between the Mongolian and Russian parts of the lake basin.

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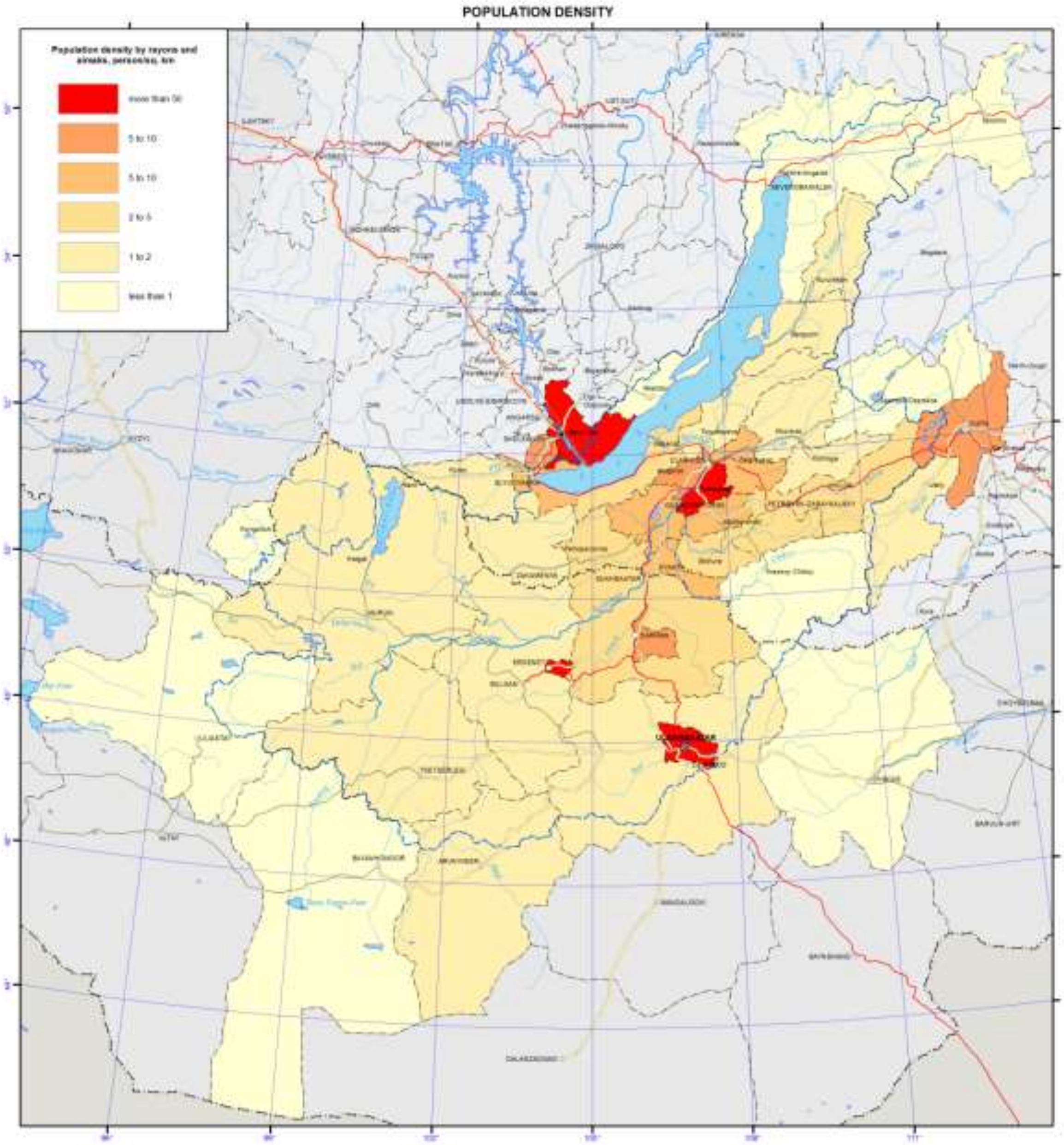
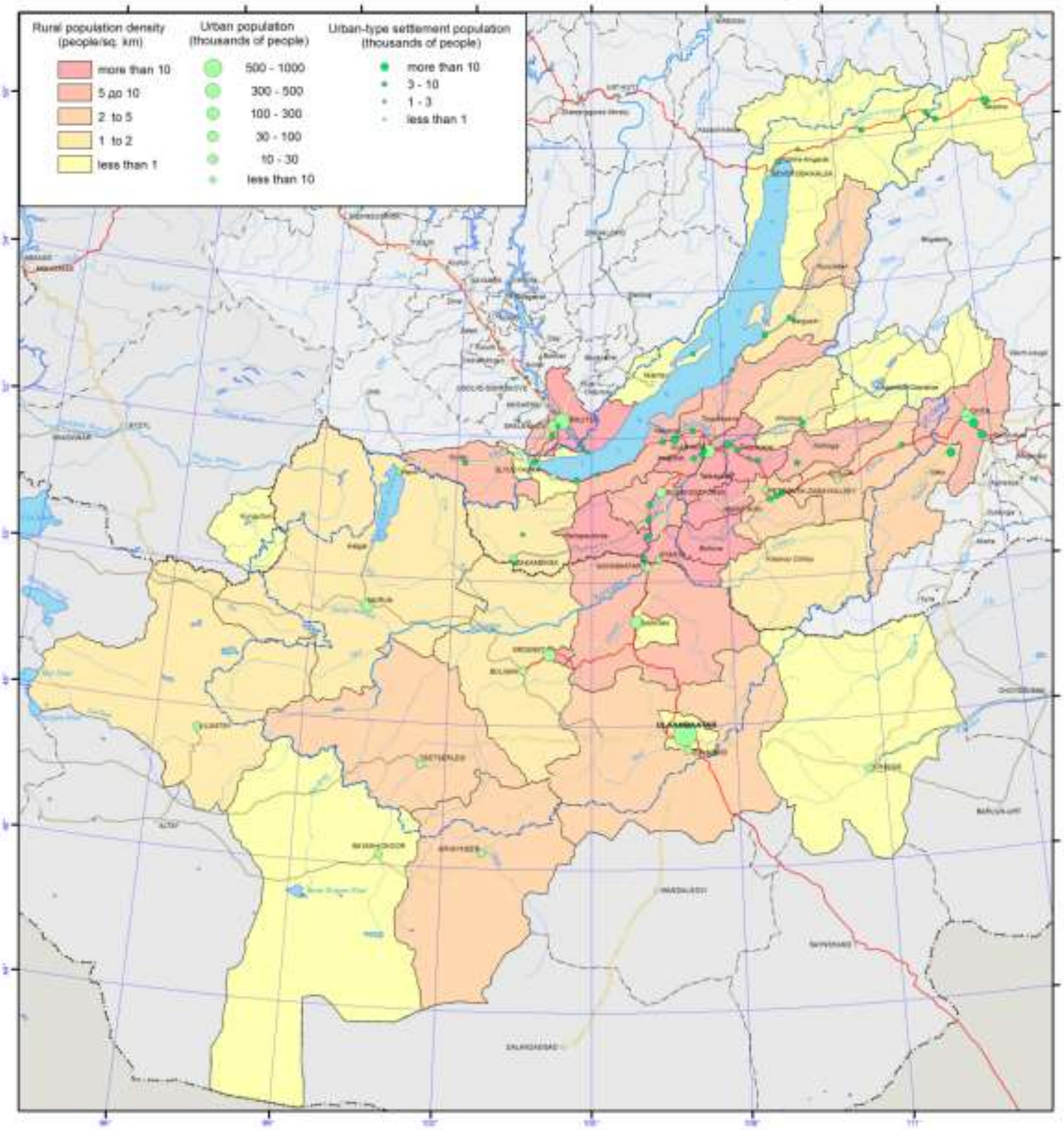
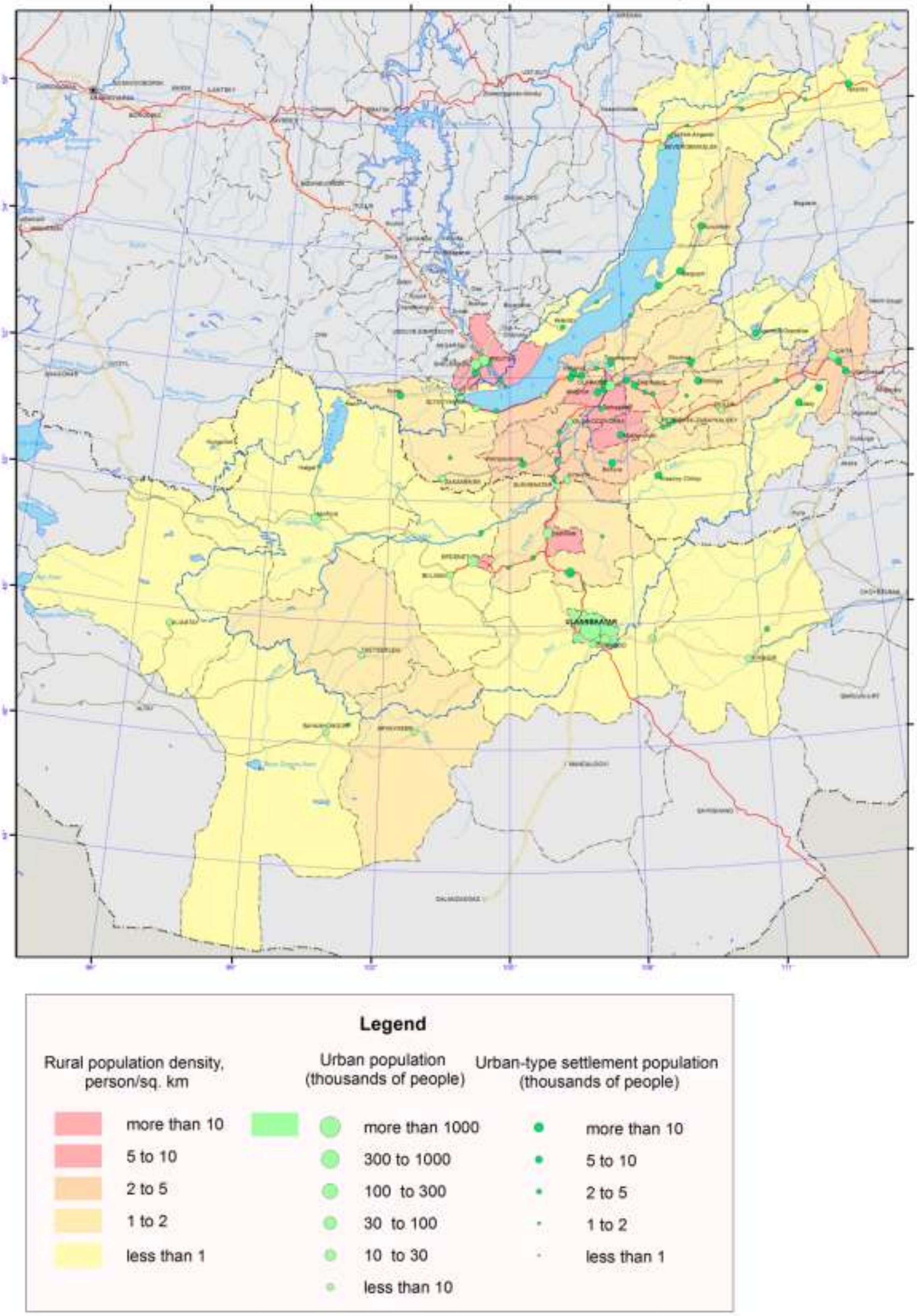

POPULATION DENSITY
5 to 10
1 to 2
less than 1

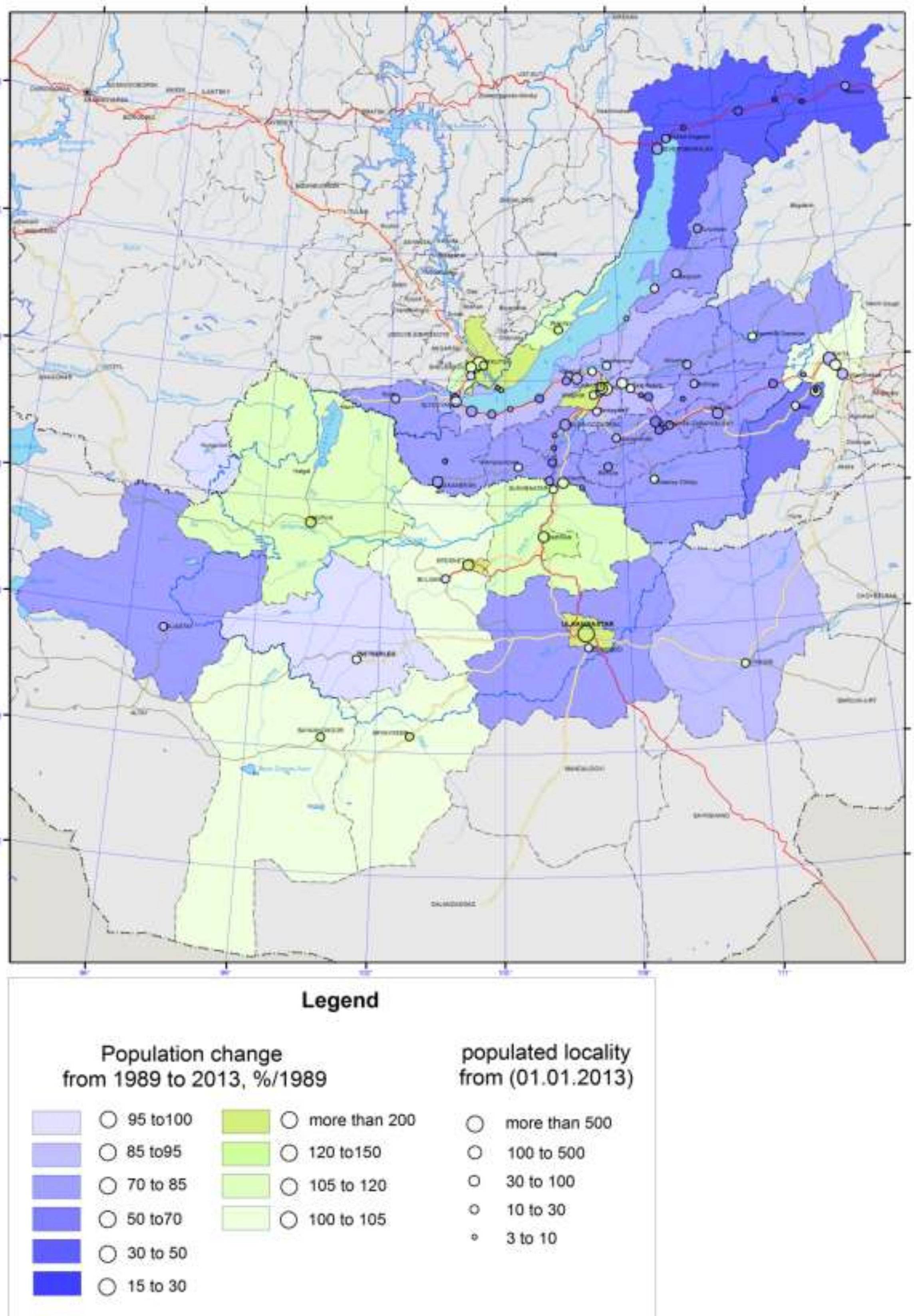
RURAL POPULATION DENSITY AND URBAN SETTLEMENT POPULATION SIZE, 1989



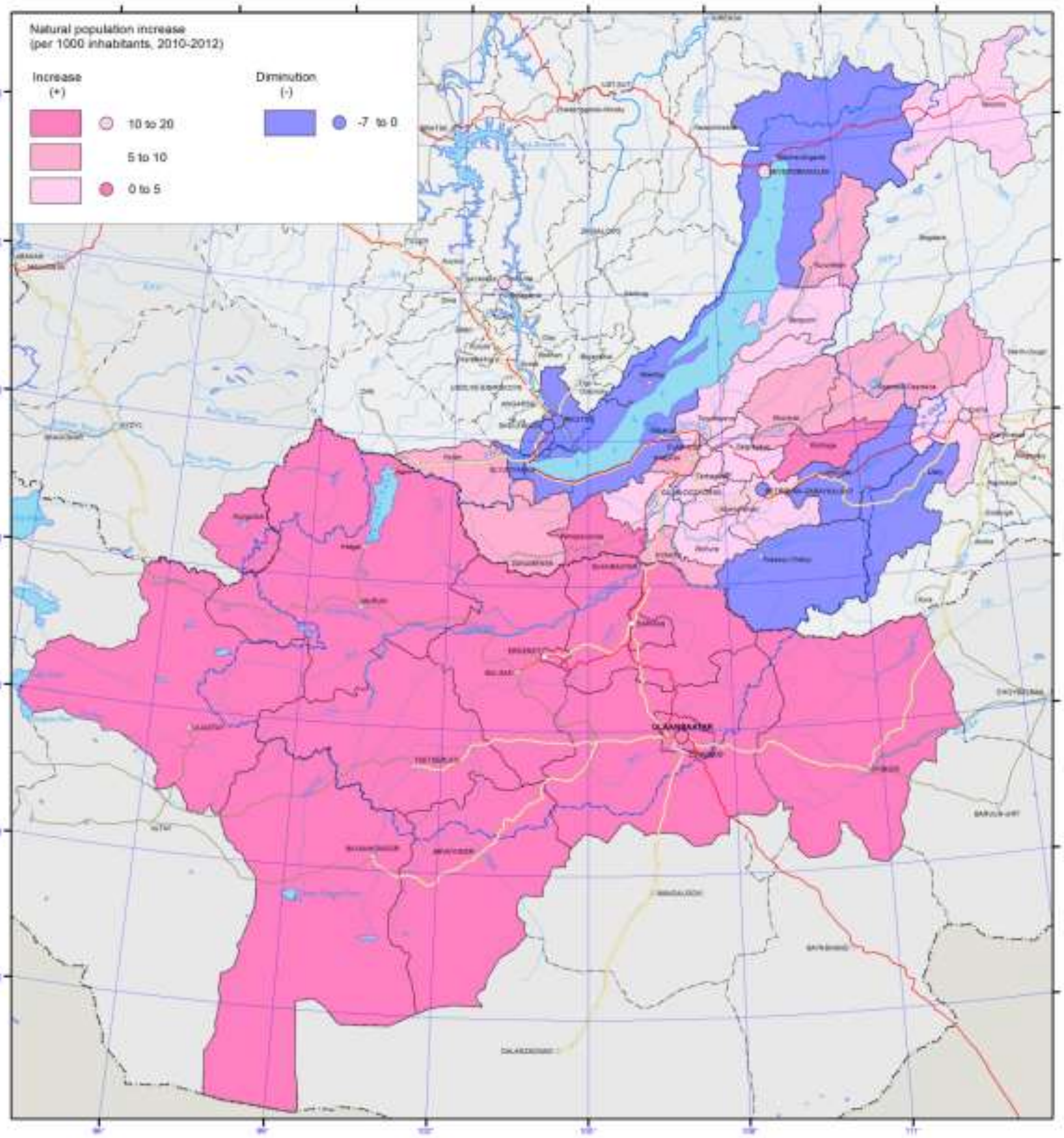
RURAL POPULATION DENSITY AND URBAN SETTLEMENT POPULATION SIZE, 2013



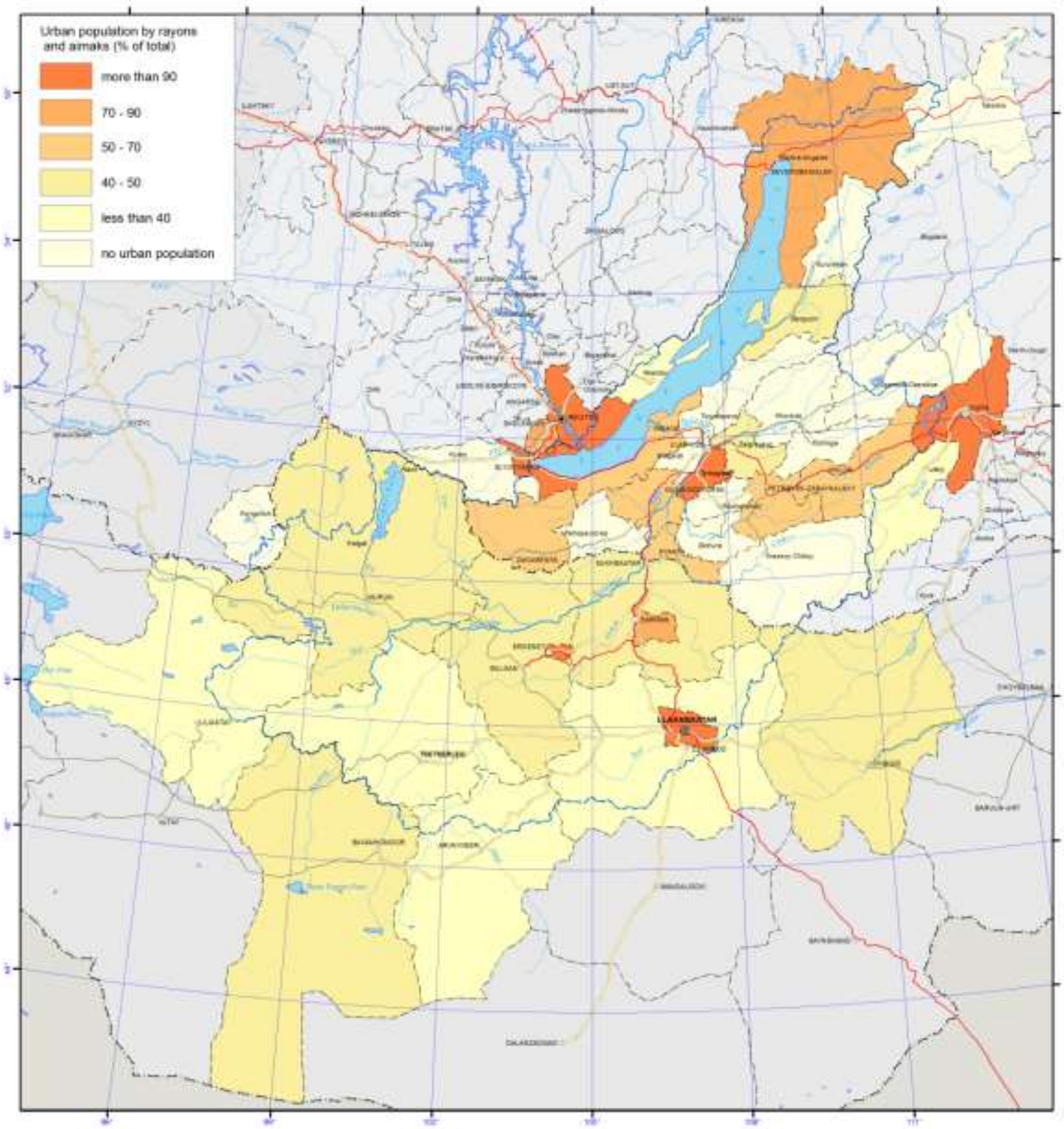
POPULATION DYNAMICS



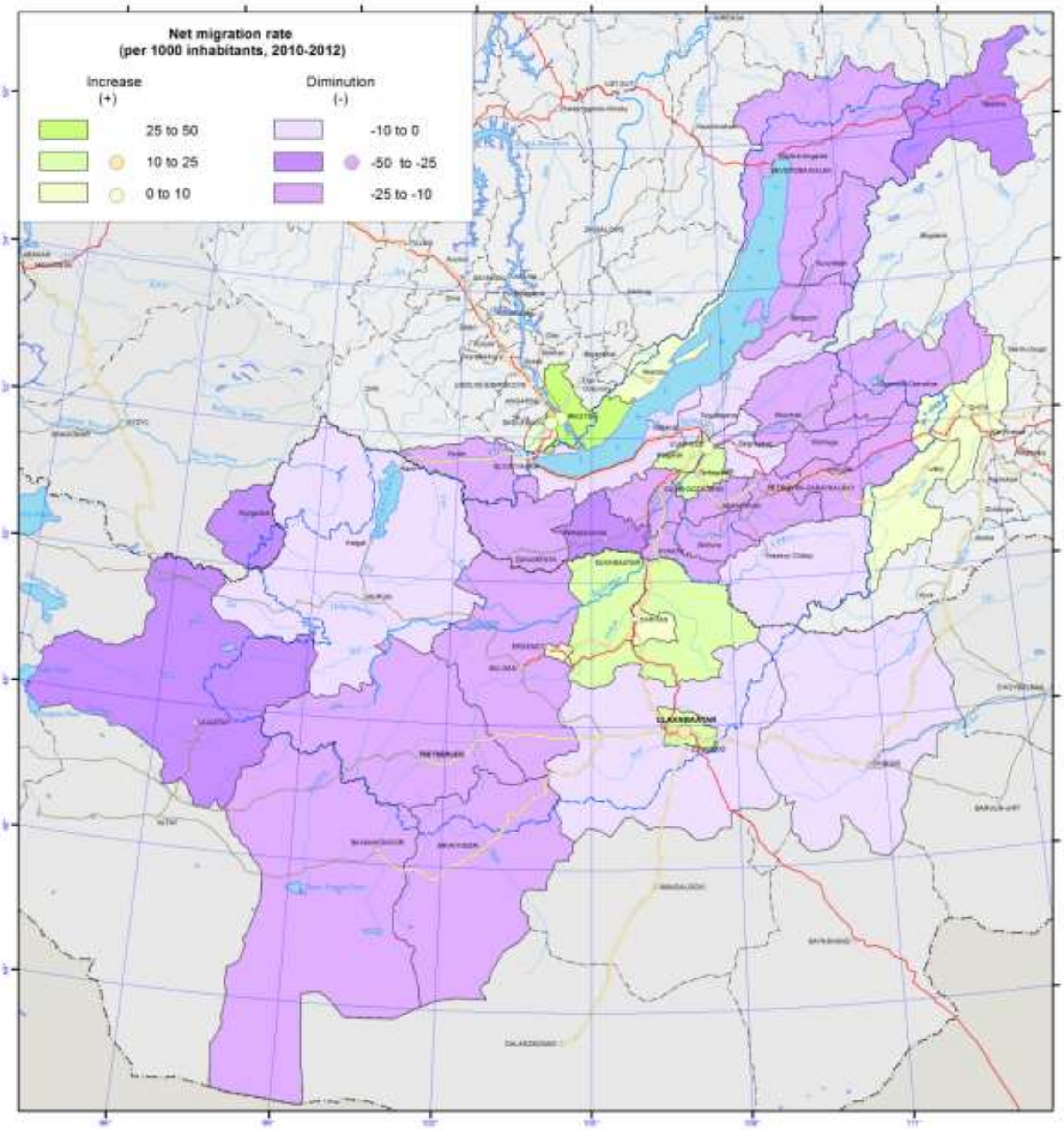
NATURAL POPULATION INCREASE



URBANIZATION



NET MIGRATION RATE



Housing facilities

The most important e indicator of up-to-date life quality is characteristic of living conditions ("roof over head "), combining the specific -indicator of housing supply and especially important from the ecological point specific indicator of housing area of old and dilapidated housing. Basic information resources needed for the design characteristics are data of territorial bodies of the Federal State Statistics Service of the Irkutsk Region, the Republic of Buryatia and Tuva, the Trans-Baikal region, as well as online resources [Housing and utilities Trans-Baikal Territory, 2013 , Housing and Communal Services of the Irkutsk region ... 2013 ; Housing ... 2013 ; ... Districts , 2013 , the Federal Service ...].

Spatial differences in the living conditions of the region in the context of lower administrative districts (district municipalities) and urban settlements (urban municipalities) are represented by: a) total index and b) specific per capita (m²/person). According to the Russian definition, housing fund is a collection of all dwellings, regardless of the forms of property, including houses, special houses (hostels, shelters, temporary public houses, special homes for lonely elderly, orphanages, and homes for the persons with disabilities, veterans, and boarding schools), apartments, office accommodation and other dwellings in other buildings suitable for residence. Meanwhile the housing fund does not include residential villa-recreational complex, i.e. cottages, sports and tourist facilities, rest homes and others. It should be noted, that the total area of residential buildings does not include communal space (stairwells, elevator lobbies, common corridors, lobbies and other), as well as non-residential space occupied by any institutions.

Background of the map is per capita housing supply on administrative districts and cities. The cartogram shows a specific provision of the population with housing within the district municipalities and municipal entities. This rate for all four subjects of Russia is much lower than the average all-Russian and the average for the Siberian Federal District (SFD) (23.4 m²/person and 22.1 m²/person respectively).

Spatial differences in the region for this indicator of housing conditions are quite sharp (two-fold difference between the minimum and maximum values - 14.1 and 29.9 m²/person (in the Tere-Kholsky district of the Republic of Tuva and Zaigraevsky district in the Republic of Buryatia respectively). Among the settlements Petrovsk –Zabaikalsky has the highest per capita rate of housing provision - 23.4 m²/pers., which corresponds to average all-Russian indicators (2012), and the town outsider is Chita (19.9 m²/person).

In terms of specific housing supply all district and municipal and urban units in the region are divided into four groups, taking into account the average index for the SFD (22.1 m²/person). The category of high-status areas (group 1, more than 22,1 m²/person) includes a bit more than 20% of the total amount. Thus, almost five 4/5 of municipalities of the district and city levels in the Baikal watershed basin refers to areas with specific housing supply lower than the average for the SFD.

The housing fund in the region is 46.8 million m² (2012), more than two fifths belongs to the Republic of Buryatia(41.3 %), about two fifths to the Irkutsk region (37.5%), and more than one fifth to Transbaikalia (21.5%), the contribution of Tuva is only 0.1%. In this case, in the whole region urban sector is clearly dominated - more than ¾ (75,8%). In major subjects of the Baikal watershed basin the situation is very contrast: in the Irkutsk region the share of the urban housing fund is more than 9/10 (90.7%), but in the neighboring Republic of Buryatia–less than 2/3 (59,8%).

The share of old and dilapidated housing is an indicative negative index of the quality of the housing fund, representing a total amount more than 5% (the index increased manyfold in comparison with 1990). Dynamics of quantitative indicators of housing in general, per capita sufficiency (m²/person), its structure (in the form of ownership, by the number of rooms), as well as spatial differences in the proportion of old and dilapidated housing and a number of other indicators reflect the complementary map charts and graphs (2010-2012).

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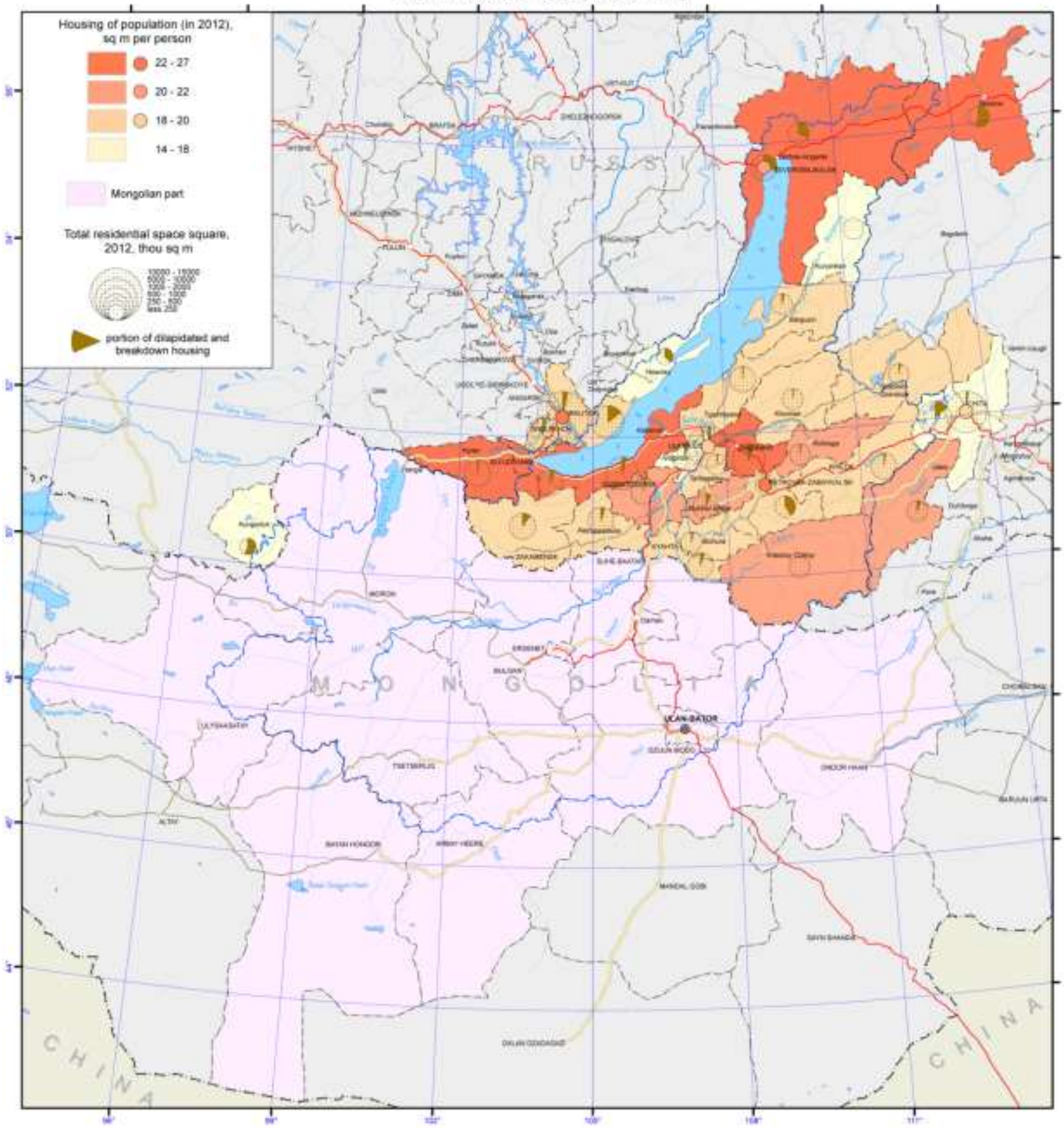
HOUSING CONDITIONS (Russian Part)



Development of housing facilities

The development level of housing facilities is an important factor for ecological well-being of the Lake Baikal basin. The Russian statistical observations include the following components of the development of housing facilities: availability of water supply system, sewage system, central heating, hot water supply, bath (shower), gas and electric stoves [Housing and Communal Services of Trans-Baikal Region, 2013; Housing and Communal Services of Irkutsk Region, 2013; Housing …, 2013; Federal Service …]. According to the current statistics, housing facilities are considered to be equipped with central heating independently on the source of heat supply (heat and electric power plant, industrial or local boiler plant, and manufactured individual boiler). As a rule, development characteristics are presented in relative indices – percentage related to total area of housing facilities and level of engineering equipment according to components enumerated above (in %).

The statistical indices of development of housing facilities in Mongolia differ significantly from those in Russia, as the initial unit in Mongolia is an apartment (private dwelling, apartment blocks, cottage, etc., but without area indication), as well as a traditional house – yurt (ger, several types of yurts depending on walls amount). Moreover, the list of components also differs (including supply with electricity, type of water source, etc.). The comparison of characteristics of housing facilities in Russian regions and Mongolian aimaks requires additional investigation.Therefore at this stage of the survey, we had to take into account the characteristics of the development of housing facilities within the Russian catchment area of Lake Baikal.

Spatial differences inthe comfort level of housing facilities are significant in the region. Such regional centres as Irkutsk, Chita, Ulan-Ude have a relatively higher development level than in a town of the republican subordination – Severobaikalsk. The engineering equipment of housing facilities in each second territorial unit of the region is lower than 25%. There is no engineering equipment, except gas and electric stoves, in Tere-Holsk District (the Tuva Republic),Yeravna District (the Republic of Buryatia) and in Olkhon District of the Irkutsk Oblast (equipment with water supply, heating, gas and electric stoves does not exceed 20 %).

However, only in each sixth district, the standard indices of engineering equipment exceed 50%. The leading districts are Muya District (the Republic of Buryatia, the effect of new buildings during the Baikal-Amur Railway construction), Shelekhov and Slyudyanka Districts in industrial surrounding of Big Irkutsk (Irkutsk Oblast). There are three more districts where about a half of housing facilities is equipped with water supply, water sewage and central heating: Severobaikalsk and Kabansk Districts in the Republic of Buryatia and Irkutsk District in the Irkutsk Oblast.

The lowest indices of development of housing facilities are recorded in rural housing of the region. The mapping presents engineering equipment of rural settlements within administrative districts distinguishing four conventional groups according to the first four indices of development (i.e., without taking into account gas and electric stoves as it will artificially improve the situation). In each second rural district, the housing facilities are equipped less than 10% (4^{th} group)with water supply, water sewage, central heating and baths, in five districts – 10-25 % (3^{rd} group) (relatively average level; equal to "rural standards" of the region but twice lower than average in the rural areas of the Siberian Federal District): Zaigraevo, Ivolgino, Kabanskoye and Kizhinga Districts in the Republic of Buryatia, Chita District in Trans-Baikal Region. The leading territory is Pre-Baikal District of the Republic of Buryatia (1^{st} group: from 45 to 65 %, it is close to average development in the Siberian Federal District); the development level in the other three districts are also close to a relatively high level of rural housing facilities: Severobaikalsk, Selenginsk Districts in the Republic of Buryatia and Irkutsk District in the Irkutsk Oblast (2^{nd} group).

Thus, as a result of the analysis of indices of housing engineering equipment (the data presented are related to 2012) on the territory of the Lake Baikal catchment area within local districts of Russian part,it is possible to conclude that the development level of modern housing facilities is rather low, as well as low comfort level of rural territories.

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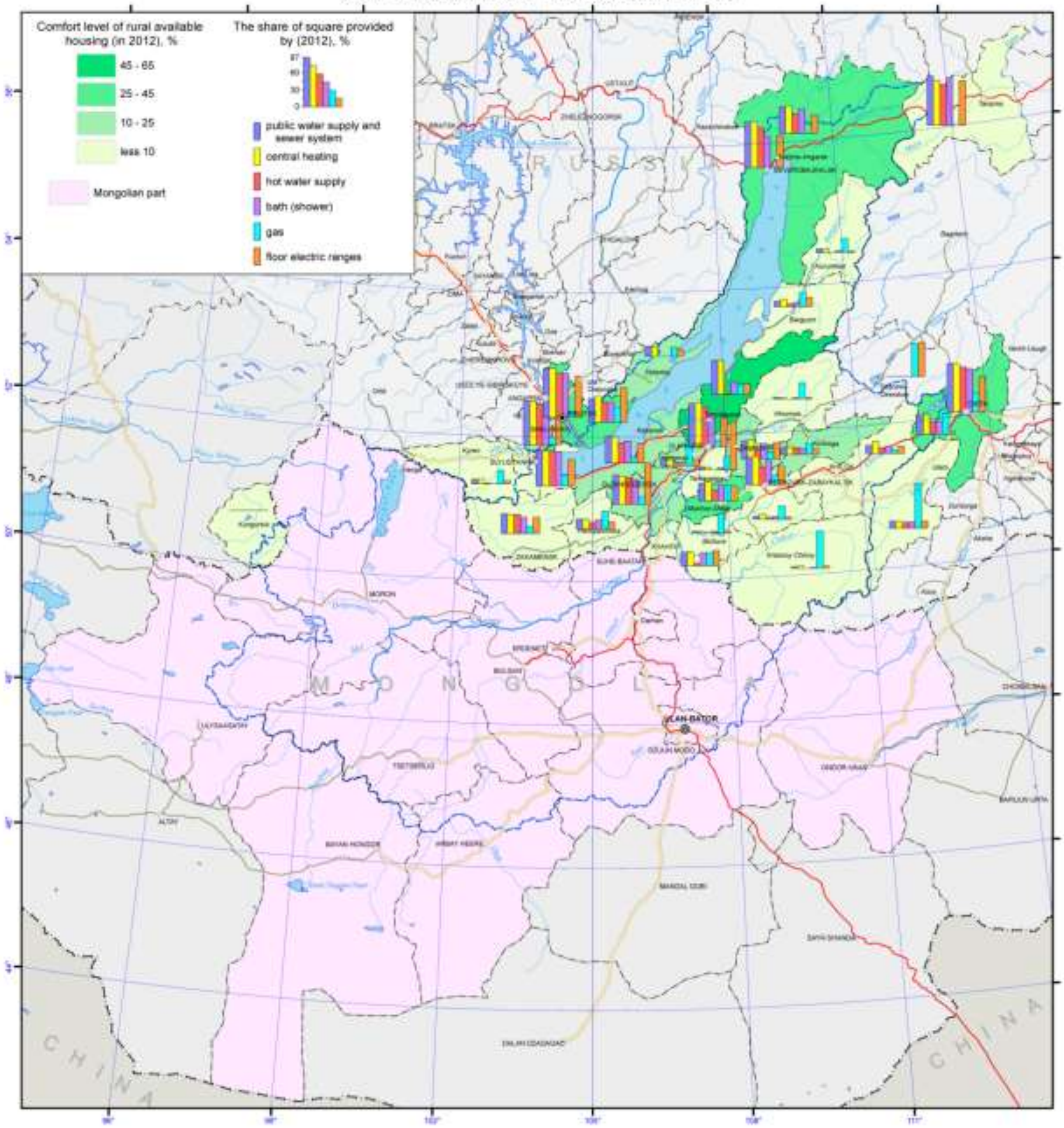
COMFORT OF AVAILABLE HOUSING (Russian Part)



Development of housing facilities. Mongolia

The map background is a proportion of households in the country (in %) living in residential houses with foundations (in permanent buildings - multi-apartment and low-rise buildings). According to the estimates, they account for more than two fifths of the housing stock of the country. Living conditions of households (families) of Mongolia to be statistically observed include the following five conditions:

- households with a reliable source of drinking water, including households that have a reliable source of drinking water connected with a centralized system, protected well, from a spring, as well as households that use purified and bottled water;
- households with a provided source of electricity (electricity is supplied by a state electric power system, diesel power plants, renewable electric energy facilities, and small-sized power generators);
- households with a domestic sewage system (inside or outside a building, but it is used only by a household);
- households with a centralized and noncentralized sewerage system for domestic disposal of waste waters that flow through a central sewerage system, through an independent system of sewage disposal, or into a cesspool;
- households dispose of solid wastes through service companies or transport by themselves to designated areas or places.

In Mongolia, more than two fifths of households (42.3%), living in permanent structures (buildings), use a centralized sewerage system, 0.4% use an independent sewerage system, almost a half (48.3%) dispose waste waters into a cesspool, and 9% - into terrain (into an open ground).

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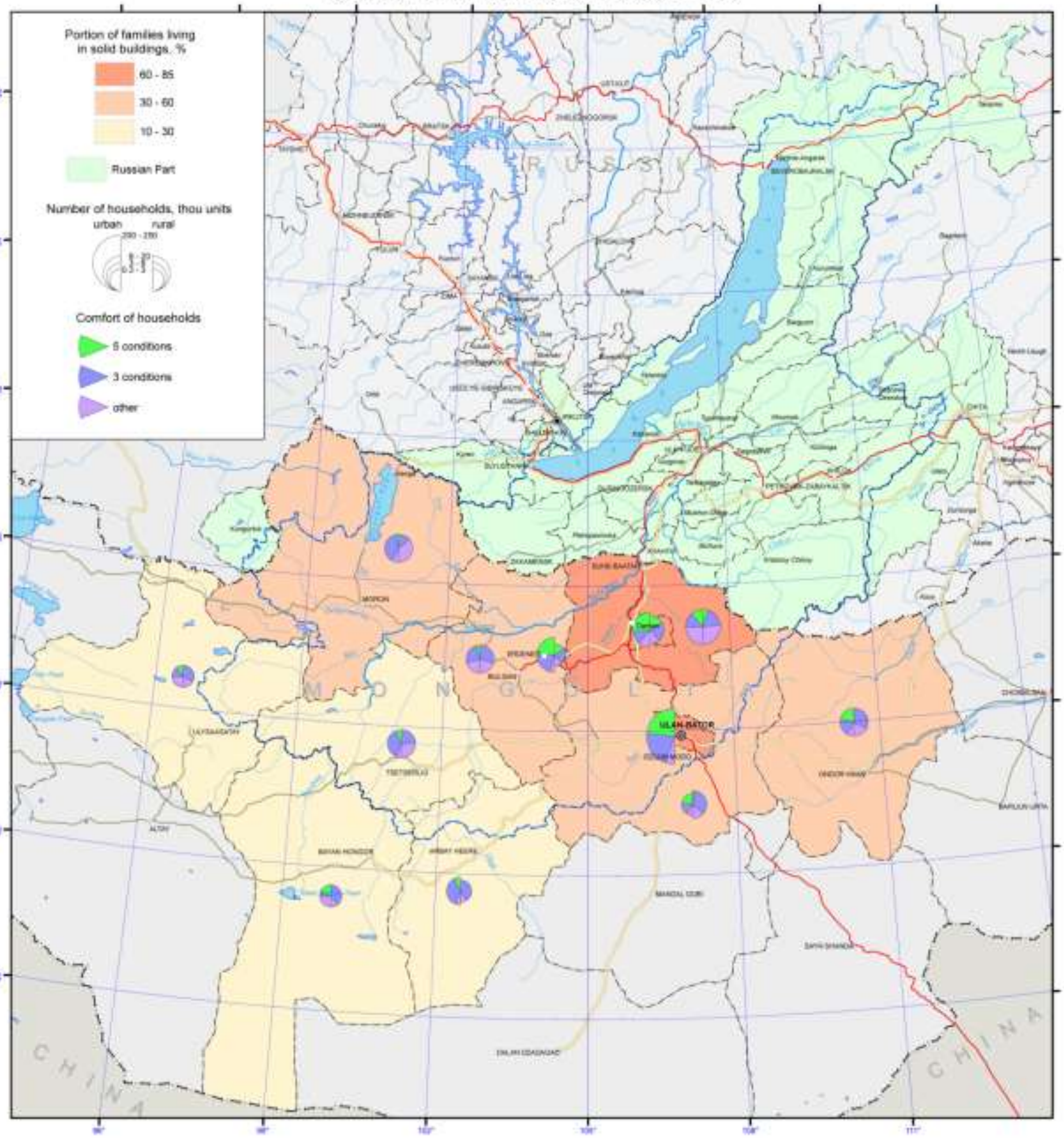
COMFORT OF AVAILABLE HOUSING (Mongolian Part)



Culture. Education

Education and culture are important parameters of the population's life in particular areas and characterize to some extent the quality of life. The main source of information for mapping was official statistical data for 2012 (in some cases for 2011).Materials of the Federal State Statistics Service and statistics digest of Mongolia were used in the work.

Cultural establishment

Cultural establishments are keepers and successors of the historical and cultural memory of a nation, as well as agents in its transfer to succeeding generations. It is generally accepted to refer libraries, museums, theaters, clubs, culture centers, cinemas, leisure centers, and cultural complexes to the network of cultural establishments.

Within the territory of the Lake Baikal basin there are about 1770 cultural establishments. The total number of cultural-and-leisure centers in the study region amounts to 875, libraries – 720, museums – 106, theaters – 30, cinemas – 36, and circuses – 4. In the Russian part of the territory there are 247 children's music, art, and dance schools. Cultural-and-leisure centers (clubs) and libraries are in each administrative district. Museums are located in most districts.

Cultural life is most vividly represented in the major cities of Ulaanbaatar, Irkutsk, Chita, and Ulan-Ude. Famous theaters, museums, circuses, large libraries, and cinemas are situated there.

Museums serve as the main tool of memory materialization; often their main focus is local history and ethnography. Information for tourists, emphasizing the originality and specificity of a place (its nature, history and culture) is also passed through museums. Museums of regional centers (Ulaanbaatar, Irkutsk, Ulan-Ude, Chita) are various in subject matter. Among the museums of the Irkutsk part of the study area, such oldest museums as the V.P. Sukachev Irkutsk Regional Art Museum, Irkutsk Regional Museum of Local Lore, architectural-and-ethnographic museum "Taltsy",historical-and-memorial Decembrists' Museum, and the Baikal Museum ISC SB RAS in Listvyanka village possess particularly valuable collections. Among the largest museums in the Republic of Buryatia, the following ones can be listed: the Sampilov Museum of Fine Arts in Ulan-Ude, museums of nature and history of Buryatia in Ulan-Ude, Kyakhtinsky museum of local lore in Kyakhta, and the Ethnographic Museum of Transbaikalia Peoples. Historical museums of local lore, illustrating the rich history of development of the region and residency of Decembrists and other exiles, predominate in Zabaikalsky Krai. The State Central Museum of Mongolia holds a comprehensive and unique collection of artifacts, which gives a possibility to get acquainted with the natural history of the country.

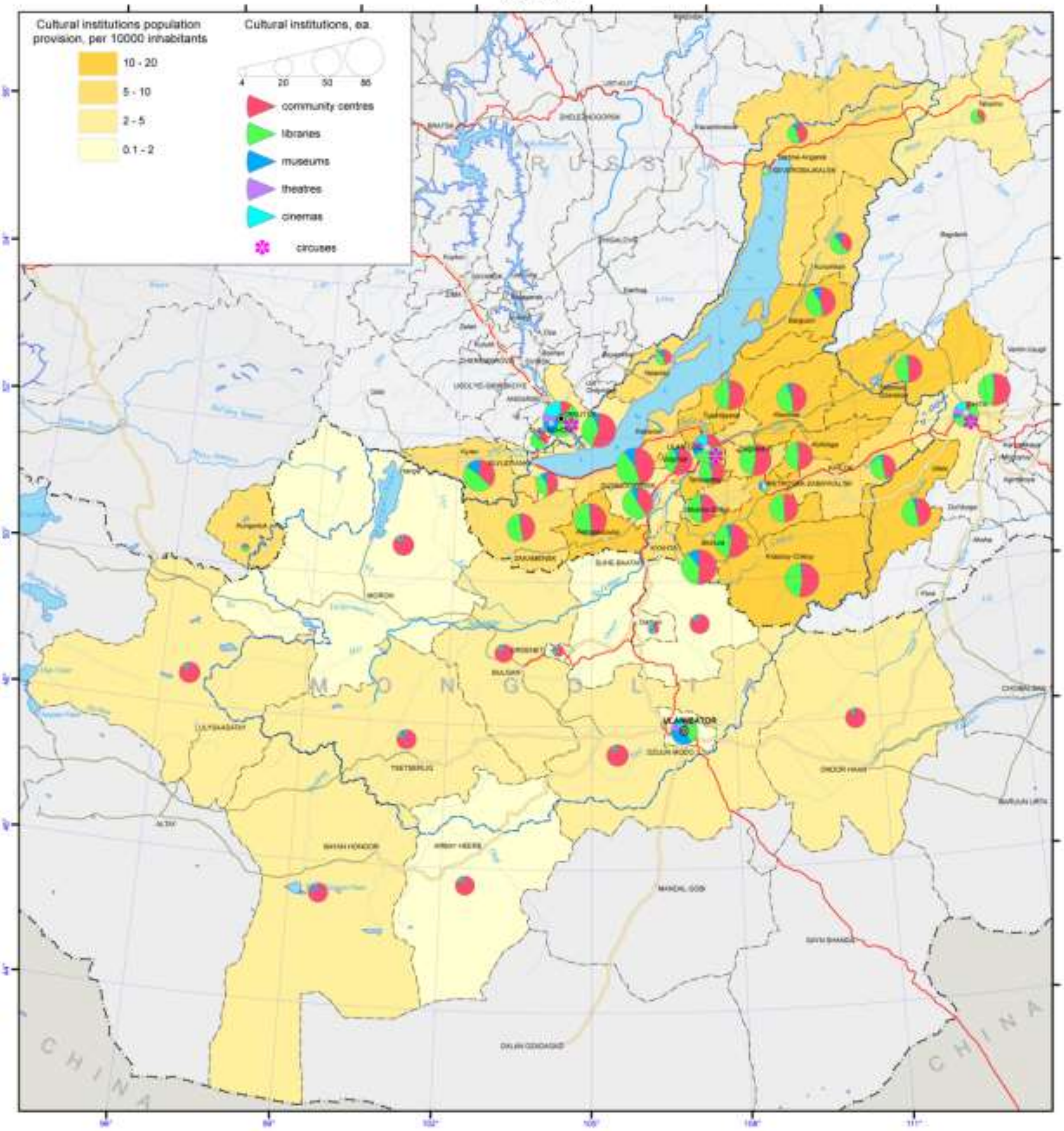
Theatres. Theatrical life is represented by a number of establishments. In Irkutsk they are the N.P.Okhlopkov Irkutsk Academic Drama Theatre and Zagursky Musical Theatre, and Puppet Theatre "Aistenok", A.Vampilov Youth Theatre and circus for children. In the Republic of Buryatia there is the Buryat State Academic Opera and Ballet Theatre; the Khotsa Namsaraev Buryat State Academic Drama Theatre and the Nikolay Bestuzhev State Russian Drama Theatre, which is the oldest theatre ensemble of the Republic, are rich in traditions. In the Republic there are also avant-garde theaters, namely, the Ulan-Ude Youth Theatre-Studio in the Dimitrov street, and Theatre-Studio of modern body movement and pantomime "AzArt". The Buryat State Philharmonia, song and dance ensemble "Baikal", state theatre of folk dance "Badma-Seseg", and the Buryat Republican Puppet Theatre "Uliger" perform in the city. In Chita there are the Transbaikalia Regional Drama Theatre and the Transbaikalia Puppet Theater "Tridevyatoe Tsarstvo" ("Far Away kingdom"). Famous theatres of Mongolia are the State Academic Opera and Ballet Theatre, and the Mongolian State Drama Theater (D. Natsagdorzh State Drama Theatre). The Mongolian circus has existed for more than 60 years and has the title of "the brand of Mongolia" a circus school functions at the circus.

Libraries collect books and other publications, process them in a special way, propagandize and organize a mass work with readers. Libraries have different specialization and subject matter. There are libraries of the Ministry for Culture, schools, universities and colleges, departmental libraries and others. In Irkutsk there is the I.I. Molchanov-Sibirsky Irkutsk Regional State Universal Scientific Library, which has been serving readers of the Priangarie region since 1861. In Ulan-Ude, there is the National Library of Buryatia, which has the image of a modern information institution. On the basis of the library the following centers function: Legal Information Center, Information Center of Cultural Tourism, Baikal Information Center, Baikal Reading Center, Agricultural Information Centre, Internet-Centre, Media-Center, and Microsoft Training Center. In Chita there is the A.S. Pushkin Transbaikalia Regional Universal Scientific Library. In Ulaanbaatar there is the State Public Library of Mongolia, which collections include the most miniature Buddhist sutra in the country “The Story of the Goddess Green Tara”.

Cinemas are designed to show movies to the population. Modern cinemas are complemented by different forms of leisure functions. In Irkutsk, Ulaanbaatar, Ulan-Ude, and Chita there are 15, 6, 5, and 4 cinemas, respectively.

Empowered lives.
Resilient nations.

CULTURE



UNOPS

Educational and scientific institutions

The sphere of education is considered as an important factor in economic and social development. A man, his knowledge and skills, and the ability to make nonstandard decisions in a rapidly changing economic environment are the main values of the society. It is the sphere of educational services that can become a kind of lever that is able to push the economy to a totally new round of development.

Preschool education is the support of the mental, personal and physical development of children aged from 2 to 8 years. Depending on the laws, traditions and cultures, the approach to the preschool education is different: different basic and specific tasks can be set, it may be compulsory or not, and it may be realized through a variety of traditional institutions. Within the study area there are 1436 preschool educational institutions, which are attended by about 237.6 thousand children.

General education is the first level of education. Currently, general education usually includes the following components: primary general, basic general, secondary (complete) general and additional education of children. Within the territory of the Lake Baikal basin there are 1412 general education institutions with about 637.5 thousand children attending them.

In the Irkutsk part of the territory there are 206 kindergartens with a number of children amounting to 35268 and 182 general education institutions with a number of children totaling **86982**. In the territory of the Republic of Buryatia there are 394 kindergartens numbering 45007 children and 517 general education institutions with a number of children amounting to **123362**. In the territory of Zabaikalsky Krai there are 150 kindergartens with 24119 children and 187 general education institutions with **57210** children, attending them. In Mongolia there are 685 kindergartens numbering 133239 children and 523 general education institutions with a number of children totaling **369900**.

Secondary vocational education (SVE) is a level of professional education, which aims at training of sub professionals and mid-level employees for all industries. The training is carried out on the basis of basic general (after the 9^{th}grade), secondary (complete) general (after the 11^{th}grade) or initial vocational education.

One hundred secondary vocational education institutions work to date in the Russian part of the Lake Baikal basin. In Mongolia, secondary vocational education is represented by 35 professional and technical educational institutions.

Higher professional education (HPE) is a level of professional education, which aims at training of professionals in any field of science on the basis of acquired secondary (complete) general or secondary vocational education.

Higher professional education in the Russian territory of the Baikal basin is provided by 40 educational institutions (state and private, and their branches). In the Mongolian territory there are 29 state and 40 private higher education institutions, mostly located in the capital.

The scientific complex of the territory includes nine academic institutes of the Irkutsk Scientific Center SB RAS, five institutes of the East-Siberian Scientific Center SB RAMS, three research organizations SB RAAS, and over 30 applied research and design institutes. The system of academic science of the Republic of Buryatia includes the Buryat Scientific Center SB RAS (BSC SB RAS), and the Buryat Research Institute of Agriculture SB RAAS. The HEI sector of scientific activities consists of research divisions of four higher education institutions of the Republic. The scientific and innovative potential of Zabaikalsky Krai is represented by academic and university science. Currently, five academic and research institutions, including branches, function in the territory of Krai. Mongolian Academy of Sciences was founded in 1961 in Ulaanbaatar on the basis of the Committee of Sciences (1921 to 1929 - the Scientific Committee). Currently, it includes seven sections, more than 60 scientific research institutes, observatories, and research stations.

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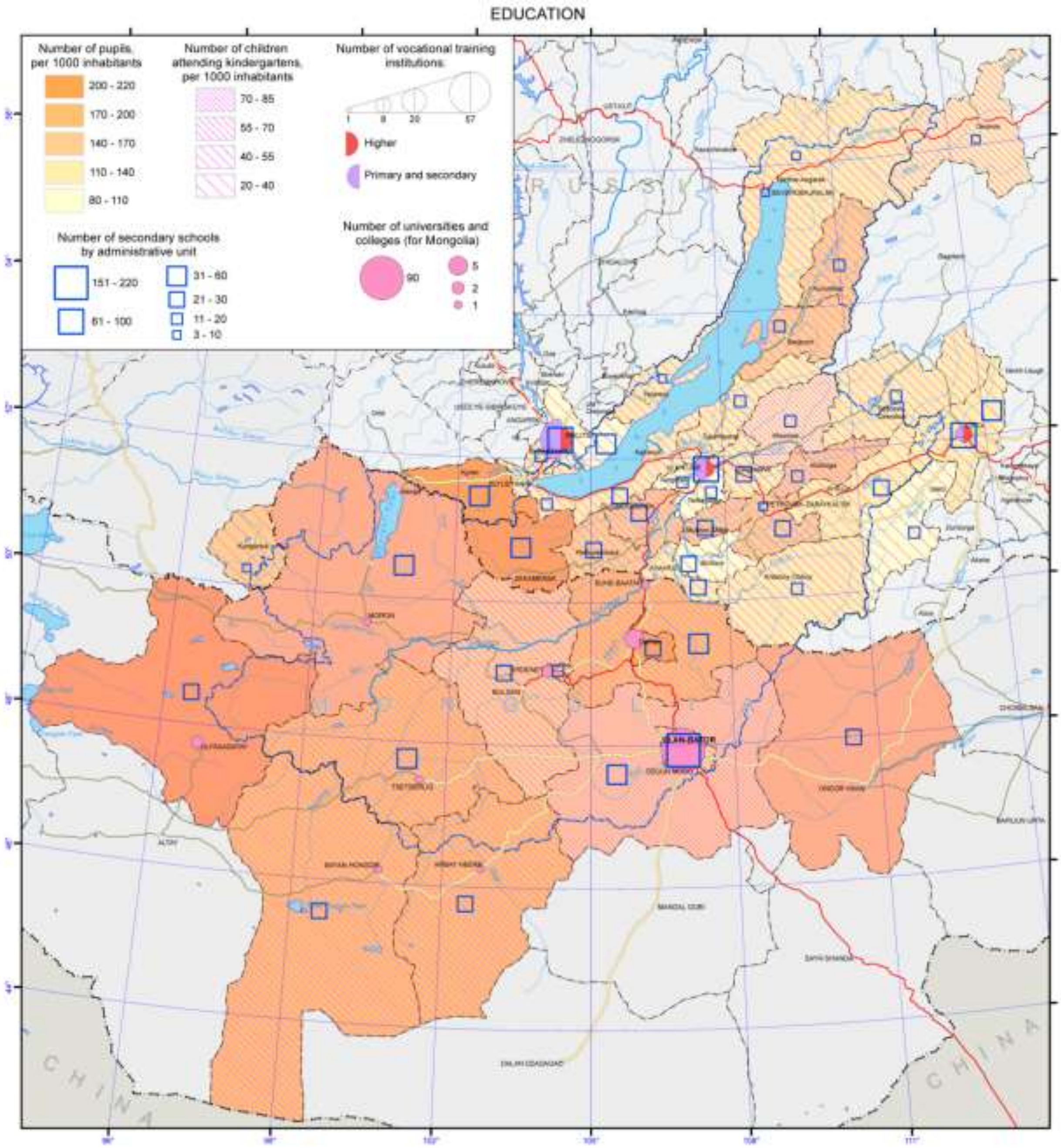

EDUCATION
Number of pupils, per 1000 inhabitants
200 - 220
170 - 200
140 - 170
110 - 140
80 - 110
Number of children attending kindergartens, per 1000 inhabitants
70 - 85
55 - 70
40 - 55
20 - 40
Number of vocational training institutions
1
8
20
57
Higher
Primary and secondary
Number of secondary schools by administrative unit
151 - 220
61 - 100
31 - 60
21 - 30
11 - 20
3 - 10
Number of universities and colleges (for Mongolia)
90
5
2
1
R U S S I A
M O N G O L I A
C H I N A
ULAN BATOR

Religions

Traditional religions in the territory of the Baikal watershed basin are represented by Shamanism, Buddhism in the form of Lamaism, and Orthodoxy. The current religious situation is, to a large measure, determined by the political reforms that were carried out in Mongolia and Russia in the 1990s. There are a plethora of religious denominations and practices to date.

Most of the population are bearers of religiousness. In most cases, the vacillating and non-believers associate themselves with a particular traditional religion. In Mongolia, for example, about 90 and 6% of the population identify themselves with Buddhism and Shamanism, respectively. On the other hand, according to the 2010 census, 61.4% of the population 15 years of age or over qualified as believers. Buddhists, Moslems, Shamanists, Christians and adherents to other religions constituted 53, 3, 3, 2 and <1%, respectively. In Buryatia, the most widespread self-identifications are those with two religions: Buddhism, and Orthodoxy. In Zabaikalsky krai and Irkutsk oblast, the overwhelming majority of the people identify themselves with Orthodoxy, whereas Buddhism holds the lead in Tyva. According to the opinion poll data, collected in 2012 by the Nonprofit Research Service "Sreda", the proportion of citizens professing Buddhism in the aforementioned regions constituted, respectively, 20; 6; <1; Christianity: 32; 32; 48; 2 (including Orthodoxy: 27; 25; 41; 1), Islam: <1; <1; 7; ; <1; Shamanism: 2; <1; 1; 8; and other religions: <1; <1;<1; <1%.

It is imperative that religious organizations pass registration; however, there are some unregistered active groups. They steadily grow in number, and the fastest growth is observed in the case of associations belonging to Protestant and Evangelical confessions.

The population is tolerant toward the differently minded. It is not unusual to find the co-existence of contradictory and mixed religious views.

Buddhism refers to eastern religions. The northern branch of Mahayana Buddhism of the Gelug-pa school (Lamaism) has existed within the Baikal watershed basin since the 17th century. Also, nontraditional (transnational inclusive) schools began to figure more and more prominently in recent years. Through an active participation of emissaries from Tibet, a number of "Dharma Centers" have been set up with the mission of promulgating the tantric forms of a complex and multifaceted Vajrayana system of Buddhist thought which were inaccessible previously to the bulk of believers.

Among the leading ethical principles of Buddhism are tolerance, rejection of violence, acting in a non-harming way toward all sentient beings, and kindness and love toward them. Buddhism is characterized by natural worships and worships of the spirits of ancestors.

Buddhism that is functioning across the territory of the Baikal watershed basin (its concepts, rtes, rituals, mythology and pandemonium of spirits) have been influenced by religious customs and habits that had existed before its appearance in this region.

An important place in the social (as well as ecological) life is occupied by Buddhist monasteries. They organize the dialog with science and education. Not only Buddhist monks but also secular specialists are involved in delivering lectures. Publishing business is a major line of activity of the monastic centers. Much attention is given to formation and preservation of the cultural memory of the population, the issues related to the adjustment of the Buddhist teaching to the contemporary conditions, and to its further development and promotion, including among the Russian-speaking population.

Christianity. In the Russian part of the territory of the Baikal watershed basin, it is represented essentially by Orthodoxy, while the Mongolian territory is the home for Protestant and Evangelical organizations (Protestants — mainly Evangelical Christian Baptists), Mormons, Catholics and Orthodox believers constitute, respectively, 90, 9 and 1% of all the Christians.

A rapid development of the Protestant and Evangelical confessions in Mongolia is determined by their large-scale proselytist activity which was favored and facilitated by the policy of the state oriented toward close cooperation with the USA. Bible Society of Mongolia (BSM) was founded in Ulaanbaatar in 1990.

Christianity deals with issues related to coping with ecological problems as a component of the pastor and missionary services to God. According to the Bible, everything on Earth was created by God. Nature was created to satisfy human requirements. However, it is not the reservoir of resources intended for egoistic and irresponsible consumption; instead, it is a temple in which Man is devoted to the service of God. Man is responsible for his/her thoughts and acts and is obliged to make thrifty use of Nature, to be its custodian. Life in its different manifestations has a sacred character; its destruction or disturbance signifies a challenge to God.

According to Christianity, ecological problems constitute the consequences of egoistic and consumers' motives; therefore, ecological activity fails to reach the desired results until people begin to live by Christian commandments.

Islam (represented largely by the Sunni branch) has an ethnical character. The Russian territory is dominated by the Tatar component. In Mongolia, it is confessed by the not numerous Kazakhs, Uzbeks, Uigurs, Tatars, and by other Moslem ethnoses. Unfortunately, there are emerging representatives of Radical Islam.

According to the Koran (Quran), Man and Nature are the great sacred creations of God Allah. People are responsible for the preservation, cleanness and beauty of nature. All living creatures on Earth are like Man. Torturing them is an absolutely prohibited deed. Any good done to an animal is as well as any good done to Man. The striving of Man to do good to Nature is regarded as a virtue which helps him to gain blessings and Paradise in the future life.

The varieties of human sins with respect to nature are recorded in Sharia which deals with many topics addressed by the legal, morale-ethical and religious norms of Islam as well as personal matters related to the life of every Moslem.

Islam pays much attention to an improvement in the condition of Earth by human hands. It poses the question as to the union of science and religion in dealing with environmental problems.

Shamanism is the oldest religion of Siberia and Central Asia. It is thought that it was originated in Olkhon Island (on Lake Baikal) which is considered a sacred place. According to the concepts of Shamanism, there exist three worlds: In accordance to shamanism, there are three worlds: upper (heavenly), middle (terrestrial), and lower (subterranean). Nowadays, Shamanism also includes the followers of Tengriism, worldwide imperial religion, showing a tendency for philosophical-metaphysical monotheism confessed previously by nomadic communities in the territory of Mongolia.

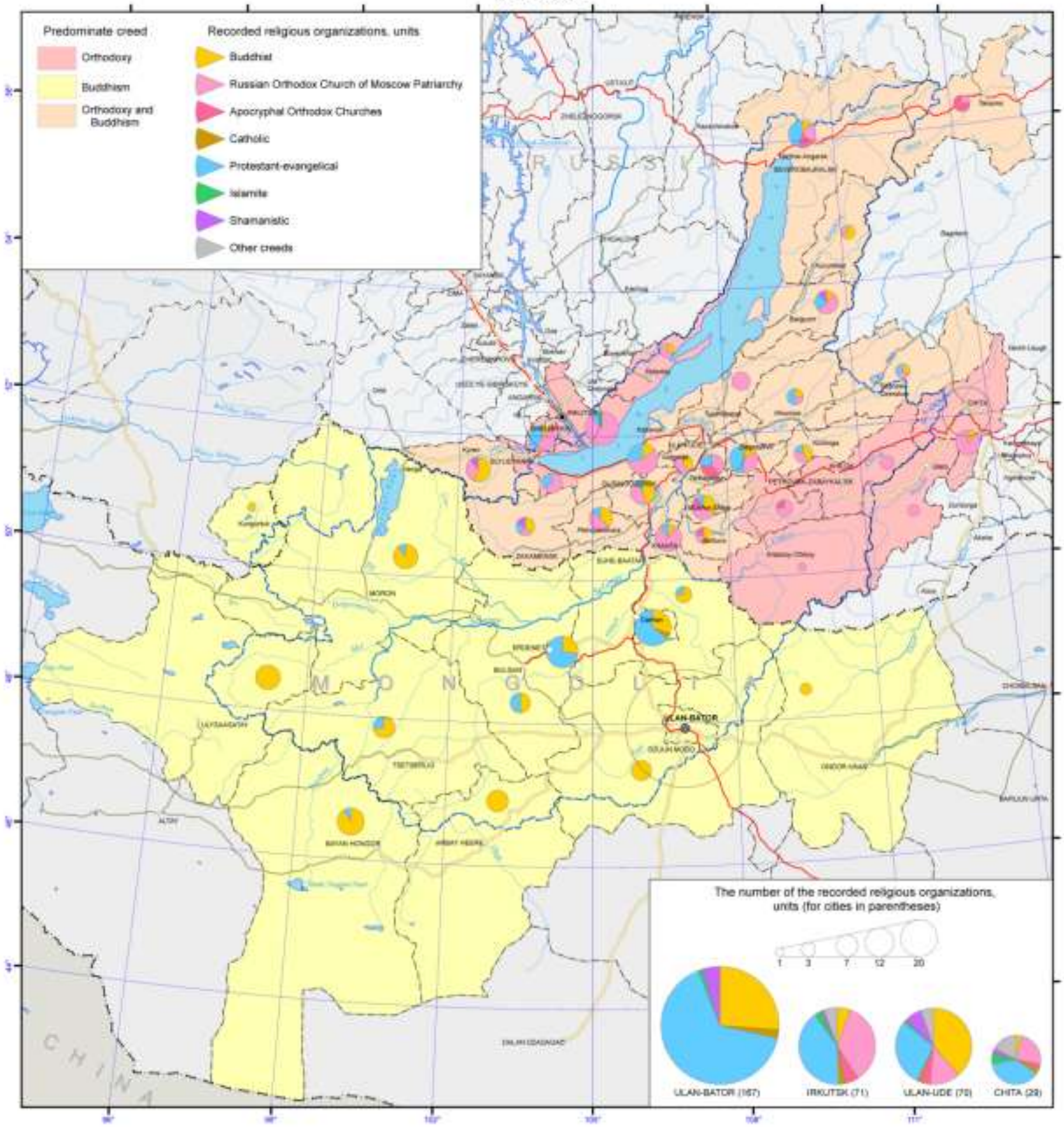
Thrifty use of natural resources is based on the cultural-religious traditions. The local natural sites have an important role in the concepts of the universe. Previously, Shamanism "served" the communal-tribal sphere; each tribe and clan had their own sacred places used to conduct rituals. In such places, they used to build ovoos (a type of shamanistic cairn) and to tie ribbons to the branches of trees. Its revival is proceeding in the form of Neoshamanism, the setting up of Pan-Buryat shamanistic organizations and associations of shamans engaged in worshipping, publishing and educational activities.

Shaman beliefs have a significant influence upon persons confessing other religions, frequently separating mixed religious views implying the presence of spirituality of the surrounding world. Every so often this determines worshipping of the sacred shamanistic places of Buddhists, Christians and representatives of other religions.

The ecological concepts of the other religions in the territory of the Baikal watershed basin are also directed toward nature conservation.

As claimed by all religions, the resolution of the ecological problems must begin with spiritual-moral perfection of Man.

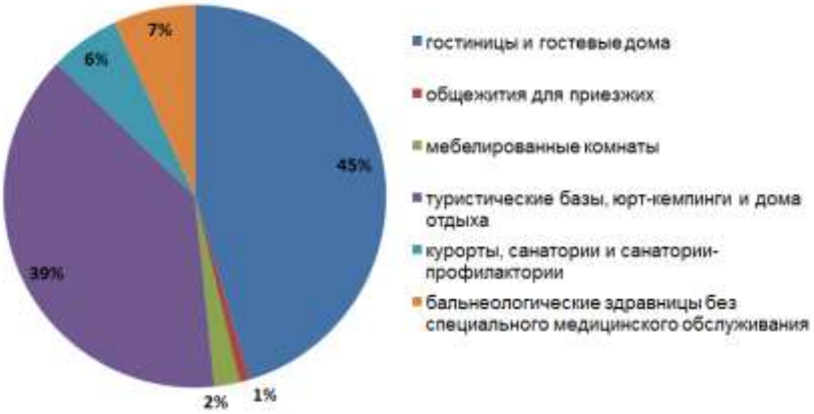
RELIGIONS


Predominate creed
Orthodoxy
Buddhism
Orthodoxy and Buddhism
Recorded religious organizations, units
Buddhist
Russian Orthodox Church of Moscow Patriarchy
Apocryphal Orthodox Churches
Catholic
Protestant-evangelical
Islamite
Shamanistic
Other creeds
R U S S I A
M O N G O L I A
C H I N A
ULAN-BATOR
The number of the recorded religious organizations, units (for cities in parentheses)
1
3
7
12
20
ULAN-BATOR (167)
IRKUTSK (71)
ULAN-UDE (70)
CHITA (29)

Tourism

The Baikal watershed basin is a unique area that attracts the tourists' attention of all over the world. Its location in the heart of the Eurasian continent has defined its high ethno-cultural and natural diversity. The land development history the Baikal watershed basin is connected with the rise of two giant empires - the Mongolian and Russian, as well as the historical development of trade and transport routes.

Natural resource recreation system kernel of the Baikal watershed basin is the oldest and deepest lake in the world. The infrastructural centers of its tourist development are the major cities of Ulan Bator, Irkutsk and Ulan-Ude, performing the role of major international transport hubs that hold administrative, educational, cultural tourism resources and significant potential reception of visitors. In 2012 Ulaanbaatar has the largest hotel fund (over 170 hotels). In Irkutsk there were 80 hotels and in Ulan-Ude - 20. In general, the cross-border area of Lake Baikal has more than thousands of tourists hotels and hostels of general and special purpose (Fig. 1).



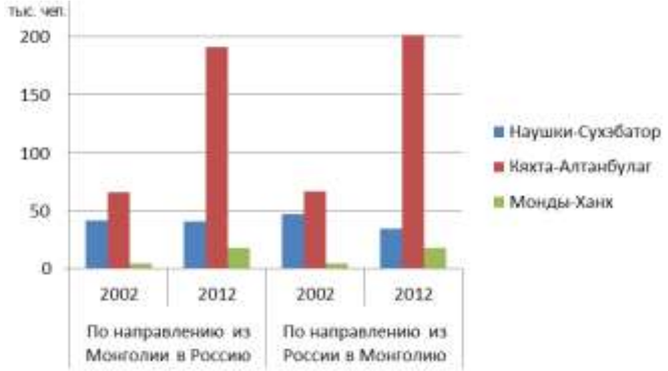
- hotels and guest houses
- hostel for visitors
- hostels, yurt camping and rest houses
- resorts, motels and sanatorium
- balneologic resorts without special health care

Figure 1.Transboundary recreational accommodation facilitiesthe Baikal watersheds basin [... Business , 2012 ; Activity ... 2011 ; ... Culture , 2012 ; ... Tourism , 2011 ; Soyol ... , 2013]

Number of accommodation facilities, the level of service offered in conjunction with the configuration and nature of tourist flows makes it possible to identify the most important areas for the industry, to assess the degree of tourism development and in general to submit the territorial structure of recreational activities. Basis for expert assessment of tourism development of administrative units of Russia and Mongolia we used matrix integrating character of tourist traffic and the predominant type of accommodation.

The main feature of the recreational system of the Baikal watershed basin is its transboundary position. Therefore the neighboring aimags of Mongolia and administrative areas of the Irkutsk region and the Republic of Buryatia have special significance, as they are confined to areas of the state border with cross-border corridors (ports of entry).

The cross border tourism in the neighboring territories of Russia and Mongolia is developing in conditions where both countries, having a unique culture and nature, are an integral part of the international recreational space, of special interest for tourists from other countries and make mutual contribution to the entry of tourist flows. The border, crossing the territory of the Russia and Mongolia has three checkpoints, which not only provide an exchange of foreign and domestic tour groups, but is a prerequisite for the development of cross-border trade. For 10 years the total volume of passenger traffic through existing checkpoints has more than doubled - from 229 thousand people in 2002 to 502.5 thousand people in 2012 (Fig. 2).



- Naushki-Sükhbaatar
- Kyakhta-Altabulag
- Mondy-Khankh

Figure 2. Volumes of passenger traffic through the Russian- Mongolian border [Mongolian ..., 2013 ; Mongolian ..., 2006]

Development of cross-border tourism involves joint decision to promote tourism products to the general public level. Currently, such projects as "Baikal- Hubsugul" connecting the two great lakes of Asia, and "Tea Road" have already gained notoriety. Great prospects for bilateral cooperation in the field of eco-tourism are associated with the establishment of transboundary protected areas. They represent a kind of organizational resource valuable not only for solving common environmental problems, but also for the coordination of the implementation of cross-border tourism projects.

Active cooperation between Russia and Mongolia promoting tourism within the boundaries of unique natural object - the Baikal watershed basin, not only opens us possibilities for foreign tourist flows in both countries, but also contributes to the expansion of similar relationships with other neighboring countries China, Kazakhstan, and Japan.

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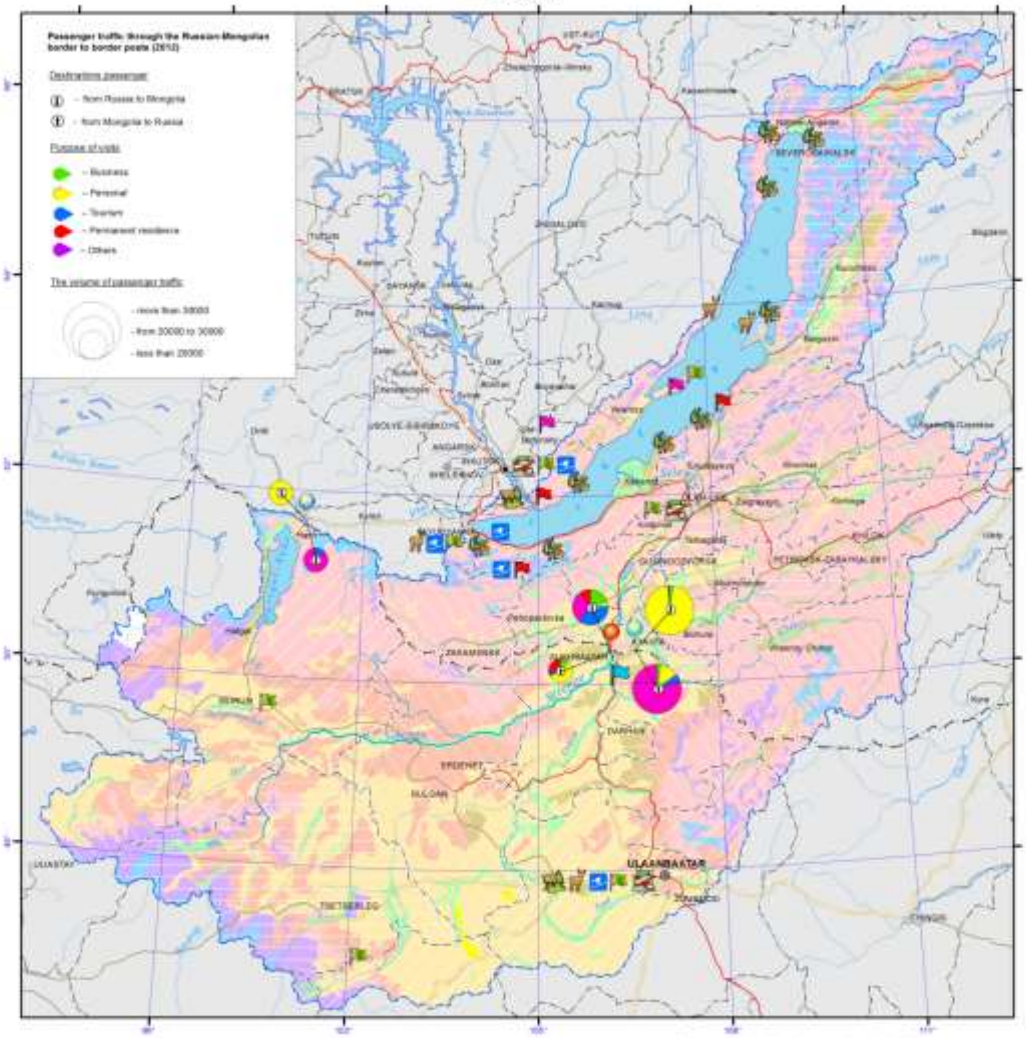
TOURISM



Nature-Recreational Complexes

1. Goltsy		- extreme unsteady to recreational loads - difficult to access - High broken relief, large number of unique nature objects (waterfalls, peaks, canyons, etc), landscape variety defines high attraction level for tourists - Highly significant for sport, extreme, and nature-educational tourism
2. Subgoltsy		
3. Mountain taiga		- low and medium steady to recreational loads - habitat of rare and commercial species of fauna and flora - Highly significant for rout sport and sport-health tourism, commercial occupations (mushroom, berries and medicinal herbs gathering), nature-educational and ecological tourism
4. Taiga		
5. Subtaiga		- Medium and high steady to recreational loads - Availability of berries and mushroom lands, species diversity of biotic elements, medium broken relief - Favourable conditions for all-the-year-round stationary health-improving recreation in combination with excursions and walking routes and commercial occupations
6. Steppe		- High and medium steady to recreational loads - Opened woodless areas characterized by good accessibility and reduced landscape variety - Potential of recreational using is motor-, motorcycle-, bicycle tourism, camping recreation, ethnic, archeological, historical- and nature-educational tourism
7. Meadow		- High steady to recreational loads - Frame river valleys and often characterized by extra humidification. Comfort, attraction and safety conditions for recreational activity are not permanent and depend on the hydrological regime of concomitant streams. They form particular biotopes where the habits of near water animals and water birds are located. - High significant for organization of ecological, nature-educational and utilitarian tourism, including fishing and hunting in combination with picnic and sport and health-improving recreation.
8. Sandy		- extreme unsteady to recreational loads - Almost impassable and discomfort regions because of combination of soil-ground and microclimatic conditions. Create the environment for unique psammophilic biocenosis. Attractive for tourists in view of exoticism and peculiar aesthetics. - Spared regions of the use for nature-educational and ecological excursions in the presence of necessary constructions, making camel biking on sandy ground. Alternative restricted using for some extreme kinds of tourism associated with overcoming barriers.

Rating recreational development strategy of Mongolia administrative districts and subjects of Russia

Criteria for evaluation			Entry tourist flows		
			International	National	Regional
			H	M	L
Outstanding accommodation facilities and tourist services	Hotels, inns, motels and resorts with special medical care, special economic zones recreation	H	H	H	M
	Tourist centers, yurt-campings, holiday houses and tourist centers	M	H	M	L
	Private houses, campgrounds	L	M	L	L

H - High, M - Medium, L - Low

Recreational Objects

- Special economic zones of tourist and recreational type
- Archeological complexes
- Shopping tourism centers
- Ethno-recreational complexes
- Skiing resorts
- Airports
- Observing sites of wild animals and birds
- Museums of wooden architecture and historical-ethnographical complexes
- Tourist routs

Transboundary Passages (boundary check-points)

- Mondy - Hanga
  Motor two-way road (only for citizens of Mongolia and Russia)
- Kyakhta - Altanbulag
  Motor road International
- Naushki - Suhe-Bator
  Railway international

ENVIRONMENT TRANSFORMATION IN THE LAKE BAIKAL BASIN

Climate change

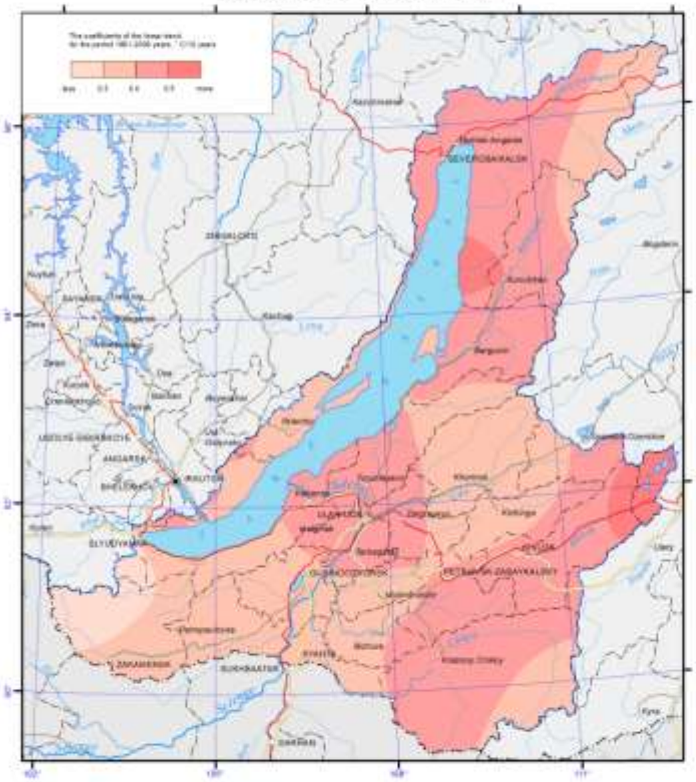
As a measure of the intensity of climate change for a specified period of time we used the linear trend coefficient determined by the method of least squares and characterizing the average rate of climate variables change, which corresponds to the trend.

Annual temperature of the lower layer of air is used for the description of the current climate changes. The physical meaning of this climate characteristics is determined by almost linear dependence of longwave radiation, outgoing from the top of the atmosphere, from the temperature of the lower air layer. Given this dependence the assessment of the indicated temperature is largely analogous to the estimation the average outgoing longwave radiation, then the speed of heating or cooling the Earth's surface can be determined [Budyko, 1991].

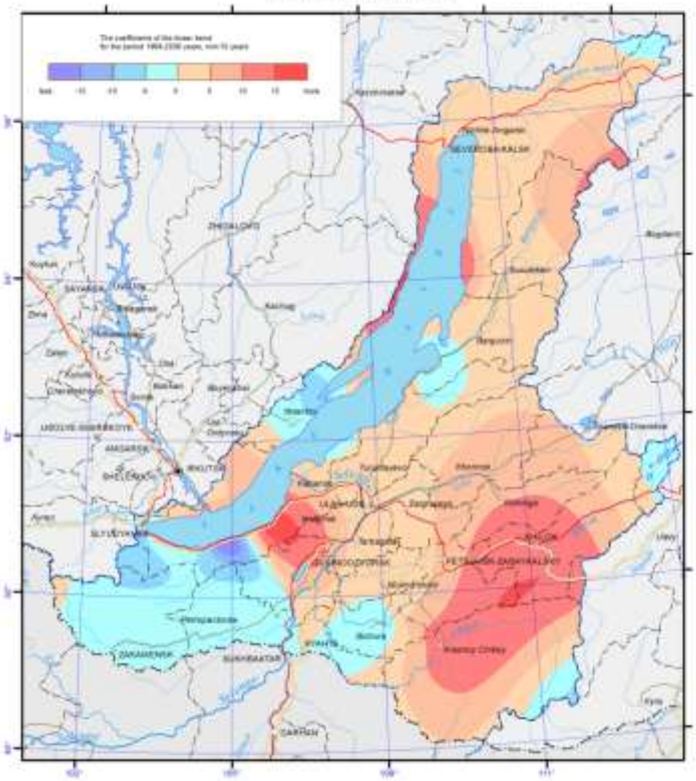
Annual trend values for years 1961-2008 on the territory are positive and ranged from 0.24 to 0,52°C/10 years, that is next- higher order than similar ratios calculated on the average for the Northern Hemisphere .

Maximum values of the trend are observed in the north of the study area. However one of the centers is located in the Barguzinsky reserve. This area (north- eastern coast of Lake Baikal) is also interesting that throughout the year here , in contrast to other weather stations, the same high trends are observed. The majority of points is characterized by the annual progress of the coefficients describing the linear trend of air temperature, with a peak in February and a minimum in the summer months. July is represented by asymmetric distribution of trend values. Though they all are statistically significant, their maximum is clearly shifted to the territory of Trans-Baikal Territory. As local areas of minimal trends in all months of the year the foothills of Khamar- Daban (station Khamar -Daban) and the upper Lena river (station Kachug) can be called.

TRENDS IN AIR TEMPERATURE. YEAR



TRENDS RAINFALL. YEAR



Open air condition

Open air condition deterioration in populated areas is still caused by:

1. Emissions from industrial enterprises:

– due to application of raw products high in pollutants;

– resulted from substantial aging aggression of equipment and/or absence of cleaning equipment;

– due to breakdown in technological processes etc.

2. Vehicle emissions:

– as a result of traffic increase including “old” cars;

– due to poor transportation performance;

– because of great quantity of traffic jams [On sanitary-epidemiologic …, 2012].

Emissions from industrial enterprises and vehicles are very high in various pollutants: sulfur dioxide, dust, carbonic oxide, nitrogen oxides, benzapyrene, methyl mercaptan and others enter the air basin from many sources. Involved in photochemical reactions with oxygen and hydrocarbons the substances generate other pollutants. Therefore, study of spatiotemporal dynamics air pollutants remains a topical issue. Nevertheless, it appears important to determine not only the way pollutants will propagate in the atmosphere around industrial centers but also the way they will spread over reference areas, one of which being Lake Baikal basin.

Wind regime at the Baikal shores combines windblasts provided by macro-scale general circulation and circulation of local origin with breezes, highland-valley circulation and gravity windblasts. The basic large-scale windblast over the Baikal basin and its shores is north-western air-mass transport. Although under complex orographic influence some peculiar Baikal winds appear here. In the cold period of the year together with large-scale air-mass transport off-shore winds are observed at the coast; in the warm period – onshore winds which is common to seashores. This fact has an apparent impact on travel of pollutants from industrial enterprises in Irkutsk Region and Republic of Buryatia.

Nowadays to protect Lake Baikal and its surroundings almost entire coastal territory of the lake is covered with reservation conditions. But in spite of natural areas of preferential protection round the lake, industrial activity is continuing to generate a negative impact.

Basic economic line of production in Baikal Region is determined by extensive fuel-and-power and primary natural resources. This fact stipulated energy-intensive industry advancement – ferrous and non-ferrous metallurgy, mining, chemical, wood-processing, pulp and paper and fuel and energy industries as well as forestry. Enterprises of the above-listed industries provide such common pollutants as dust, channel black, sulfur and nitrogen oxides, heavy metals etc. Moreover, each manufacture is accompanied by its specific list of pollutants.

Atmospheric pollution in the basin of Lake Baikal was estimated by the numerically simulated model based on analytic calculations of differential equation of travel and eddy mixing extraneous substances. Contaminated air plumes from anthropogenic sources were evaluated; critical concentration excess zones (MPC daily average) as well as excess duration estimated in hours per month were determined.

Inventory data for indicators of emitters together with long-standing data of wind velocity and air temperature daily weather observations with 8-prefix of time were applied as the input information for calculations to obtain statistically stable climatological characteristics.

The quoted results demonstrate that the environmental situation in the number of populated areas of Baikal Region does not answer to the enforceable standard (MPC daily average) for air quality. Furthermore, pollutants from industrial enterprises overspread not over the territory of the polluted area only but run far beyond it.

On the grounds of the city of Irkutsk there are approximately 250 industrial enterprises with more than 3000 stationary air pollution sources carried as an asset. They provide substances of 113 names and create dangerous air contamination levels. It is proved by the fact that Irkutsk has made the list of prioritized cities with highest air pollution levels over the recent 10 years. The main production facilities furthering repugnant substances high levels are “Irkutskenergo”

JSC (contributes 52,9 %), “Baikalenergo” JSC, “Irkutsk Corporation” JSC. It is worth noting that power industry plays the leading role in air pollution emissions. It is accounted for 82,7 % of the total harmful air contamination in Irkutsk [Akhtimankina, 2013]. According to the results obtained almost entire territory of the city is influenced by air contamination over the enforceable hygienic standard. Hazardous substances concentration reaches a maximum closer to emission points.

The basic stationary air pollution sources in the city of Ulan-Ude are CHPP-1 and CHPP-2, locomotive repair plant, aircraft factory, construction and food processing facilities and others [On the condition…, 2009] with approximately 2000 point and areal sources carried as an asset.

The fuel-and-power complex in the city of Ulan-Ude vents almost half of the total amount of citywide pollution emission. Combustion gases from cogeneration plants and other power assets travel long distances (about some kilometers) with prevailing winds contributing to regional environmental pollution. But the most dangerous for the city of Ulan-Ude are those which settle on the areas surrounding the source, in the sphere of so-called intensive technogenic pollution. Majority of fuel-and-power enterprises (e.g. CHPP-1) are located in high density areas and it makes the situation even worse. In combination with flue gases air basin is polluted with a number of solid and gas contaminants containing such repugnant substances as refuse burnout, carbon oxide, sulfur and nitrogen oxides. Machine building enterprises sources vent dust, various acids and lye, nitriles and other compounds, phenol, methyl hydroxide, polycyclic aromatic hydrocarbon, solvents vapors (toluene, xylol, paint thinner, benzene chloride, dichloroethane, spirits, acetates, etc.), ingredients of organic and inorganic fillers (salts and oxides of titanium, zinc, lead, chrome and other metals), as well as components of film-forming agents (styrole, formaldehyde, etc.). The major contamination resources are the following: galvanizing, paint and foundry plants, galvanic and accumulator shops, repair rooms, etc [Imetkhenov, 2001]. Research suggested environmental situation in Ulan-Ude to be unfavorable, conditioned, on the one hand, by high level of technogenic burden, and, on the other hand, by poor air dissipative capacity resulted in polluted air blanketing. The city’s location in an intermountain basin contributes to industrial emissions accumulation.

On the grounds of the city of Ulaanbaatar there are 860 areal sources mainly presented by household ovens [Arguchintseva, 2011]. In accordance with estimations, the ultimate air pollution was registered in the areas of concentration of yurts which occupy the entire northern part of the city and spread towards west and east from the center of Ulan-Bator. High level air pollution zone is situated on the south-western city outskirts, near Buyant-Ukhaa airport with the yurt village nearby. Here wind direction and relief contribute to the yurt village’s emission travel towards the airport. Heating of the yurt village air emission creates a stable critical pollutant concentration excess field around the airport. Combined with unfavorable meteorological conditions, this means a problem takeoff and landing situation for almost a two week period. It brings about risk and considerable financial losses due to aircraft idle time.

The data represented demonstrate that in a number of populated areas of Lake Baikal Region, especially large ones, experience adverse environment, which undoubtedly tells on the local people’s health. Permanent residence under the air pollution conditions leads to overall health decline and higher disease incidence, diseases of the respiratory system in particular.

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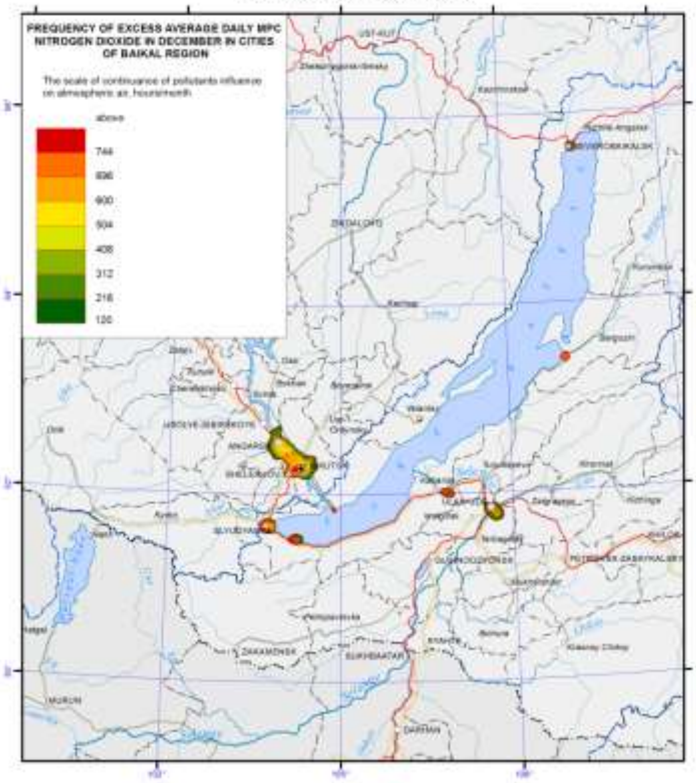
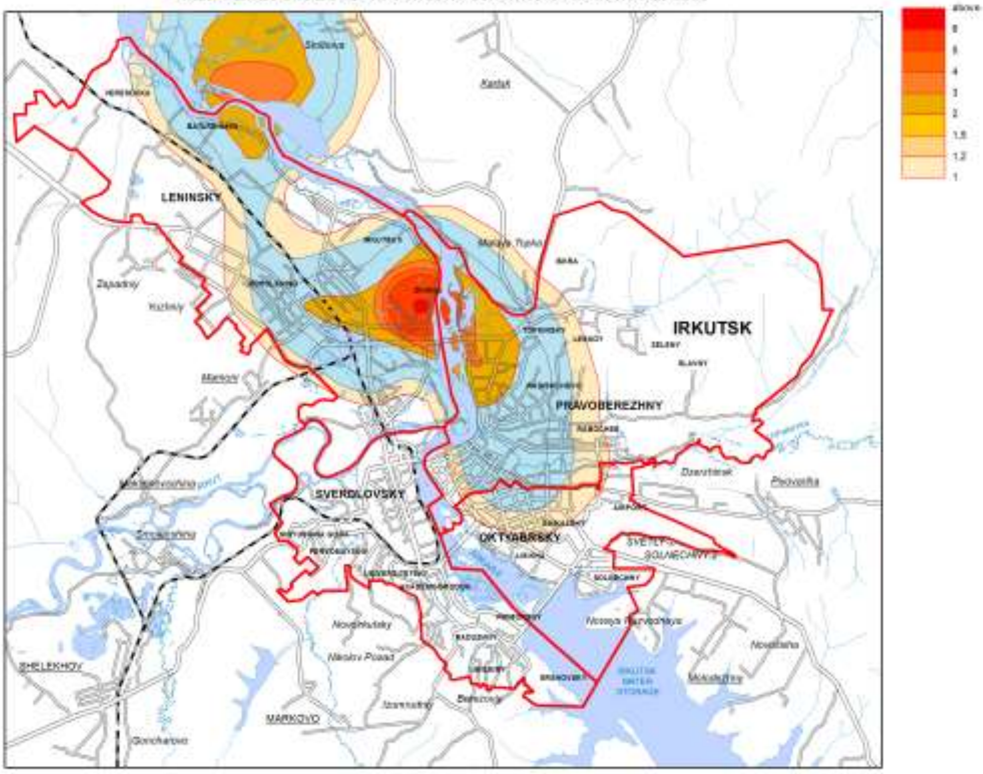
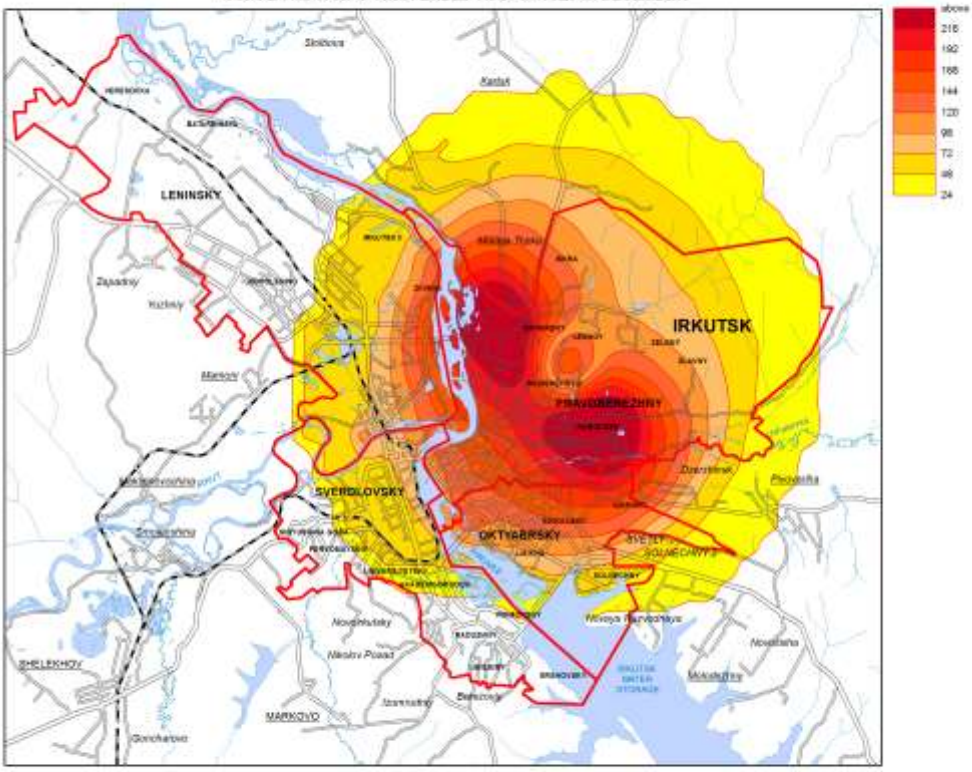
ATMOSPHERIC AIR CONDITION



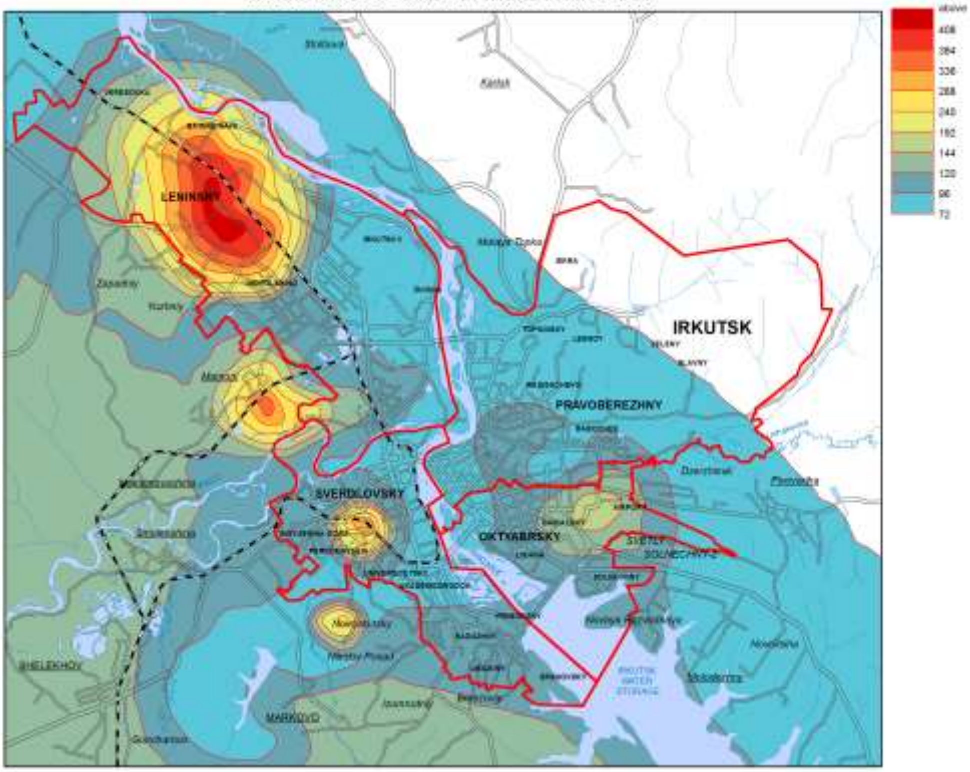
THE ISOLINES OF ABSOLUTE CONCENTRATION OF SOOT IN WINTERTIME



THE ISOLINES OF EXCESS FREQUENCY OF THE AVERAGE DAILY MAXIMUM ALLOWABLE CONCENTRATION OF SUSPENDED SUBSTANCES IN DECEMBER



THE ISOLINES OF EXCESS FREQUENCY OF THE AVERAGE DAILY MAXIMUM ALLOWABLE CONCENTRATION OF NITROGEN DIOXIDE IN DECEMBER



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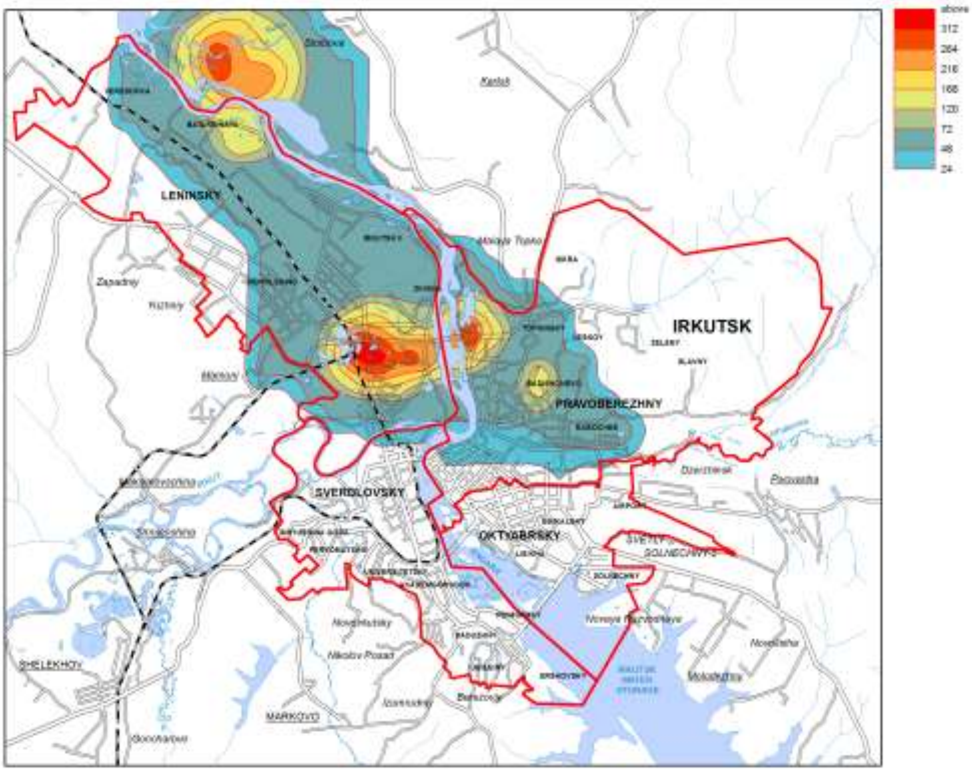
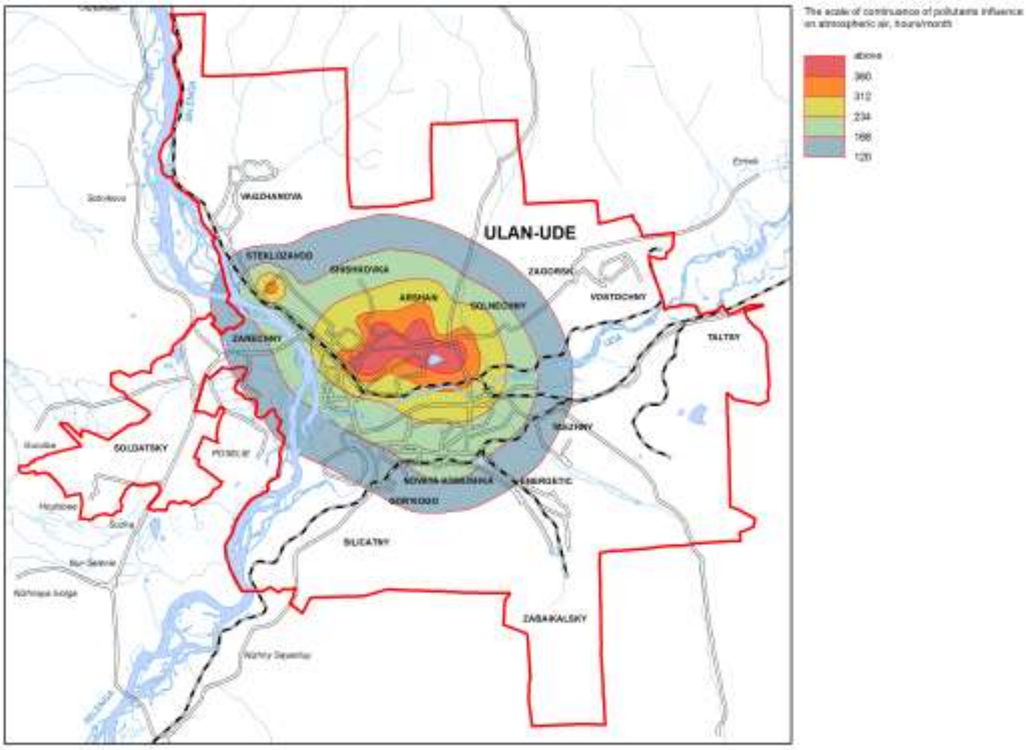
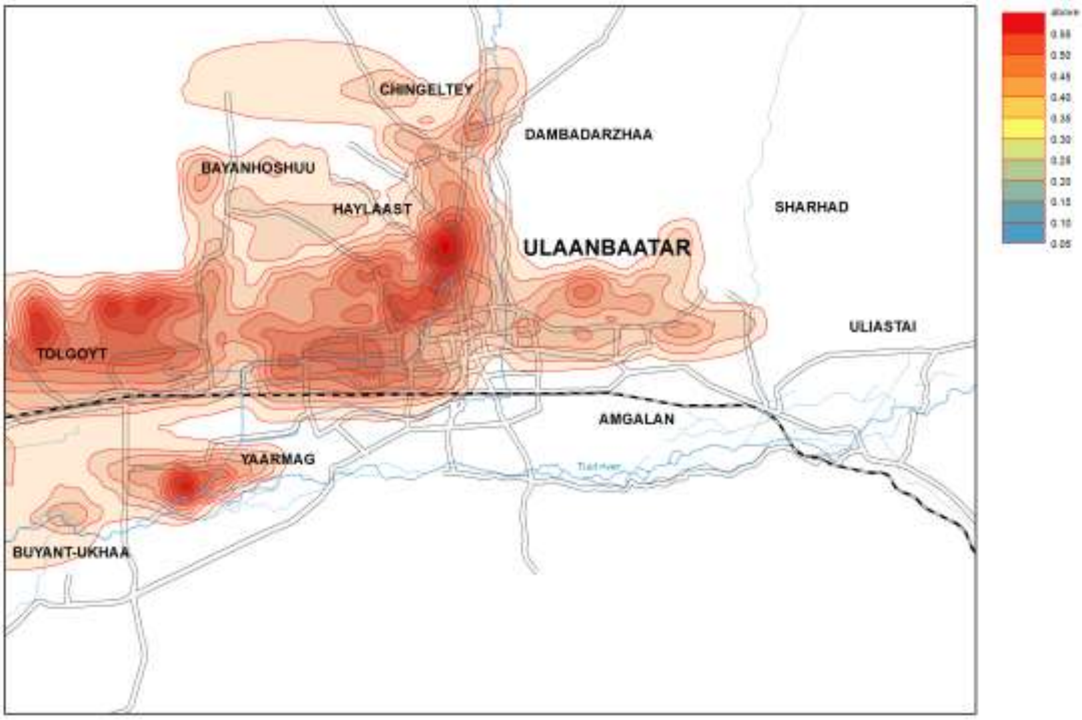


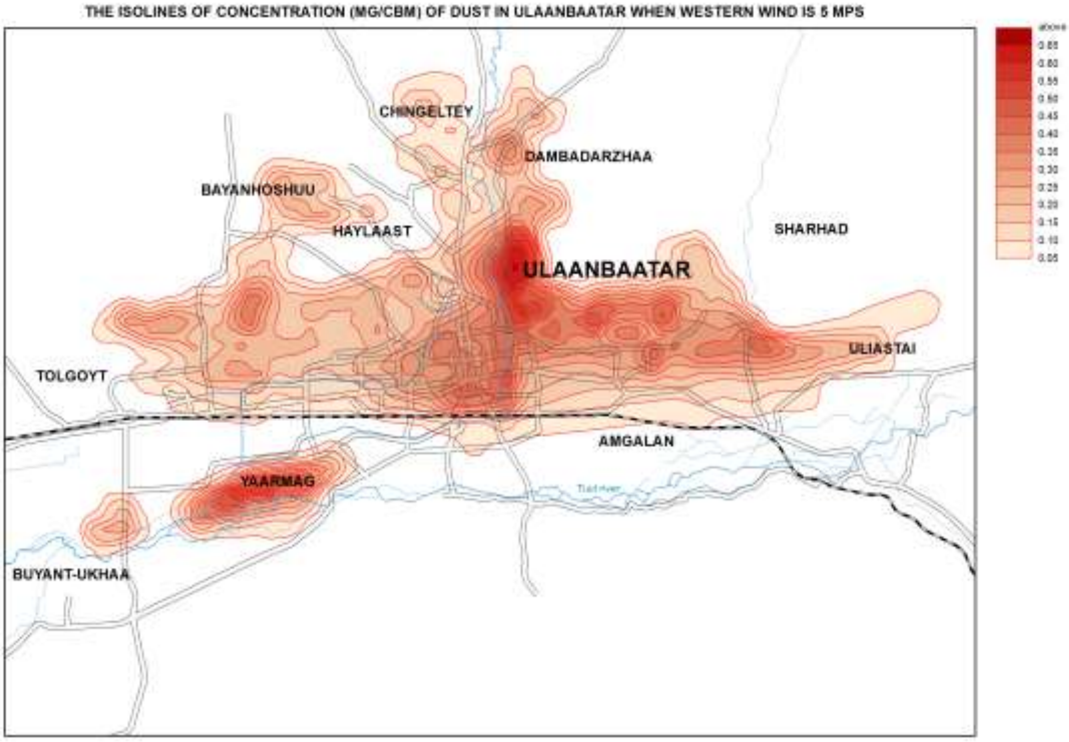
FREQUENCY OF EXCESS AVERAGE DAILY MPC NITROGEN DIOXIDE IN ULAN-UDE IN DECEMBER



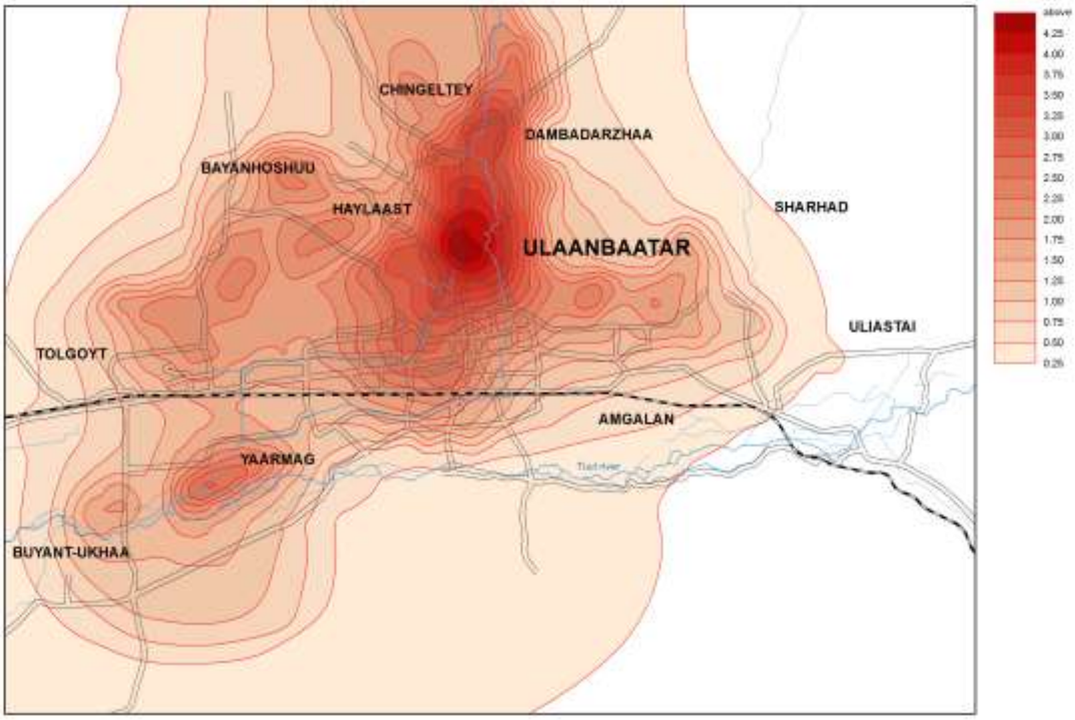
THE ISOLINES OF CONCENTRATION (MG/CBM) OF DUST IN ULAANBAATAR WHEN EASTERN WIND IS 5 MPS



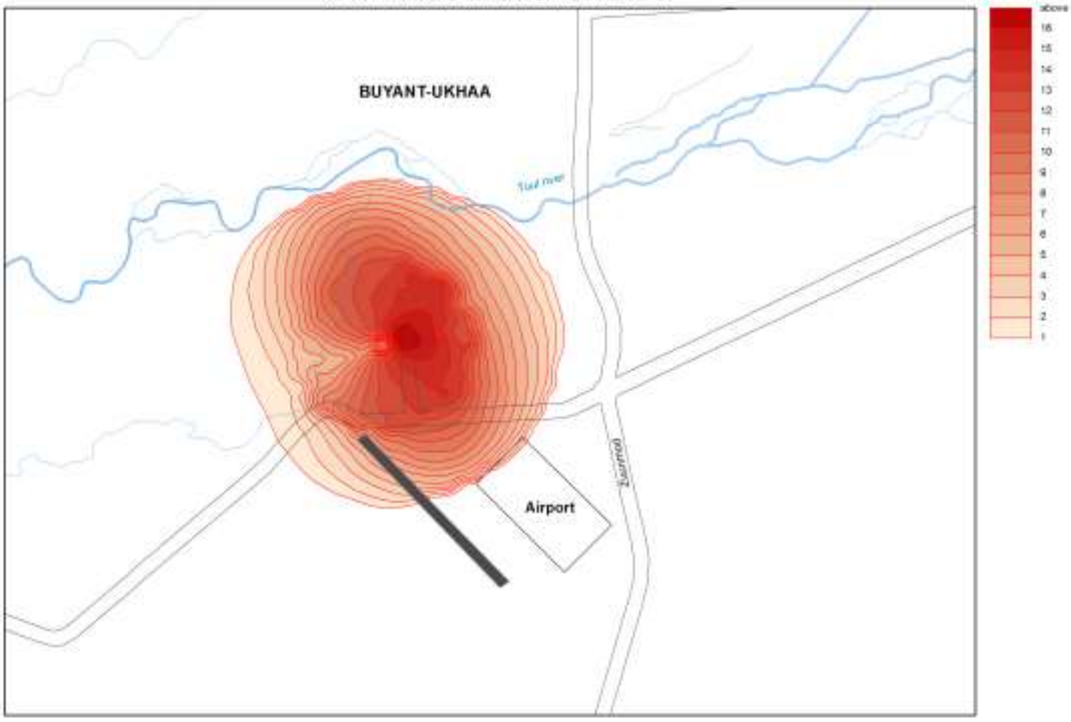
THE ISOLINES OF CONCENTRATION (MG/CBM) OF DUST IN ULAANBAATAR WHEN WESTERN WIND IS 5 MPS



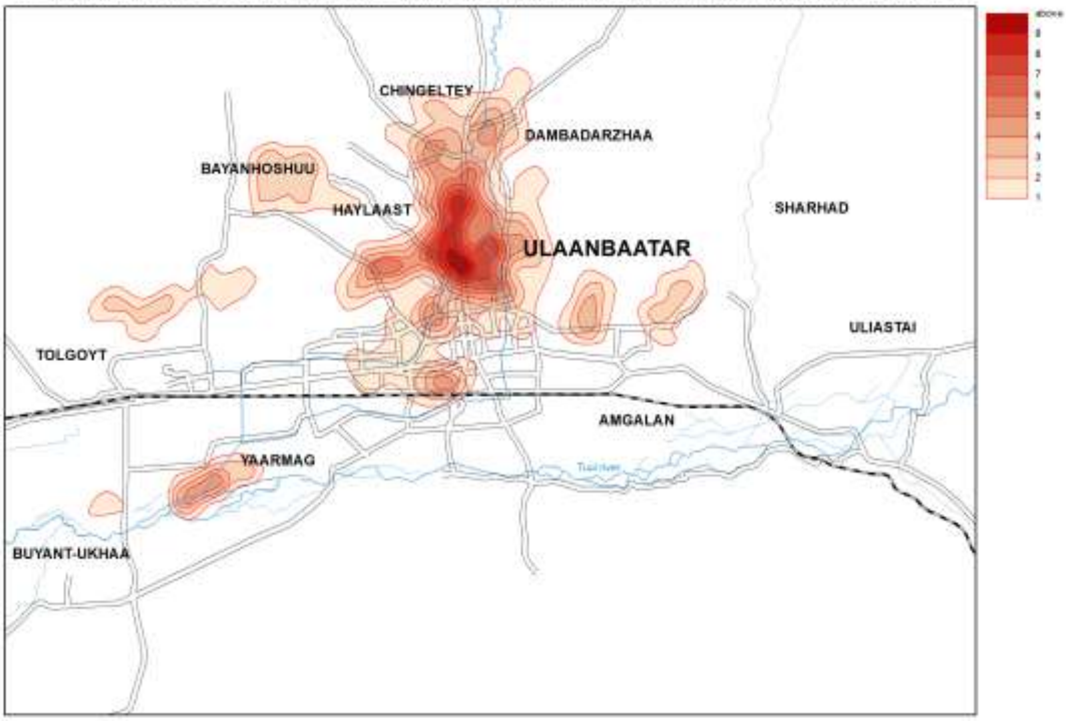
THE ISOLINES OF CONCENTRATION OF DUST IN ULAANBAATAR WHEN CALM IS



THE EXCESS FREQUENCY OF THE AVERAGE DAILY MAXIMUM ALLOWABLE CONCENTRATION OF SOOT AROUND AIRPORT OF ULAANBAATAR



THE EXCESS FREQUENCY OF THE AVERAGE DAILY MAXIMUM ALLOWABLE CONCENTRATION OF DUST IN ULAANBAATAR IN APRIL



Quality of surface waters

Quality of surface waters depends on the combination of natural properties, conditions of self-purification of water bodies and input of contaminants from ambient environments. Hydrochemical and hydrobiological parameters are the main characteristics for water quality assessment. Their measurements are conducted at the network of observations sites according to the standard procedure, as well as by sanitary-epidemiological organizations and appropriate agencies.

Water quality is one of the main parameters for human activity, and it is strictly regulated in Russia and other countries. Exploitation of water bodies for different economic purposes is stipulated by several standards with the list of chemical and biological elements in the water and their permissible concentrations. The water designated for household and recreational purposes has the strictest requirements to the water quality. The standards for water bodies designated for fishery are less strict and used in comparative assessments of the quality of natural waters, including those used in this investigation of the basin of Lake Baikal.

Qualitative characteristics of surface waters summarised from the territorial reports are presented in a form of a map “Quality of Surface Waters”, whose scale and information fullness are attributed to the sizes of the lake catchment area. The original information of this map was borrowed from the national reports “On State and Conservation of Environment” at Lake Baikal, in the Republic of Buryatia and Irkutsk Oblast, from the annual reports on “Quality of Surface Waters in the Russian Federation”, and data of 2012 provided by scientists of the Mongolian People’s Republic (National …, 2012, 2013; National …, 2013; Annual …, 2012). To assess the state of water bodies, a specific index of water pollution (SIWP) was calculated from the most common contaminants of surface waters (RD 52.24 643-2002). Water quality was assessed from SIWP and, as a result, five classes (categories) of water quality were identified in the water objects under study.

The water quality in the basin of the Selenga River (the largest tributary of Lake Baikal) on the territory of Mongolia was classified according to the procedure similar to the Russian one. The main list and standards of chemical elements (dissolved oxygen, suspended particles, acidity, etc.) are almost identical for both countries (Harmonized …, 2012). The final classification of water bodies of the Selenga River basin on the Mongolian territory was based on calculated values of water pollution (Gombo Davaa, http://fofj.org) and brought into conformity with the Russian classification.

The water quality classes of water bodies are depicted by colored lines laid along the channels when mapping. In the cross sections of hydrochemical monitoring chemical elements which are priority pollutants for the site are designated (list of posts attached).

The major part of the lake catchment area belongs to the Selenga River basin; the upper and central parts of the river are situated on the territory of the Mongolia. The Selenga River and a number of its large tributaries mainly cross the underdeveloped territories and are not subject to significant pollution. The water quality in the main large rivers of this area (Delger-Muren, Ider, Orkhon, and Selenga) is referred to class 1 (“practically pure”). Waters in some areas of the hydrographic network of these streams, which are adjacent to the developed regions and subject to anthropogenic effect, belong to class 2 (“slightly polluted”). The Tuul River that experiences severe anthropogenic effect (the city of Ulaanbaatar) significantly differs from other streams on the Mongolian territory: its surface water quality is classified as class 4 (“dirty”) and class 5 (“very dirty”). The main pollutants of this river are ammonium and nitrite nitrogen, phosphate and sulphate. However, due to self-purification processes occurring in the mouth area at the confluent of the Orkhon River, the Tuul River water is recovered to class 1. The water in the Khiagt River is also of low quality (class 4) on the northern border of Mongolia, which brings its waters to the territory of Buryatia (the Kyakhtinka River). Relatively low characteristics of the water quality (classes 2 and 3) are recorded in some developed areas – in the Rivers Khangol (the town of Erdenet) and Orkhon (the town of Sukhbaatar).

Up to the confluence of the Orkhon River, the water quality of the Selenga River on the territory of Mongolia is regarded as classes 1 and 2. Further, down the town of Sukhbaatar and the Orkhon River mouth, the Selenga River crosses the border, and on the territory of Buryatia the water quality at the cross section of the town of Naushki is of class 3 ("polluted"). The main pollutants in this part of the river are compounds of aluminium, iron and copper, the values of which exceed maximum permissible concentrations. Further, the Dzhida River (together with the Modonkul River – class 4) and the Kyakhtinka River (class 4) enter the Selenga River; the first is affected by discharges of mine and drainage waters from the non-functional stock company "Dzhidacomplex", and the second contains elevated maximum permissible concentrations of 11 elements due to the transboundary transfer (the Khiagt River).

Large tributaries of the Selenga River, which enter the river downstream, bring polluted waters of class 3. The most unfavourable situation is observed at some sites of the Rivers Kuitunka, Chikoy, Khilok, and Uda, whose water quality is regarded as "very dirty". The main pollutants are different forms of nitrogen, organic substances and phenol. The water in the Lower Selenga is characterised as class 3.

The quality of surface waters in other largest tributaries of Lake Baikal is also low. Such large rivers as Upper Angara, Barguzin and Turka have polluted waters of class 3, whilst the waters in such small rivers as Tyya, Kholodnaya, Kika, Snezhnaya, Utulik, Buguldeika and others are of class 2. Phenols in combination with oil products, zinc, copper, and organic substances are typical contaminants of these rivers.

There is scarce information on water quality in the lakes located on the territory under study as no monitoring has been conducted there. The exception is Lake Gusinoye, whose water quality is of class 3 ("dirty"). The main pollutants of this lake are phenol, oil products, copper, and others. Moreover, the lake is subject to thermal pollution from the Gusinoozerskaya Hydropower Station. Another water body, Lake Kotokel, located within the Lake Baikal basin has very low water quality. It is banned to use its waters for any purposes, except technical use, which is confirmed by the Decree of the Chief Sanitary Inspector of the Republic of Buryatia (June 6, 2009, No. 4) "On Initiation of Restrictive Measures at Lake Kotokel" (National …, 2013).

It should be noted that there is a trend of significant improvement of surface water quality within the Lake Baikal basin due to the increase of sewage disposal on the territory in 2012. The water quality in the majority of water bodies have been improved by 1-2 classes compared to that in 2011 and previous years (National …, 2012, 2013; Annual …, 2012).

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	Water body	Observation point
	Angarakan	Angarakan
	Upper Angara	Uoyan
	Upper Angara	Upper Zaimka
	Kholodnaya	Kholodnaya
	Tyya	Tyya
	Goudzhekit	Goudzhekit

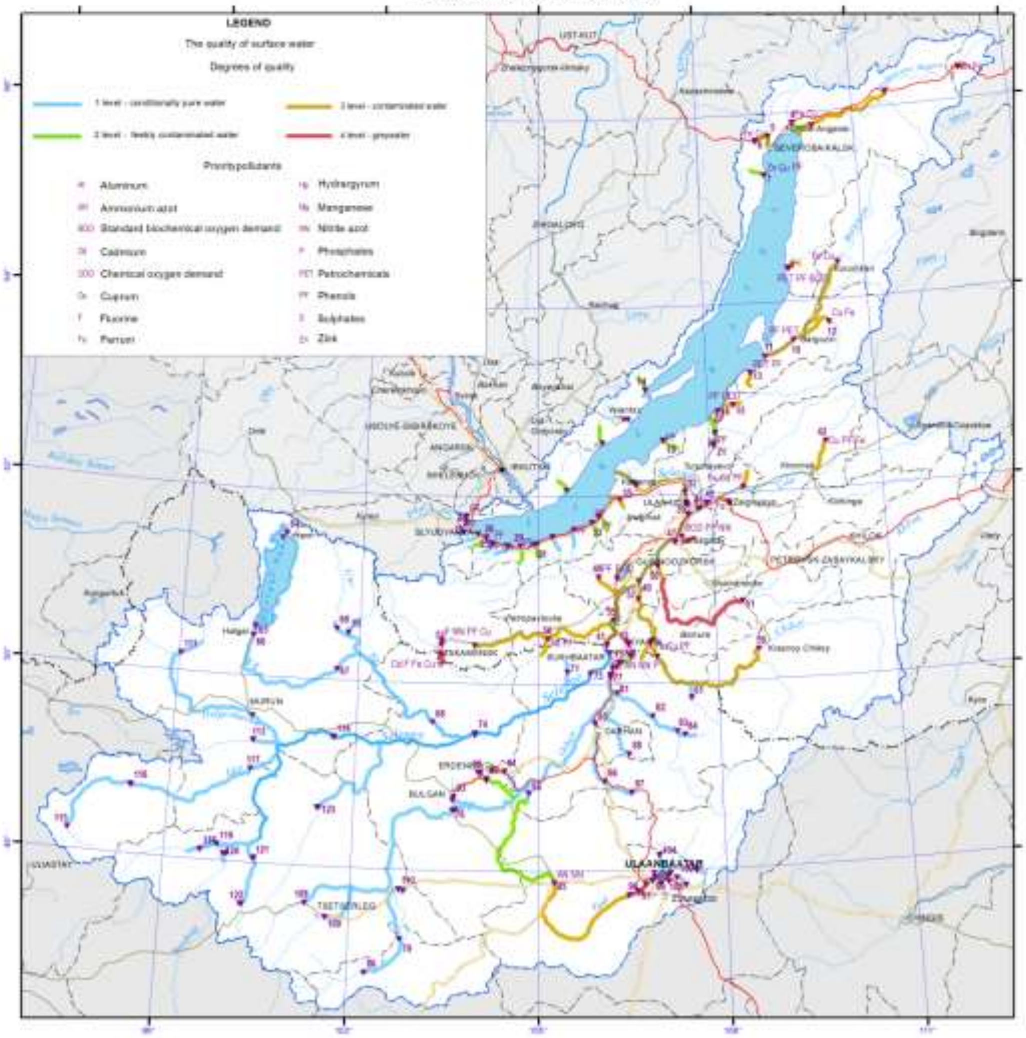
	Rel	Baikalskoye
	Davsha	Davsha
	Barguzine	Mogoito
0	Barguzine	Barguzine
1	Barguzine	Ust -Barguzin
2	Ina	Ina
3	Maksimikha	Maksimikha
4	Sarma	Sarma
5	Turka	Sobolikha
6	Lake Kotokel	Yartsy
7	Anga	Elantsy
8	Buguldeika	Bol. Buguldeika
9	Bol Sukhaya	Sukhaya
0	Kika	Haim
1	Kika	Kika
2	Goloustnaya	Bol. Goloustnaya
3	Kultuchnaya	Kultuk
4	Pokhabikha	Sludyanka
5	Bezymyannaya	Mangutay
6	Utulik	Utulik
7	Kharlakhta	Bajkalsk
8	Khara- Murin	Murino
9	Snezhnaya	Vydrino
0	Vydrinaya	245 km of East Siberian Railway
1	Pereemnaya	Tankhoy
2	Mishikha	Mishikha
3	Mysovka	Babushkin
4	Manturikha	Manturikha
5	Bolshaya Rechka	Posolskaya
6	Selenga	Kabansk
7	Selenga	Mostovoy
8	Selenga	Ulan-Ude

9	Selenga	Ulan-Ude
0	Selenga	Novoselenginsk
1	Selenga	Naushki
2	Ona	Lower Maila
3	Kurba	Novaya Kurba
4	Bryanka	Zaigraevo
5	Uda	Ulan-Ude
6	Uda	Ulan-Ude
7	Kuitunka	Tarbagatai
8	Temnik	Ulan Udunga
9	Lake Gusinoye	Lake Gusinoye
0	Khilok	Khailastuy
1	Khilok	Maleta
2	Modonkul	Zakamensk
3	Modonkul	Zakamensk
4	Djida	Khamnei
5	Djida	Djida
6	Zheltura	Zheltura
7	Chikoi	Povorot
8	Chikoi	Chikoi
9	Chikoi	Gremyachka
0	Kieran	Ust- Kieran
1	Khuder-Gol	Khuder
2	Kyakhtinka	Kyakhta
3	Khyagt-Gol	Altanbulag
4	Lake Hovsgol	Khankh
5	Lake Hovsgol	Khatgal
6	Egiyn Gol	Khatgal
7	Egiyn Gol	Erdenbulgan
8	Egiyn Gol	Khantav
	Uur Gol	Tsagaan-Uur

9		
0	Uilgan Gol	Tsagaan-Uur
1	Dzelter Gol	Tsagaanuur
2	Selenge	Sukhbaatar
3	Selenge	Zuunburen
4	Selenge	Khyalgant
5	Buur - Gol	Sukhbaatar
6	Orkhon Gol	Sukhbaatar
7	Orkhon Gol	Shamaar
8	Orkhon Gol	Orkhon
9	Orkhon Gol	Kharkhorin
0	Orkhon Gol	Bat Ulzy
1	Eree Gol	Dulaanhaan
2	Eree Gol	Eree
3	Eree Gol	Bugant
4	Bugant Gol	Bugant
5	Hara Gol	Darkhan
6	Hara Gol	Baruunharaa
7	Hara Gol	Zuunharaa
8	Sharyn Gol	Sharyngol
9	Hurt - Bulag	Erdenet
0	Khangang Gol	Erdenet
1	Khangang Gol	Ulaan-Tolgoi
2	Chingel Gol	Erdenet
3	Zuun - turuu	Bulgan
4	Tuul	Orkhontuul
5	Tuul	Lune
6	Tuul	Altanbulag
7	Tuul	Shuvuun Fabric
8	Tuul	Songino
9	Tuul	Songsolon

00	Tuul	Zaisan
01	Tuul	Ulaanbaatar
02	Tuul	Bayanzurkh
03	Tuul	Nalaykh
04	Selbe Gol	Sanzay
05	Selbe Gol	Ulaanbaatar
06	Uliastain Gol	Ulaanbaatar
07	Terelj Gol	Terelj
08	Hoyt Tameer-Gol	Ikhtamir
09	Urd Tamir-Gol	Tsetserleg
10	Lake Ugiyn-Nur	Ugiynuur
11	Beltes Gol	Bayanzurkh
12	Delger - Muren	Muren
13	Bugsey Gol	Tumerbulag
14	Ider	Tosontsengel
15	Ider	Ider
16	Ider	Tosontsengel
17	Ider	Zurkh
18	Suman Gol	Tharyat
19	Lake Terkh-Tsagaan Nuur	Tharyat
20	Gichgenii Gol	Tharyat
21	Chuluut Gol	Under-Ulaan
22	Chuluut Gol	Chuluut
23	Hanuy Gol	Erdenemandal

THE QUALITY OF SURFACE WATER



Mining industry impact onto the environment

Mining industry is referred to the one strongly affecting the environment. The intense land use in terms of mining mineral resources causes destruction of the surface ground layer, when constructing mines and piling overburden, disturbance of hydrological regime of rivers, pollution of soils, surface and underground waters, destruction of environment integrity and natural landscapes.

A great importance of mining industry for Siberia and Mongolia is due to its abundant resources. Under conditions of transition to the sustainable (balanced) development of essential significance is a high cost-effectiveness of the mining branch with observance of ecological risk, raising social level and quality of life of population. The map was produced to disclose the ecological component of sustainable development of the Baikal-Mongolian region. It depicts the impact of mining industry onto the environment. Table 1 provides complete information for map compilation and profound presentation of its contents.

The map was compiled on the basis of archived and published data, e.g. «National Atlas of Mongolia (1990), «Ecological-geographic map of the Russian Federation» (1996), «Atlas of social-economic development of Russia» (2009) [4], «Atlas of Mongolia» in the Mongolian language, etc. the interpreted space images of high resolution (flights of 2010-2013) have been used to investigate the landscape structure of the territory. Besides, it was feasible to determine the effect of industries and environment state at the sites of land use.

The objects of ecology evaluation were mineral deposits and mining enterprises. The information was obtained from the Atlas base maps: «Fuel-energy resources and their development», «Resources of ferrous, non-ferrous and rare metals and their production», «Basic types of nonmetallic resources, resources and development».

A larger part of the study area is involved into the central and buffer zones of the Baikal natural territory within RF. The natural continuation of the buffer zone is the Baikal watershed within Mongolia. In accordance with RF Law "On Lake Baikal protection" the ecological zoning of the Baikal natural territory is the main tool for its implementation. Specific nature-protective constraints are referred to the central ecologic zone surrounding the Baikal Lake basin. Some activities prohibited in this zone are: recovery of crude oil and natural gas, radioactive and metallic ores, prospecting and development of new deposits, formerly not developed. It is prohibited to recover mineral resources within water area of Baikal, in its water-protective zone, in the river streams of spawning rivers and their water-protective zones.

In the buffer zone the prospected and explored deposits are located within the ecological districts of type 6, i.e. industrial, regulated intense development. This type is characterized by highly valued landscapes and their components at the mean and low sensitivity to loads. They basically occupy valley, submountainous, steppe and subtaiga landscapes. They were distinguished based on the input of mining industry to regional economy. Altogether, the activities of mining industries should not negatively affect the ecological system of Lake Baikal.

The cartographic evaluation of man-made violation of landscapes was provided for 380 mineral deposits. At present 75 deposits are being developed; at 12 deposits production is stopped, they are conserved or transferred into a reserve. Brief data are listed in Table 2. The impact of mining enterprises is primarily determined by the recovery process, as well as toxicity of raw material and reagents used in processing, and landscape features (Table 1).

The maximum impact on the environment is implemented through a radical rearrangement of relief with formation of denudation and accumulative units, open-cast mining operations, which are preferred for economic benefits.

On the territory under observation 73 deposits are being developed by open-cast mining and only 2 deposits are operated by underground mining, e.g. Bon-Gorkhon deposits of tungsten and brown coal deposit at Nailakh. The prime indication of man-made impact onto lithosphere is the area of broken lands. Disturbance of the area as a square kilometer is evaluated in numerical units: I – over 10 km^2 – is strongest impact, II – 1-10 km^2 it is strong, III – 0.1-1 km^2

it is moderate, IV – less than 0.1 km^2 it is weak. The most significant impact resulting from mining activities is recorded at the deposits Erdenetiin ovoo (Fig. 1), Gusinoozersky (Fig. 2), Olonj-Shibirskoe.

Sizable sites of broken lands in the river valleys appear due to a recovery of placer gold thus causing intensified erosion, change of structure and productivity of meadows, pollution and deformation of riverbeds, reduction of groundwater level, and destruction of biotic components of ecosystems. On the surveyed territory there are about 30 sites where placer gold is dredged; nearly all of them located in the river valleys of Krasny Chikoy, Zakamensk District, aimaks Selenege and Tuv. The maximum size of breakage reaches about 40 sq. km; it was identified in the Tuul River valley (Fig. 3).

Where deposits are not developed, the main impact onto the lithosphere is drilling holes, construction and exploitation of temporary roads and settlements. The area of such disturbance is fairly small, and it is conventionally accepted as 0.01 sq. km.

The background indicator of technogenous disturbance of lands is density (spacing) of disturbances (damage). It is determined as the ratio of summary area of distorted lands in the administrative district to total area of this district. The following scale of disturbance is accepted (sq. km / thous. sq. km) in intensity units: I – over 10 is very high, II – 1.0 to 10 is high, III – 0.1 to 1.0 intermediate, IV – 0.01 to 0.1 low, V – less than 0.01 it is lowest. Using this scale these areas with highest and high land disturbance were distinguished in aimaks Orkhon, Darkhan-Uul, Tuv, city Ulan-Baatar and towns Petrovsk-Zabaikalsk, Zakamensk, Slyudyanka and Selenginsk.

On some developed deposits, as Olonj-Shibirsky (coal), Tumurtolgoy (iron), Erdenetiin ovoo (copper, molybdenum), Bom-Gorkhon (tungsten), Boroo (ore gold), etc., the extracted mineral resources undergo primary processing. For storage or burial of dumped material tailings are placed at the deposits (Fig. 4). They can represent ecological risk if they are made without proper filtration system; therefore they become the source of contamination of surface and ground waters, atmosphere through dusting. The strongest ecological effect is produced at the tailings of mining-recovering enterprises like Erdenet, Dzhida tungsten-molybdenum Combine (now shut down) and Kyakhta mill (currently not operating).

The recovered raw materials and processed produce are classified into 5 classes of toxicity according to the degree of ecological risk: I – very high: rare metal and radioactive ores, II – high: ores of nonferrous and noble metals, fluorite, III – increased: coal and brown coal, iron ores, IV – moderate: placer gold and tungsten, V – low: nonmetallic raw materials.

For every mining enterprise the environment components (nature, economy, and people's health) are differentiated by the degree of man-made impact.

The negative impact onto the environment and health is exemplified by dumps and tailings of non-operating Dzhida tungsten-molybdenum Combine located in the surroundings of Zakamensk town (Fig. 5). Waste accumulated for 50 years is a considerable contaminant of surface and ground waters with toxic components, as well as atmospheric air (dusting).

The mining enterprises are depicted as symbols of varying shape, size, structure and color. The shape designates the process of recovery, size implies the degree of land disturbance, external contour (rim) means landscape stability and internal contour means its significance. The color of contour corresponds to the values of indices. The circle in the center of map sign and its color show the level of toxicity or ecological risk of recovered resources and products of concentration. The circles on the map designate the deposits undergoing geological exploration. The density of disturbed lands in administrative districts is reflected on the map by the method of quantitative background.

The map shows that the larger part of mining enterprises is concentrated in the central most developed part of the territory. In the south-western margin within the Mongolian part of watershed basin there are plentiful deposits which are currently not developed. The lands are least disturbed in the north-east. In the central ecological zone of the Baikal natural territory three non-metallic deposits are being in operation, e.g. Angasolka deposit of construction stone, Slyudyanka cement marble and Tarakanovsky cement limestone lying at distance over 4 km from the coast of Lake Baikal. The recovered raw material is referred to the low class of ecological risk. The development of these deposits is not referred to the types of activities banned in the central ecological zone of the Baikal natural territory. In general, it does not affect the integrity of the Baikal ecosystem.

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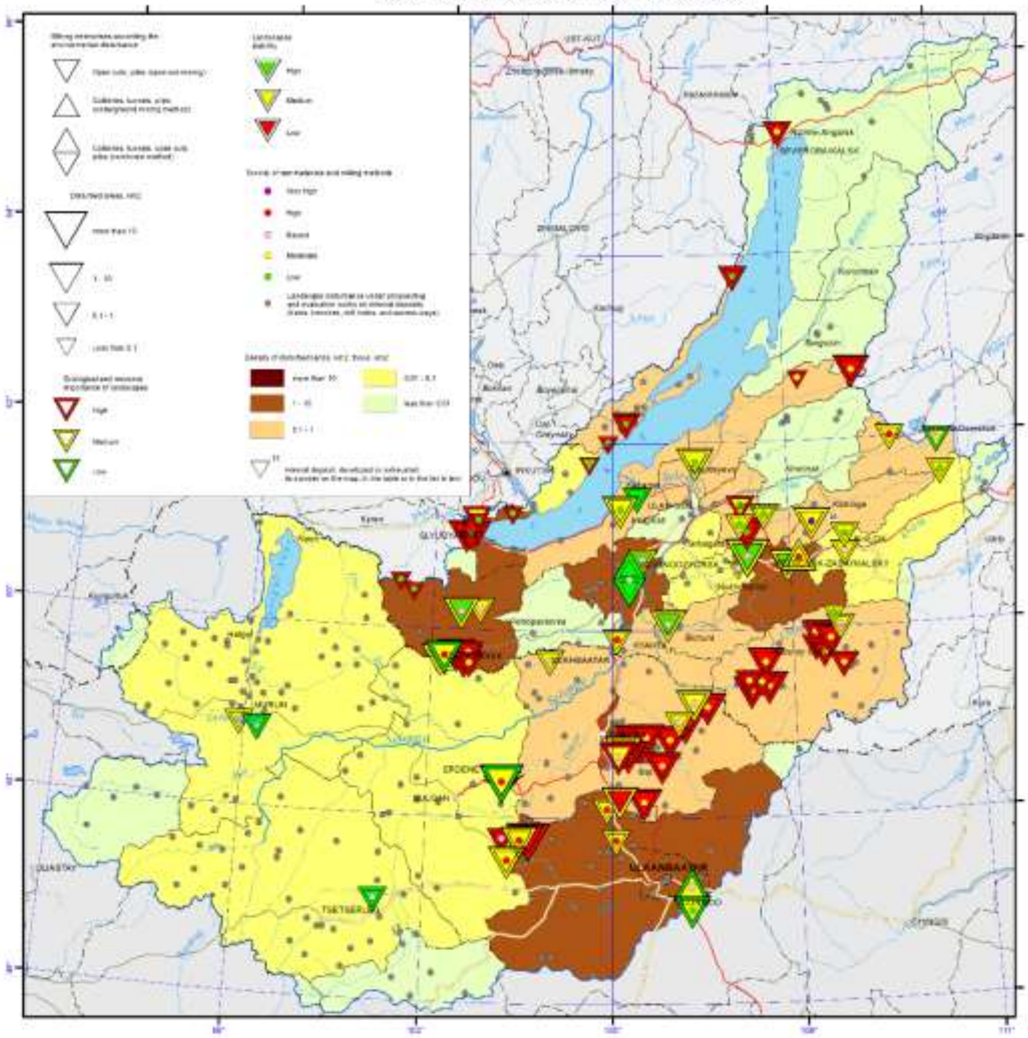
CONVENTIONAL SYMBOLS MINING ENTERPRISES



Soil degradation and contamination

Materials of the Natural Resources Committee of Irkutsk oblast, Buryatia Republican Center and Chita Territorial Administration for Hydrometeorology and Environmental Monitoring, Ministry of Natural Resources of Russia, and Ministry of Nature and Environment of Mongolia were used when assessing the technogenic load on the soil cover, its mechanical degradation and chemical contamination. Authors' soil and monitoring investigations and various published data of the Irkutsk Scientific Center's institutions and other research organizations and universities and colleges of Russia and Mongolia also served as the basis for the map content.

The background basis of the map is the differentiation of the soil cover according to the conditions of its self-purification capacity, controlled by the processes of migration and accumulation of chemical elements. In this regard, the largest territory units are landscape-geochemical areas. They are distinguished based on the boundaries of the major lithologic-geomorphological structures and bioclimatic conditions. These areas of the given territory in general correspond to its physical-and-geographical division (Sochava, Timofeev, 1968), specifying their borders according to the landscape-geochemical situation (Nechaeva, 2001; Nechaeva et al., 2009; Dorzhgotov and Batkhishig, 2008, 2009).

More fractional territory subdivisions are landscape-geochemical provinces, singled out based on a complex of factors of potential contamination of soils and their degradation in the process of different types of nature management. Among these factors is the zonal and altitude-belt specificity of bioclimatic conditions, determined by hydrothermal parameters of the territory. The possibility of involving elements-pollutants of the environment into the biological cycle and the food chain of living organisms depends on them. The rate of development of biochemical processes of pollutants transformation in the soil medium and neutralization of their toxic action also depends on the amount and ratio of heat and moisture. Another equally important factor of self-purification of the soil cover is a water migration of material. Criteria for determining the differentiation of the territory according to the intensity of material migration (IMM) are topography and true altitude (TA) of the area. Weak IMM is peculiar to lowland plain surfaces with TA below 200 m; medium IMM – to low-hill terrain, and high and low plateau with TA from 400 to 600 m; high IMM – to middle altitudes and steep slopes with TA of 600-1000 m; and intensive IMM – to highlands with TA above 1000 m. Mountain-depression landscapes widespread within the given territory are characterized by contrast migration: from intense to weak.

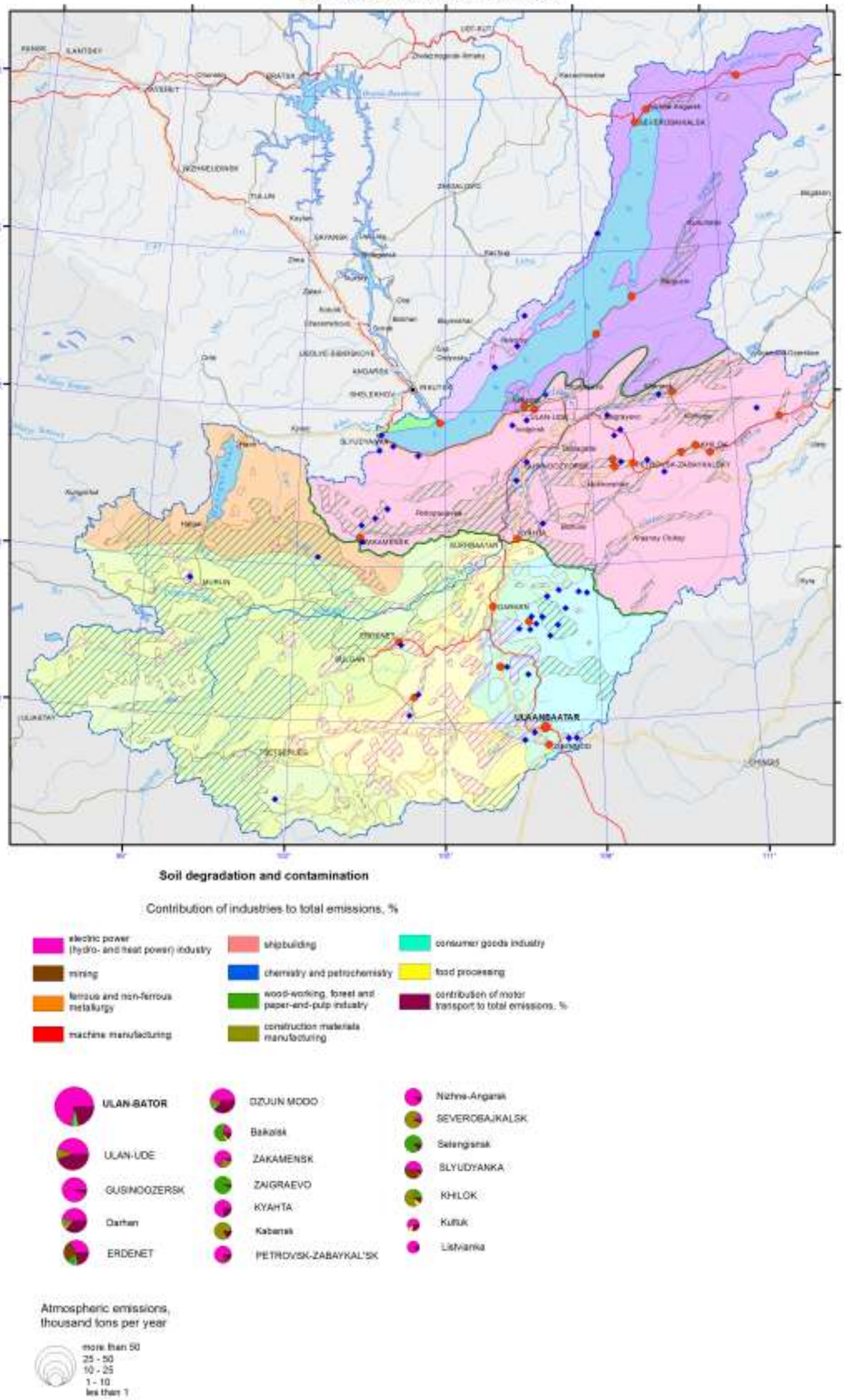
Natural provinces distinguished in the map are characterized by combinations of basic genetic types of soils forming the soil cover. Specificity of factors of soil formation, properties, composition and processes are integrated in the names of soils of these combinations. The Soil map of Irkutsk oblast (2004), the Soil map of Buryatia (2011), the Soil map of Mongolia (2009), maps in regional atlases, and the in-house soil-geographical studies of the territory were used when analyzing the structure of the soil cover. Geochemical classes, denoted by the indices of typomorphic elements, contain the integral characteristics of the soil medium, which is depositing with respect to the pollutants. The classes reflect alkaline-acid and redox conditions of the environment peculiar to different landscapes: the main factors of functioning of the migration-accumulation mechanism in soils and formation of various geochemical barriers, where elements-pollutants may deposit.

Physical-and-geographical characteristics of the natural provinces, their specific combinations of dominating soils and geochemical classes, and the intensity of migration are presented in the legend. Based on these main criteria for evaluating the self-purification capacity of soils taking into account the location of currently functioning sources of industrial emissions into the environment within the territory, an assessment of the hazard level of its technogenic-chemical pollution was made.

Against the background of the degree of the potential hazard of soil contamination estimated according to the natural factors, the main sources of pollution are shown. They are industrial and boiler facilities of the towns of Slyudyanka, Baikalsk, Severobaikalsk, Nizhneangarsk, Listvyanka, Ulan-Ude, Gusinoozersk, Petrovsk-Zabaikalsk, Kyakhta, Ulaanbaatar, Darkhan, Erdenet, Zuunmod, etc. Virtually all industrial complexes are located in the conditions with insufficient self-purification of the environment, and those ones, emissions of which are sent into the Baikal depression, represent a factor of environmental risk for it. The map shows the areas of soil contamination with the exceedance of pollutants MPC, their total emissions, industrial sources, and their contribution to the air pollution. The pollution halos, 1-10 times exceeding the MPC values in the sum of the priority toxic elements (of the I-III class of hazard), are contoured with linear map sign. Emission rates into the atmosphere are presented in a pie chart for the sources with emissions of more than 1 thousand tons per year. The proportion (%) of different industries in the gross emissions is marked in the diagram. Halos with the emission sources of less than 1 thousand tons per year cover a small area, and in the given scale they are marked with conventional signs.

Significant contribution to the mechanical degradation and contamination of the soil cover in the Lake Baikal basin, rich with various mineral resources, is made by their industrial development. Conventional signs mark the lands of mining industry(quarries, terricones, dumps, etc.). The most significant in size and intensive in the degree of disturbance of the soil cover and the geological environment are objects, registered in the Gusinoozersky and Erdenetsogt coal basins.

SOIL DEGRADATION AND CONTAMINATION



Pasture Degradation

Under the conditions of a complex geomorphological structure of the territory, nonuniform particle-size distribution, and often thin profile of soils, degradation processes are dominated by linear and sheet erosion. When mapping its manifestations in the given territory, the experience in presenting the extent and types of erosion (water, wind, and their combinations) on agricultural lands of Irkutsk oblast (Khismatullin, 1991) was used. Based on the intensity of development of water-erosion and deflationary processes and, therefore, on the soil profile of different disturbance, as well as according to the results of evaluating the areal development of all types of erosion processes, three degrees of land degradation are shown on the map in shading: slight, moderate, and severe. They were determined by the share of the main categories of eroded soils as a percentage of the agricultural lands area. Twenty-four percent, up to 42%, 47%, and more than 60% of developed lands are eroded in varying degrees in the Baikal region, in the territory of the Republic of Buryatia, in the Olkhon district, and in some areas of Mongolia, respectively.

As a result of a special analysis and assessment of the pasture condition, three categories of the degree of their degradation are distinguished in the map “Pasture degradation”, namely: low, moderate, and high. In the legend of the map the diagnostic features of pasture degradation are presented. The predominant part of pastures, experiencing moderate anthropogenic impact, is classified as slightly or moderately disturbed.

On the whole the map is the basis for preventing the development of dangerous geo-ecological situations in the region, for organizing environmental activities, and for optimization management of the biogeochemical environment of the population life activity.

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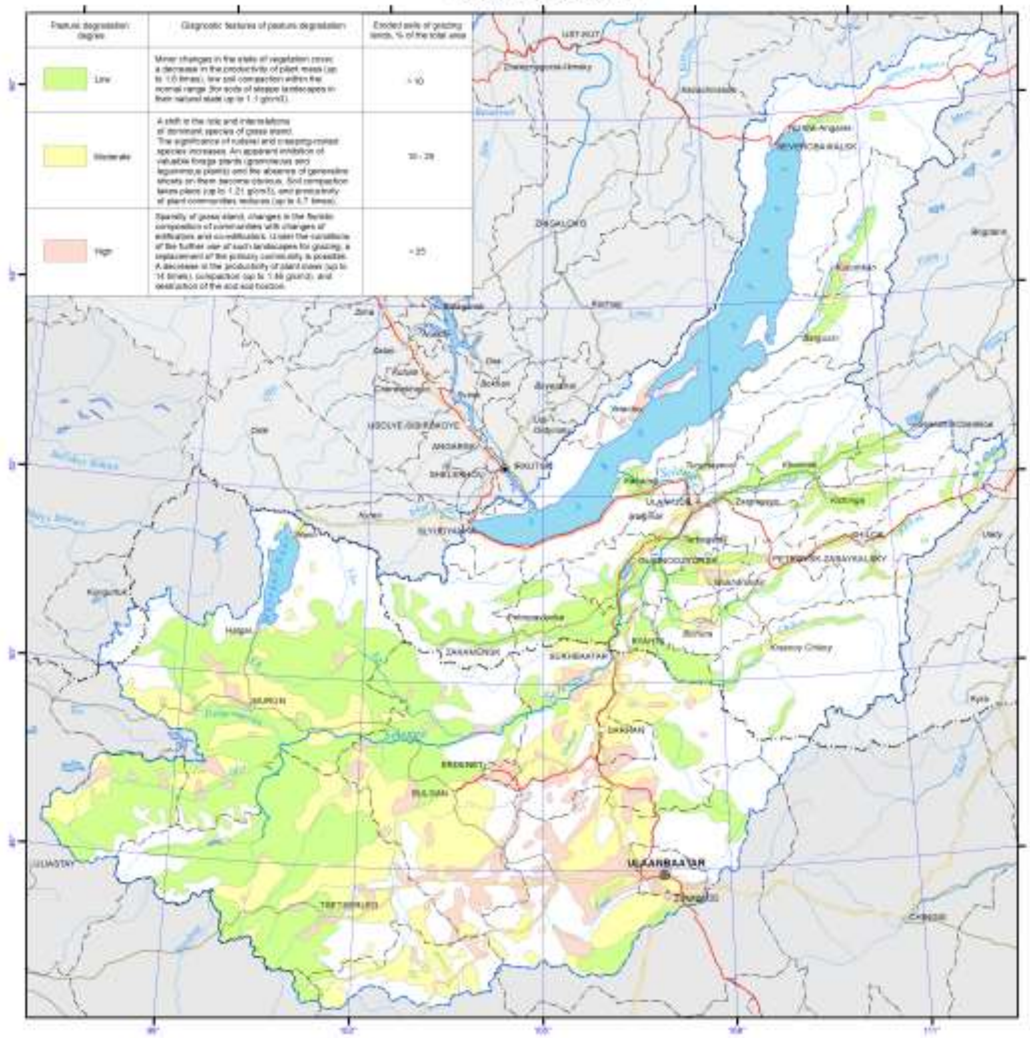
PASTURE DEGRADATION



Vegetation disturbance

Cartographic evaluation of anthropogenic disturbance of vegetation is the most effective method for solving many issues of environment protection and rational use of biotic resources in the basin of Lake Baikal. It was carried out taking into account the major changes in the floristic composition and cenotic structure of vegetation, which is developing mainly under the influence of anthropogenic factors. Degree of anthropogenic disturbance of the vegetation was determined by deviation criteria by the composition and structure of plant communities from their native state.

The evaluation is based on a modern universal map "Vegetation of the Baikal watershed basin" 1:4 000000, which is compiled on the principles of structural-dynamic classification of vegetation, given its main regional-typological features and dynamic processes, caused by human and natural factors. Thus, invariants of plant communities' epistructure were established and thereby the base (zero) estimation level was defined, which was the starting point for the countdown of actual spontaneous and human-induced changes in vegetation cover.

Except the universal geobotanic map in assessing the vegetation disturbances basic cartographic sources were used that provide information about the boundaries of arable land and farmland and forests damaged by technogenesis, recreation and harmful insects, burnt sites and regenerated cutover stands. Forest and land use management materials and surveying satellite images Google 2013 were used.

The Baikal watershed basin vegetation consists of a large variety of plant communities. Mountain tundra, Alpine, boreal (taiga) and steppe vegetation communities are common here, which form complex spatial combinations, depending on the regional-geographical conditions of their habitat. Most areas of the basin are mountainous, so the vegetation is characterized by high-altitude zone. Golets (alpine) vegetation type is represented in alpine tundra, alpine meadows and wastelands. Mountain-taiga vegetation is characterized by the dominance of dark coniferous (spruce, fir, Siberian pine) light coniferous (pine, Siberian and Daurian larch) and small-leaved (birch, aspen) stands. Vast areas of the river valleys are occupied by bushland combined with boggy meadows and marshes. Steppe vegetation is developed both in large areas of the Republic of Buryatia and Transbaikalia and in Mongolia, and is represented by various steppe communities.

Disturbance of vegetation of the Baikal watershed basin is determined primarily by using its industrial and agricultural resource, which is based on forests, grasslands and steppes.

Industrial logging lead to a change of indigenous coniferous stands on small-leaved, less valuable for the economy. Abandoned semi-subsistence raw materials on slashes increase forest fire debris and entomological danger. Light coniferous forests located in the riversides, especially on fertile soils, used for agriculture are often cut.

Besides logging, the forests in the Irkutsk Region, the Republic of Buryatia, Transbaikalia, as well as in Mongolia are annually exposed to forest fire. Fire damages not only the forest but also the community of other vegetation types - mountain tundra, subalpine elfin cedar thickets, yerniks, steppes and others. That leads to the accumulation of large burnt areas, replacing native forests derivatives.

Negative impact on the steppe vegetation is also provided by plowing and irrational use of grazing territory. As for pasture digression of vegetation, it has completely or partially changed the floristic composition and structure of many steppe and meadow communities.

In Mongolia grazing currently remains the main type of agriculture. Here they raise cattle, sheep, camels, goats and horses, as well as Mongolian yaks and deer. Alpine pastures are even mountain-tundra, cryophyte steppe, marshy meadow and steppe. Vegetation communities of middle mountain, foothill, lowland areas and basins are widely used for pasture. Vegetation communities of floodplains and lakeshores with forest, meadow, prairie and wetland vegetation are especially strongly violated [Banzragch et al, 1990].

In general, in Mongolia, as well as in the Irkutsk region, the Republic of Buryatia and the Transbaikalia in the remote and undeveloped alpine areas where there is no human activities, undisturbed (indigenous) vegetation is provisionally preserved. According to the development and availability of space assessment of vegetation disturbance is changing.

As a result of the analysis and assessment of vegetation communities on the map five categories of vegetation disturbance are identified - conditionally radical, weakly, moderately, and strongly disturbed and reformed (see legend).

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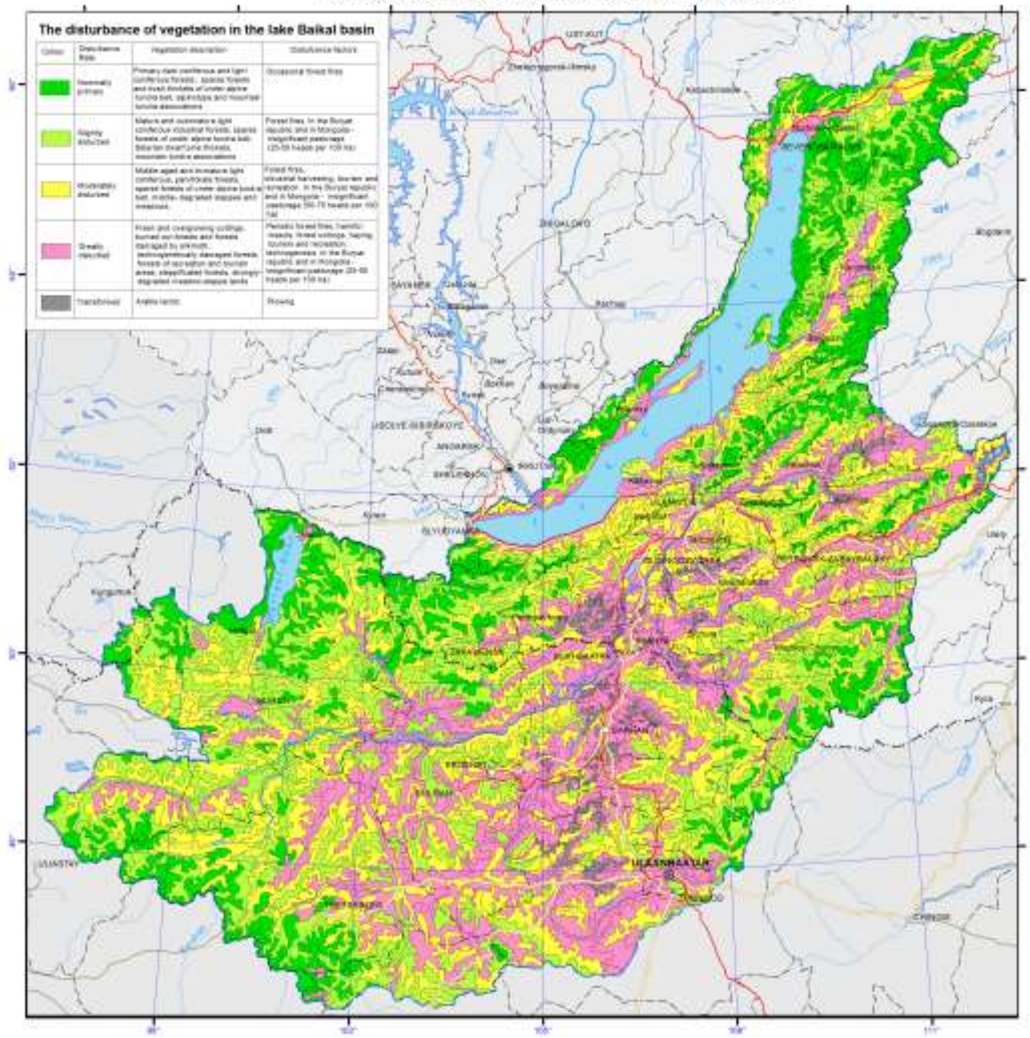
THE DISTURBANCE OF VEGETATION IN THE LAKE BAIKAL BASIN



Disturbance of forest land

Under the disturbed land we understand the value that reflects the attitude of the reforestation fund area to the area of forest lands (on forest land and other land areas where forests are located). Reforestation Fund consolidates the areas of forest land with stands, damaged by fires, insects and logging. Forest land in contrast to non-forest one represents a category with the following main functions: cultivation, conservation, improving the properties of the main forest forming species. The major part of the forest land is forested and the rest is not covered by forest (burnt areas, dead stands, slashes, clearings and wastelands). There they conduct reforestation measures or contribute to the natural reforestation.

On the territory of the Russian part of the Baikal watershed basin the average disturbance of forest land is 6.1% and it is fluctuating from 0.06 % in Krasnochikoisky district of Transbaikalia to 9% in Kizhinga of the Republic of Buryatia. On the Mongolian part of the basin the disturbance of forest land is higher than in Russia - at the average 9.7%. However in aimags it is fluctuating from 0.1 to 19.9 %. In six aimags the disturbance of forest lands is more considerable – up to 10%. Such a situation in Mongolia is possibly caused by more accurate description of forest areas with damaged forest stands.

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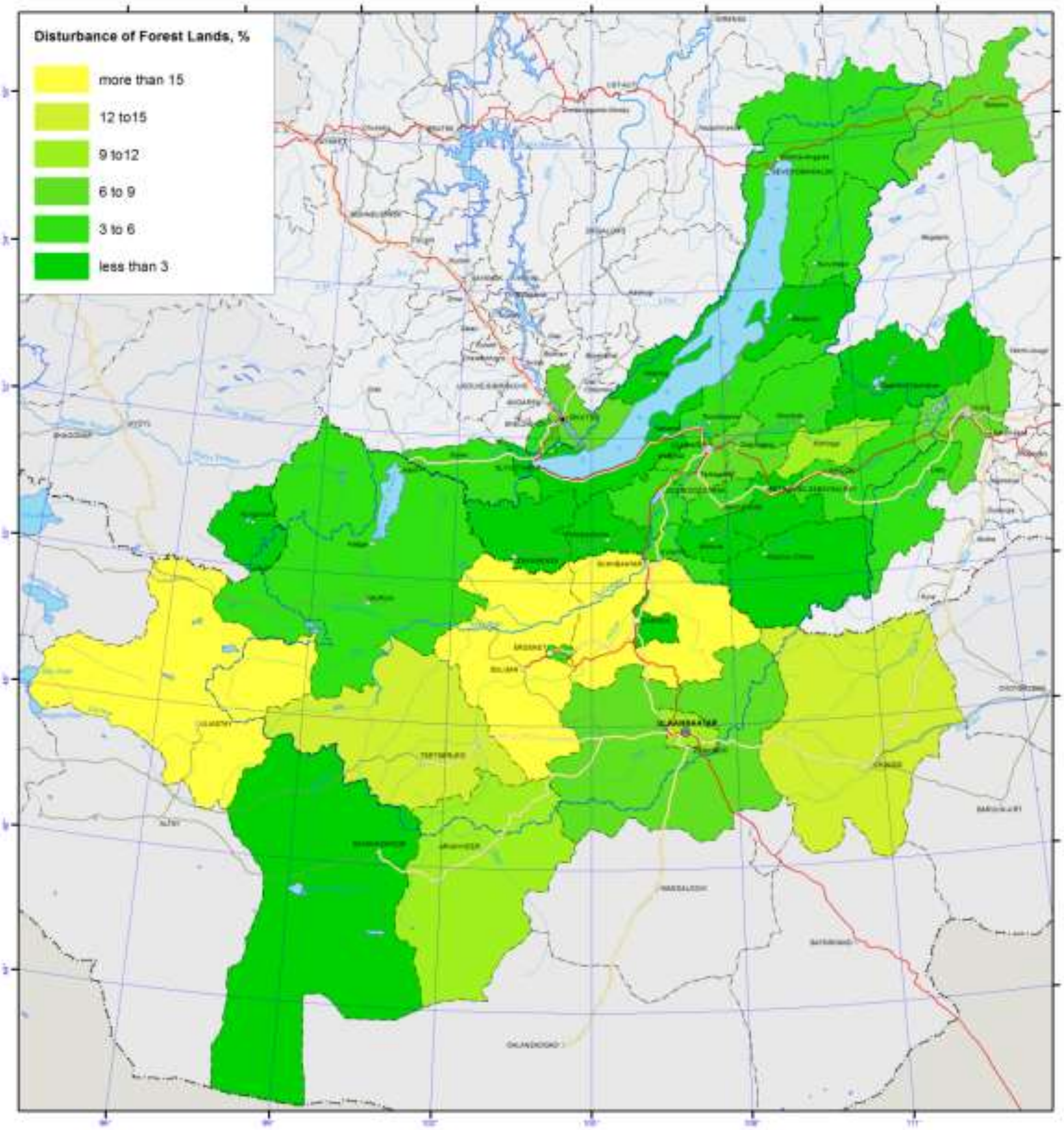
DISTURBANCE OF FOREST LANDS



UNOPS

Disturbance of fauna

The growth of industry and agriculture, increase of population and demand from the second half of the XX century have interfered with the Lake Baikal ecosystems, leaving very few places untouched by people's activities. Anthropogenic impact on the wild animals of the Lake Baikal watershed basin was also very significant. Indigenous animals and intact ecosystems are preserved only on the territories, where human activities are limited by some special factors (reserve status, hard access, harsh natural conditions, etc.)

Disturbance of wild animals is regarded as any change of the existing populations and communities, causing the decrease in size, loss or fragmentation of habitats, variations in species composition, including introduction of new species, and changes in the ecosystems; as a result the indigenous species or communities can no longer exist [Belov and others, 2002] Disturbance of zoocenosis directly correlates with the intensiveness of human activities. As a rule, the mostly disturbed fauna complexes are located in the basins of major rivers, where people have settles long time ago. Species composition in these areas is represented by flexible eurytopic species, synanthropic and invasive animals. It is often the case when species which are not common for the biocenosis of some ecosystems, start to dominate when the ecosystem is disturbed.

Plowing, cattle grazing, forest cuts, fires, construction works, mining, pollutants emission influence the vertebrates fauna directly or indirectly, causing changes of ecosystems, reduction of the size of animal populations, fragmentation or full transformation of communities. Agriculture is the major factor that determines fauna of the most part of the basin. Overgrazing along with plowing deteriorate habitats, transform structure and species composition of vertebrates, destroy nests of ground-nestling birds. Fauna complexes of the steppe zone suffer most from the abovementioned two factors. In highly degraded steppes, vertebrates are extinct almost totally. Forest felling, steppe and forest fires largely affect the habitats of vertebrate animals, its species composition, structure, and abundance of certain species. A complex multilayered ecosystem is replaced by open spaces with altered protective, feeding and microclimatic conditions that brings about significant changes of vertebrates. Post-fire changes in ecosystems are so drastic that restoration of certain species of vertebrates does not happen for decades.

Invasive alien species are justly regarded as one of the two most hazardous threats to biodiversity, coming second only to the devastation of habitats. In the XX century, intentional and unintentional introduction of various animals as a result of the intense economic activities has become a global problem of biotic exchange between the biogeographical regions [Tishkov and others, 1995], the significance of which has not been fully recognized yet. In the Lake Baikal watershed basin, the zones where fauna suffers from introduction of alien species are localized in the areas of long-term anthropogenic activities; however, there is a clear trend towards areal expansion of the adventive species of fauna. Introduction of alien species has an adverse impact on biodiversity, structure and functioning of ecosystems. Synanthropes invaded settlements, warehouses, industrial buildings, causing economic loss.

Diversity of fauna and the abundance of animals made hunting very attractive in the Baikal watershed basin. As a result of long-term and intensive harvesting of birds and animals their populations were put at risk of extinction; many of these species were included into the Regional Red Data Books. At present, hunting is not so popular, which has an ambiguous effect on the animal populations. Some species (Far eastern red deer, wolf, squirrel, muskrat, Siberian striped weasel, and ermine) grow in number due to the reduced harvesting pressure and the extension of the areas disturbed by anthropogenic factor (deforested and post-fire lands). Population of other species (roe deer, Siberian musk deer, and sable) are shrinking in size due to poaching. Hoofed mammals in Mongolia are on the margin of their habitats; therefore, their populations are rather small and require special protection and size regulation. Populations of other species are stable in size over the years, and the fluctuations are determined by natural dynamics.

Pollution and drainage of water bodies, changes in their hydrological regime due to damming, increase of water intake, disposal of wastewater by dilution, and unlimited harvesting had a negative effect on the populations of many fish species, especially of the valuable commercial species. The rise of the Baikal water level by 1 meter after the construction of the Irkutsk power plant reduces spawning areas of some fish species, changed nutritive base and feeding places that caused weight loss of some fish species. [Monitoring …, 1991; Hydropower …, 1999] Some nestling grounds of semi-aquatic birds at the river estuaries were flooded. There is evidence that some species of fish and freshwater seal (nerpa) accumulate heavy metals, radioactive isotopes, and chlororganic compounds [Grachev, 2002].

“Disturbance of Fauna” Map gives an idea about the present state of the communities of the vertebrate animals in the Lake Baikal watershed basin. The map was created with the use of methodological guidelines for making evaluation maps developed by the scientists of the V.B. Sochava Institute of Geography SB RAS [Belov and others, 2002]. The key information about the changes of the regional fauna complexes was obtained from the cartographic materials, Landsat space images, statistics of forest fires, forest cuts, and industrial pollution, and from other published materials [The Zabaikalye Atlas, 1967; Mongolian People’s Republic…, 1990; Ecosystems of Mongolia, 2005]. The map was developed on the basis of the vegetation maps and flora disturbance maps, published in the abovementioned atlas. The map’s explanatory note distinguishes three stages of disturbance of the indigenous ecological fauna complexes and ihtiofauna. Additionally, we supply the information about the extinct and near-extinct vertebrate animals, and about the primary causes of the fauna complexes disturbance and degradation. This map can serve as a resource for developing recommendations on protection and rational use of the Lake Baikal watershed basin wild life.

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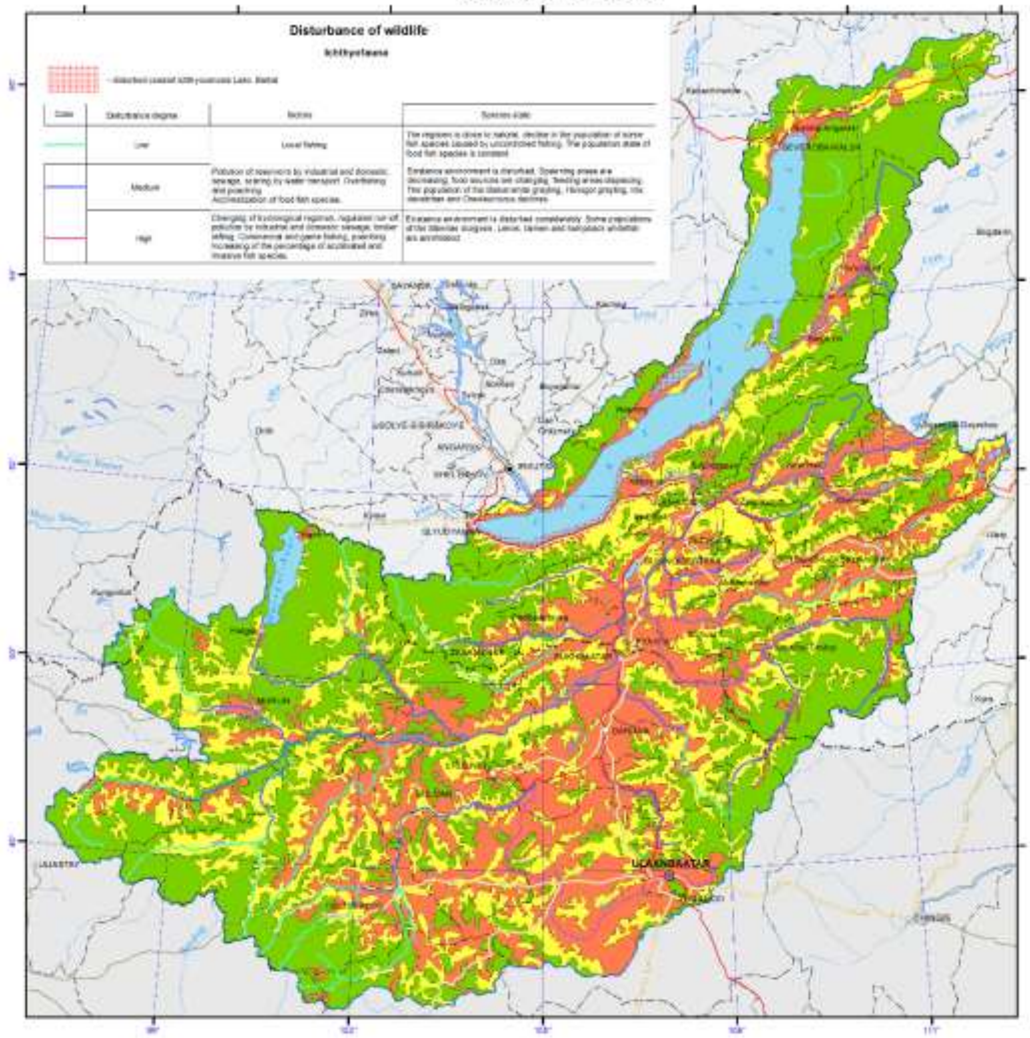
DISTURBANCE OF WILDLIFE



Terrestrial vertebrate animals

Color	Disturbance degree	Factors	Species State	Game species state
Green	Low, less than 30 % of the area	Forest and steppe fires of small areas. Commercial and game hunting and fishing, poaching. Slight cattle grazing (25-50 livestock units per 100 ha) in Buryatia and Mongolia. Active tourism.	Decline in the population of the Siberian salamander in Mongolia, the European adder in Buryatia. It is recording decrease number and extinction of some population of the Ibex, Snow leopard, Argali and Siberian Ibex remaining everywhere. Decline in the population of the Bean Goose, Swan Goose, Gyrfalcon, Peregrine Falcon, Hooded Crane and White-naped Crane (in Zabaikalskii Krai) during migration and in the places of nesting.	The state of the most species is stable. Decline in the population is possible on some plots of hunting areas.
Orange	Medium, up to 60 % of the area	Forest and steppe fires covering large areas. Deafforestation, entomological pest damage. Ploughing up of lands, hay-mowing, intense cattle grazing (50-70 livestock units per 100 ha) in Buryatia and Mongolia. Ecosystem pollution by industrial and domestic waste. Commercial and game hunting and fishing. Overhunting, overfishing and poaching, distribution of acclimated and invasive species. Local recreation and recreation on small area.	There are tendencies to the decline in the population and cutting down habitats of the Mongolian toad in Predbaikalia, Mongolia Racerunner and sand lizard in Buryatia, rat snakes and glass snake everywhere. Special methods are required for protection of the Olkhon Mountain Vole in Irkutskaya Oblast, the Eurasian Otter and reindeer in Buryatia, the Mongolian Marmot and Eurasian Otter in Zabaikalskii Krai, the Mongolian Marmot, Moose, Siberian Musk Deer, Red Deer and Przewalski's Horse in Mongolia. The population decreases or somewhere completely becomes extinct in the places of nesting or during migration for the such species as the Black Stork, Lesser White-fronted Goose, Bewick's Swan, Baikal Teal, Booted Eagle, Steppe Eagle, Golden Eagle, Bearded Vulture, Saker Falcon, Altai Snowcock, Common Crane, Demoiselle Crane, Black-winged Stilt, Pied Avocet, Asian Dowitcher, Eurasian Eagle-Owl, European Scops Owl, Isabelline Shrike and Yellow-breasted Bunting.	The hunting-commercial species diversity is relatively retained. The population of furry animals (the sable, mountain weasel, stoat), big predators (the bear, wolverine, Eurasian lynx), ungulates (the moose, reindeer, red deer, Siberian musk deer) decreases or completely disappears in some places. Squirrels, hares, marmots, badgers, foxes, wolfs, [illegible] (in Buryatia) and roe deer specialize to living on changed biocoenosis. The number of some of them can exceed the population in not disturbed areas. The hunting bird species diversity declines during migration and in the places of nesting. The population of the hazel grouse, partridge and some duck species can reach high quantity in disturbed biocoenosis.
Yellow	High, up to 80 % of the area	Often repeated forest (1-2 times per 3-5 years) and steppe (1-3 times per season) fires. Entomological pest damage on large areas (silkworm). Forming of agrocoenosis with synanthropic fauna, machine hay-mowing, overgrazing (more than 75 livestock units per 100 ha). Overhunting and overfishing. Technogenical ecosystem pollution. Accumulation of hazardous substances in animal organisms. Organization of recreational zones. Domination of synanthropic fauna in settlements, storage facilities, farms etc.	The populations of the Dalmatian Pelican, Eastern Imperial Eagle, Greater Spotted Eagle, White-tailed Eagle, Pallas's Fish Eagle and Great Bustard are in critical state.	The sable, stoat, bear, wolverine, Eurasian lynx, Moose and Siberian Musk Deer almost disappeared with possible coming in some years or during migration. Places of nesting for most of the duck, goose, sandpiper, grouse and pheasant species are destroyed or divided into small plots.

MEDICO-ECOLOGICAL SITUATION IN THE LAKE BAIKAL BASIN

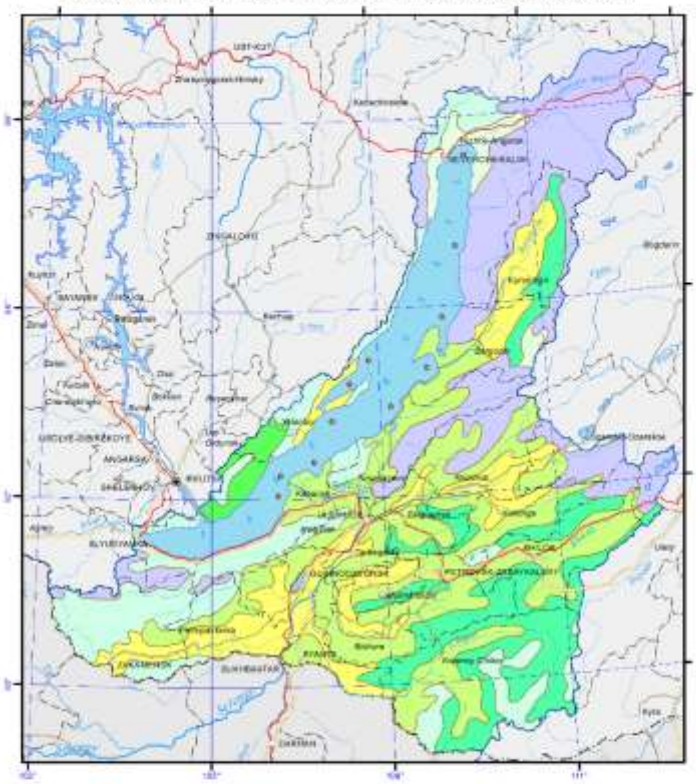
Ecological preconditions for the spread of zooanthroponoses

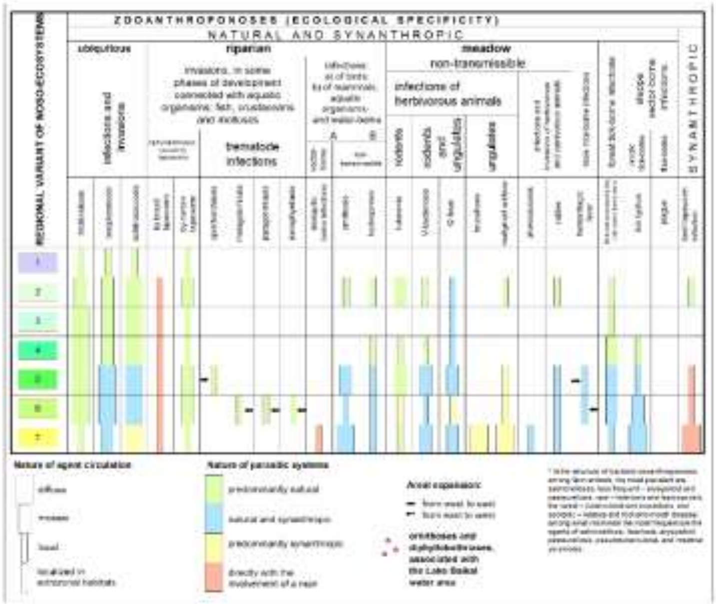
The synthetic map "Ecological preconditions for the spread of zooanthroponoses" is intended primarily for institutions concerned with the issues of nature conservation, environmental management, and human safety ensuring (in a broad sense of the term), and for organizers of the territory development. When compiling the map, an ecological classification of zooanthroponoses was developed according to their relations with natural complexes and groups of animals, subdividing them into ubiquitous (widely, almost universally spread), riparian, meadow, forest, and steppe ones. Each of these groups unites ecologically close species of pathogens with similar need for heat and moisture, and circulating in the same-type biocenoses.

The map depicts the distribution within the territory of spatial units of the nosoecological division of different taxonomic ranks, namely: nosoecological belts, zones, and regional variants of zonal nosoecosystems. Above mentioned ecological groups of pathogens dominate in corresponding nosoecosystems of the high rank (zonal). In this case, representatives of other ecological groups are usually widespread in local habitats. The map gives a key to the formation of the strategy in the prevention of zooanthroponoses in the environmental management system, as there is reason to believe that different ecological groups of pathogens perform different roles in maintaining the stability of biocenoses and preserving the natural environment. Representatives of the riparian and meadow groups regulate the quantitative composition of the vertebrate animals' population (mostly rodents), stopping their mass reproduction and thus preventing the destruction of vegetation. Pathogens of the forest group (in particular, it concerns the tick-borne encephalitis virus) apparently are able to regulate the qualitative composition of a biocenosis, protecting it from the aliens, i.e. the inhabitants of other (neighboring) terrain types (meadow, steppe), the number of which is liable to large fluctuations. Pathogens of the group of ubiquitous zooanthroponoses can probably perform various functions, regulating qualitative and quantitative characteristics, but in a group of parasites associated with vertebrates in a given biocenosis, thereby ensuring survival and well-being to their hosts.

It is these functional differences that can become the basis for the development of a system of differentiated (according to landscape types) prevention of zooanthroponoses taking into account the issue of nature and human health preservation. The current level of research gives grounds to consider the regulation of the epizootic process being reasonable in those parasitic systems (riparian and meadow), where the function of pathogens is the reduction of the hosts number. The prevention of most zooanthroponoses (included in the riparian and meadow groups) should be carried out to optimize the density of the animal population through sustainable use of meadow vegetation by human and timely harvesting of crops. The consequences of the human intervention in the process of circulation of pathogens, regulating qualitative parameters of the structure of biocenoses, are less obvious. The intensity of pathogens circulation of almost all zooanthroponoses (infections and invasions) increases in habitable and populated areas, which is due both to the introduction of farm animals, the increased concentration of which favors the development of infections, and to the human impact on the natural environment, accompanied by an increase in the number of rodents, a change in the chemistry of soils, creation of artificial ponds, etc.

ECOLOGICAL PRECONDITIONS FOR THE SPREAD OF ZOOANTHROPONOSES





Healthcare

The inclement climatic conditions throughout the entire territory of the Baikal watershed basin, the surface and subsurface waters used for drinking and food purposes but not meeting the drinking water quality standards (first and foremost Mongolia and Buryatia), coupled with atmospheric emissions from industrial facilities and motor transport vehicles (in some part of the territory), are responsible for the state of human health, influencing the organization of healthcare. The ecological situation becomes substantially worse at the winter period, which is encouraged by topography of the terrain. In Mongolia, the spring period is very hard time to bear: temperature differences, abrupt variations in atmospheric pressure, and frequent dist and magnetic storms.

The organization pattern of healthcare in Russia and Mongolia has much in common. This derives from cooperation of the two countries in this sphere as well as from the fact that medical education and medical care in Mongolia are organized having regard to experience of Russia. Nowadays, the medical facilities operate on the principles of state-private partnership concurrent with demonopolization of the state system of rendering medical services to the population. The country maintains obligatory and voluntary medical insurance with the involvement of state-owned and private medical institutions. Various health institutes and centers are in operation, including traditional medicine centers.

Currently a three-level health care system is developing. It is based on the principles of territoriality and preventive orientation that makes it possible to compensate the unequal development of a network of medical institutions and to carry out stage treatment, to provide every citizen with access to world-class health services, regardless of his residence. It implies the transition from the principle of regionalization of medical services to the zonal principle. Its development was facilitated by the introduction of electronic technology and telemedicine.

In Russia, the first level includes hospitals, providing a wide range of medical services from pre-hospital to specialized medical care. The second includes the hospitals having specialized intermunicipal offices or centers (vascular, traumatology and other). The third one includes the hospitals of regional level, which are capable to provide high-tech medical aid. In Mongolia, the first level of medical care are includes physician assistant service, somon medical centers performing functions of health clinics with a small bed capacity, family physicians, somon hospitals (reorganized currently in health centers) and intersomon hospitals. The second level consists of district and aimak hospitals, the third one - the national centers, including general hospitals and specialized centers located in Ulaanbaatar, as well as national (regional) diagnostic and treatment centers outside the capital, acting on the basis of aimak general hospitals.

In rural areas there is a shortage of first aid. In Mongolia, physician assistant’s stations are created in bugs (brigades). In Russia, medical and obstetric stations operate in settlements numbering several hundred people. They are created taking into account the remote of the nearest medical facility. The problem is solved by laying first aid functions on farm units (whose owners are trained), by an increasing number of general medical practice (family physicians) , as well as the expansion of outreach activities.

To date the territory of the Baikal watershed basin is experiencing a scarcity of medical workers. As of 2012, the availability of physicians per 10 000 people varied from 13.8 to 30.1 and from 16.1 to 29.0, respectively, of nurses - from 25.1 to 112.2 and from 47.6 to 66.2. Ratio of doctors and nurses in Mongolia does not exceed 1:2. The World Health Organization (WHO) recommends that this ratio be 1:4. A narrowing of this indicator brings about an imbalance in the medical care system thereby limiting the possibilities for a further development of the after treatment, casework and rehabilitation services.

Considerable measures are undertaken along different directions in order to cope with the personnel issues. However, the positive changes in the personnel structure are only of a minor nature to date.

The target indicators of healthcare activity are represented by the standard rates of medical assistance per inhabitant. It is being planned to decrease the per capita rate of in-patient assistance and to increase the per capita rate of hospital-replacing aid; accordingly, there will be an increase in the number of twenty-four-hour medical beds and an increase in the number of beds in day hospitals. On the whole, the available beds comply with the calculated standards and meet the requirements of the population for in-patient medical aid.

The incidence of many infectious diseases, particularly driven by means of specific prevention, is reducing by prophylactic, hygienic and anti-epidemic measures, as well as by improvement the socio-economic situation. Smallpox is eliminated, stable epidemiological situation on plague is provided. At the same time, there are problem situations related to viral hepatitis and HIV infection.

As of now, there is an array of problems relating to the high level of sickness and invalidization rates of the population which are growing steadily. This is due to the inadequate measures for prevention of diseases; however, an important contributor in this respect is an increase in the proportion of the elderly population as well as an improvement in the efficiency of revealing diseases through the use of new diagnosing methods concurrent with an increase in the magnitude of prophylactic clinical examination.

Diseases of the respiration and blood circulation organs, the eyes, the digestive system, the musculoskeletal system, traumas, poisoning, certain other consequences of external causes. Diseases of the circulatory system, neoplasms, and injuries over the years are the main causes of death and disability in the population.

Comparison of the incidence of the population of Mongolia and Russia currently has significant challenges, as the statistical authorities of these countries use different figures. In Russia, when characterizing the public health general indicators (pain, prevalence) and the incidence of the primary population (newly diagnosed cases) are used, and in Mongolia they use the total outpatiently system (number of diseases identified in this year with an increment in outpatient clinics to the average annual number of the population). General admission rate contains in medical statistical yearbooks of Mongolia (number of diseases identified in a given year when applying to the hospital facilities to the average annual population).

Although there are difficulties in comparing the Russian and Mongolian morbidity, joint demonstration of overall morbidity on the map (Russia) and outpatient morbidity (Mongolia) in comparison with other maps make it possible to identify common trends impact on the incidence of the population of various factors.

A complex of anthropogenic environmental factors has a particular impact on the increasing incidence of populations. According to public health monitoring by Federal Supervision Agency for Customer Protection and Human Welfare, working in the Baikal region, the incidence of the population correlates with air pollution in the localities with maximum atmospheric emission.

Health of communities and, accordingly, a further development of care of public health depend on the ecological, social and economic factors. The respective problems can only be resolved by using integral approaches to improving the quality of life of the population.

The strategic goal of healthcare in Russia and Mongolia is build such a system that would ensure the quality and accessibility of medical assistance (primarily first aid), increase the efficiency of medical services, the volumes, kinds and quality of which ought to correspond to the level of sickness rate and the requirements of the population, and to the latest achievements of medical science, based on perfecting the system of territorial planning of public health services.

UNDP-GEF project
"Integrated Natural Resource Management in the Baikal Basin Transboundary Ecosystem"

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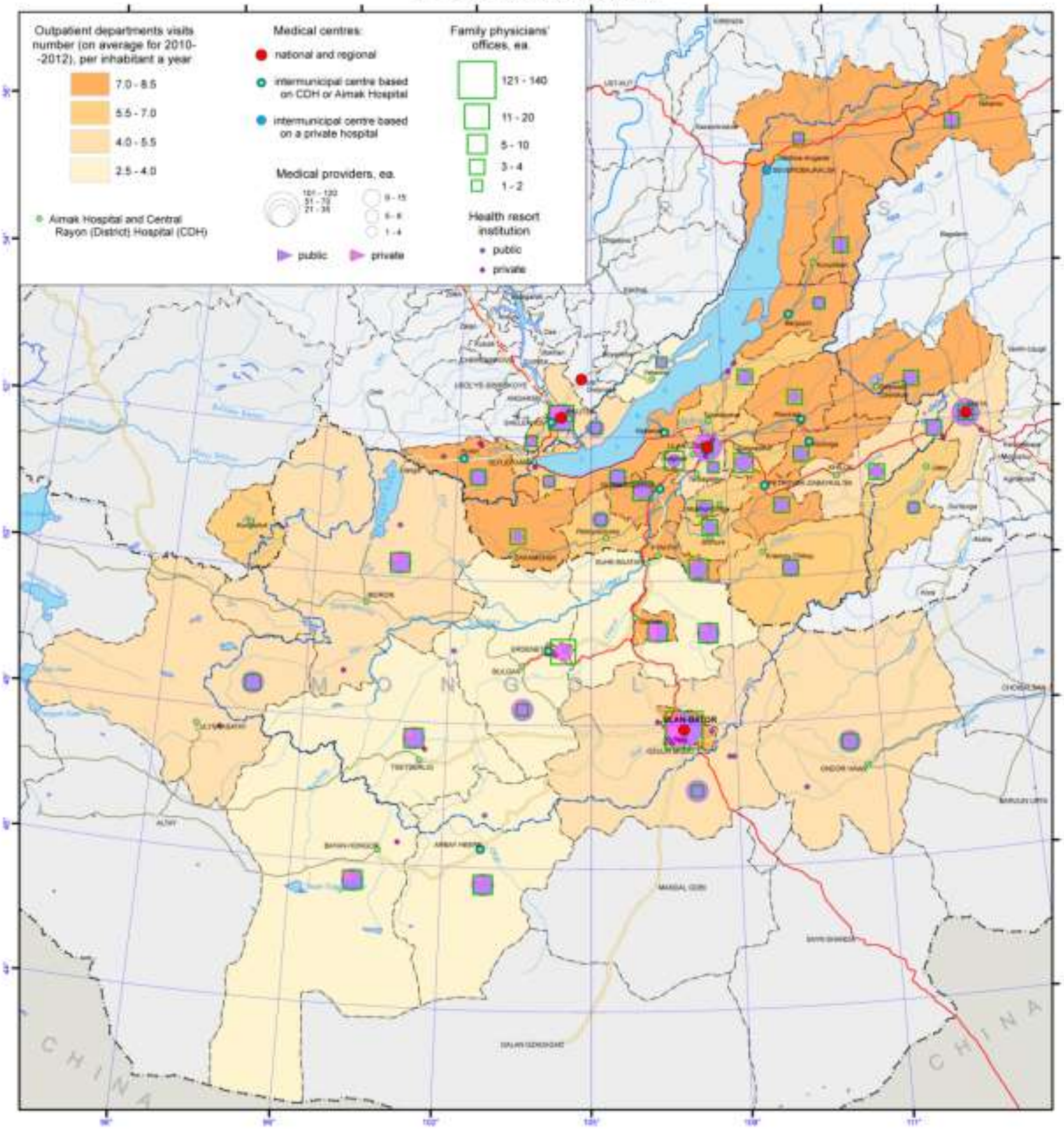
FREE MEDICAL CARE SYSTEM



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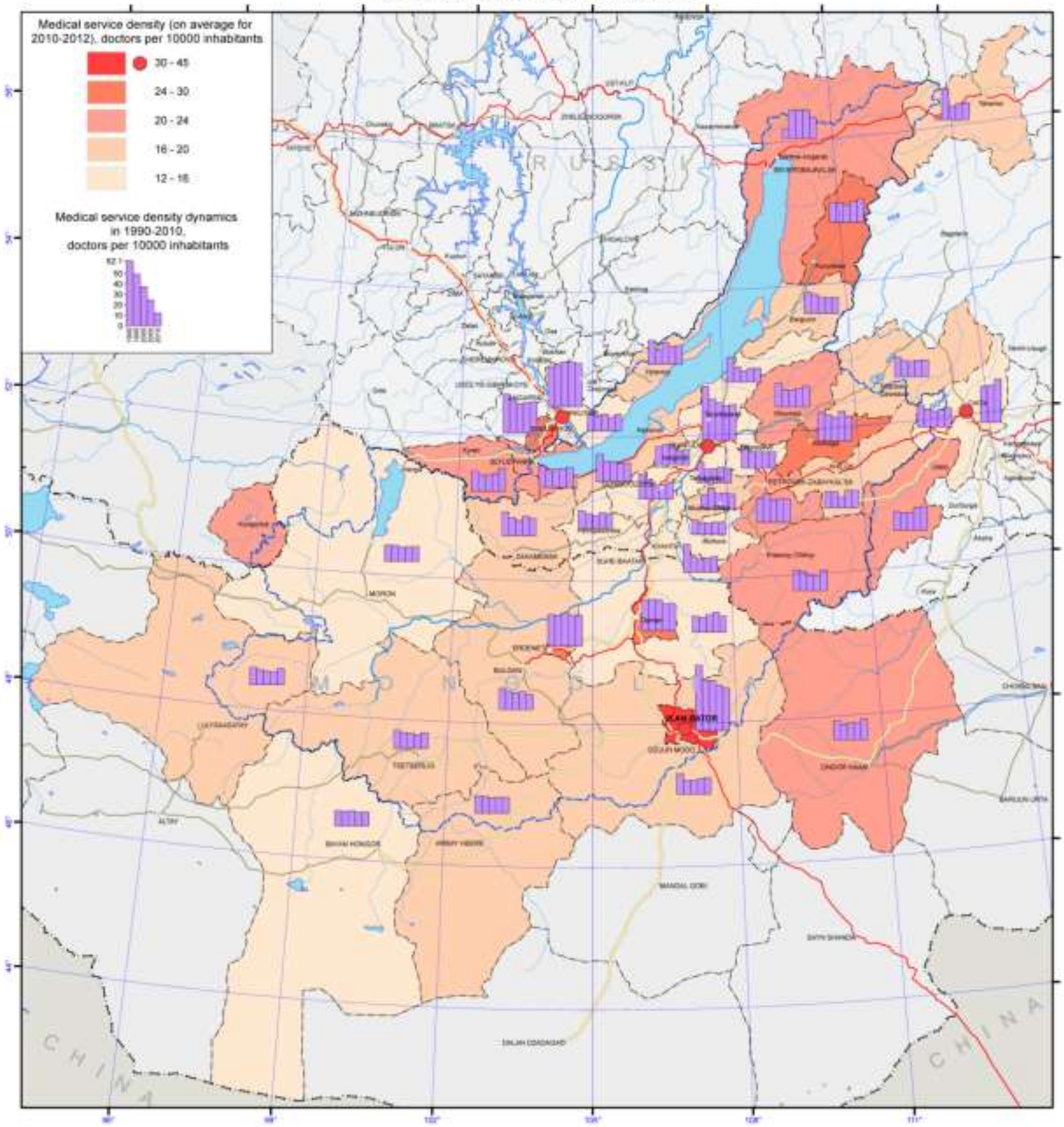
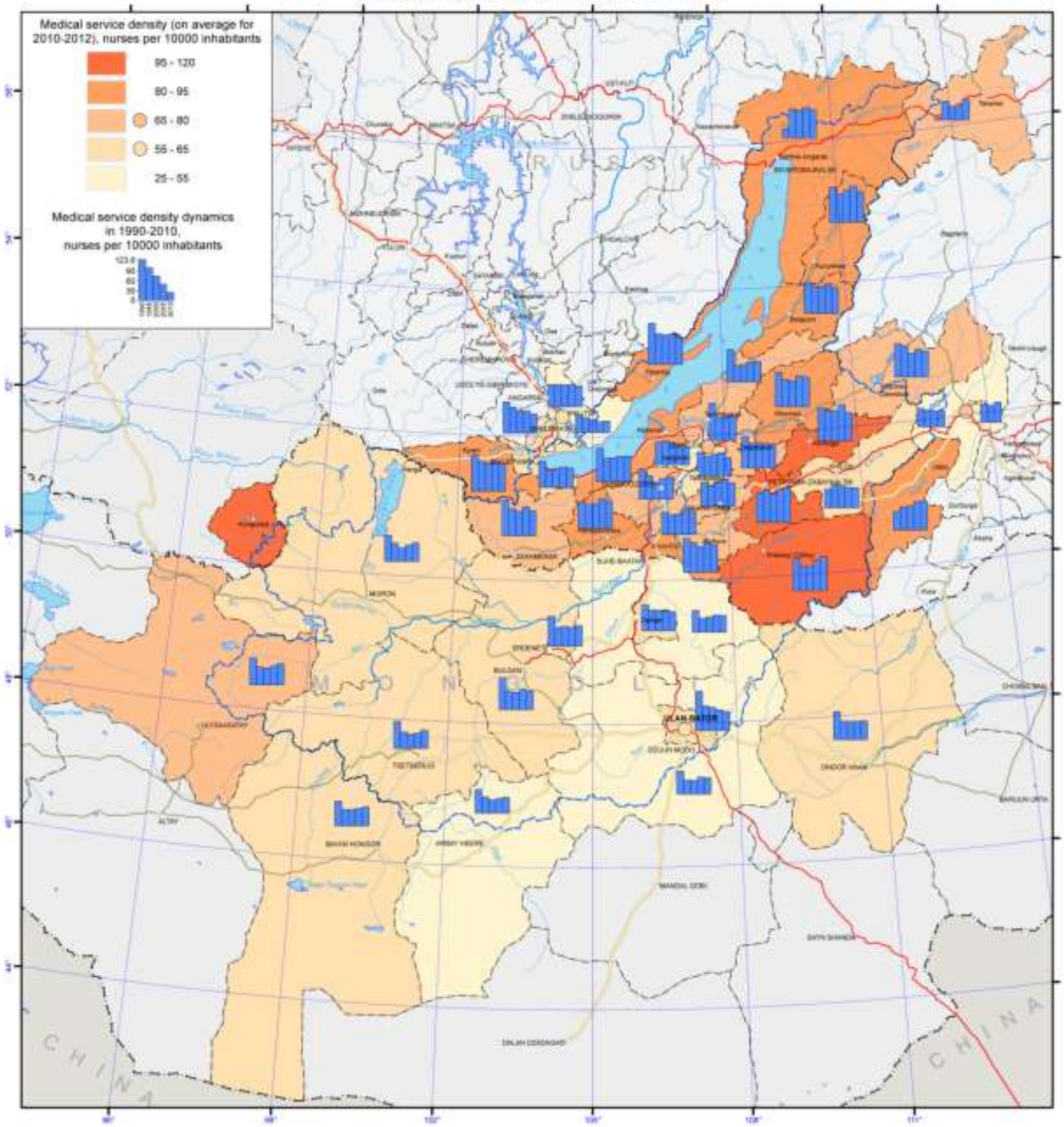
MEDICAL SERVICE DENSITY - DOCTORS



UNOPS

MEDICAL SERVICE DENSITY – NURSING STAFF



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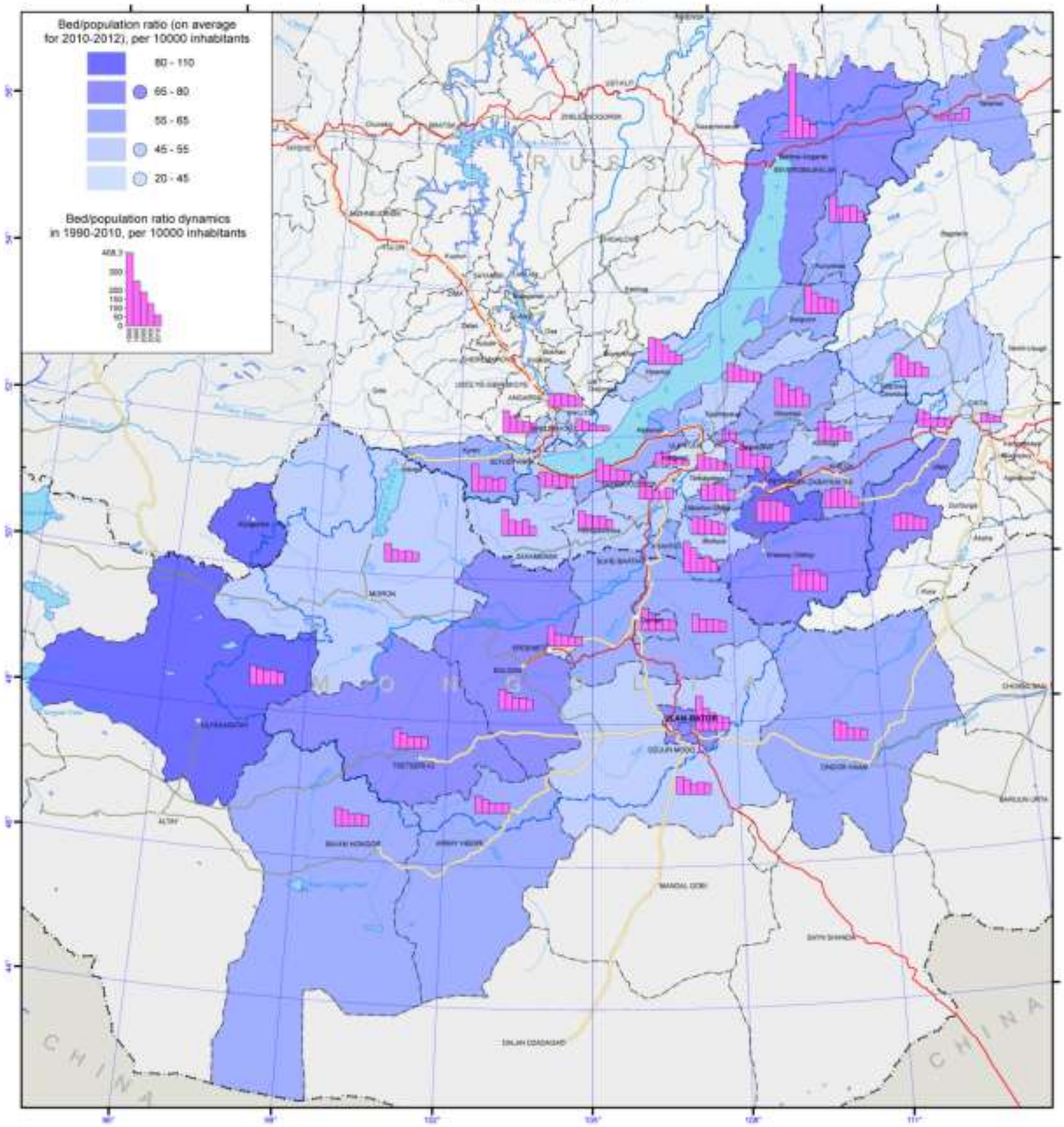
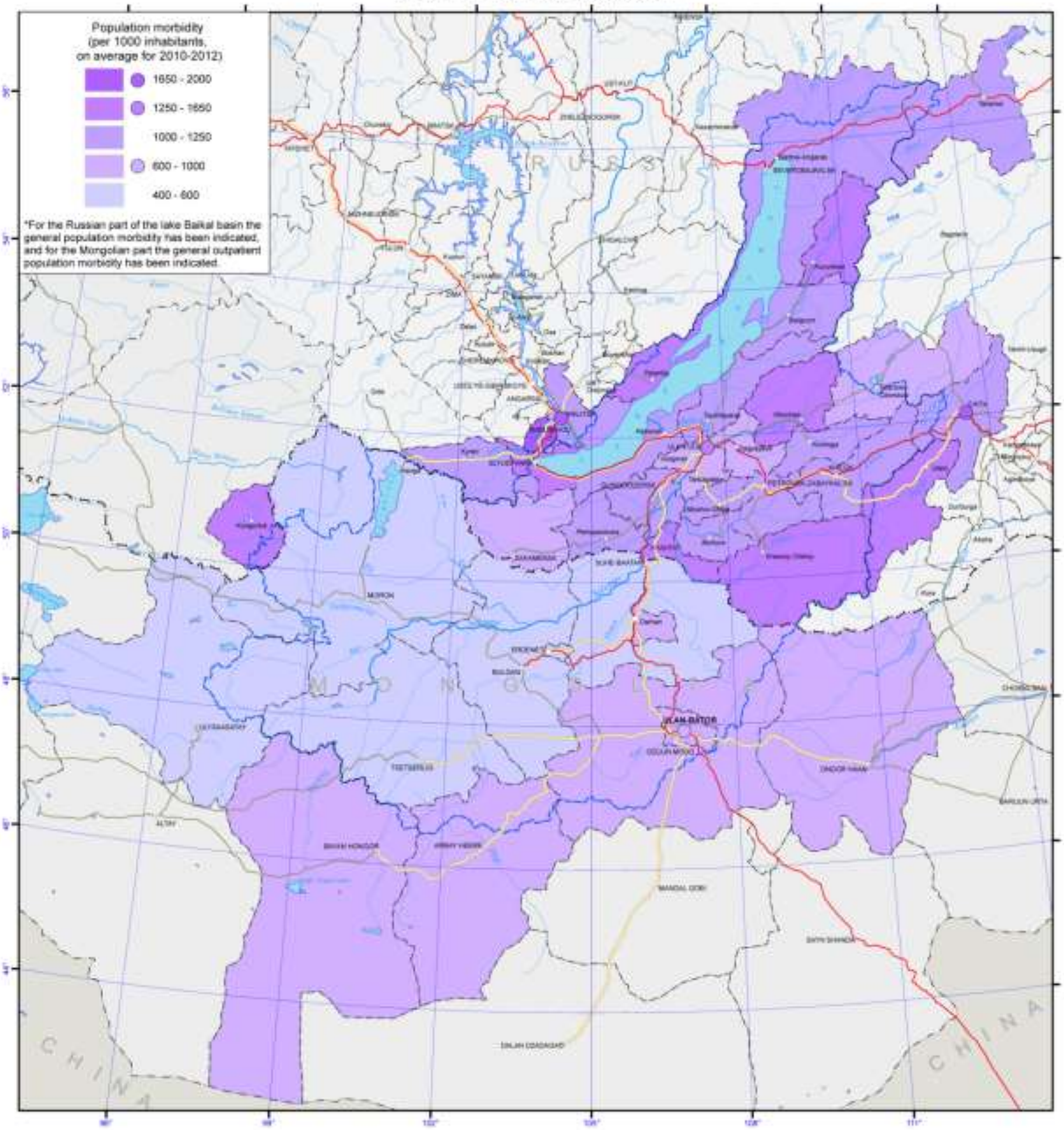
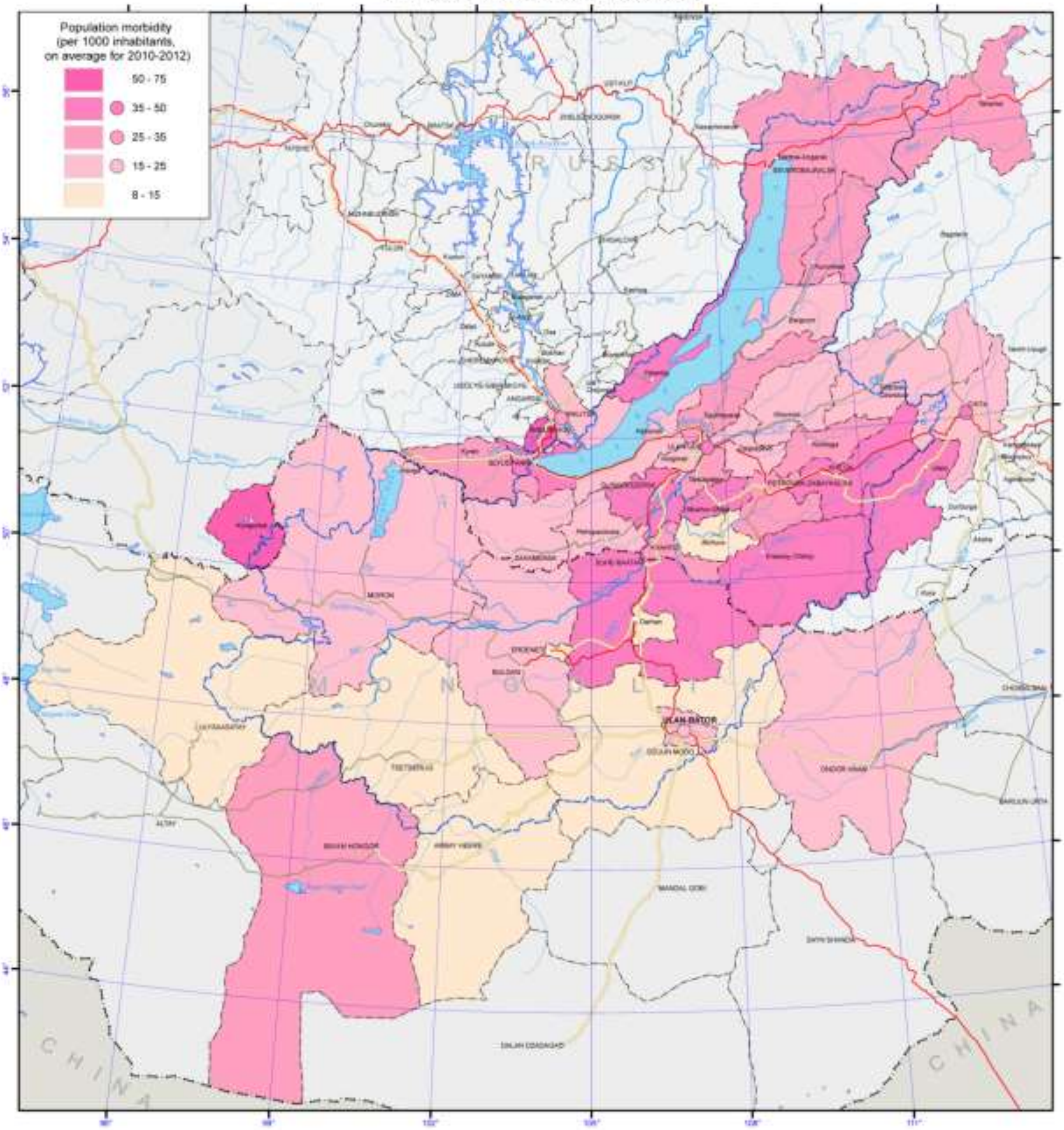
HOSPITAL BED CAPACITY



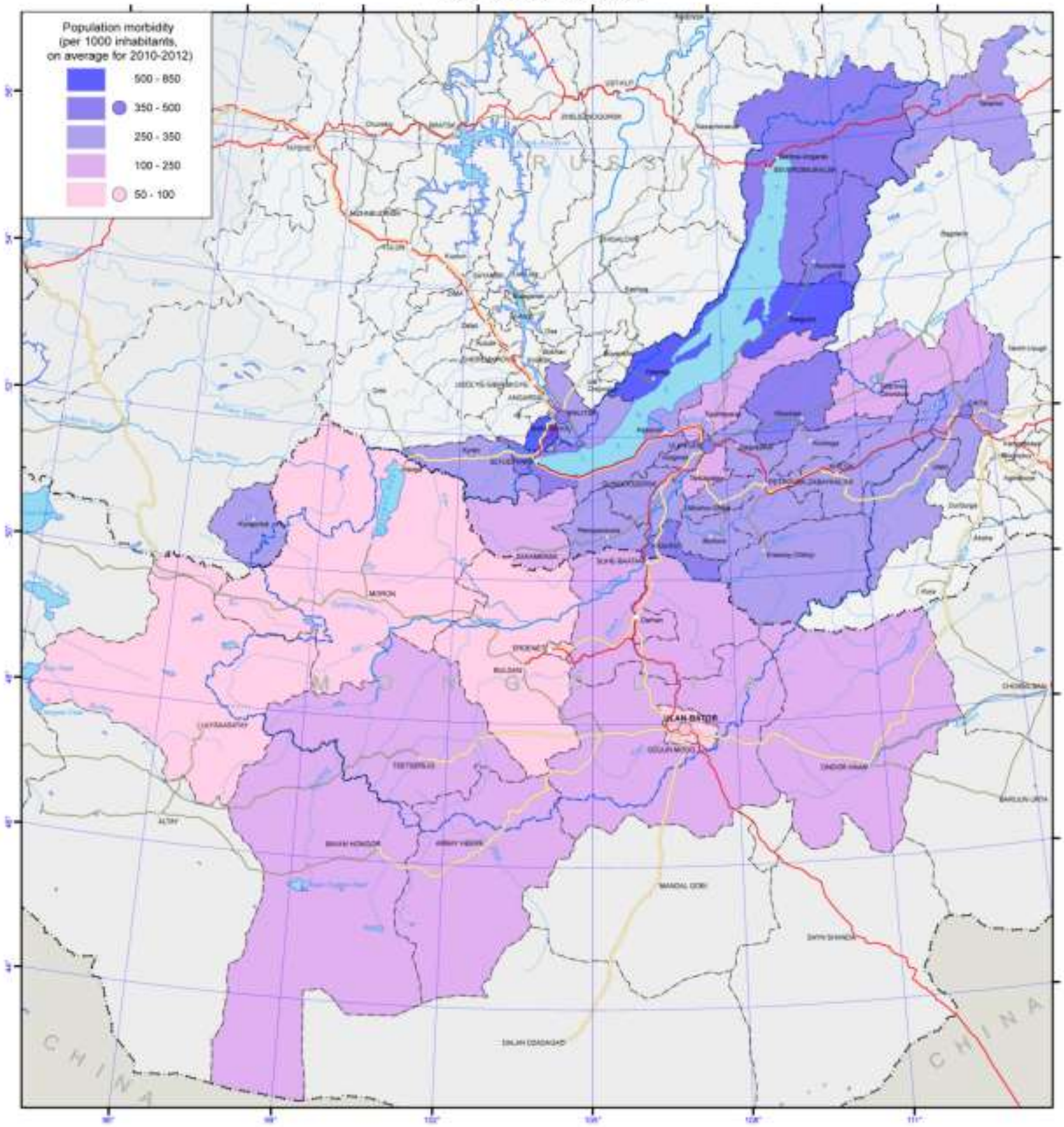
GENERAL POPULATION MORBIDITY



INFECTIOUS AND PARASITIC DISEASES



RESPIRATORY DISEASES



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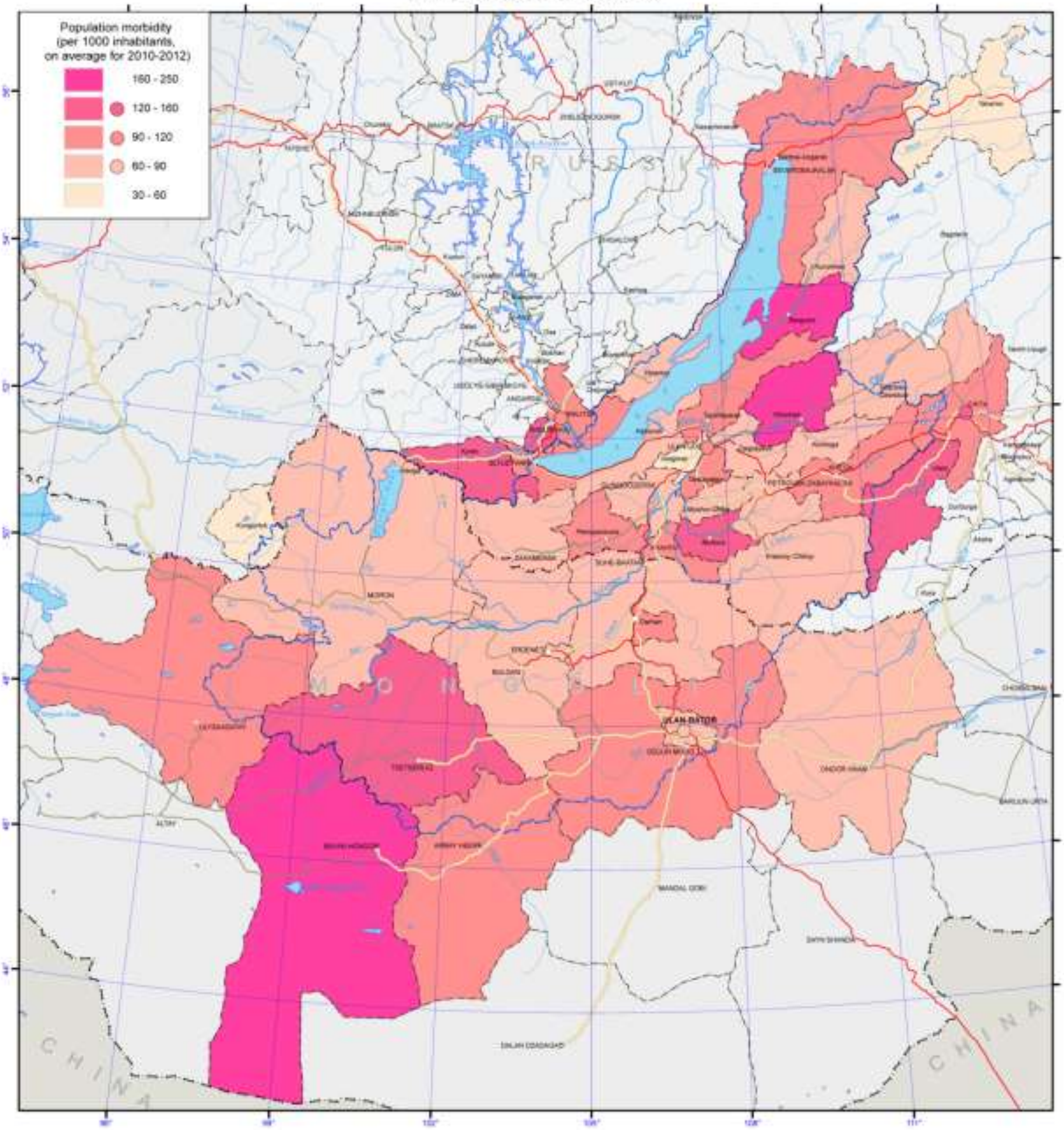

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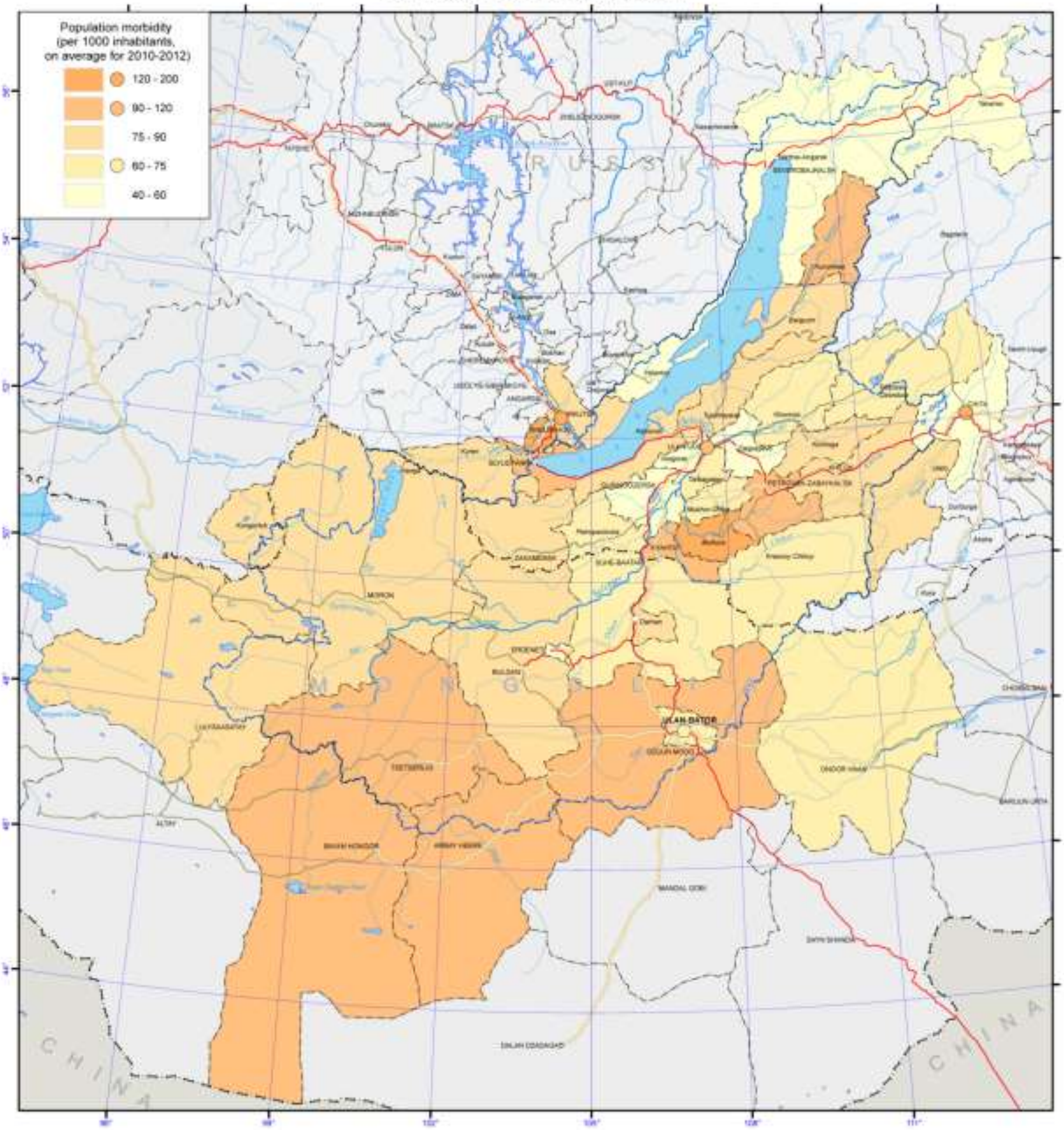

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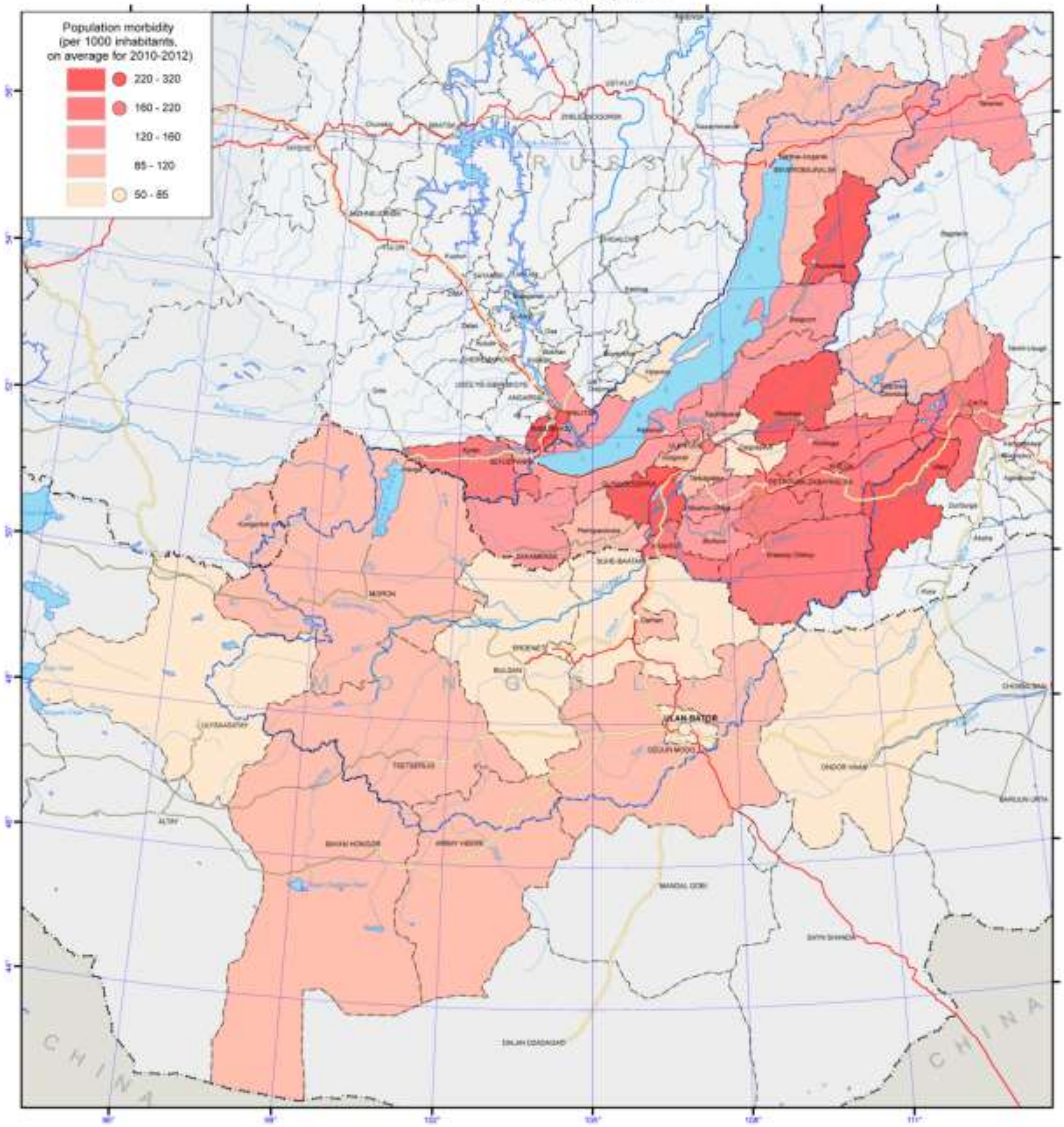
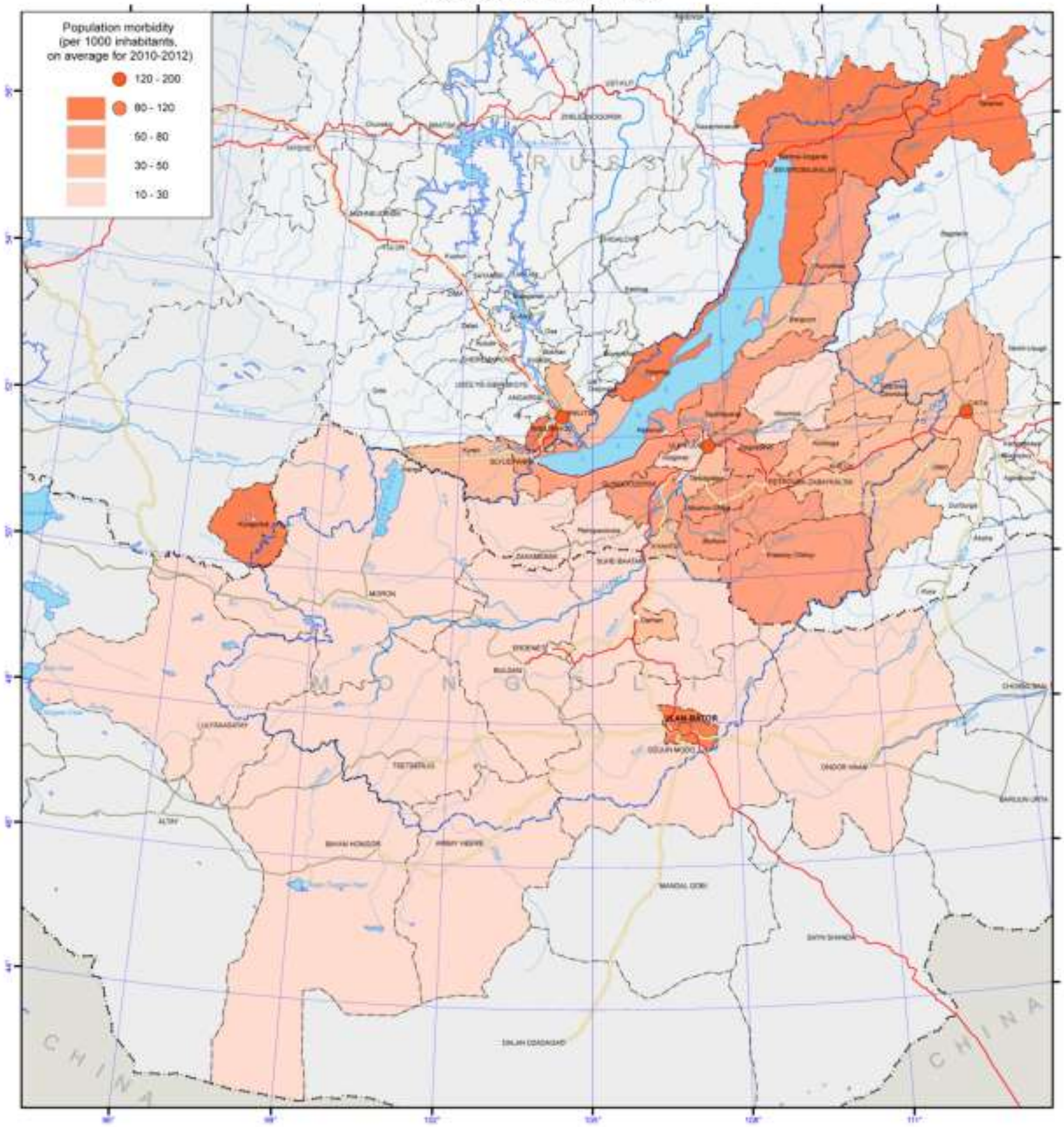
Resilient nations.

CIRCULATORY SYSTEM DISEASES

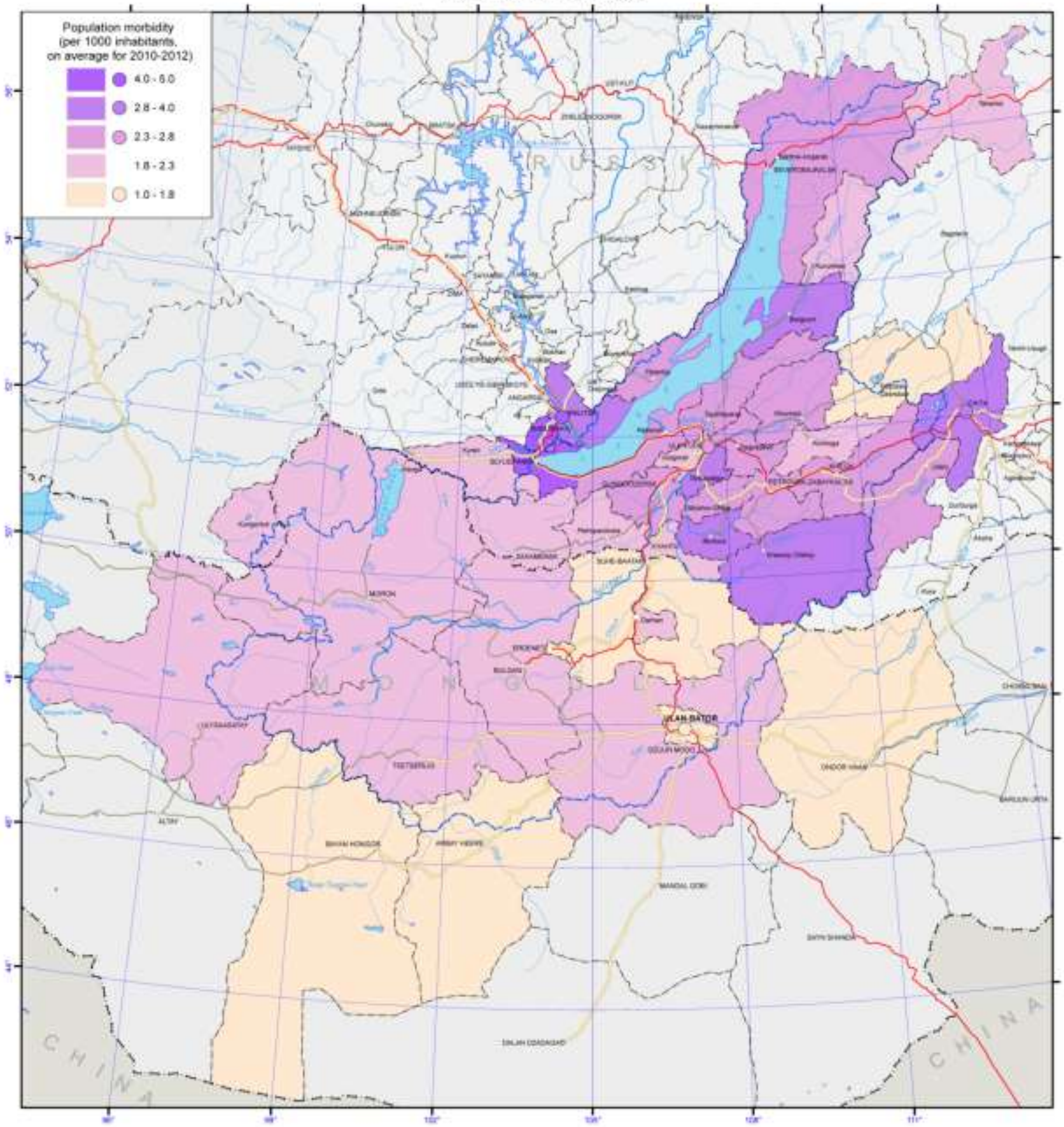


UNOPS

INJURIES AND TOXICATIONS



MALIGNANT NEOPLASMS



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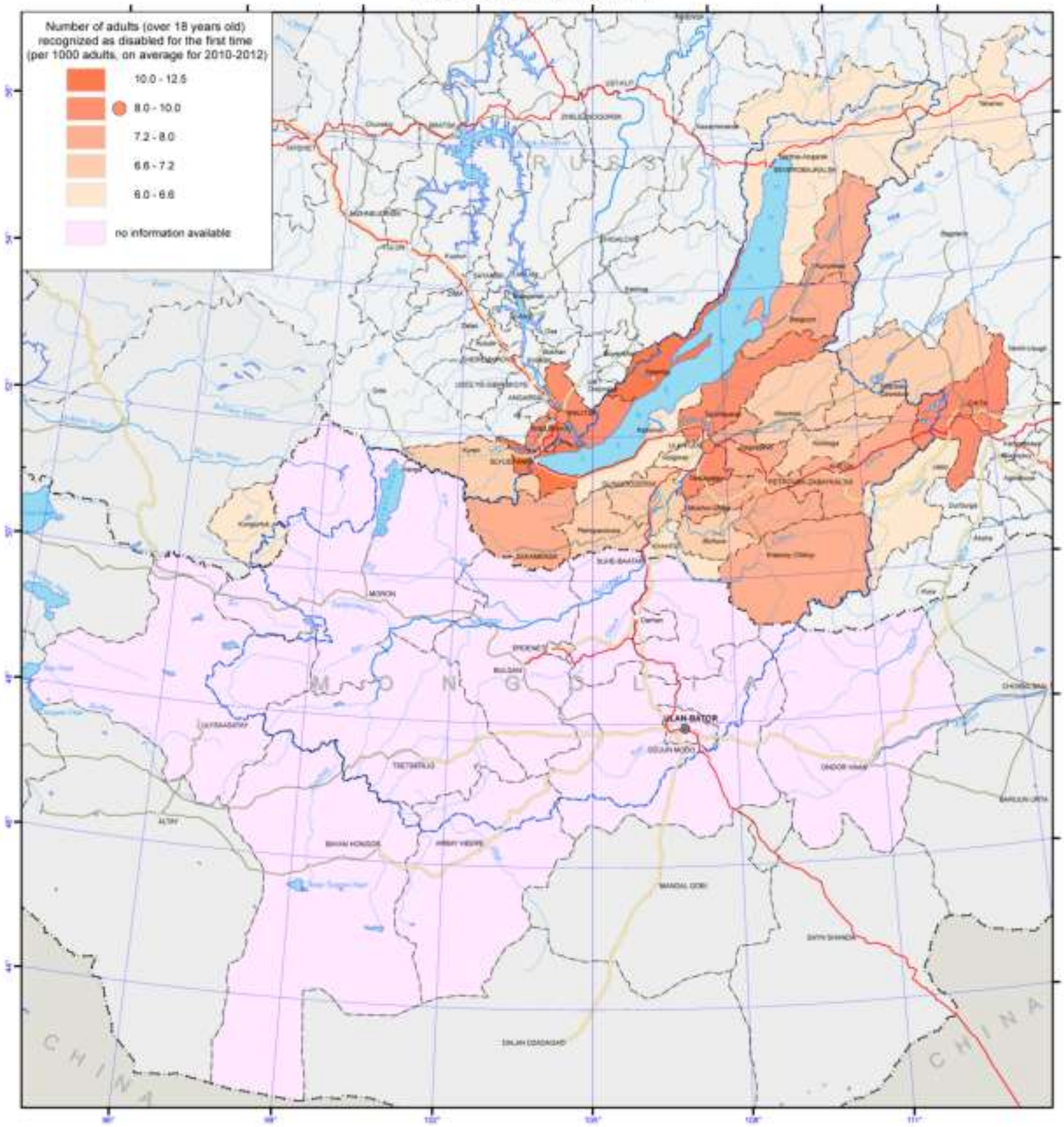
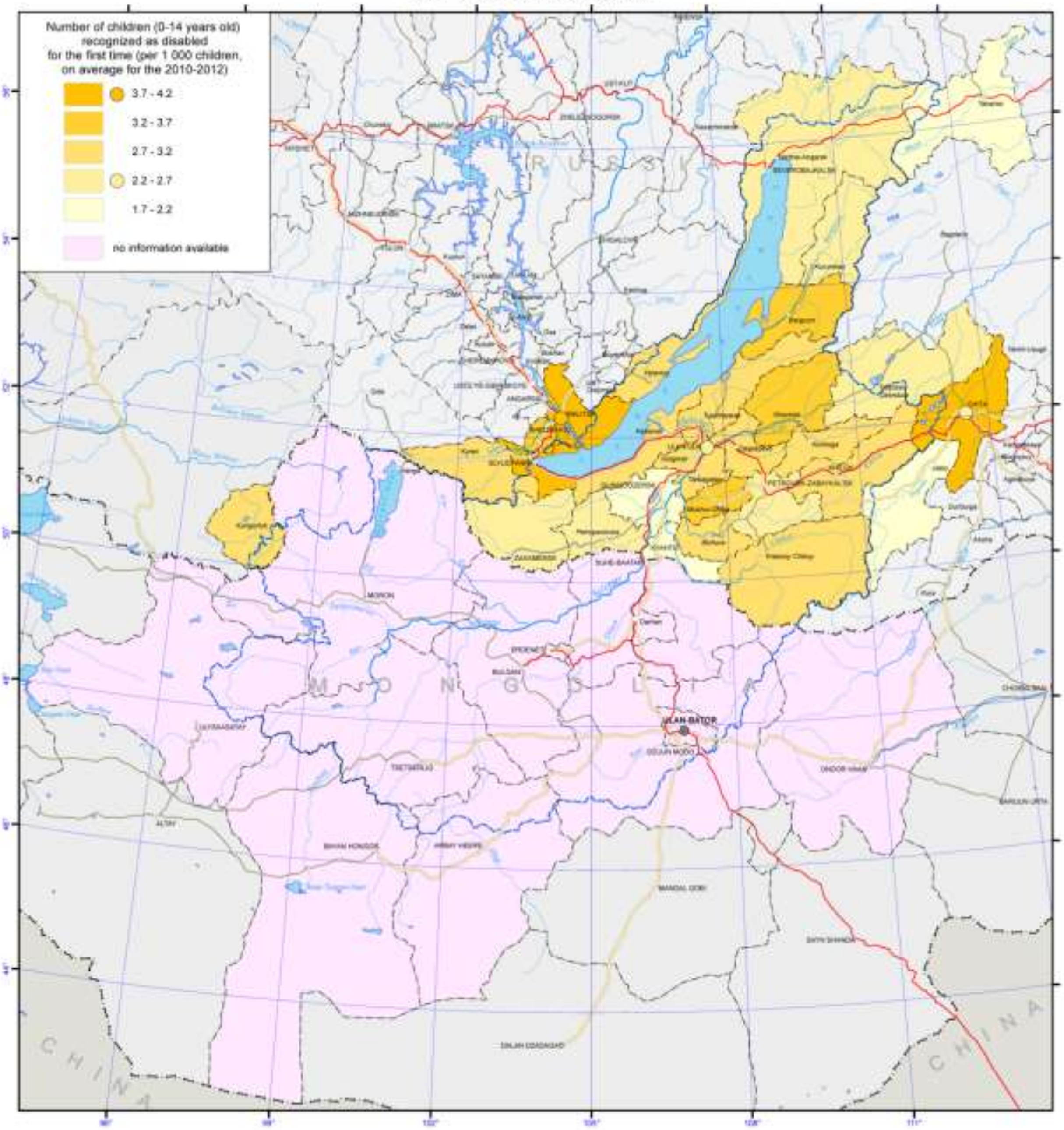
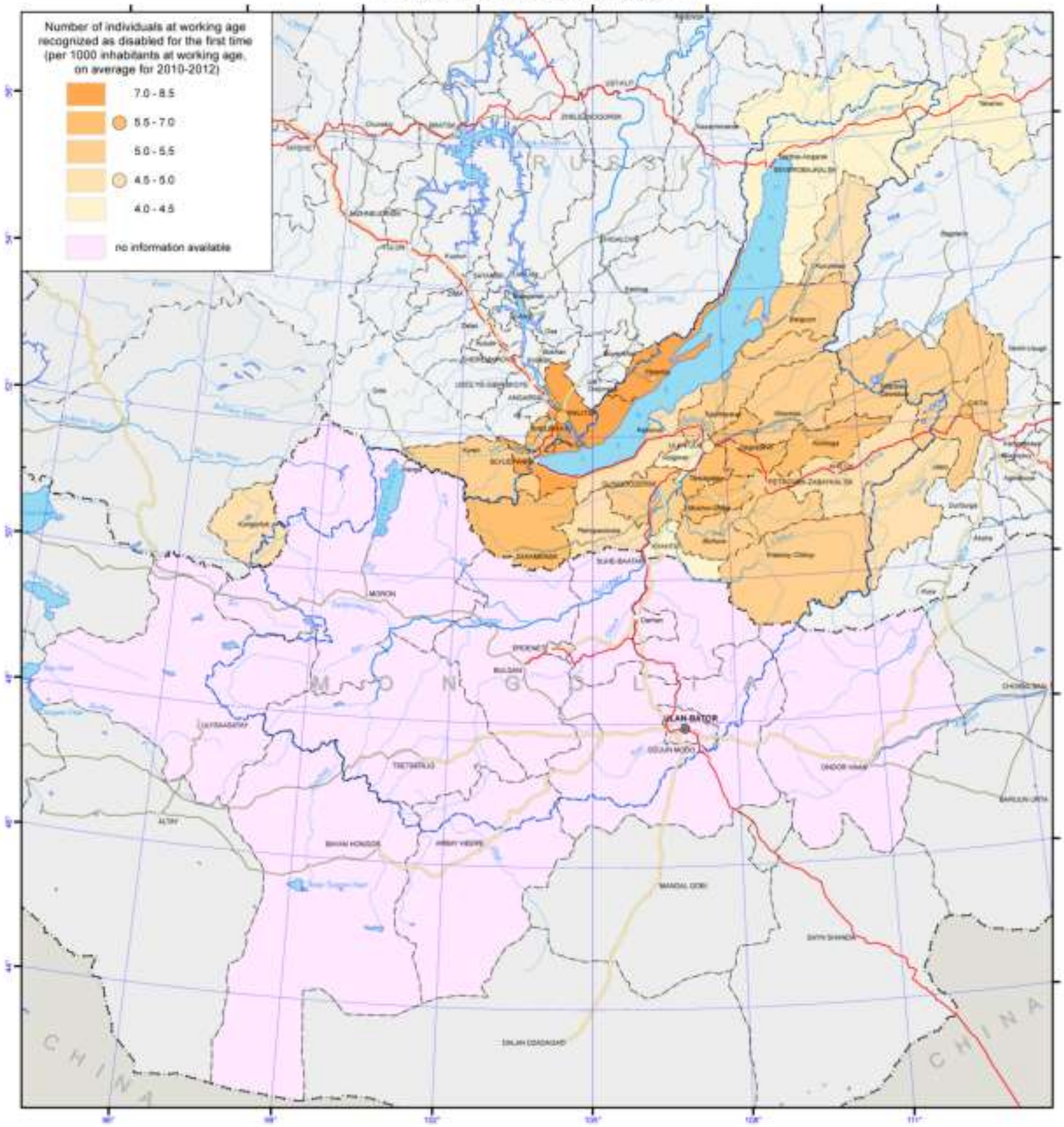
ADULT POPULATION DISABILITY



CHILD POPULATION DISABILITY



WORKING-AGE POPULATION DISABILITY



ENVIRONMENT PROTECTION IN THE LAKE BAIKAL BASIN

Environment-protective infrastructure

The environment-protective infrastructure (EPI) is a component of ecological infrastructure, important sector of the present-day economic complex of the territory. Its basic function is to minimize the effect onto the environment of deposited and utilized waste (on the territory), sewage into water reservoirs, production effluents into atmosphere and consumption with a developed selective (separate) collection of the second material resources. The EPI activity contributes to a conservation of the favorable environment for man's life activity and rational use of resources over the territory. This map reflects EPI to deal with only solid waste of production and consumption, the latter is often referred to “municipal”.

The database includes the data of the administrative bodies of the Ministry of natural resources of Russia, Russian state report on the status of Lake Baikal and protection activities (2013), Ministry of nature, environment and tourism of Mongolia (2012), project materials of regional development. It must be noted that the register of location sites (storage or deposition), production waste burial and consumption for some administrative subjects is incomplete (based on forms 2 waste).

On the territory of the Baikal Lake watershed (in terms of the smallest administrative districts of the Russian part and Mongolian aimaks/villages) they annually produce about 86 million tons of production and consumption, its predominant part supplied into the EPI objects of industrial enterprises (slag accumulation, tailings, waste banks, slag and ash heaps) and municipalities (primarily onto polygons and scrap heaps). The official statistics takes into account over 600 objects depositing waste, operating scrap-processing mill (SPM) in Ulan-Ude. Three SPMs are planned to be erected in Irkutsk, Ulan-Baatar, on the territory of Free economic zone «Baikal Harbor» in the Republic of Buryatia), garbage-sorting factory in |Chita in the Trans-Baikal region, as well as some complex reception camps to collect garbage and waste from floating vessels on Lake Baikal.

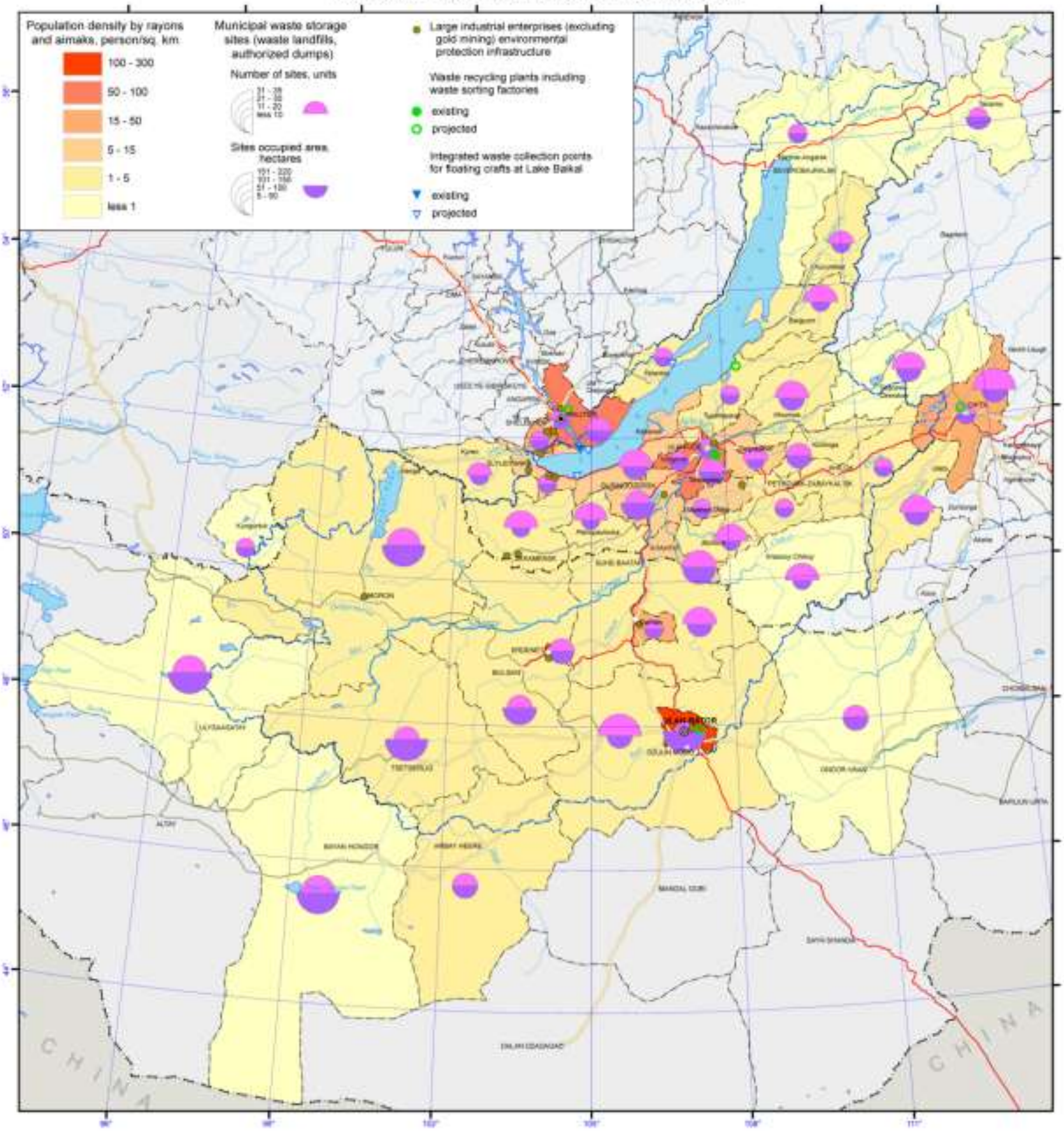
The total volume of production waste formation and consumption on the Baikal watershed area increases annually. The leader is the Trans-Baikal Kray (region), where 2/3 of accounted waste sites in the watershed are located. The Irkutsk Region is leading as regards the index waste formation intensity per the unit of regional gross product (tons/million rubles). As to the number of accounted EPI objects and occupied area the prime position is taken by Mongolia, 2nd one is given to Republic of Buryatia that corresponds to the occupied territory in the watershed zone of Baikal. The mid-regional size of EPI municipalities and aimaks totals to 4.3 hectares, nearly 1.5-fold exceeds this index EPI objects in the Mongolian aimaks (6.3 hectares) and 1.3-fold by the indicated objects in Irkutsk Region. Potentially, in all regions of the Baikal watershed territory they plan to launch a selective (separate) collection of the utilized part of produced consumed waste that essentially will reduce the territories occupied by polygons and equipped scrap-heaps, as well as numerous non-sanctioned heaps of solid domestic waste.

The total volume of waste in terms of vital economic activities is dominated by the waste produced by the mineral resource recovery and heat power engineering, e.g. in Trans-Baikal Kray, Irkutsk Region and in Buryatia their proportion makes up over 90 %. Multi-tonnage waste dumps of mining enterprises, as well as construction and slag-and-ash waste heaps are referred to class V of risk (not dangerous or low-dangerous) regarding their effect on the environment.

Reference:

Public reporting «On the lake Baikal status and protection measures to be undertaken in year 2012. Irkutsk: Siberian Branch «RosGeolFond», 2013, 436 p.

ENVIRONMENTAL PROTECTION INFRASTRUCTURE



Recommended regimes for nature management

Ecological functions of landscapes on this map correlate with recommended regimes for nature management. For example, *strict protection* regime of nature management exploitation is recommended for golets-tundra-sparse wood landscapes with environment-forming ecological function, which implies preventing nature protection measures at any type of this territory use [Mikheev, 1988]. They possess high sensitivity to anthropogenic effects. It is necessary to take into account the possibility of development of any dangerous natural phenomena.

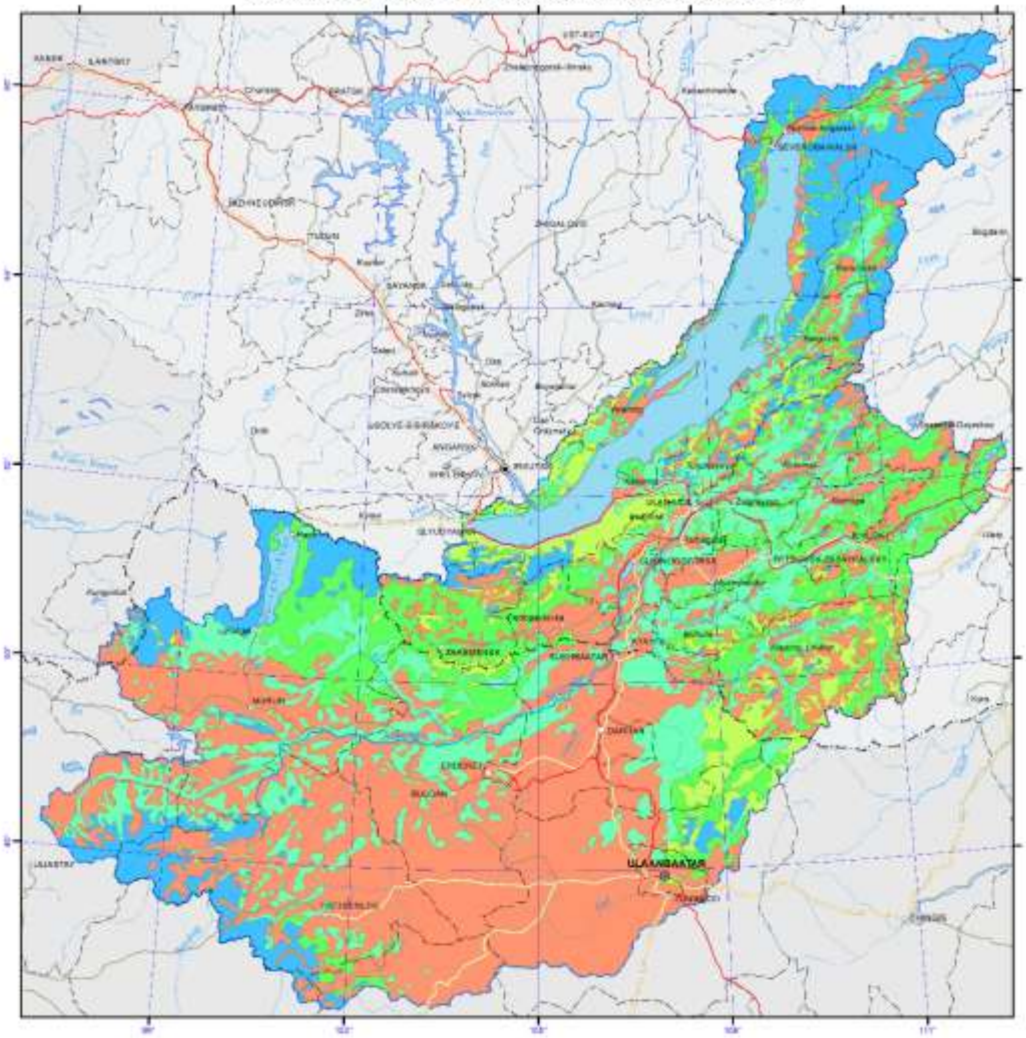
Steppe and dry steppe landscapes with moisture deficit are also sensitive to anthropogenic stress. They possess relatively low ecological potential. Steppe landscapes are more densely populated and developed by a man. Therefore, *exploitation-protection* regime of nature management is recommended for these landscapes. This regime supposes to monitor permanently the landscape state during exploitation and to conduct planned measures for its improvement.

Dark coniferous forests with cedar belong to the category of protected forests, e.g. nut commercial and hunting lands. *Protection regime* of nature management is recommended for these forests.

Exploitation-protection regime of nature management is recommended for moss landscapes with environment-stabilising function. Anthropogenic effect accompanied by deforestation can cause the increase of soil aridization on the slopes, whereas on the flat surface with slow flow this can cause swamping of the land. To preserve moss taiga, which is of great ecological and forest exploitation significance, it is necessary to constantly monitor its state and to follow the rules for forest exploitation.

Herb taiga and subtaiga landscapes with environment-protective function are of great economic value. Therefore, *protection-exploitation regime* of nature management is recommended for these landscapes. They are characterised by high ecological potential and relatively favourable conditions for nature management. However, they have moistening deficit. It is necessary to develop and observe production-ecological specialisation of nature protection measures.

RECOMMENDED LANDSCAPE USE PROVISIONS OF THE LAKE BAIKAL BASIN



Recommended landscape use provisions of the lake Baikal basin

Colour	Recommended landscape use provisions	Principal landscape structures
	1	2
	I - strictly protective (preventive environmental measures with any types of use)	High-altitude alpine tundra (goltsy) - upper-taiga Eastern Siberian and Southern-Siberian type landscapes (alpine-type, subalpine type, alpine tundra, under alpine tundra, sparse forests)
	II - exploitation-protecting (strictly regulated use with separation of cedar protecting zones)	Mountain-taiga and intermontane depressions' larch Baikal-Dzhugdzhursky and dark coniferous, and Southern Siberian landscapes of reduced development conditions Mountain-steppe herb-bunchgrass and sod-grass-mixed-herbs Dakhuro-Mongolian type landscapes Dry-steppe, bunchgrass piedmont, bolit-mountain and plain Dakhuro-Mongolian type landscapes
	III - Protection regime (for cedar forests) and exploitation-protecting regime with remediation of used components	Mountain-taiga dark-coniferous medium-altitude and intermontane depressions' taiga, mostly Siberian cedar (mossy) Southern-Siberian type landscapes of reduced development conditions Mountain-taiga dark-coniferous medium altitude and intermontane depressions' taiga(grassy, sometimes with Siberian cedar) Southern-Siberian type landscapes of optimal development conditions
	IV - exploitation-protecting regime with remediation of used components	Mountain-taiga larch and taiga landscapes of intermontane depressions (mossy; shrubby; dwarf-birch thickets) Baikal-Dzhugdzhursky type landscapes of reduced development conditions Mountain-taiga light-coniferous Southern-Siberian type (larch, cedar-larch and pine-larch) landscapes of reduced development conditions Mountain-taiga larch low-altitude and intermontane depressions' taiga Baikal-Dzhugdzhursky type landscapes of optimal development conditions
	V - exploitation regime with separation of nature defensive zones	Mountain and piedmont under-taiga and steppificated Baikal-Dzhugdzhursky and Southern-Siberian type landscapes Piedmont and intermontane depressions' shrubby and steppificated meadow Southern-Siberian type landscapes

Rare species of plants

Location of rare species for part of the territories of the Russian Federation and Mongolia, included into Lake Baikal basin, are visualized by cartographic methods of interpretation on the map "Rare species of vascular plants of the Russian Federation and Mongolia". The following lists and features of rare species of Russia were used for map composition: the Red Book of the Russian Federation (plants and fungi)/Ministry of Natural Resources and Environment, the Federal Service for Supervision of Natural Resources; RAS, Russian Botanical Society, Lomonosov MSU/Comp. by Kamelin R.V. etc. - Moscow : KMK , 2008. . - 885 p.On Russian territory, including the southern part of the Irkutsk region, part of the territory of the Republic of Buryatia and the Trans-Baikal region, location of 31 species of vascular plants, related to the different status, according to the scale assessment of population status categories adopted in the Red Book of the International Union for Conservation of Nature (IUCN - IUCN Plant Red Data Book, 1978) is marked.

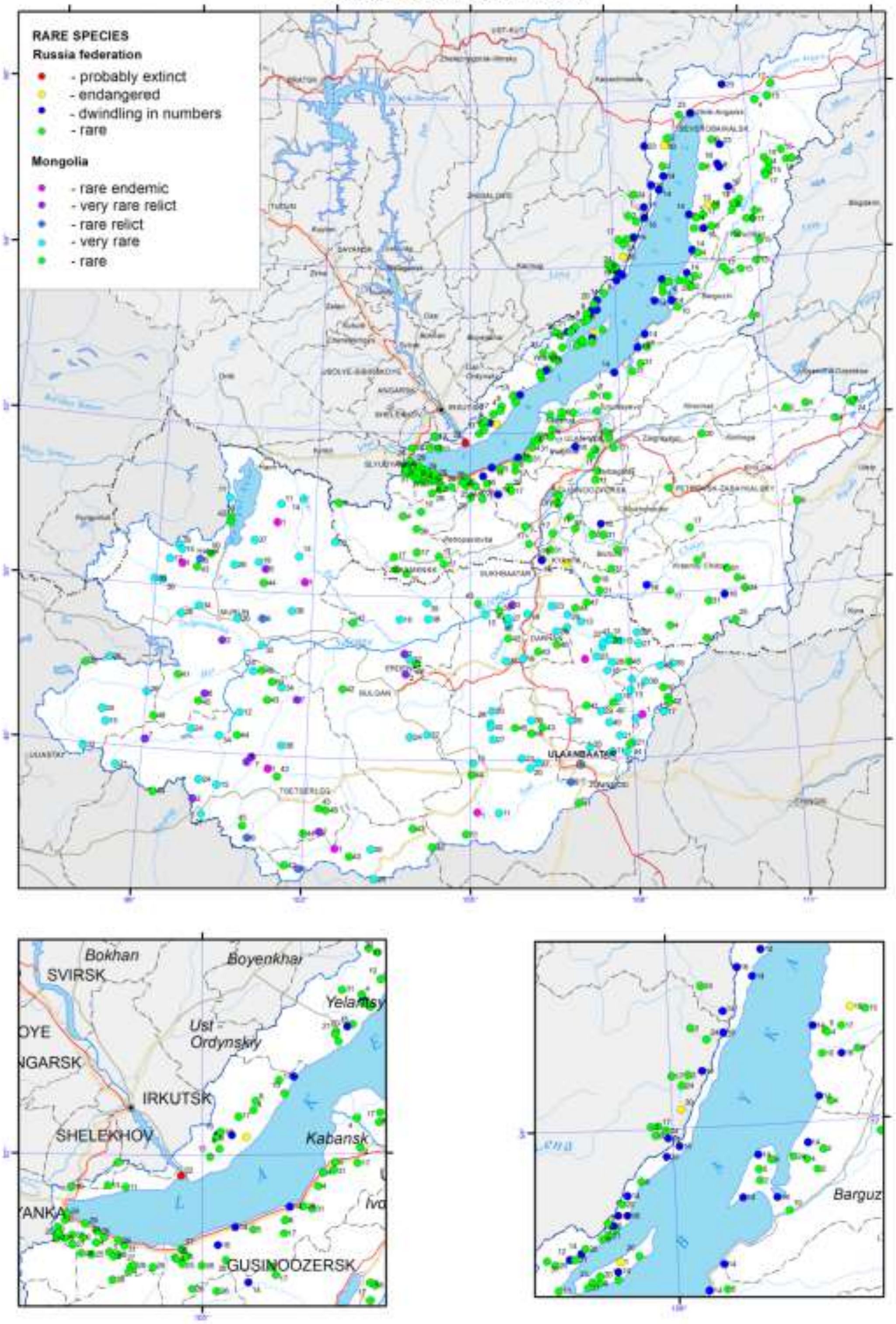
The following species are marked with the status 0 (probably extinct species, but the conservation possibility can not be excluded): Isoetes lacustris; with the status 1 (endangered species) 4 species: Astragalus olchonensis, Vicia tsydenii, Festuca bargusinensis, Viola incisa. With the status 2 (threatened) 4 species: Caulinia flexilis, Hedysarum zundukii, Epipogium aphyllum, Deschampsia turczaninowii; and 25 species with status 3 (rare), i.e. species represented by small populations that are not currently threatened with extinction and are not vulnerable, but may get under the threat. Most often, these species are distributed within a limited area, or have narrow ecological amplitude. For map composition for the territory of Mongolia, included into the Lake Baikal basin, we used information on the species composition and location of rare species of vascular plants of the electronic version of Mongolian Red book (Copyright by MMM Production Centre, 1999). Locations of 51 species are presented. In particular, a rare endemic species Saxifraga hirculus, six very rare relics: Adonis mongolica, Vicia tsydenii, Kobresia robusta, Nymphaea tetragona, Lancea tibetica, and Tulipa uniflora, as well as rare relics: Zigadenus sibiricus and Caryopteris mongolica are marked. Totally, 31 very rare species and 11 rare ones are marked.

On the map "Rare species of vascular plants of regional protection" species locations of regional protection of Irkutsk region (Red Book of the Irkutsk region. - Irkutsk: OOO Izd-vo "Vremya stranstviy", 2010.- 480 p.), the Republic of Buryatia (Red Book of the Republic of Buryatia: Rare and endangered species of plants and fungi . - Novosibirsk : Nauka, 2002. – 340 p.) and the Trans-Baikal region (Red Book of Chita Oblast and Agin-Buryat Autonomous Okrug. Chita - 2002) within the boundaries of the Lake Baikal basin are presented. 868 points of locations of 201 species of vascular plants listed in the regional Red Books, including into the Red Book of the Russian Federation are marked. In regions the species have a different status depending on the status of populations. Among the regional species Lagopsis eriostachya and Isoetes lacustris belong to the status 0 (probably extinct species) and 28 species are endangered (status 1).

The map "Plant communities in need of protection" is compiled by the out of scale marks on the basis of information contained in the Green Book of Siberia (Rare plant communities in need of protection. - Novosibirsk: Nauka. RAS Siberian Publishing House, 1996. - 396 p.) Atlas of the Irkutsk region (Irkutsk region: environmental conditions of development. - Moscow-Irkutsk, 2004. - P. 42.), electronic atlas of the Slyudyansky district (Slyudyansky district of Irkutsk Region. Nature, economy and population. Irkutsk - 2012). In the basin of Lake Baikal the first group forests protection should be protected in accordance with the Forest Code of the Russian Federation as the most environmentally and socially valuable, the main purpose of which is implementation of water protection, safety, sanitation health and other functions, as well as forest protected areas. The following communities need protection, having a high scientific value as standards of indigenous vegetation: Polygonum bistorta + Carex aterrima and Stemmacantha carthamoides meadows, Rhododendron aureum alpine tundra and subalpine zone;

Filifolium sibiricum, Festuca litvinovii and Stipa klemenzii - S. Baicalensis - Eremogone capillaries steppes; Ulmus macrocarpa + Spiraea pubescens shrub steppe communities, Betula davurica - Artemisia desertorum + Calamagrostis brachytricha + Carex reventa forest communities ; Carex lasiocarpa + C. pseudocuraica + Iris laevigata bog communities . Very rare communities (Spodiopogon sibiricus; Armeniaca sibirica + Spiraea pubescens), relict communities (Arundinella anomala + Lespedeza hedysaroides) and unique (Stipa baicalensis + Paeonia lactiflora); and communities on the border of its distribution (Pinus pumila; Caragana jubata) and reducing habitat because of the high importance of the resource (Filifolium sibiricum + Phlojodicarpus sibiricus) are in need of protection as well. Maps of distribution of rare vascular plant species and plant communities in need of protection can be used in the formation of environmental policy on wildlife management optimization in the Baikal region with the purpose of biodiversity conservation.

RARE SPECIES OF VASCULAR PLANTS



Rare species of vascular plants of the Russian Federation and Mongolia

Rare species of vascular plants of the Russian Federation

1. *Astragalus olchonensis*
2. *Borodinia macrophylla*
3. *Cypripediym ventricosum*
4. *Cypripedium macranthon*
5. *Cypripedium calceolus*
6. *Anemone baikalensis*
7. *Vicia tsydenii*
8. *Calypso bulbosa*
9. *Caulinia flexilis*
10. *Cotoneaster lucidus*
11. *Stipa pennata*
12. *Hedysarum zundukii*
13. *Astragalus olchonensis*
14. Deschampsia turczaninowii
15. *Mertensia serrulata*
16. *Epipogium aphyllum*
17. *Neottianthe cucullata*
18. *Festuca bargusinensis*
19. *Caryopteris mongholica*
20. *Oxytropis triphylla*
21. *Primula pinnata*
22. *Isoëtes lacustris*
23. *Isoëtes setacea*
24. *Rhodiola rosea*
25. *Fritillaria dagana*
26. *Swertia baicalensis*
27. *Aegopodium latifolium*
28. *Stemmacantha carthamoides*
29. *Tridactylina kirilowii*
30. *Viola incise*
31. *Orchis militaris*

Rare species of vascular plants of Mongolia

Endemics, rare species

1. *Saxifraga hirculus*

Cladotypes, endangered species

2. *Adonis mongolica*
3. *Vicia tsydenii*
4. *Kobresia robusta*
5. *Nymphaea tetragona*
6. *Lancea tibetica*
7. *Tulipa uniflora*

Cladotypes, rare species

8. *Zigadenus sibiricus*
9. *Caryopteris mongolica*

Endangered species

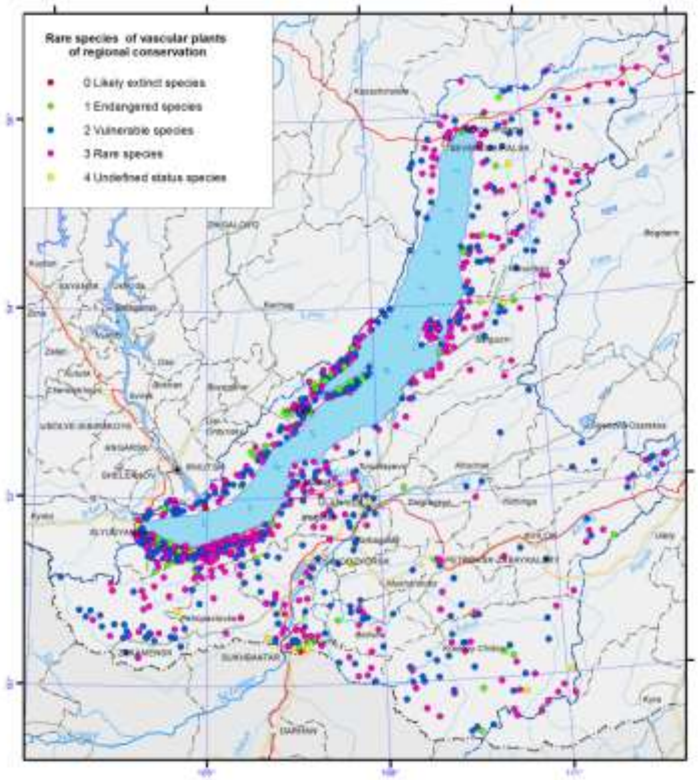
10. *Acorus calamus*
11. *Sambucus manshurica*
12. *Gentiana algida*
13. *Botrychium lanceolatum*
14. *Neottia camtschatea*
15. *Neottianthe cucullata*
16. *Lycopodium alpinum*
17. *Pinus pumila*
18. *Convallaria keiskei*
19. *Lilium dahuricum*
20. *Platanthera bifolia*
21. *Juniperus Sabina*
22. *Mitella nuda*
23. *Epipogium aphyllum*

24. *Carex parva*
25. *Carex selengensis*
26. *Oxytropis acanthacea*
27. *Orchis fuchsia*
28. *Abies sibirica*
29. *Lycopodium clavatum*
30. *Physochlana albiflora*
31. *Drosera anglica*
32. *Rhodiola rosea*
33. *Drosera rotundifolia*
34. *Rhododendron adamsii*
35. *Rhododendron dauricum*
36. *Rhododendron aureum*
37. *Rhododendron ledebourii*
38. *Rhododendron parvifolium*
39. *Vaccinium myrtilus*
40. *Orchis militars*

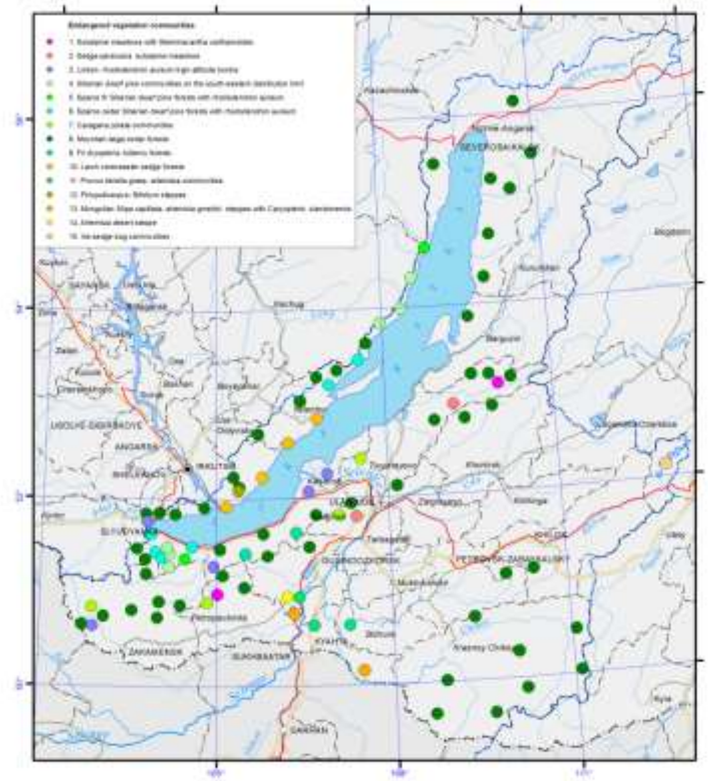
Rare species

41. *Adonis sibirica*
42. *Valeriana officinalis*
43. *Stellaria dichotoma.*
44. *Aium altaicum*
45. *Juniperus pseudosabina*
46. *Melica nutans*
47. *Lycopodium complanatum*
48. *Paeonia anomala*
49. *Saussurea dorogostaiskii*
50. *Saussurea involucrate*
51. *Ephedra equisetina*

RARE SPECIES OF VASCULAR PLANTS OF REGIONAL CONSERVATION



ENDANGERED VEGETATION COMMUNITIES



Rare species of fauna

Fauna around Lake Baikal is rich and diverse. Due to the unique geographical location, the fauna around Lake Baikal is represented by a high number of species, that vary on genetic as well as on ecological levels. This is a region where habitats of many systematically and ecologically allied species and subspecies adjoin or overlap. A good many of species are represented by peripheral or isolated populations, some of which were conserved in local refugiums since the time of the last glacial period. As a rule, these species are scarce, their habitat is usually small, and therefore they are Red Listed and require special protection.

More than 60 species of fish live in rivers and other water bodies of the Baikal basin, half of them are endemic or relict. The ihtiofauna of the rivers and lakes of the Baikal basin is formed by the species typical of boreal piedmont and boreal lowland complexes, and those of the arctic freshwater complex; only Siberian sturgeon and tench go back to the ancient late Tertiary fauna complex. Species typical of other fauna complexes have penetrated the water bodies by introduction or invasion. 55% of all the fish species in Lake Baikal are endemic, which is indicative of the autochthonous origin of the core of the lake ihtiofauna. Only 10 species of fish are found in lake Khubsugul, but half of them are precious commercial fishery species. More than half of the fish species listed in the regional Red Data Book of the Russian Federation and the Mongolian Red List are precious commercial species, which headcount has dropped significantly over the past 100 years of active anthropogenic activities. Overfishing, hydro-technical constructions, contamination of water bodies had a negative effect on the fish populations, and brought about partial loss of habitat. At present 15 fish species native to the basin, require special protection and artificial breeding in order to restore their number.

Lake Baikal basin has very few herpetofauna species (about 20), which is a result of harsh weather conditions and the formation history of the region. However, the basin is the place where the Western Palearctic species habitat overlaps the Eastern Palearctic species habitat, while representatives of Central Asian, Daurian and Mongolian fauna penetrate the south. Half of the species present in the basin are on the margin of their habitats. Anthropogenic influence, drainage and contamination of water bodies, frequent fires, active recreation and pursuit by people decrease the headcount and fragment the habitats of herpetofauna species. At present, 4 amphibian species and 6 reptile species need protection.

Ornitofauna species are very diverse, due to unique landscapes, climatic and geomorphological conditions, as well as the specific process of the ornitofauna establishment. Birds, typical of Siberian, Mongolian, Chinese, European and Arctic faunas make up the core of ornitofauna population. There is a sizeable proportion of the transpalearctic species in the basin. There is also a tiny fraction of birds typical of the Tibet and Mediterranean ornitofaunas. The present-day ornitofauna of the Lake Baikal basin has more than 400 species, about 100 of them need special protection. Anthropogenic impact on the ornitofauna is ambiguous. The changes in the environment brought about by forest cuttings, fires, excessive grazing, or steppe plowing reduces some bird populations, while other species on the contrary increase in number and extend their habitats. Usually, the stenobiotic species suffer most from the anthropogenic factor, while their headcount is rather low anyway. Transformation of habitats, changes in hydrological regime of some rivers and the lake, poaching, forest cuttings and fires, industrial pollution against a background of fluctuating environmental and climatic conditions lead to the decrease in diversity and number of the majority of bird species.

The fauna of mammals is quite specific and diverse in the region. There are more than 90 species of mammals here, many of which are on the margin of their habitats. The present fauna of mammals in the basin breaks down to almost 20 faunulas; the faunulas with the largest variety of species are the following: the Holarctic arctoboreal, the taiga Palearctic, the Western Palearctic taiga, Holarctic and alpine tundra elements, the steppe Southern Palearctic and Central Asian, as well as the Eastern Asian and Southern Palearctic flying mammals. Some small number of species appeared here through acclimatization or was introduced by people.

Compared to other animals, mammals are more exposed to the direct anthropogenic pressure. Thus, most mammals included into the list of rare species, recently were or still are commercially harvested. Their headcount was damaged by overharvesting or poaching. It is not uncommon, when fight against feral herd infections caused a sharp decrease in the number of the reservoir hosts, i.e. rodents. Forest cuttings, steppe plowing, overgrazing, frequent forest fires and fragmenting of landscape had an adverse effect on the most mammal species, which are present in the Lake Baikal basin; therefore, more than 30 of them need protection and restoration.

The map series gives an idea about the distribution of rare species, grouped according to their systematic features: fish, amphibians and reptiles, birds and mammals. The authors researched literature and museum collections, and added their own studies and observations in order to map the areal distribution of rare animals, and in some cases to indicate their habitats. The tables that go with the maps contain information about the category of a rare species according to the Red Data Books of the Irkutsk Oblast (2010), the Buryat Republic (2013) and the Zabaikalye Region (2012). The regional scale of categories of rarity and vulnerability of species was developed on the basis of the scale applied by the Red Data Book of the Russian Federation (2008) slightly changed to adapt to the specific features of the local biota. Thus, two regional categories (VI и VII) were added in order to reflect the specific geographical position of the Buryat Republic, such as near-border location, presence of the significant biogeographical boundaries and migration routes, etc. (For rare vertebrates of Mongolia, we have applied the IUCN scale of categories, used in the Mongolian Red List of fishes (2006), reptiles and amphibians (2006), birds (2011), mammals (2006).

Categories of rarity of species and subspecies according to the risk of their extinction (The Irkutsk Oblast, the Buryat Republic and the Zabaikalye Region)

Category 0 – apparently extinct

Category I – near extinct; species (subspecies), the number of animals of which has critically decreased

Category II– species (subspecies), constantly decreasing in the number of animals

Category III –species (subspecies), naturally low in the number of animals, distributed sporadically or on a limited territory

Category IV – species (subspecies) of uncertain status, apparently falling into one of the above categories

Category V – species (subspecies), which have been restored or undergoing restoration

Category VI – rare species (subspecies) with irregular occurrence

Category VII – species (subspecies) apparently secure in the Buryat Republic, but Red Listed in the Russian Federation, Mongolia or the neighbor regions

Categories of rarity of species and subspecies according to the risk of their extinction (Mongolia)

Regionally Extinct (RE)
Critically Endangered (CR)
Endangered (EN)
Vulnerable (VU)
Near Threatened (NT)
Least Concern (LC)
Data Deficient (DD)

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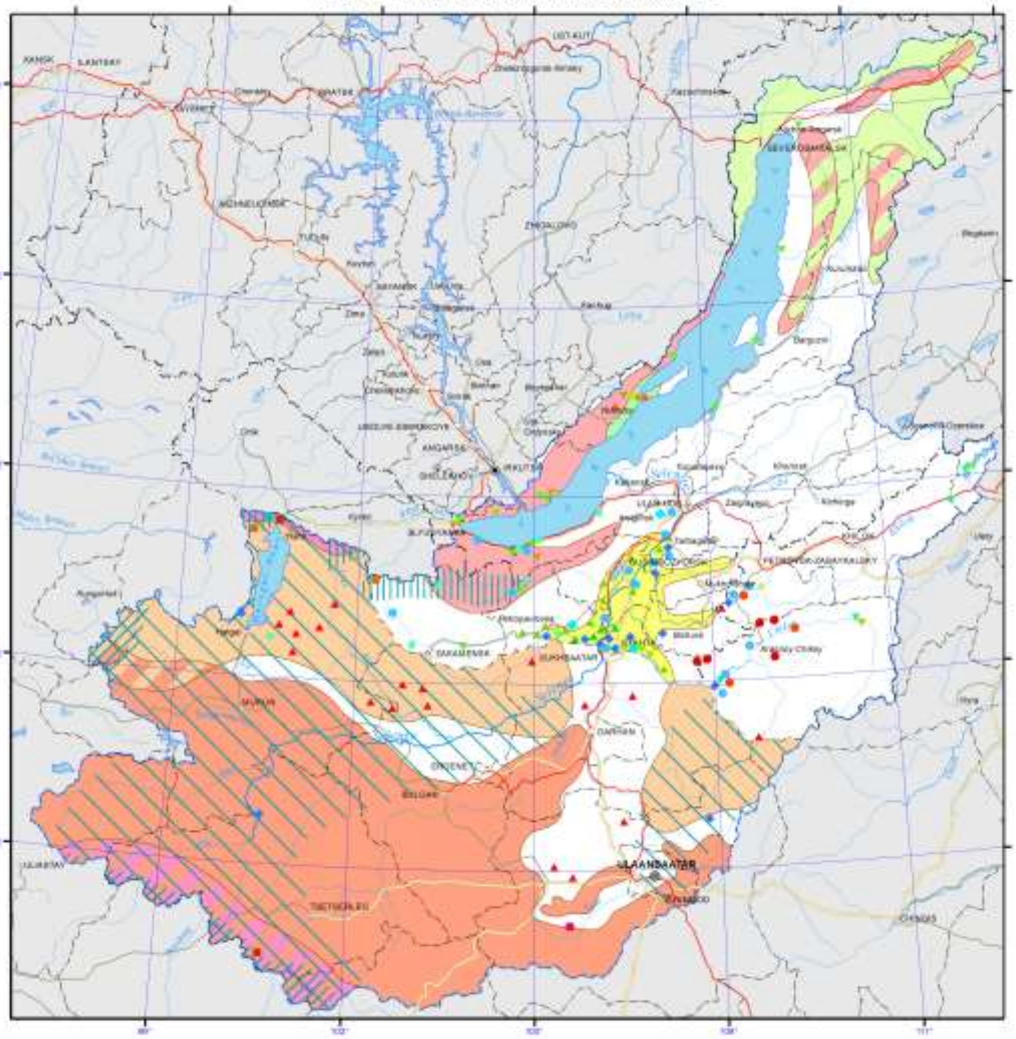
DISTRIBUTION OF RARE ANIMAL SPECIES. MAMMALS



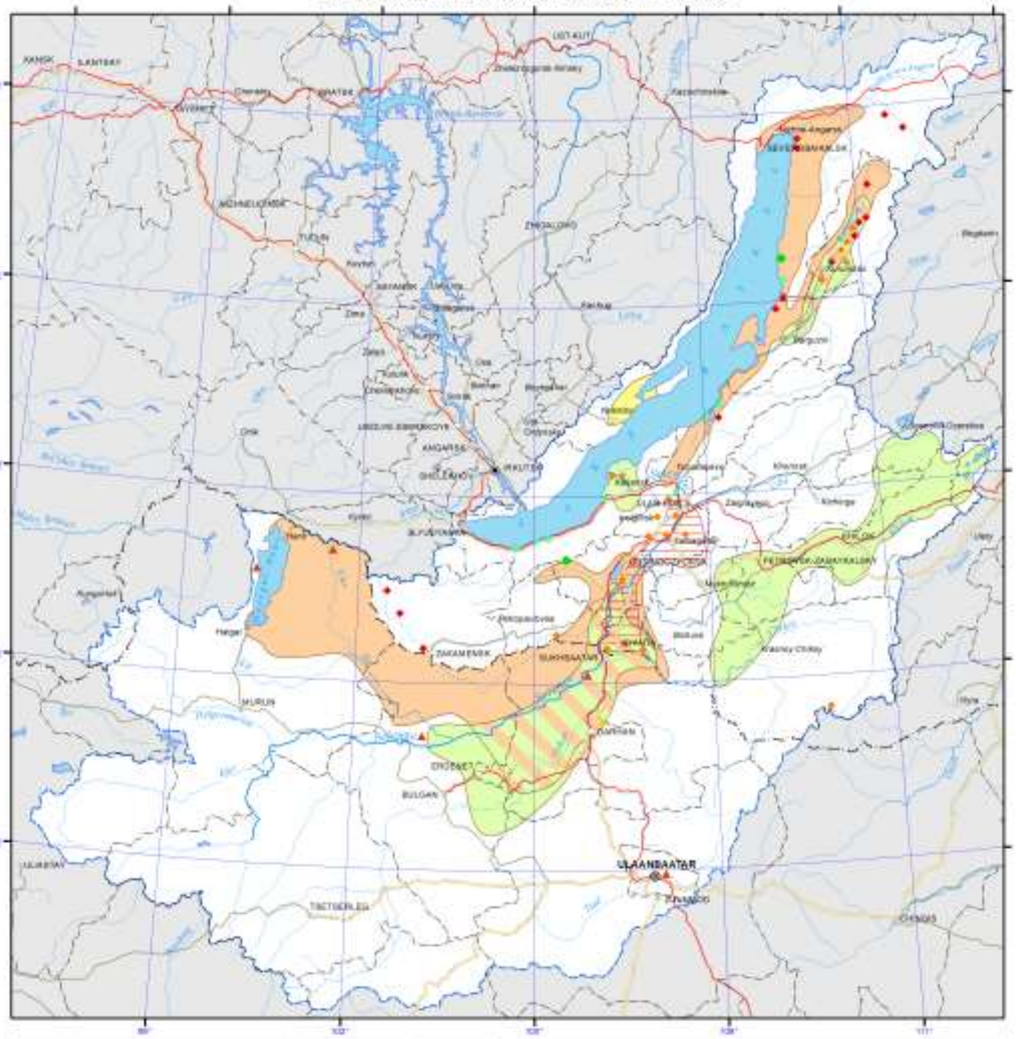
Symbol	Species	Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
	Daurian hedgehog *Hemiechinus dauuricus*		III	V	LC
	Altai mole *Talpa altaica*		III		DD
	Asian lesser white-toothed shrew *Crocidura shantungensis*		IV		
	Hilgendorf's tube-nosed bat *Murina hilgendorfi*	III	III		
	Daubenton's bat *Myotis daubentonii*		III		
	Fraternal myotis *Myotis frater*	III		III	
	Steppe whiskered bat *Myotis aurascens*		III		
	Ikonnikov's bat *Myotis ikonnikovi*	III	III	IV	
	Brown long-eared bat *Plecotus auritus*			III	
	Asian parti-colored bat *Vespertilio sinensis*			III	
	Corsac * *Vulpes corsac*		III		
	Dhole *Cuon alpinus*	I	IV		RE
	Steppe polecat *Mustela eversmanni*	III			
	European otter *Lutra lutra*	III	II	I	

	Species	Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
	Pallas's cat *Otocolobus manul*	IV	III	V	
	Snow Leopard *Uncia uncia*	I	I	I	EN
	Tolai Hare *Lepus tolai*		III		
	Tarbagan Marmot *Marmota sibirica*			I	EN
	Black-capped marmot *Marmota camtschatica*	III	III	II	
	Siberian Jerboa * *Allactaga sibirica*		III		
	Long-tailed dwarf hamster *Cricetulus longicaudatus*		III		
	Olkhon Mountain Vole *Cricetulus longicaudatus*	II			
	Siberian musk deer *Moschus moschiferus*				EN
	Eurasian elk *Alces alces*				EN
	Reindeer *Rangifer tarandus*	III	II		VU
	Siberian ibex *Capra sibirica*		II		NT
	Argali *Ovis ammon*		VI		EN
	Przewalski's horse *Equus przewalskii*				CR

Letters and Roman numerals denote the categories of species rarity by the degree of their extinction threat.

* Areas of Corsac (Vulpes corsac) and Siberian Jerboa (Allactaga sibirica) coincide.

DISTRIBUTION OF RARE ANIMAL SPECIES. AMPHIBIANS



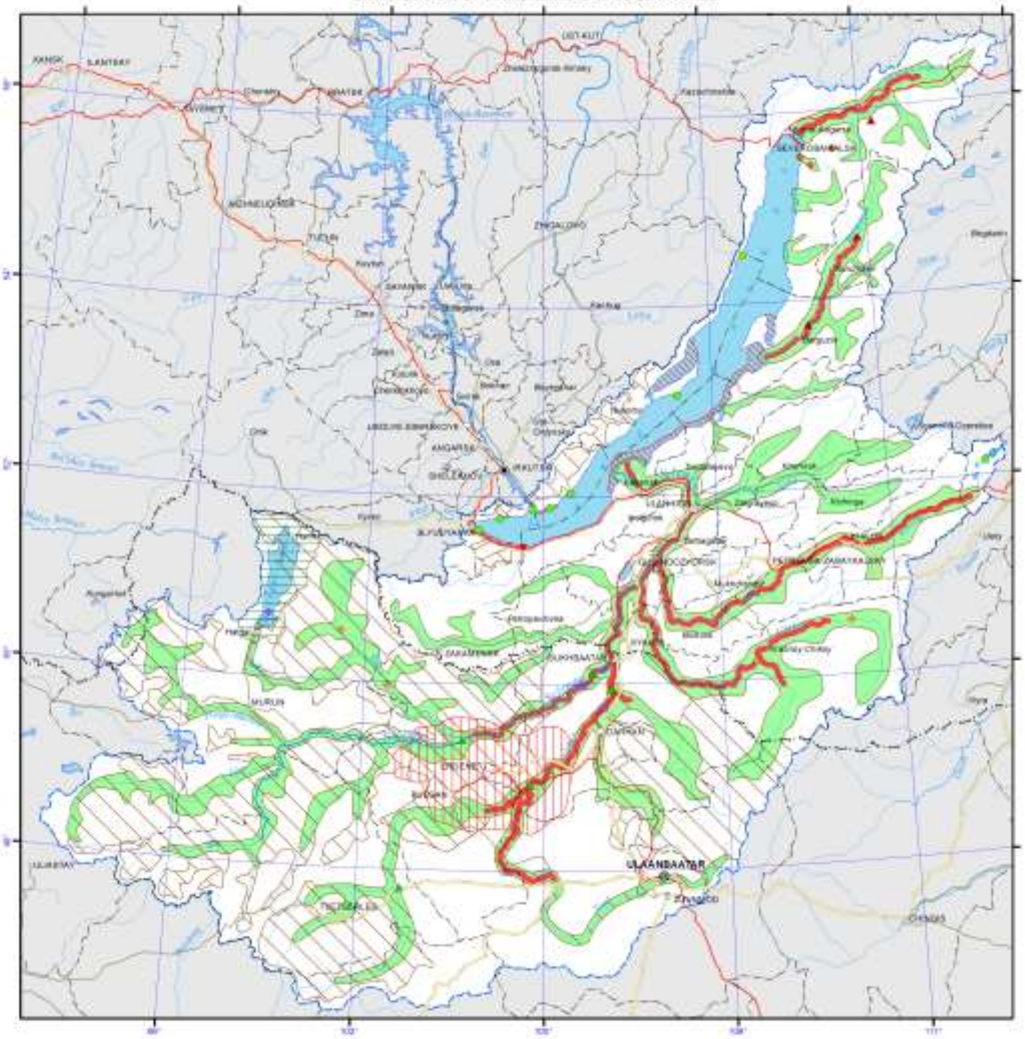
Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
Amphibia					
▲	Сибирский углозуб *Salamandrella keyserlingii*				VU
	Монгольская жаба * *Bufo raddei*	II			LC
	Дальневосточная квакша *Hyla japonica*		III	III	VU
●	Остромордая лягушка *Rana arvalis*		III		

Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
Reptilia					
	Монгольская ящурка *Eremias argus*		II		LC
●	Прыткая ящерица *Lacerta agilis*		III		
●	Полосатый полоз *Coluber spinalis*				NT
	Узорчатый полоз * *Elaphe dione*	II	II	III	LC
	Обыкновенный уж *Natrix natrix*		II	III	NT
●	Обыкновенная гадюка *Zootoca vivipara*		0		VU

Letters and Roman numerals denote the categories of species rarity by the degree of their extinction threat.

* Areas of Corsac (Vulpes corsac) and Siberian Jerboa (Allactaga sibirica) coincide

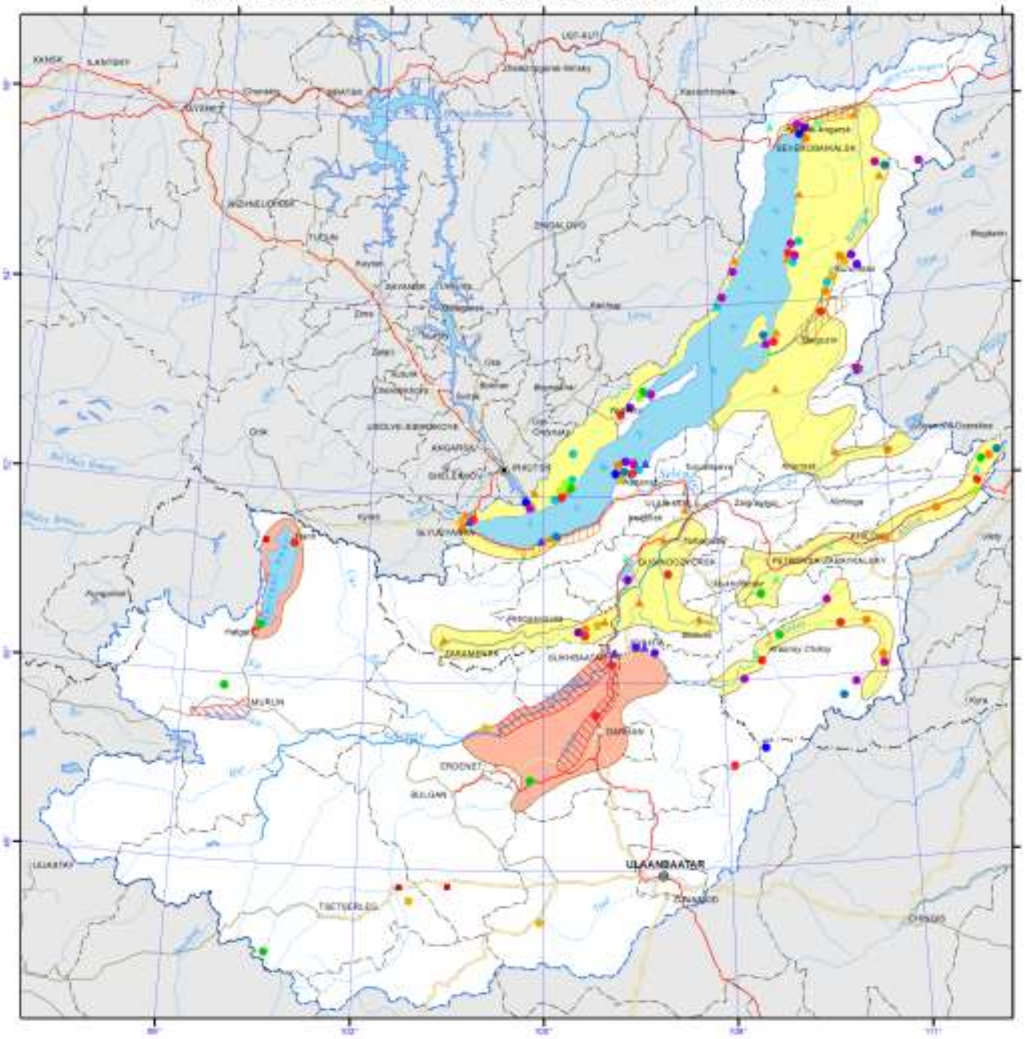
DISTRIBUTION OF RARE ANIMAL SPECIES. FISHES



Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
	Сибирский осетр *Acipenser baerii*	I	II	I	CR
	Язь *Leuciscus idus*				NT
	Карликовый алтайский османом *Oreoleuciscus humilis*				VU
	Линь *Tinca tinca*		III		
	Арктический голец *Salvelinus alpinus*		II		
	Ленок *Brachymystax lenok*	II			VU
	Таймень *Hucho taimen*	I	IV	I	EN

Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
	Белый байкальский хариус *Thymallus arcticus brevipinnis*			IV	NT
	Косогольский хариус *Thymallus nigrescens*				EN
	Байкальский омуль *Coregonus migratorius*				DD
	Сибирский сиг Сибирский *lavaretus pidschian*	III		II	EN
	Елохинская широколобка *Abyssocottus elochini*	III			
	Карликовая широколобка *Procottus gurwicii*				
	Арктическая песчаная широколобка *Leocottus kesslerii*			IV	

RARE ANIMALS DISTRIBUTION. BIRDS. PELECANIFORMES, CICONIIFORMES, ANSERIFORMES

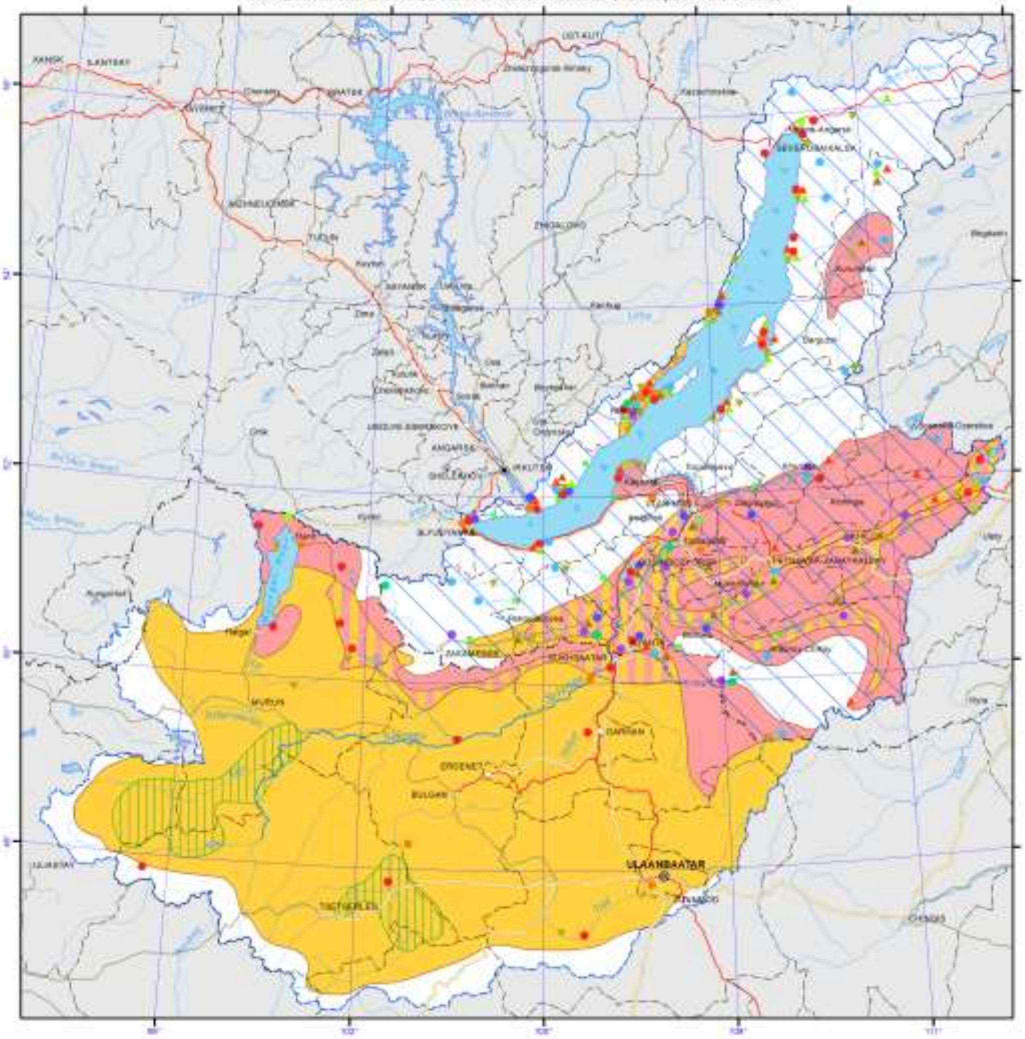


Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
●	Dalmatian pelican *Pelecanus crispus*	0			CR
▲	Eurasian bittern *Botaurus stellaris*		III	II	
▲	Spoonbill *Platalea leucorodia*	IV	IV	I	LC
▲	Black stork *Ciconia nigra*	III	III	I	LC
●	Red-breasted goose *Branta ruficollis*	III	III	I	
●	Lesser white-fronted goose *Anser erythropus*	III	IV	I	VU
●	Bean goose *Anser fabalis*	I	III	II	LC

Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
●	Swan goose *Anser cygnoides*	0	III	I	NT
●	Whooper swan *Cygnus cygnus*	III		II	LC
●	Bewick's swan *Cygnus bewickii*	III	III	I	LC
●	Common shelduck *Tadorna tadorna*	III	III		LC
●	Spotbill duck *Anas poecilorhyncha*		III	II	LC
●	Baikal teal *Anas formosa*	I	III	II	VU
●	Harlequin duck *Histrionicus histrionicus*	III	III	IV	

Species rarity categories are marked with letters and Roman numbers according to the threat of extinction

RARE ANIMALS DISTRIBUTION. BIRDS. FALCONIFORMES, STRIGIFORMES

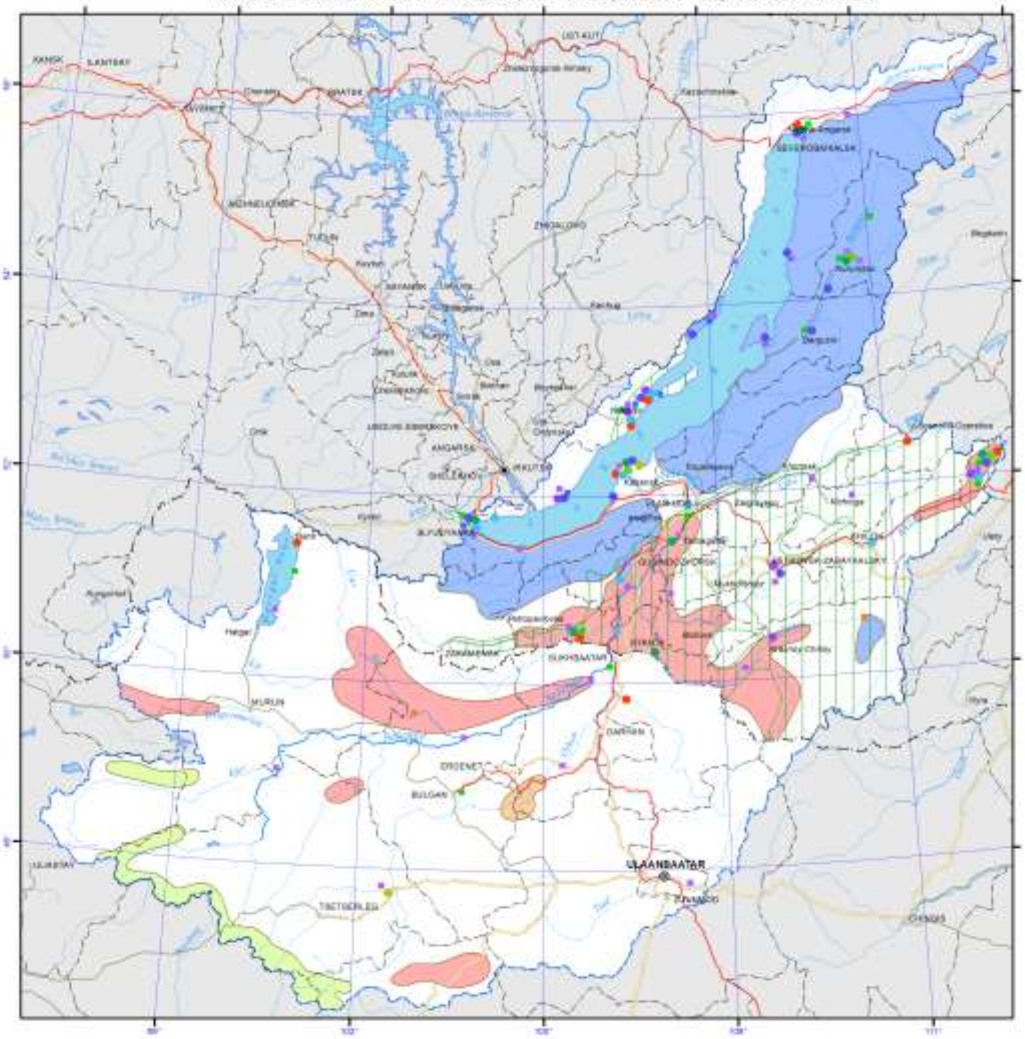


	Species	Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
▼	Western Osprey *Pandion haliaetus*	III	III	I	LC
●	Blue hawk *Circus cyaneus*			II	LC
●	Booted eagle *Hieraaetus pennatus*	III	III		LC
●	Steppe eagle *Aquila nipalensis*	III	V	III	LC
	Imperial eagle *Aquila heliaca*	III	I	I	VU
●	Golden eagle *Aquila chrysaetos*	III	III	I	LC
●	Pallas' sea eagle *Haliaeetus leucoryphus*	IV	I		EN

	Species	Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
●	White-tailed eagle *Haliaeetus albicilla*	III	I	I	NT
●	Black vulture *Aegypius monachus*	III	III	I	LC
●	Bearded vulture *Gypaetus barbatus*		III		VU
▲	Northern falcon *Falco rusticolus*	III	I	I	DD
▲	Saker falcon *Falco cherrug*	III	III	I	VU
▲	Peregrine falcon *Falco peregrinus*	III	III	I	DD
	Eagle owl *Bubo bubo*	III	III	I	LC
●	Scops owl *Otus scops*	III	III		LC

Species rarity categories are marked with letters and Roman numbers according to the threat of extinction.

RARE ANIMALS DISTRIBUTION. BIRDS. GALLIFORMES, GRUIFORMES, CHARADRIIFORMES

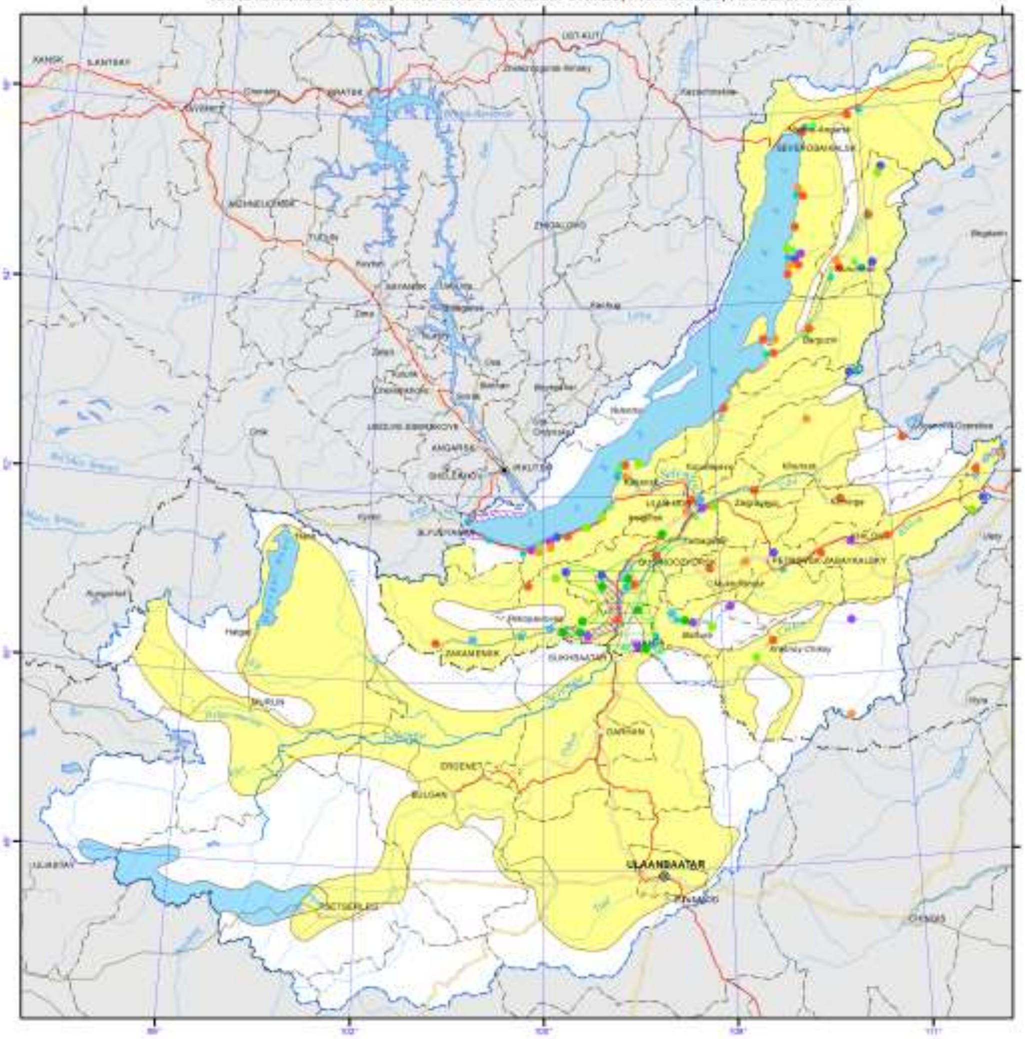


Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
	Altai snowcock *Tetraogallus altaicus*		III		NT
	Common crane *Grus grus*	III	III	III	NT
	White-naped crane *Grus vipio*	III		I	VU
	Hooded crane *[illegible]*	IV	IV	I	VU
	Demoiselle crane *Anthropoides virgo*	III	VII	I	LC
	Great bustard *Otis tarda*	0	III	I	VU
	Great bustard *Wassimyus Amaniayus*		III	I	LC

Species rarity categories are marked with letters and numbers according to the threat of extinction.

Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
	Pied avocet *Recurvirostra avosetta*	IV	III	I	LC
	Solitary snipe *Gallinago solitaria*	III	IV	III	LC
	Eurasian curlew *Numenius arquata*	III		III	LC
	Far Eastern curlew *Numenius madagascariensis*	IV	III	I	LC
	Asiatic dowitcher *Limnodromus semipalmatus*	I	III	I	VU
	Lonnberg's gull *Larus relictus*		VI	I	EN
	Caspian tern *Hydroprogne caspia*	IV	III	I	LC

RARE ANIMALS DISTRIBUTION. BIRDS. CORACIIFORMES, PICIFORMES, PASSERIFORMES



Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
●	[illegible] *Alcedo atthis*	IV	III		LC
●	Gruiformes, Charadriiformes *Dendrocopos leucotos*		III		
▭	White-backed woodpecker *Lanius isabellinus*		II		
●	Isabelline shrike *Troglodytes troglodytes*		III	IV	LC
●	Common wren *Tribura tacsanowskia*		III	IV	LC
●	Chinese Bush Warbler *Regulus regulus*		III	II	LC

Species		Irkutskaya Oblast	Republic of Buryatia	Zabaikal'skii Krai	Republic of Mongolia
▭	Golden-crested kinglet *Saxicola insignis*				NT
●	Hodgson's bushchat *Remiz pendulinus*		III		LC
●	Common penduline tit *Petronia petronia*		III	II	LC
▨	Rock sparrow *Emberiza godlewskii*	III	III		LC
●	Godlewski's rock bunting *Ocyris chrysophrys*		III	II	LC
▭ ●	Yellow-browed bunting *Ocyris aureolus*		II	II	NT

Species rarity categories are marked with letters and numbers according to the threat of extinction.

Protected areas

The drainage basin of Lake Baikal is a unique region with a high biotic and landscape diversity. Baikal Basin ecosystem conservation is provided by activities of the protected areas.

The importance of the principle of the territorial nature protection is shown in the history of creation of protected natural territories (PNT): the first in the confirmed written sources Mongolian protected area near Bogd mountain range was created in the Baikal basin in 1778. The Barguzinsky reserve became the first of the existing Russian state reserves, it was founded in 1916. International significance of the PNT Lake Baikal Basin currently is confirmed by the status of Lake Baikal as World Heritage Site by UNESCO, and the inclusion of four protected areas of the basin into the network of natural biosphere reserves by UNESCO program "Man and Biosphere" (MAB). In recent years, the environmental policy is entrusted with the task of implementation the concept of sustainable development, the Convention on Biological Diversity, ratified by Russia and other international environmental conventions, as well as requirements for the ecosystem of Lake Baikal as a World Heritage Site.

A special federal law "On the Protection of Lake Baikal" was adopted to save a World Heritage Site, which highlights two ecological zones - the central and buffer zone within the Russian part of the basin of Lake Baikal, which is the part of the Baikal Natural Territory (BNT). For determination of the conservation regime of each category of protected areas in Russia and Mongolia very similar laws are adopted: the federal law "On Specially Protected Areas" (from 14.03.1995) and the national law of Mongolia "On Specially Protected Areas" (from 15.11.1994 entered into force 01.04.1995) [Mongolian, 1996]. Due to the differences in definitions in these papers we adopted a common name "protected areas."

It should be noted that a significant number of protected areas are cut by the basin boundary; nevertheless, they are discussed in this atlas.

The PNT within the boundaries of the basin are unevenly distributed [Savenkova, 2001, 2002]. A part of the basin related to the Irkutsk region is almost completely reserved by Baikal National Park, the Baikal-Lena Reserve, Kochergatsky reserve and is an almost continuous strip along the western shore of the lake. In Buryatia the largest protected areas tend to Lake Baikal, and the rest are small reserves. The PNT in the Transbaikal part of the basin have a small area, but allow preserving the environment at the key rivers' heads. In the Mongolian part the PNT are distributed along the basin boundary, and in the center they are very few in number: only a small National Park Tuzhiyn Nars can be mentioned. Thus, the ecosystems surrounding Lake Baikal are saved sufficiently, although the PNT distribution on the rest of the basin and the protection of waters of the lake are not always optimal.

42 PNT of main categories of protected areas (see table) with a total area of 9326.525 thous. hectares operate within the boundaries of Lake Baikal Basin as of 2009. There are 8 reserves (including 4 biosphere reserves), 12 national parks, 22 partial and nature reserves. In addition, in the Russian part of the basin there are the so-called recreational areas – the PNT of local subordination, and in the Mongolian part- the PNT of regional status, aimag subordinated [Mongolia's Wild Heritage, 1996; Mongolia's tentative, 1999; Savenkova, Erdenetsetseg, 2000, 2002 ; Oyuungerel, 2009].

Table

List and brief description of the existing protected areas of the Baikal basin

Title	Administrative subject	*Aimag*	Area, ha	Year of foundaion
Reserves				
1. Baikal-Lena	Irkutsk Oblast	Olchonsky, Kachugsky	659919	1986
2. Baikalsky (biospheric)	the Republik of Buryatia	Kabansky, Seneginsky, Dzhidinsky	165724	1969
3. Barguzinsky (biospheric)	the Republik of Buryatia	Severobaikalsky	374346	1916

4. Bogdhan Uul (biospheric)	Mongolia	Tov	41651	1778
5. Dzherginsky*	the Republik of Buryatia	Kurumkansky	238594	1992
6. Sokhondinsky (biospheric)	Trans-Baikal region	Krasnochikoisky, Kyrinsky, Uletovsky	210988	1973
7. Khan Khentii	Mongolia	Tov, Khentii	1227074	1992
8. Hordol Sardag	Mongolia	Hevsgel	188634	1997
			3106930	
National Parks				
1. Noen Khangai	Mongolia	Arhangai	59088	1998
2. Trans-Baikal	the Republik of Buryatia	Barguzinsky	269002	1986
3. Prebaikal	Irkutsk Oblast	Ol'khonsky, Irkutsky, Slyudyansky	417297	1986
4. Tarvagatay Nuruu	Mongolia	Arhangai , Zavkhan	525440	2000
5. Tunkinsky	the Republik of Buryatia	Tunkinsky	1183662	1991
6. Tuzhiyn Nars	Mongolia	Selenge	70119	2002
7. Terelj	Mongolia	Tov	293168	1993
8. Hangayn Nuruu	Mongolia	Arhangai, Ovorhangay, Bayanhongor	888455	1996
9. Hevsgel	Mongolia	Hevsgel	838070	1992
10. Hogno Tarna	Mongolia	Arhangai , Ovorhangay , Bulgan	83612	1996
11. Khorgo	Mongolia	Архангай	77267	1965
12. Khustain Nuruu	Mongolia	Tov	50620	1998
			4755800	
Wildlife sanctuaries and nature reserves				
1. Altacheysky ***	the Republik of Buryatia	Mukhorshibirsky	71627	1966
2. Angirsky	the Republik of Buryatia	Zaigraevsky	40380	1968
3. Atsinsky	Trans-Baikal region	Krasnochikoisky	64500	1968
4. Bathaan Uul ***	Монголия	Ovorhangay, Tov	58800	1957
5. Borgoyskoy	the Republik of Buryatia	Dzhidinsky	42180	1979
6. Burkalsky ***	Trans-Baikal region	Krasnochikoisky	195700	1978
7. Butungarsky	Trans-Baikal region	P-Transbaikal	73500	1977
8. Upper Angara.	the Republik of Buryatia	Severobaikalsk	12290	1979
9. Ivano- Arakhleysky	Забайкальский край	Chita	210000	1993
10. Kabansky ***	the Republik of Buryatia	Kabansky	12100	1967
11. Kizhinginsky	the Republik of Buryatia	Kizhinginsky	40070	1970
12. Kochergatsky region	Иркутская область	Irkutsk	12428	1967
13. Namnan Uul ***	Mongolia	Bulgan Hevsgel	29600	2003
14. Prebaikal	the Republik of Buryatia	Prebaikalsky	73170	1981
15. Snezhinskiy	the Republik of Buryatia	Zakamensky	230000	1976
16. Tugnuisky	the Republik of Buryatia	Mukhorshibirsky	30000	1977
17. Uzkolugsky	the Republik of Buryatia	Bichursky	15330	1973
18. Ulyunsky	the Republik of Buryatia	Barguzinsky	18350	1984
19. Frolikhinsky ***	the Republik of Buryatia	North-Baikal	109200	1976
20. Hanzhargalant Uul	Mongolia	Bulgan	60000	2003
21.Hudaksky	the Republik of Buryatia	Khorinsky	50000	1976
22. Enheluksky	the Republik of Buryatia	Kabansky	14570	1995
			1463795	
		TOTAL	**9326525**	

Notes:

(red)	The PNT is part of the central ecological zone of the BNT and the World Heritage Site "Lake Baikal"
(green)	The PNT is a part of the buffer ecological zone of the BPT

* 1/3 of its territory belongs to the buffer ecological zone of the BNT;
** 1/10 of its territory belongs to the central ecological zone of the BNT and the World Heritage Site "Lake Baikal";
*** Has a federal status (Russia) or nationwide (Mongolia) of the PNT

They plan to create 20 new protected areas of different categories within the Baikal basin.

In the Russian part these are the preserves "The Selenga Delta" (Buryatia) and "Ikh Tayrisin" (Tyva), national parks "Chikoysky" (Trans-Baikal region) and "Onotsky" (Irkutsk region), partial preserves "Verhneulkansky" (Buryatia/Irkutsk Region), "Khila" (Buryatia/Chita region), "Malkhansky" (Trans-Baikal region), "Talovskiye Lakes" (Irkutsk region), as well as the dominant largest natural parks "Arey", "Yamarovka" (Trans-Baikal region), "Utulik - Babkha", "Chersky Peak", "Warm Lakes" (Irkutsk region), "Upper Angara", "Kurkulinsky", "Mezhdurechye", "Posolsky Sor"," Slyudyanskiye Lakes", "Tagley", "Khakusy", "Yarki"(Buryatia) [Kalikhman, 2007].

In the Mongolian part of the basin the new protected areas will be the following 11 areas: parks "Burengiyn Nuruu", "Delger-Muren," national park "Zed - Buteliyn Nuruu" and nature reserves "Arkhan Buural-Badaryn Nuruu", "Bohloo-Chagtayn Nuruu", "Ikh Tunel-Emged Ovgod", "Namnyn uul", "Tovhonhaan uul", "Terhen Tsagaan uul", "Khalkhali bulnay", "Hanzhargalant uul" [Kalikhman, 2011; Special protected, 2000].

Besides, they plan to organize five transboundary protected areas within the boundaries of the basin: "The Amur river head", "Khentei - Chikoyskoye Highlands", "Selenga", "From Kubsugul to Lake Baikal", "Delger - Muren" [Savenkova, 2001; Oyungerel, Savenkova, 2004]. Relative similarity laws on the PNT in Russia and Mongolia allows you to coordinate their activities and in general the territorial nature protection in the neighboring territories. This fact can be proved by the already existing transboundary protected area between Mongolia and Russia out of the Baikal Basin: from 1994 the tripartite cluster transboundary reserve "Dauria", which is composed of the Russian reserve "Daursky" (Trans-Baikal region), the Mongolian "Mongol Daguur" and the Chinese "Dalainor". In 2003 a clustered transboundary World Heritage Site "Uvs Nuur Basin" was founded, consisting of 12 scattered sites, 5 of which are located on the territory of Mongolia, and 7 on the territory of Russia in the Republic of Tyva [Kalikhman, 2012].

It is possible to insist that the current system of protected areas of the Baikal Basin covers the ecosystems in the region not fully and is unevenly distributed. In this regards, it is expected to increase the number of protected areas and their total area to increase the effectiveness of conservation measures.

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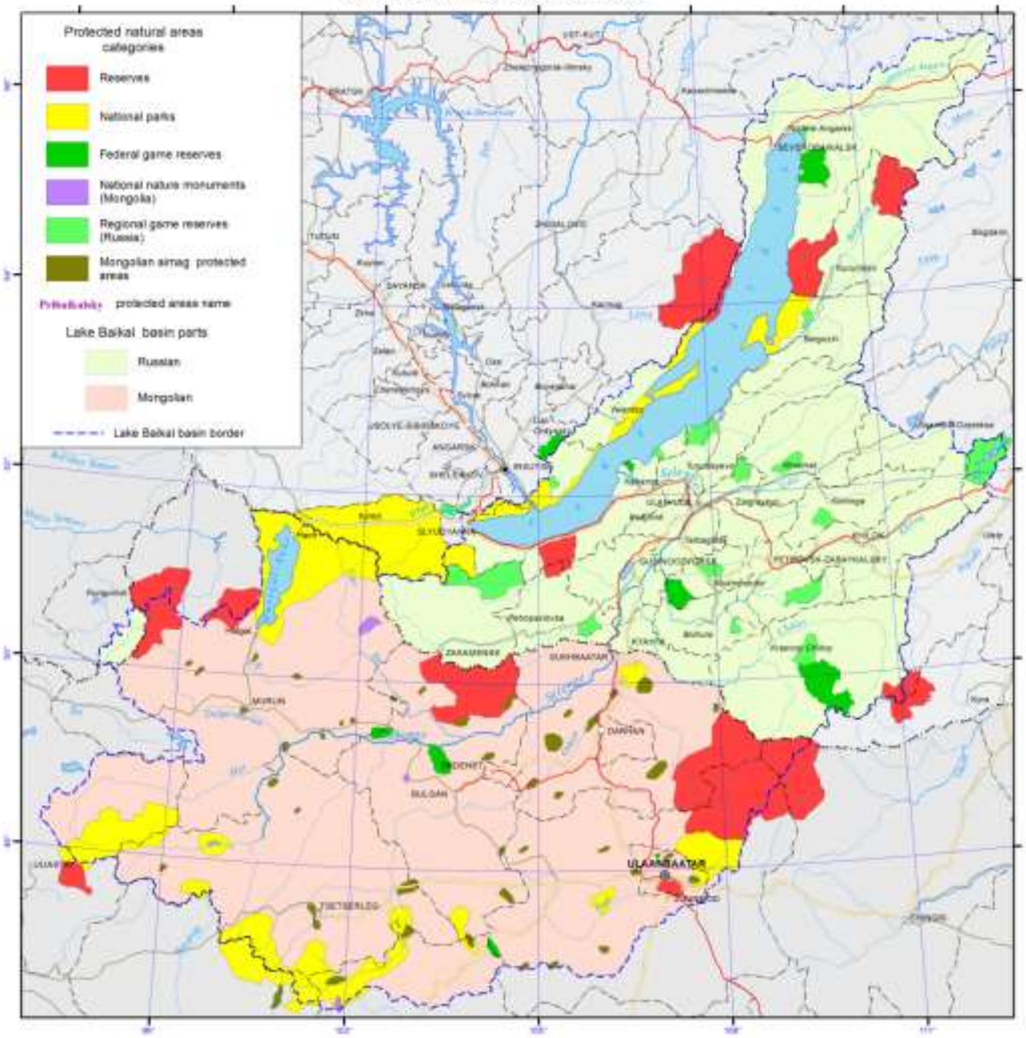
SPECIALLY PROTECTED NATURAL AREAS



Environmental non-profit organizations

Environmental wellbeing of the Baikal watershed basin is largely determined by the activities of the environmental non-governmental organizations (ecoNGOs). The main purpose of the ecoNGOs is to protect nature. In keeping it they see the basis of sustainable development of society. Their effectiveness is determined by the personal qualities and civic engagement of people working there, and especially by the leaders.

The number increase of ecoNGOs was observed in the 90 ies of 20th century that was determined by state reforms in Russia and Mongolia and the growing interests of citizens to nature protection. Their creation and activities was supported from abroad. Since 2012 their functioning in Russia is influenced negatively by the entry into force of the law "Foreign Agents", the NGOs involved in political activities and financed from abroad fall within the scope of this law.

EkoNGOs operating in the territory of the Baikal watershed basin, are different in their territorial status (international, national, inter-regional, regional and local) and organizational and legal forms (*public associations* - public organization, public fund, public institution, social movement and *non-profit organizations* - autonomous , nonprofit organization, nonprofit foundation, non-profit partnership, association (union, alliance) legal persons and institution).

In Mongolia, the creation of ekoNGOs is related to the protection of the Selenga river and its tributaries from the negative effects of mining, construction of power plants, water transfer projects of the Orkhon River in arid areas of the Gobi. The ekoNGOs established in all the river basins with the open field development. The largest public associations are "United movement of rivers and lakes of Mongolia" and "Nature Protection Coalition of Mongolia". In the actions of ekoNGOs are involved from 300 to 8,000 persons.

On the Russian part of the Baikal basin the organizations, defining public environmental activities for protection of Lake Baikal are Russian public organization "Russian Society of Nature" and the All-Russian public organization "Russian Geographical Society", which offices operate in all regions of the Baikal basin. In 2012 the participants of the project initiated by Russian Society of Nature "Clean Waters of Pribaikalia", were presented by more than 60 environmental organizations, educational institutions established in 23 areas of the Irkutsk region. The members of Russian Geographical Society are individuals and legal persons. Widely known of these is the "Fund for Protection of Lake Baikal", established by the Group of Companies "Metropol". Great job is conducting by non-profit organization "WWF - Russia" and others all-Russian organization.

Total number of registered ekoNGOs at the beginning of 2013 in Buryatia, Transbaikalia and Irkutsk region was about 100 organizations. The overwhelming majority of them belong to the public associations, which are mainly represented by non-profit organizations.

In Buryatia the most famous ekoNGOs include regional public associations "Buryat Regional Association on Baikal", "Baikal Information Center Gran", "Baikal -Eco", "Ecological Association LAT", "Ecological and Humanitarian Center ETNA", "Ecological center "Planet and Delta", "Ekoliga", NGO "Great Baikal Trail Buryatia", Local environmental NGO "Turka". In the Irkutsk region these are regional non-profit organizations "Baikal Environmental Wave" (BEW), "Association of Baikal Ecological Network", "Baikal Environmental Patrol", Interregional public organization "Great Baikal Trail", private non-state research institution "Baikal center of field studies “Wildlife of Asia”, NGO "Protecting Baikal together", Irkutsk city public organization "Youth Environmental alliance". In the Transbaikalia this is regional public institution "Public Environmental Centre Daura". Also many other organizations operate successfully.

Regional and local ekoNGOs involve volunteers from different countries to fulfill their projects and their projects are often international.

Information on the activities of the most active ekoNGOs operating in the Russian part of the Baikal region is provided in public reports on the state of Lake Baikal and government reports on the state and protection of the environment in Buryatia, Transbaikalia and Irkutsk Region. Summary information on them are given in the form of separate essays and reference "White Paper" prepared by the ekoNGO "Ekoliga" and is published in 2010.

International non-governmental non-profit organization "Greenpeace" is the most active of the organizations having the head offices outside Russia and Mongolia.

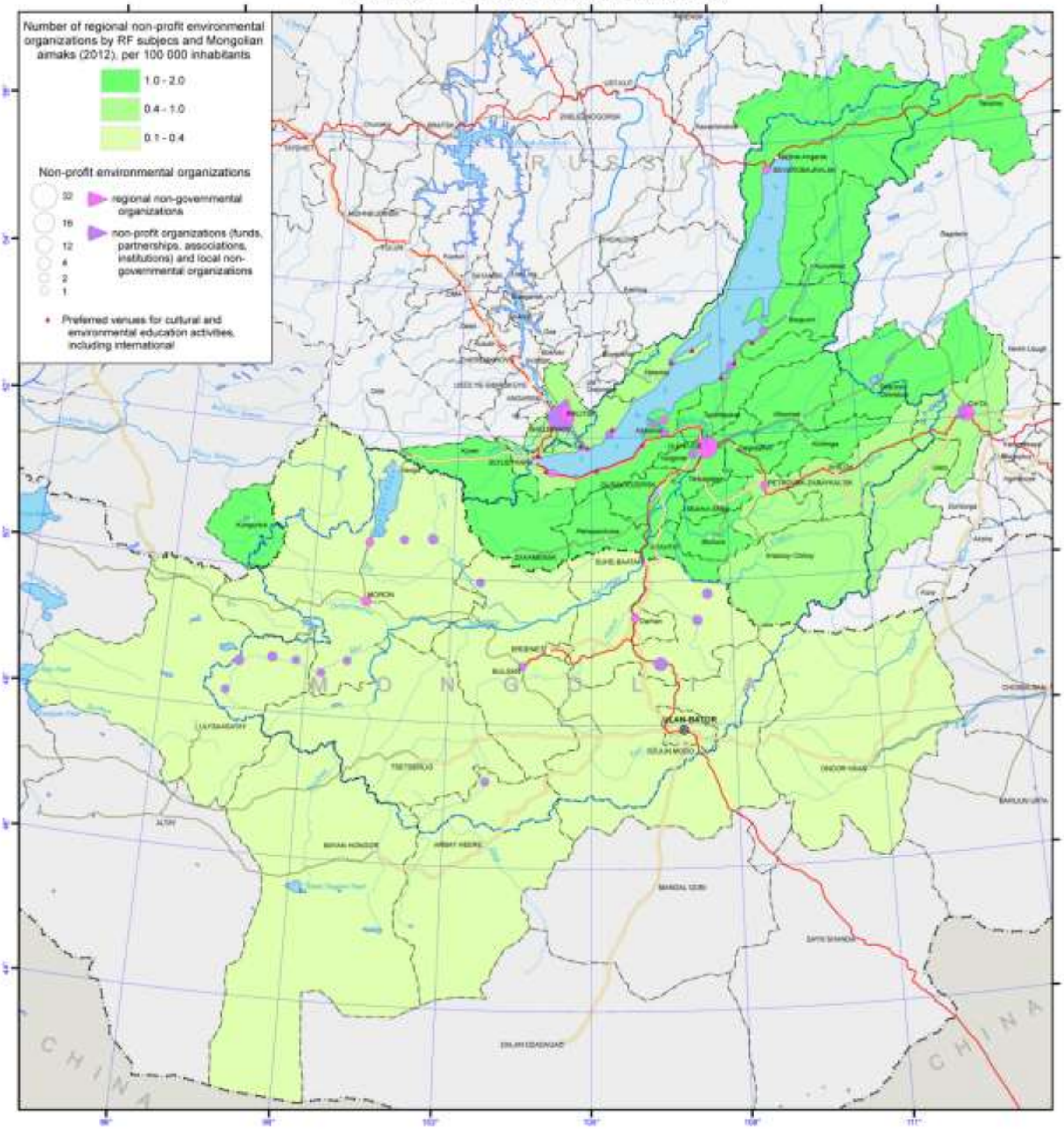
In the Baikal watershed basin the ekoNGOs conduct research, educational and propaganda work among the population, intensifying its environmental activities, also involve population in the decision-making process. They organize social control, participate in the preparation and discussion of laws aimed at optimizing the nature management, in public hearings on the development of fields and construction of industrial facilities in the creation of protected areas. They develop eco-tourism, and shoreline restoration, as well as other activities, including the "Days of Baikal". The ekoNGOs often receive federal or regional funding, winning contests of socially-oriented projects.

The ekoNKOs help unite the efforts of government, science, business and society in finding solutions of environmental problems. They enter public environmental councils in the regions, hold conferences, round tables, telethons, presentations, seminars, courses, summer schools, etc. In 2013, the international scientific-practical conference held by BEW ("Rivers of Siberia and the Far East", Irkutsk and Listvyanka) and "Russian Society for Ecological Economics" together with Irkutsk regional divisions of Russian Geographical Society and Russian Society of Nature ("Management of ecological and economic systems: interaction of government, business, science and society", Irkutsk).

Building of ekoNGOs coalitions and international cooperation is essential for achieving sustainable development of the regions. This defines the creation of a network of ekoNGOs in Buryatia and Mongolia "Friends of Lake Baikal", long-term cooperation with American organization "Tahoe-Baikal Institute" to exchange experiences in environmental management in the territory of the Baikal watershed basin, Tahoe, Hovsgol and Great Lakes. Other joint projects, which promote sustainable development of communities of different levels, are successfully conducted.

As a result of activity of ekoNGOs to large extent Baikal was included on the List of World Heritage, the Baikal natural territory was zoned, more than 700 kilometers of trails were built, the activity of several environmentally hazardous industries were stopped, including the Baikal pulp and paper mill. On its territory, the Russian government in December 2013 decided to create a nature museum and exhibition, information and educational complex, for which control jointly with the Charitable Fund for Environmental Protection "Green Future" (NF, Moscow) they established ANO "Expocentre" "Reserves of Russia". Often the results of ekoNGOs activity become the basis of major federal and regional programs.

NON-PROFIT ENVIRONMENTAL ORGANIZATIONS



ECOLOGICAL STATE AND PROTECTION OF LAKE BAIKAL

Maps of the bottom of lake Baikal: ITS RELIEF AND SLOPES

History of depth measurements in Lake Baikal

The history of depth measurements in Lake Baikal goes back to 1798, when E. Kopylov and S. Smetanin, employees of a mine plant, carried out 28 measurements between the head of the Angara River and the mouth of the Selenga River. One of such measurements yielded a maximum depth of 1,238 m. Lake Baikal was immediately recognised as the second deepest lake in the world.

In 1869-1876, B. Dybovsky and V. Godlevsky compiled a detailed and precise (for that time) map of Southern Baikal, which covered 11 cross-sections. Measurements of depth were carried out from the ice, which provided high accuracy [Dybovsky, Godlevsky, 1871, 1877].

In 1902-1908, the Pilot Chart of Lake Baikal and Atlas of Lake Baikal were published as a result of numerous hydrographic expeditions under the leadership of F. Drizhenko, in which the depths were shown in detail for the coastal areas of the lake.

In 1925, the USSR Academy of Sciences developed a long-term project under the supervision of G. Vereshchagin to study bathymetry of Lake Baikal. This initiative resulted in the organisation of Limnological Station, later reorganised into Limnological Institute. This project helped discover the deepest place in the lake and an underwater shallow ridge named the Akademichesky Ridge, which separates the northern basin from the central one. New bathymetric maps (scales 1:300,000 and 1:500,000) were compiled. They were demonstrated at the International Limnological Congress held in Rome in 1934.

In 1962, A. Rogozin and B. Lut compiled a new bathymetric map (scale 1:300 000) as a result of long-term bathymetric expeditions. Based on this map, the Central Department for Navigation and Oceanography of the Russian Federation Ministry of Defence (CDNO) published maps "Northern and Southern Areas of Lake Baikal" in 1973 and 1974.

In 1979-1985, HDNO carried out new systematic echo-sounding bathymetric measurements throughout the entire Lake Baikal. Traverses had a spacing of 100 and 250 m in the coastal waters and 1 km in the abyssal areas. As a result of these investigations, a four-sheet bathymetric map of Lake Baikal was published in 1992 (scale of 1:200,000). To date, this is the most reliable bathymetric map of Lake Baikal. However, it has some shortcomings:

- bathymetry is based only on some available original data;
- bathymetry is mainly represented by isobaths with a step of 100 m up to a depth of 1,000 m and 500 m for depths exceeding 1,000 m;
- recent investigations showed that significant discrepancies can exist between true depth values and echo-sounding measurements, which are attributed to discrepancies between real acoustic speed in Lake Baikal and calculated rate for the echo-sounder.

New bathymetric map of Lake Baikal

In 1999, an international group of experts was organised to jointly compile a new, more precise bathymetric map of Lake Baikal. It was necessary to carry out more detailed recalculations of measurement values, which were used for maps in 1992, to digitise and adjust them to the real acoustic speed, to integrate them with the echo-sounding data obtained earlier, and to compile a new more complete computer map of Lake Baikal based on ALL available measurement data. This project was financially supported by INTAS (International Association for the Promotion of Cooperation with Scientists from the New Independent States of the Former Soviet Union).

The CD ROM is available with final results of this project. Coordinates of points are in the Mercator's projection, Ellipsoid WGS 1984. The latitude for all generated maps is $53^{0}00'$N.

New bathymetric data made it possible to obtain specified morphometric information on Lake Baikal and to present it in tables. Taking into account that the lake surface is at 455.5 m a.s.l. (the Baltic system), the highest point of Lake Baikal is situated at 1,186,5 m below the sea level.

Table 1. Maximal depths, coordinates of maximal depths, volume, surface and average depths of Lake Baikal and its basins

Basin	Maximal depths, m		Coordinates (De Batist et.al., 2002)		Volume, km^3	Surface, km^2	Average depth, m
Whole lake	-	-	N	E	23,615.39	31,772	744.4
Northern	904	903*	54°20'43"	108°42'53"	8,192.07	13,690	598.4
Central	1,642	1637*	53°14'59"	108°05'11"	9,080.65	10,600	856.7
Southern	1,461	1,446*	51°46'32"	105°22'03"	6342.67	7,432	853.4

Table 2. Sectional area from isobaths (km^2)

Isobaths (m)	Whole Lake Baikal De Batist et.al., 2002	Southern basin	Central basin	Northern basin	Whole Lake Baikal
0	31,722	7,432	10,600	13,690	31,722
50		6,681	9,650	13,842	30,173
100	27,770	6,315	9,218	12,664	28,197
150		6,279	9,078	12,053	27,410
200	26,290	6,151	8,803	11,701	26,655
250		6,041	8,618	11,271	25,930
300	24,890	5,871	8,431	10,916	25,218
350		5,706	8,189	10,488	24,383
400	23,260	5,636	8,026	9,863	23,525
450		5,512	7,749	9,371	22,632
500	21,530	5,341	7,501	8,902	21,744
550		5,145	7,270	8,352	20,767
600	19,630	4,898	7,029	7,871	19,798
650		4,693	6,732	7,399	18,824
700	17,720	4,484	6,517	6,840	17,841
750		4,173	6,244	6,221	16,638
800	15,360	4,025	6,121	5,242	15,388
850		3,652	5,998	3,049	12,699
900	9,443	3,597	5,583	68.,5	9,248.5
950		480	5,489		8,969
1,000	8,478	3,382	5,104		8,486
1,050		3,298	4,800		8,098
1,100	7,703	3121	4,588		7,709
1,150		2927	4,237		7,164
1,200	6,614	2889	3,731		6,620
1,250		2594	3,433		6,027

1,300	5,428	2364	2,879		5,243
1,350		1658	2,707		4,365
1,400	3,562	1021	2,461		3,482
1,450		15,69	2,106		2,122
1,500	31,798		1,799		1,799
1,550			1,482		1,482
1,600	1,091		1,092		1,092
Total volume		6,681	9,650	13,842	31,626

Table 3. Volumes between isobath surfaces (km^3)

Isobaths (m)	Whole Lake Baikal De Batist et.al., 2002	Southern basin	Central basin	Northern basin	Whole Lake Baikal
0-50		355	507	683	1,545
50-100	2,894,950	325	472	663	1,460
100-150		315	457	618	1,390
150-200	2,700,160	311	447	594	1,352
200-250		305	436	574	1,315
250-300	2,558,930	298	426	555	1,279
300-350		289	416	535	1,240
350-400	2,411,740	284	405	509	1,198
400-450		279	394	481	1,154
450-500	2,240,230	271	381	457	1,109
500-550		262	369	431	1,062
550-600	2,058,090	251	357	406	1,014
600-650		240	344	382	966
650-700	1,868,860	229	331	356	916
700-750		216	319	327	862
750-800	1,659,940	205	309	287	801
800-850		192	303	207	702
850-900	1,338,580	181	290	77.9	549
900-950		177	277		454
950-1,000	887,896	172	265		437
1,000-1,050		167	248		415
1,050-1,100	811,060	160	235		395
1,100-1,150		151	221		372
1,150-1,200	716,666	145	199		344
1,200-1,250		137	179		316
1,250-1,300	606,627	124	158		282
1,300-1,350		101	140		241
1,350-1,400	452,442	67	129		196

1,400-1,450		25.9	114		140
1,450-1,500	243,954		97.6		97.6
1,500-1,550			82.0		82
1,550-1,600	148,175		64.4		64.4
1,600-1,640			27		27
Total volume	18,360	6,235	9,399	8,143	23,777

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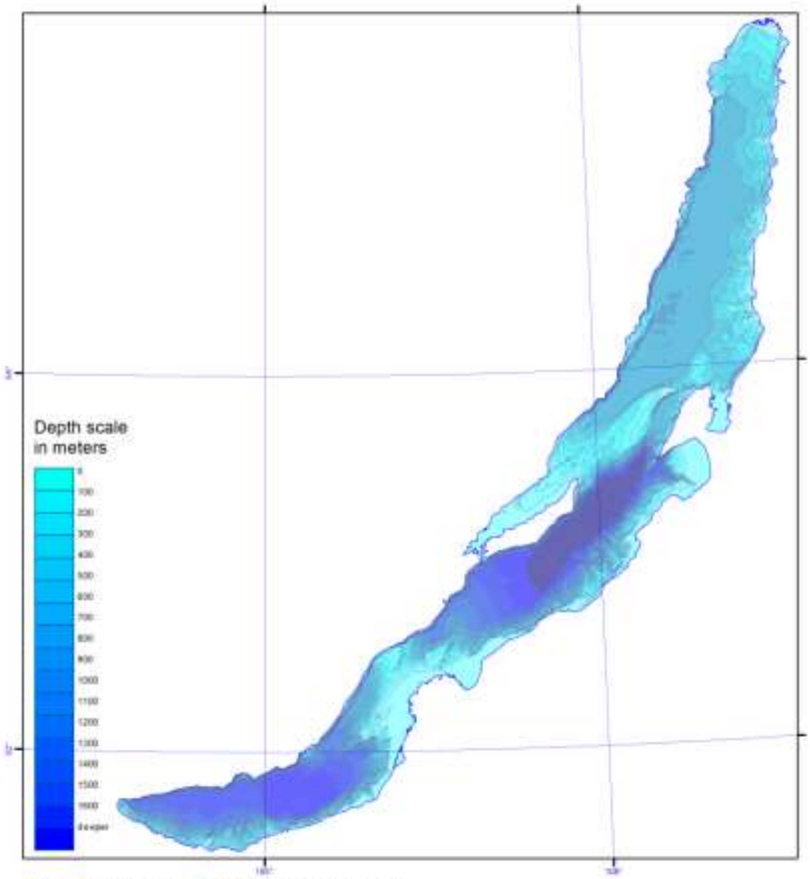
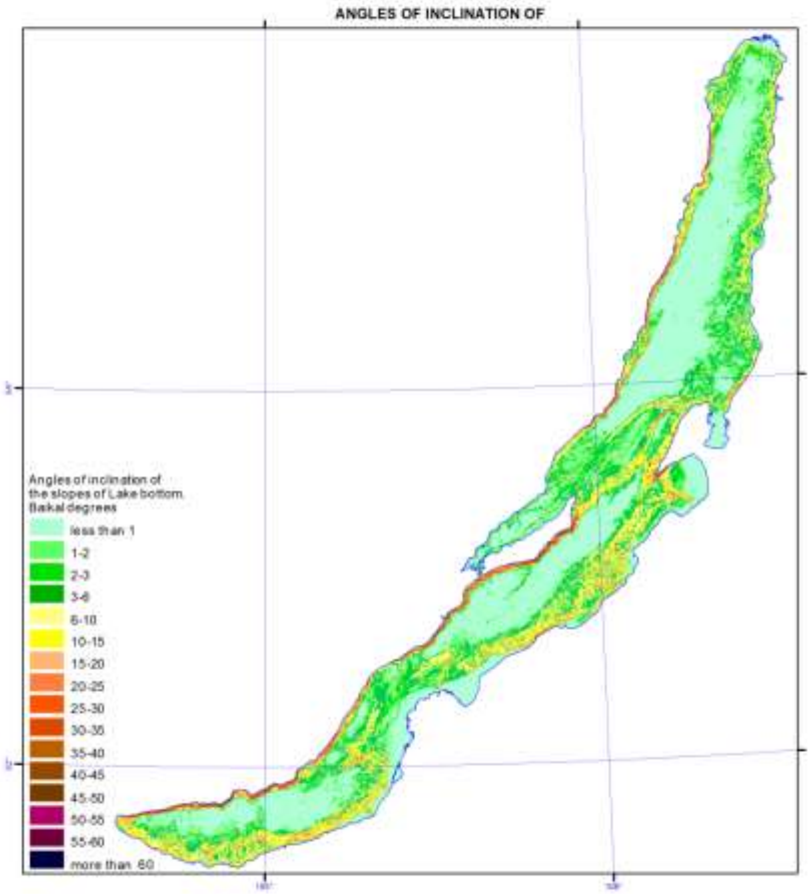
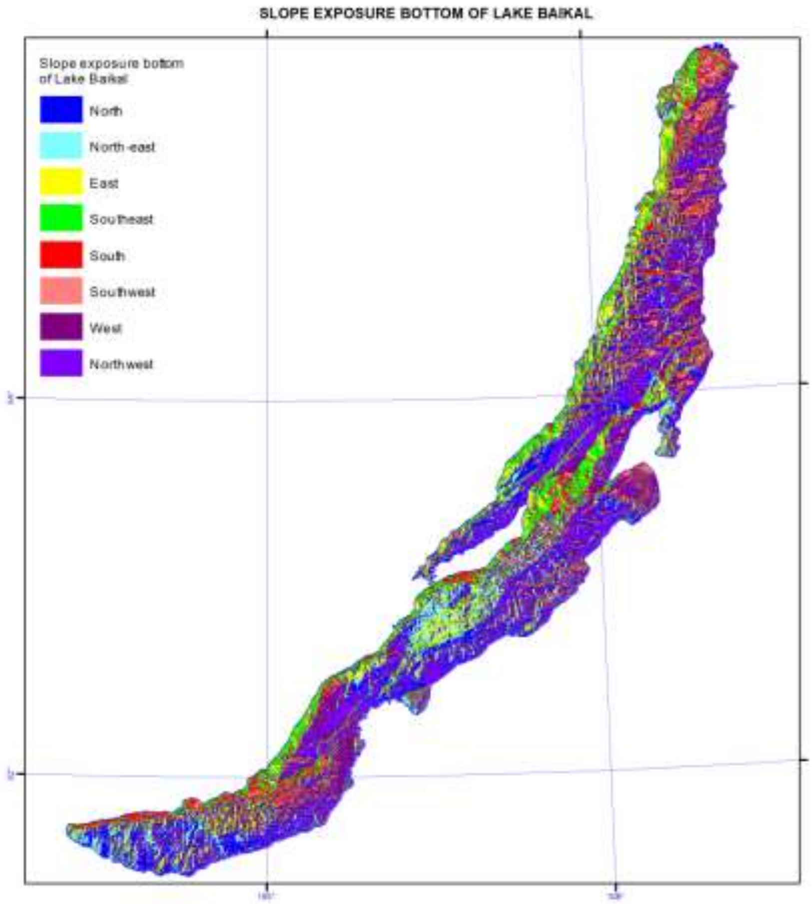
BOTTOM CONTOUR



Edge of Lake Baikal 456 meters above sea level

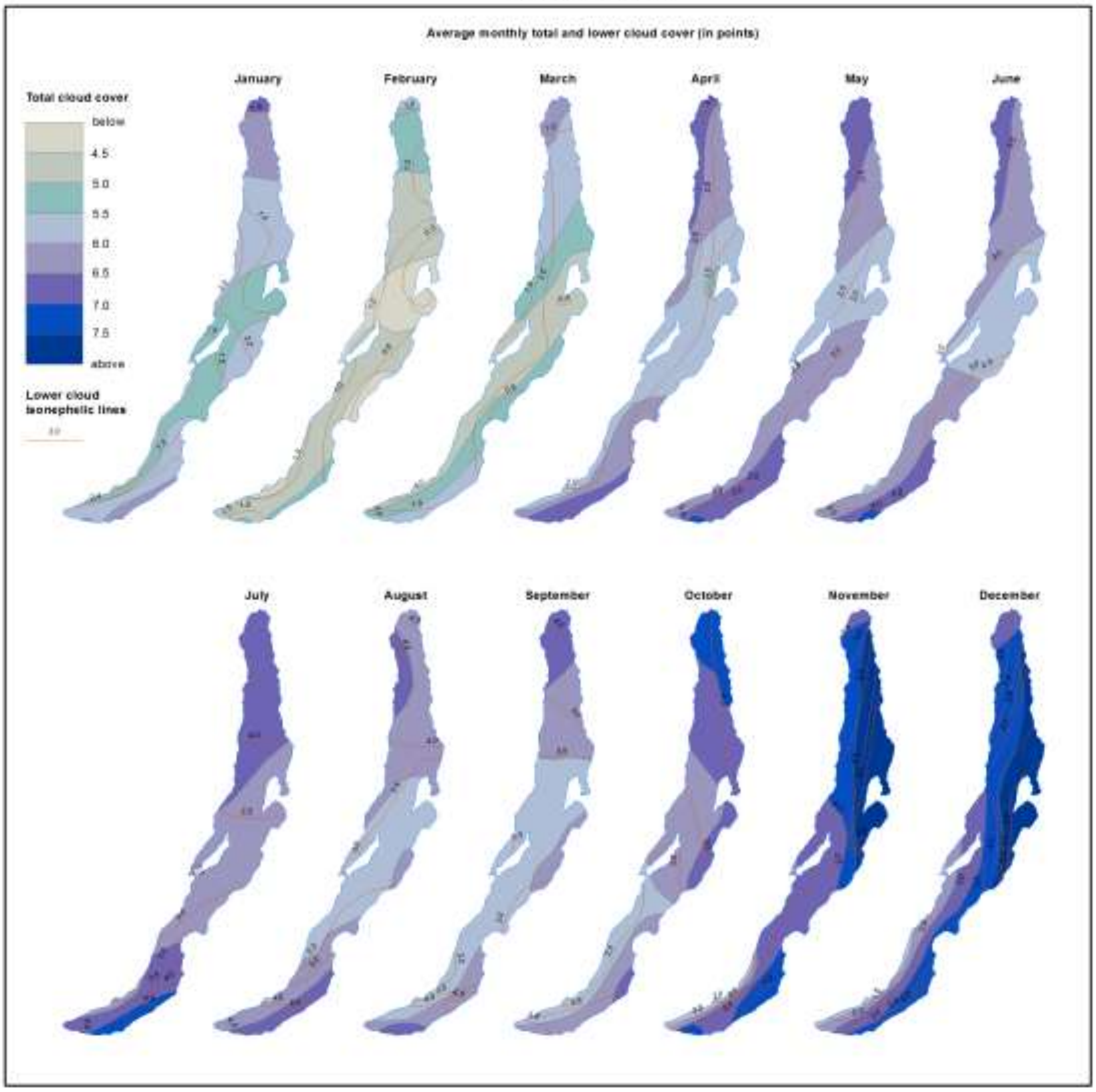

ANGLES OF INCLINATION OF
Angles of inclination of the slopes of Lake bottom. Baikal degrees
less than 1
1-2
2-3
3-6
6-10
10-15
15-20
20-25
25-30
30-35
35-40
40-45
45-50
50-55
55-60
more than 60


SLOPE EXPOSURE BOTTOM OF LAKE BAIKAL
Slope exposure bottom of Lake Baikal
North
North-east
East
Southeast
South
Southwest
West
Northwest

Cloud cover

Two maxima are recorded in the annual trend of cloud cover: summer (June-July) and pre-ice freezing (November-December). The latter prevails. The highest cloud cover values (7-8 oktas) and increased recurrence of overcast days (up to 75-80%) are registered in December on the north-eastern coast of the lake, whereas the lowest values (no higher than 4 oktas) are observed in February-March on the western shore, particularly in Maloye More (Small Sea). The foehn effect plays a significant role during the transfer of air masses via the Primorsky and Baikal Ridges, which causes considerable drop of air humidity. In October-December, the cloud cover is very low above Lake Baikal due to the intense water evaporation from the ice free surface of the lake.

CLOUD COVER


Average monthly total and lower cloud cover (in points)
Total cloud cover
below
4.5
5.0
5.5
6.0
6.5
7.0
7.5
above
Lower cloud isonephelic lines
January
February
March
April
May
June
July
August
September
October
November
December

Fogs

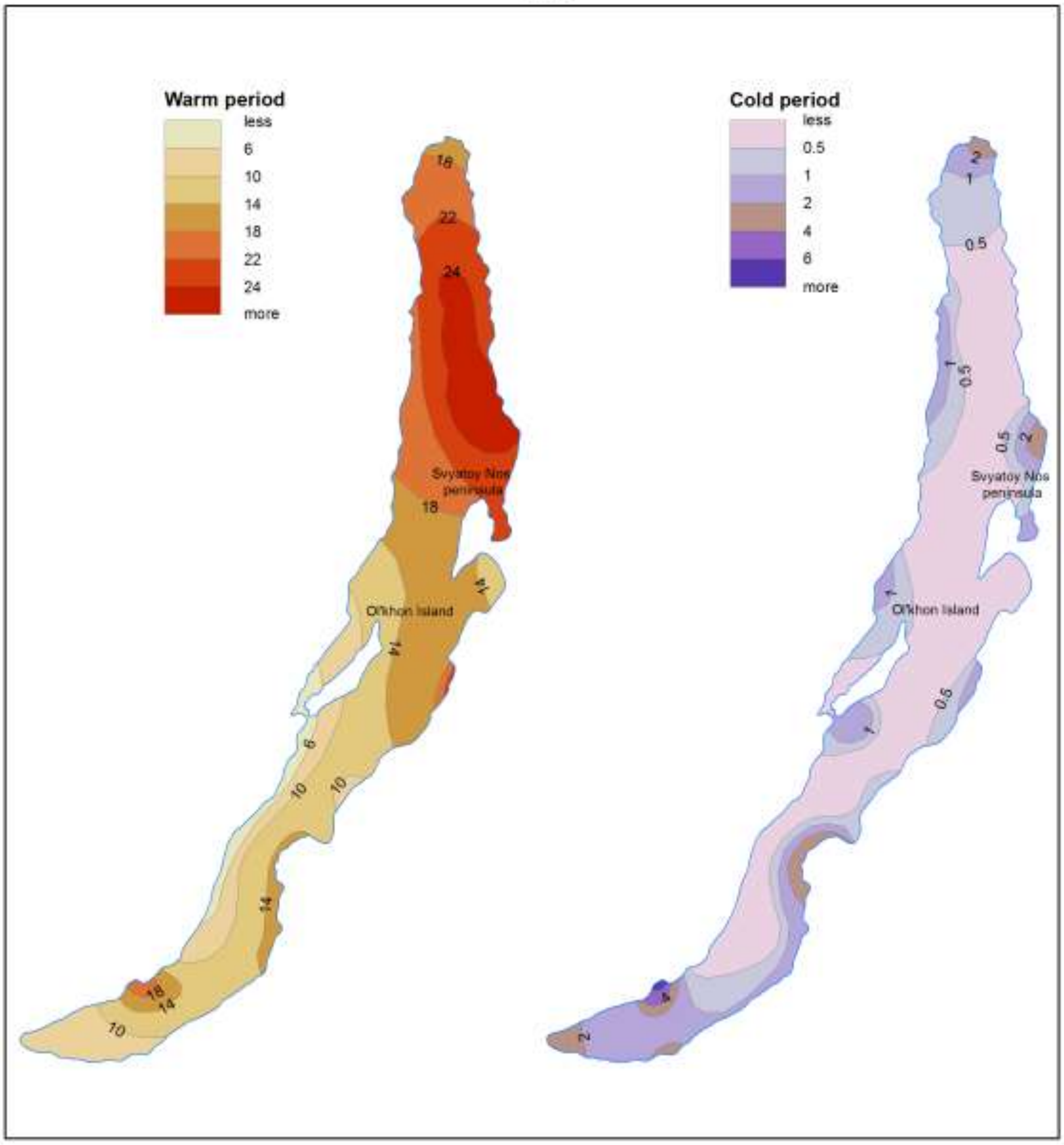
Fogs at Lake Baikal form similar to sea fogs: they correlate with the relatively consistent seasonal drifting of air masses and with the seasonal distribution of winds. However due to the isolated inland location of the lake and the influence of the surrounding continental landmass, the Baikal fogs are to be classified as a separate type of advection fogs of large inland lakes and water reservoirs. The number of foggy days is the highest along the Northeast coast of Lake Baikal, and the lowest in the Central and the Southwest parts of the lake. The fogs lie mainly in the curves of the coastline, bays, coves, mouths of the rivers, flowing into Lake Baikal, and the numerous creek valleys that are open towards the lake. In the annual cycle, the fogs are most frequent in July, while the meteorological stations located beyond the Lake Baikal watershed (Irkutsk, Goudzhekit, Bayanday) register the fog frequency peak in August. The Irkutsk meteorological stations registers also the second peak in winter, in December-January. The Northern stations report higher frequency of fogs in summer and register a single sharp peak in July. The Southern stations report lower frequency of fogs in the annual cycle, while the annual peak is extended over June, July and August.

At Lake Baikal, condensation prevails in summer, and evaporation – in winter. In the warm season, fogs are formed by passing of a warm front, or within a diffused pressure field above the wet underlying terrain. These fogs are formed by condensation of vapor in a mass o fair warmed up above the land as it passes over the cold water. Summer fogs are very dense and persistent, especially in the first half of summer.

Evaporation fogs occur during the cold season. Until the lake freezes over, these fogs continuously stay above the water surface or can be lifted into low cloud. In winter, the Siberian High and ground inversions accompanied by significant fall of temperature form radiation fogs. Winter fog formation is most commonly connected with advection of cold air over the warmer water surface. In cold season, as well as during the summer months, other types of fog can occur at Lake Baikal, caused by various reasons: temperature gradient between land and sea, the occurrence of floe patches and clear water surface, clearings in the fast ice of Lake Baikal.

Forecasting Baikal fogs requires an integrated approach with attention to such factors as their movability and the complexity of their formation processes. One has to take into account the general meteorological situation, the character of breeze/monsoon circulation in the area, the influence of coastline. It is important to consider the influence of West winds on the fog formation at the East coast, especially in winter.

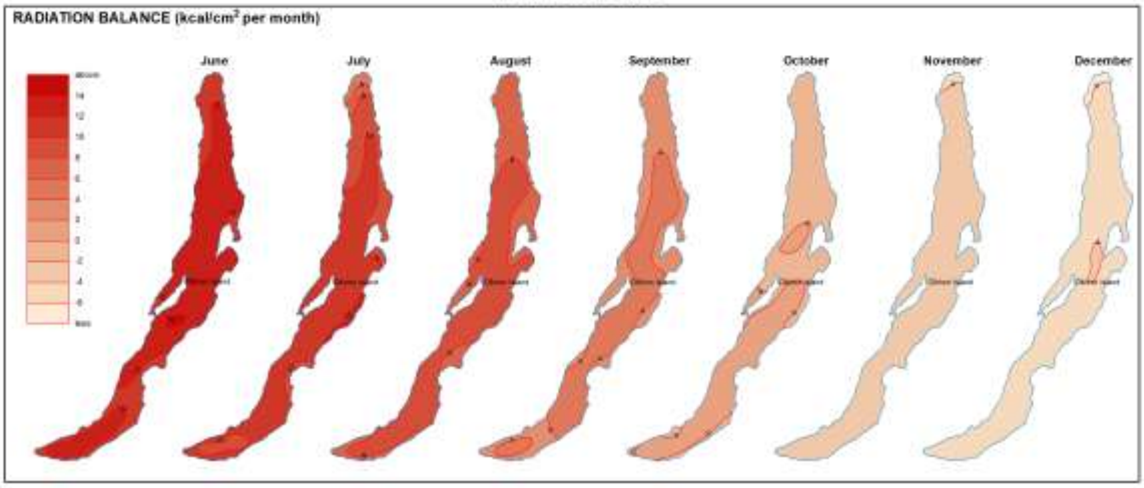
FOGS


Warm period
less
6
10
14
18
22
24
more
Svyatoy Nos peninsula
Ol'khon Island
Cold period
less
0.5
1
2
4
6
more
Svyatoy Nos peninsula
Ol'khon Island

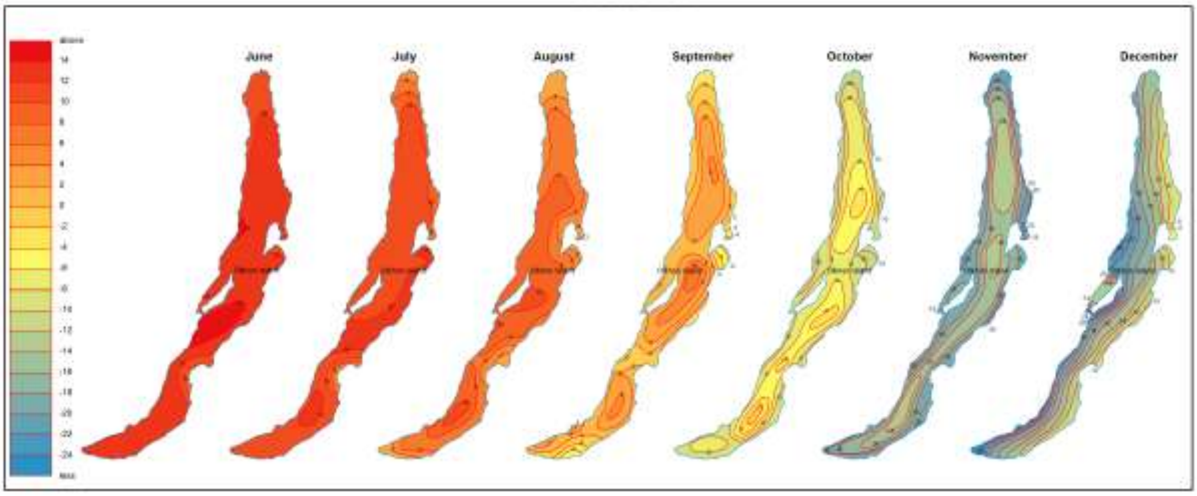
Radiation and thermal balance of water surface

Absorbed solar radiation is the main thermal source of the lake water column. It depends on incident solar radiation and reflected radiation (albedo). Thus, it has a well-defined seasonal trend. Radiation balance of the Lake Baikal water surface is a sum of absorbed solar radiation and effective radiation of water surface. This balance is positive from April to September and negative from October to March. In general, radiation balance of the lake is positive throughout the year, changing from 1,900 MJ/m^2 in the Selenga River area to 700-800 MJ/m^2 in the northern part of the lake. Spatial distribution of radiation balance of the lake surface depends on cloud regime during warm period. Radiation balance varies insignificantly because of inconsiderable changes of the cloud cover. In cold period, the distribution of radiation balance is affected not only by the cloud cover but also by the difference in the albedo of water and snow. Therefore, the radiation balance in Northern Baikal is much lower than that in Central and Southern Baikal. Radiation balance of the water surface is a determining element in the thermal regime of the lake. Because of high water heat capacity, constant time lag is recorded in the seasonal trend of temperature parameters in comparison with radiation characteristics. Therefore, maximal accumulated radiation and radiation balance are recorded at Lake Baikal in June and the highest air and water temperatures in August.

RADIATION BALANCE



HEAT BALANCE



Thermal and ice regimes

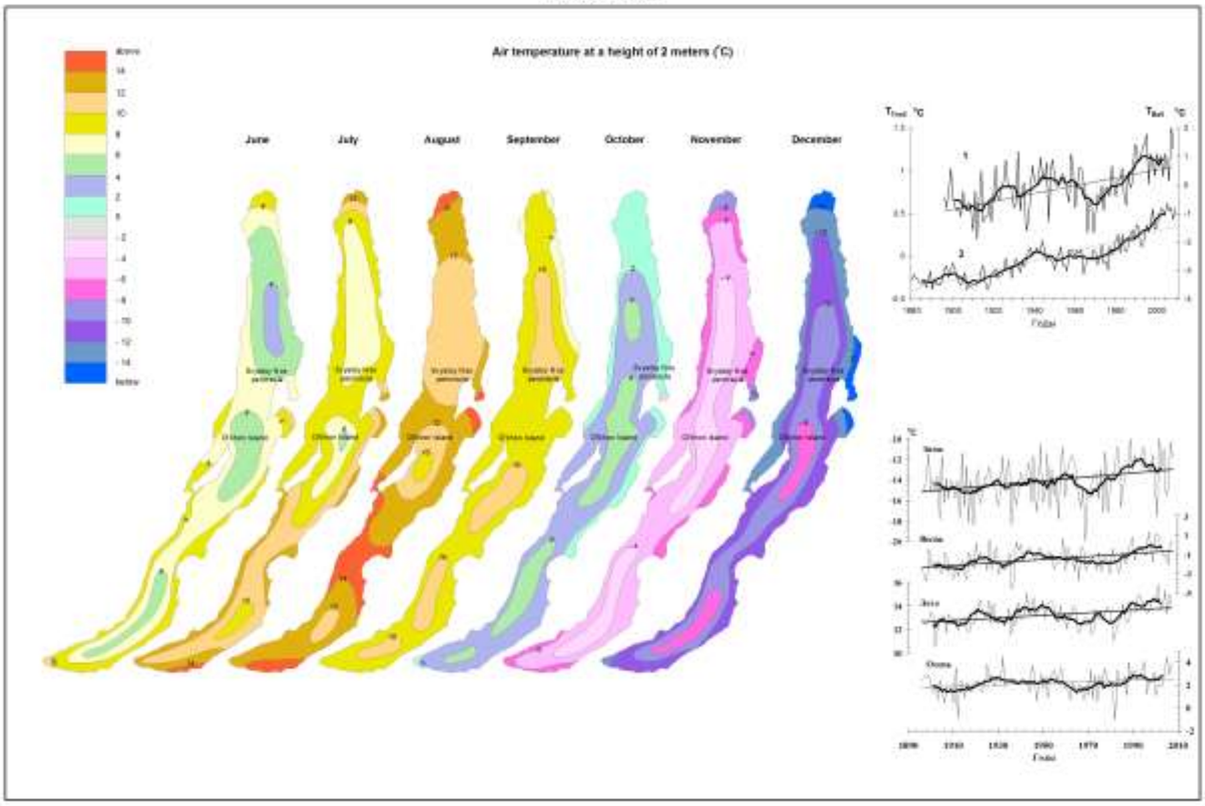
Air temperature. General trend of air temperature changes at Lake Baikal corresponded to the global temperature trend with its rise from the late 1910-s to the middle of the 20th century, to the temperature decrease by the early 1970-s and its significant rise by the end of the 20th century. The trend of annual temperature in the lake area (+1.2°C/100 years) was two times higher than the average Earth's trend (+0.6°C/100 years). The rise of air temperature was recorded for all seasons of the year from 1986 to 2008 with the trend of +1.9, +1.5, +1.1 and +0.66°C/100 years in winter, spring, summer and autumn, respectively. Maximal trend (+2.1-2.2°C) was registered in December and January and minimal trend (+0.1-0.5°C) in August, September and October. Statistical analysis showed both short-term (2-7 years) and long-term inter-annual (about 20 years) cycles with well-defined phases of increase and decrease of air temperature. The 20th century had two complete cycles (1912-1936 and 1937-1969) and phases of two incomplete cycles – decrease from 1896 to 1911 and increase from 1970. The increase phase at the end of the century to the mid 1990-s was characterized by anomalously long duration (25 years) and rise of air temperature (by 2.1°C). Beginning from 1995, there was a tendency to annual temperature decrease, which may be regarded as the beginning of the temperature drop phase in the current inter-annual climate cycle.

Temperature of water surface. The temperature of water surface increased together with the rise of air temperature due to global change. According to the observation data since 1941, the average temperature of water surface in Southern Baikal (the settlement of Listvennichnoye) decreased insignificantly in May-September from the 1950-s to the 1970-s, and then sharply increased by the mid 1990-s. The same temperature changes were recorded in other areas of the lake. The rate of its increase (0.64-0.60°C/10 years) was higher in the central and northern parts of Lake Baikal than in its southern part (0.25-0.35°C/10 years). The temperature of the warmer 1994-2005 decade exceeded the temperature of the cold 1964-1975 period by 0.9-1.5°C in the southern area and by 1.8-2°C in the central and northern regions of the lake. In some years of this period (e.g., several days in August of 2002), the increase of surface water temperature up to 18-20°C was recorded even in the deeper areas of the lake.

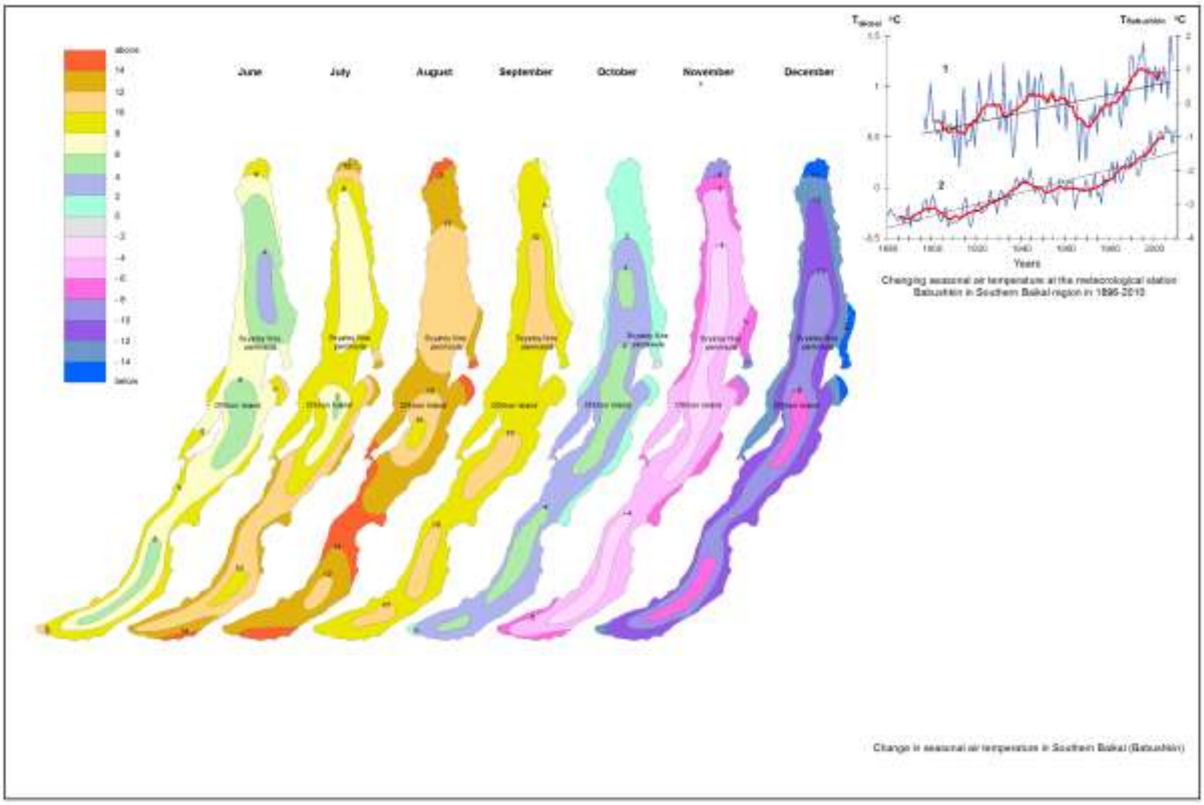
Ice regime. Beginning from the middle of the 20th century, the warming caused "mitigation" of the ice regime at Lake Baikal [Verbolov et al., 1965; Magnusson et al., 2000]. Freezing of the lake started later, whereas ice breaking began earlier. In1868-2010, in Southern Baikal (the settlement of Listvennichnoye) the trend of freezing and ice breaking terms were 10 and 7 days per 100 years, respectively. The duration of ice free period prolonged, whilst the ice cover period shortened by 17 days. According to the 1950-2010 data, the maximal ice thickness decreased on average by 2.4 cm every 10 years. During the phase of significant warming (1970-1995,) the rate of ice process changes sharply increased: freezing started by 10 days later and ice breaking by 15 days earlier; the ice period shortened by 25 days, and the ice thickness decreased on average by 8.8 cm per 10 years. The observation data from shore stations and satellites showed that beginning from the mid 1990-s to the middle of 2010 there was a tendency towards early freezing, late ice breaking and prolongation of ice period [Kouraev et al., 2007]. These changes are consistent with inter-annual climate periodicity associated with fluctuations of atmospheric circulation in the Northern Hemisphere.

The main meteorological factor, which causes fluctuations of freezing terms (D_{fr}) is the air temperature in November-December (T_a) affecting the rate of heat losses from the water surface. The correlation between these characteristics in Southern Baikal is described by equation $D_{fr}=4.26Ta+75$ ($R^2=0.57$, $p<0.001$) for the period of 1896-2010, where D_{fr} is the number of days from 1 December to the freezing date. Temperature conditions in spring also affect the date of ice breaking. However, the correlation between ice breaking dates and air temperature is not high [Livingston, 1999]. It is attributed to the effect of both thermal and dynamic (wind) factors on the ice cover breaking [Kouraev et al., 2007; Shimaraev, 2008] as well as to the influence of ice thickness which depends on air temperature in winter months.

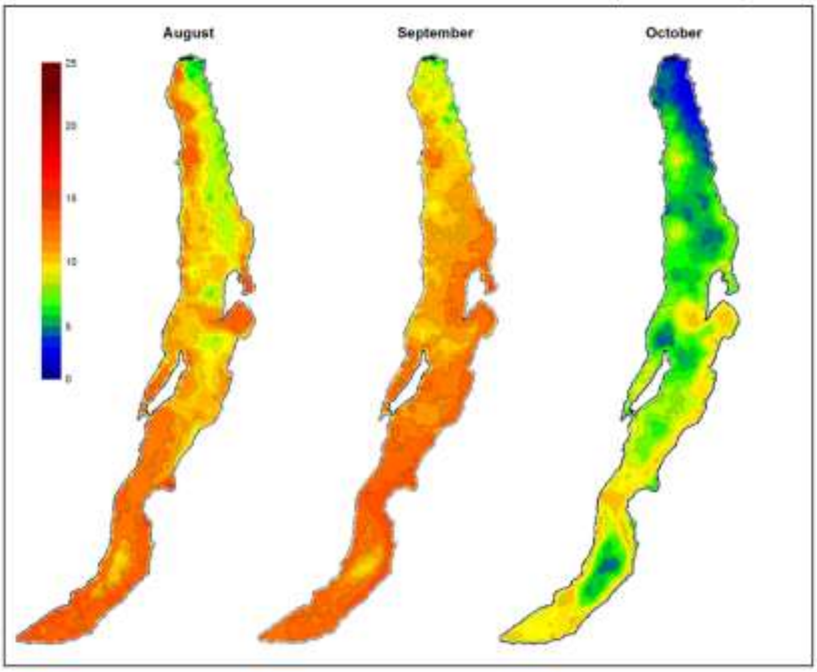
TEMPERATURE



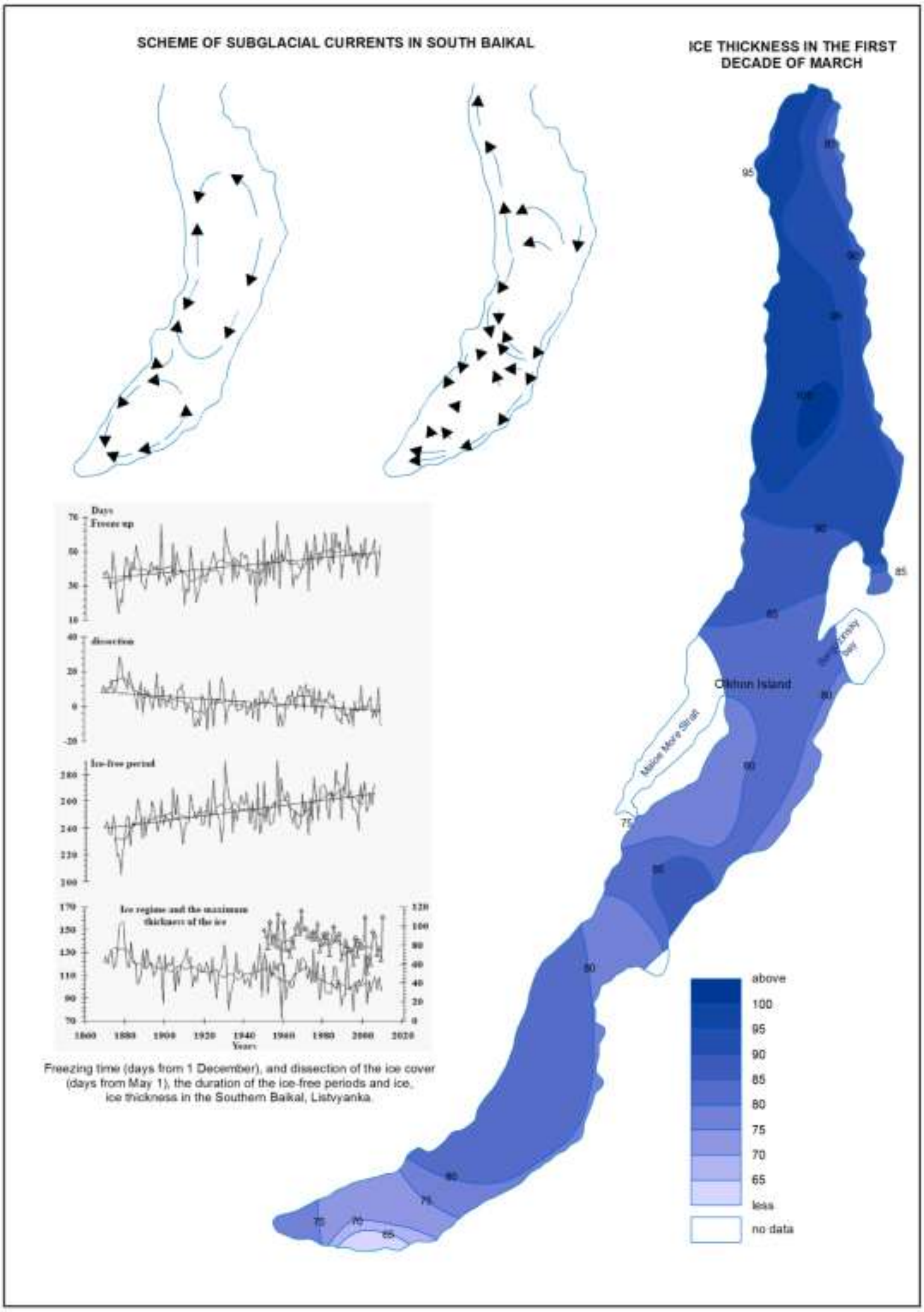
TEMPERATURE OF THE SURFACE LAYERS OF WATER



SURFACE TEMPERATURE BAIKAL WATER FROM SATELLITE MEASUREMENTS (E.S.TROITSKAYA)



ICE CONDITIONS. SUBGLACIAL CURRENTS



Freezing time (days from 1 December), and dissection of the ice cover (days from May 1), the duration of the ice-free periods and ice, ice thickness in the Southern Baikal, Listvyanka.

Currents

The main cause of currents during ice free period is the wind. Depending on changes of the wind velocities, wind (drift) currents intensify in May, subside in June-August and again intensify in autumn reaching its maximum in December. Wind-induced currents take place during strong winds when the surface waters are transferred, thus causing the water level decrease by 10 cm. In summer and autumn, the upsurge lasts approximately 40 h, and in winter about 35 h, whereas the downsurge continues 44 and 40 h, respectively. Average upsurge height (decrease of the level near the windward shore) is 9-11 cm, and that of downsurge (increase of the level near windless shore) is 7-8 cm. Moreover, geostrophic currents are formed at Lake Baikal, which are stationary currents retaining their main characteristics (location, direction and velocity) for a long period of time. They are induced by the difference in temperature (density) of coastal and lacustrine waters, deflecting force of the Earth's rotation and other factors. These currents covering both the entire Lake Baikal and separate basins are observed throughout the whole year.

Water is transferred counter-clockwise (cyclonic circulation) under the deflecting force of the Earth's rotation (Coriolis parameter). Secondary cyclonic circulations are observed in separate basins. The water at the interface of neighbouring cyclonic circulations is transferred across the lake (in Listvennichny Bay, the Selenga River delta, Academichesky Ridge and Cape Kotelnikovsky). The same direction of water transfer is also observed in deep water layers of the lake.

The highest current velocities are recorded in the upper lake layers – in the epilimnion and sometimes below the thermocline. Their average velocities are up to tens of centimetres per second intensifying from summer to autumn. Maximal velocity registered near the surface can be over 1 m/sec. In winter, when the whole lake is covered with ice, the vertical structure of the velocity field is usually the same, although because of the ice cover the currents attenuate significantly. Their average velocity in the upper layers (up to 40-50 m) can be 2 cm/s and lower during "calm" periods. However, it can increase up to 3-5 cm/s and even to 10 cm/s during atmospheric pressure drop in case of atmospheric fronts. General character of water mass transfer corresponds to cyclonic circulation (Fig. 2.33) in the water column.

In the 1960-s, V. Sokolnikov [1964], working on the lake ice, discovered the effect of current intensification in the near-bottom layer at large depths of the lake, which was later observed in other seasons of the year. The studies of this phenomenon carried out by V. Verbolov [1996] and A. Zhdanov [2006] showed that the velocities in the near-bottom layer are seasonal. In winter, they episodically exceed 10 cm/s and in summer (July-early August) they are 4-8 cm/s during weak winds. In spring (May) and autumn (October-November) they become one order stronger at seasonal increase of the wind with the values similar to those in the upper 200-m layer (up to tens of centimetres per second). Usually current velocities decrease in the near-bottom layer with the distance from the foot of the underwater slope, their highest values being recorded at the bottom.

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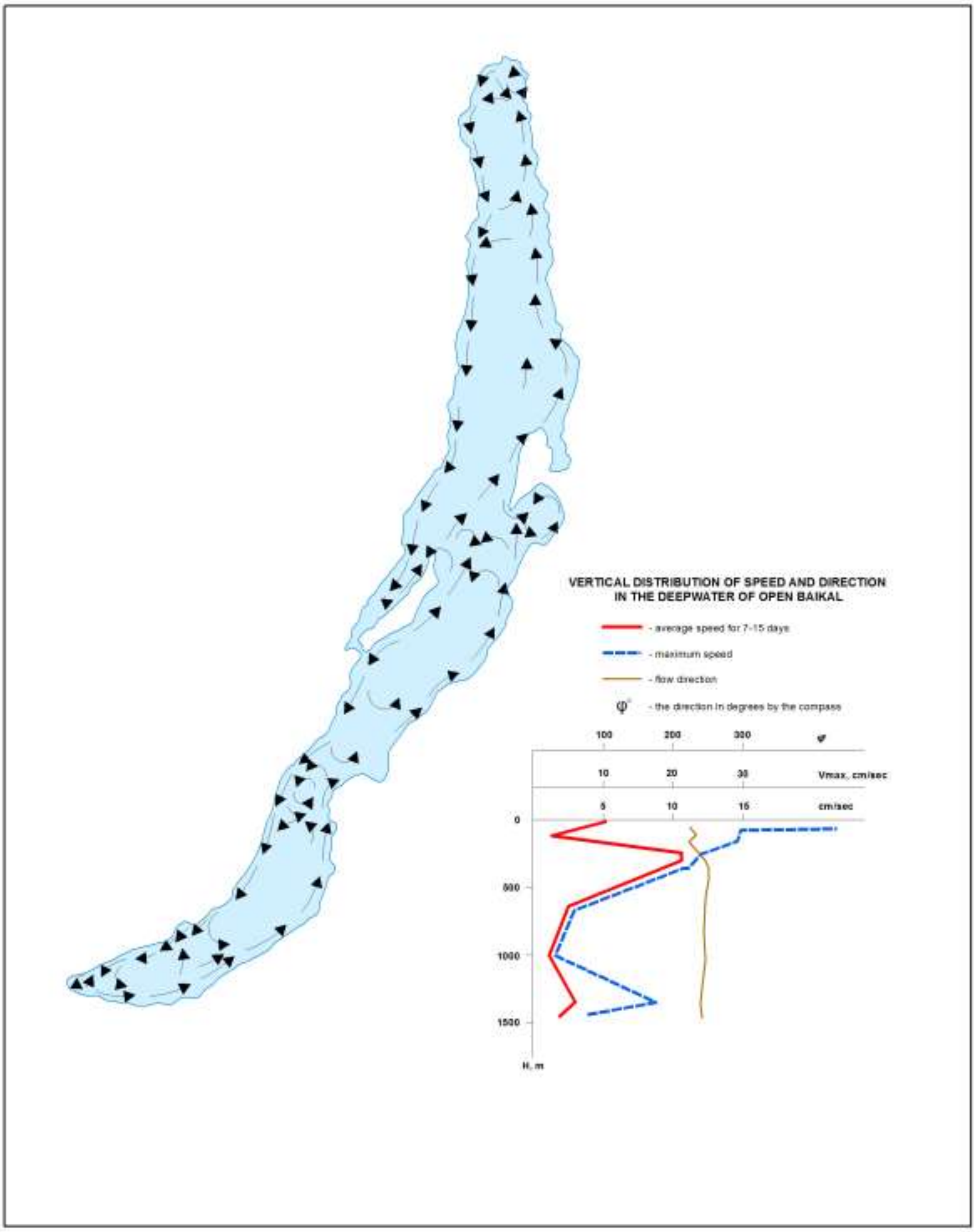
CURRENTS


VERTICAL DISTRIBUTION OF SPEED AND DIRECTION
IN THE DEEPWATER OF OPEN BAIKAL
- average speed for 7-15 days
- maximum speed
- flow direction
φ° - the direction in degrees by the compass
100
200
300
φ
10
20
30
Vmax, cm/sec
5
10
15
cm/sec
0
500
1000
1500
H, m

Seiche oscillations

Seiches are standing waves in an enclosed or partially closed water body. Seiche oscillations in Lake Baikal are observed almost continuously throughout the whole year. Some characteristics of these oscillations were obtained from in-situ observations, laboratory experiments on a spatial hydraulic model and from appropriate theoretical calculations. The results of these studies have been published in the papers (References). However, available information on Baikal seiches is scarce due to the difficulties of in-situ measurements and rather crude data on bottom topography. Sophisticated instrumental tools and advanced techniques for in-situ measurements were used to perform calculations of seiche oscillations in Lake Baikal based on a spectral difference model using specified bathymetric data obtained by researchers from Limnological Institute SB RAS. All these data are included in this atlas. The main aim of this study was to investigate solutions corresponding to oscillations with the periods of 277, 152, 84, 67, and 59 min, which were identified during in-situ observations.

The spectral difference model is based on the linearized system of equations for shallow water in the spherical coordinate system. Difference approximation is based on irregular triangular spatial mesh. The side length of the calculation mesh is 30 m near the shoreline and about 1 km for the rest of the model area. The numerical model includes solutions ofeigen values. It allows the researchers to get a set of frequencies and corresponding forms of seiche oscillations.

The calculations were obtained taking into consideration the Earth’s rotation. Complex solutions were standardised in such a way that imaginary component was minimal, whereas true components of solutions for the rest of the model area were within the range of -10 to 10. The values in the nodes with the depth less than 10 m and in the nodes within the contour of Maloye More (Small Sea) were not taken into account. Spatial distribution of seicheoscillations with the periods of 276.96; 151.58; 84.25; and 67.38 min corresponds to uninodal, bimodal, trinodal, and quadrinodal longitudinal seiche modes of Lake Baikal. The level distribution along the centreline is shown for the enumerated modes in Figure. It should be noted that it is necessary to use other approaches for specification of solutions in shallow areas of Lake Baikal, such as Mukhor and Proval Bays and Cherkalovsky and Posolsk Sors, where the bottom friction is likely to play a significant role. The results for the first mode are consistent with the data on distribution of seiche oscillation height along the Baikal length in [Sudolsky, 1991, Fig. 5.2], in which the data on calculations and survey results from the spatial hydraulic model are compared.

Amplitudes of seiche oscillations in Lake Baikal and their seasonal variability were analysed from the data obtained at 3 stations located in the southern basin of the lake. Well-defined maxima for the oscillations with the periods of 277, 152, 84, and 67 min are observed within the range of power density derived from the annual level record. No significant differences were recorded between the amplitudes for a uninodalseiche and amplitudes during the rest of the year when the lake is covered with ice and protected from wind. It was established that a seiche with the period of 67 min is observed in different seasons of the year. At three stations, level changes for the oscillation with the 277 min period differ in significantly. For the 152 min period they have slight differences, and for the 84 and 67 min periods they are similar only at those sites with relatively high amplitudes of oscillations. This is attributed to the effect of wind and atmospheric pressure. Measured and calculated periods for the first four seiche modes are given in Table.

Table. Measured and calculated periods for four seiche modes

Modes	T1, min	T2, min	T3, min	T4, min
Measurements	277	152	84	67
Measurements according to [Sudolsky, 1968; Timofeev et al., 2009]	278.4	153	87.7	–
Numerical model	276.96	151.58	84.25	67.38

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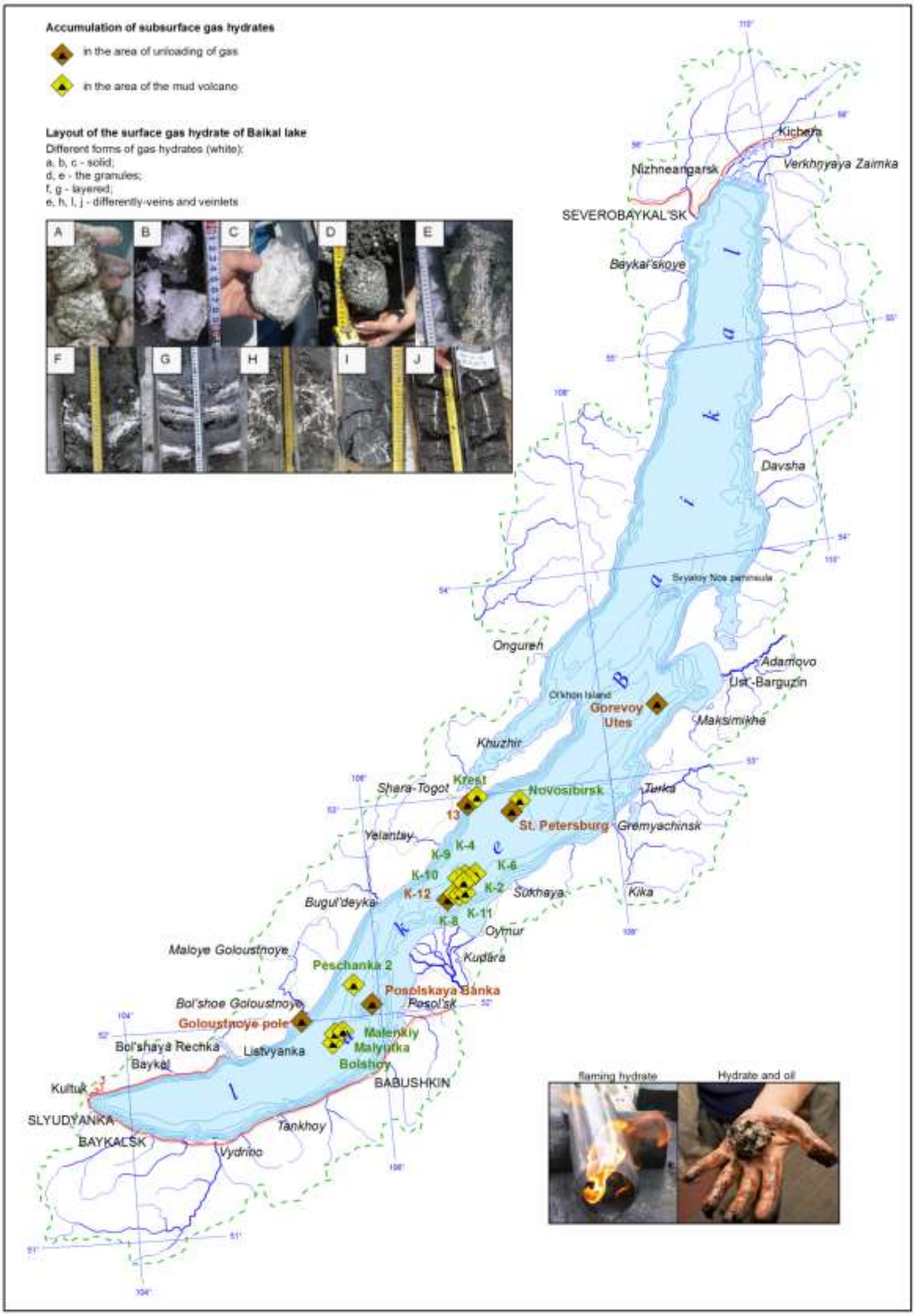
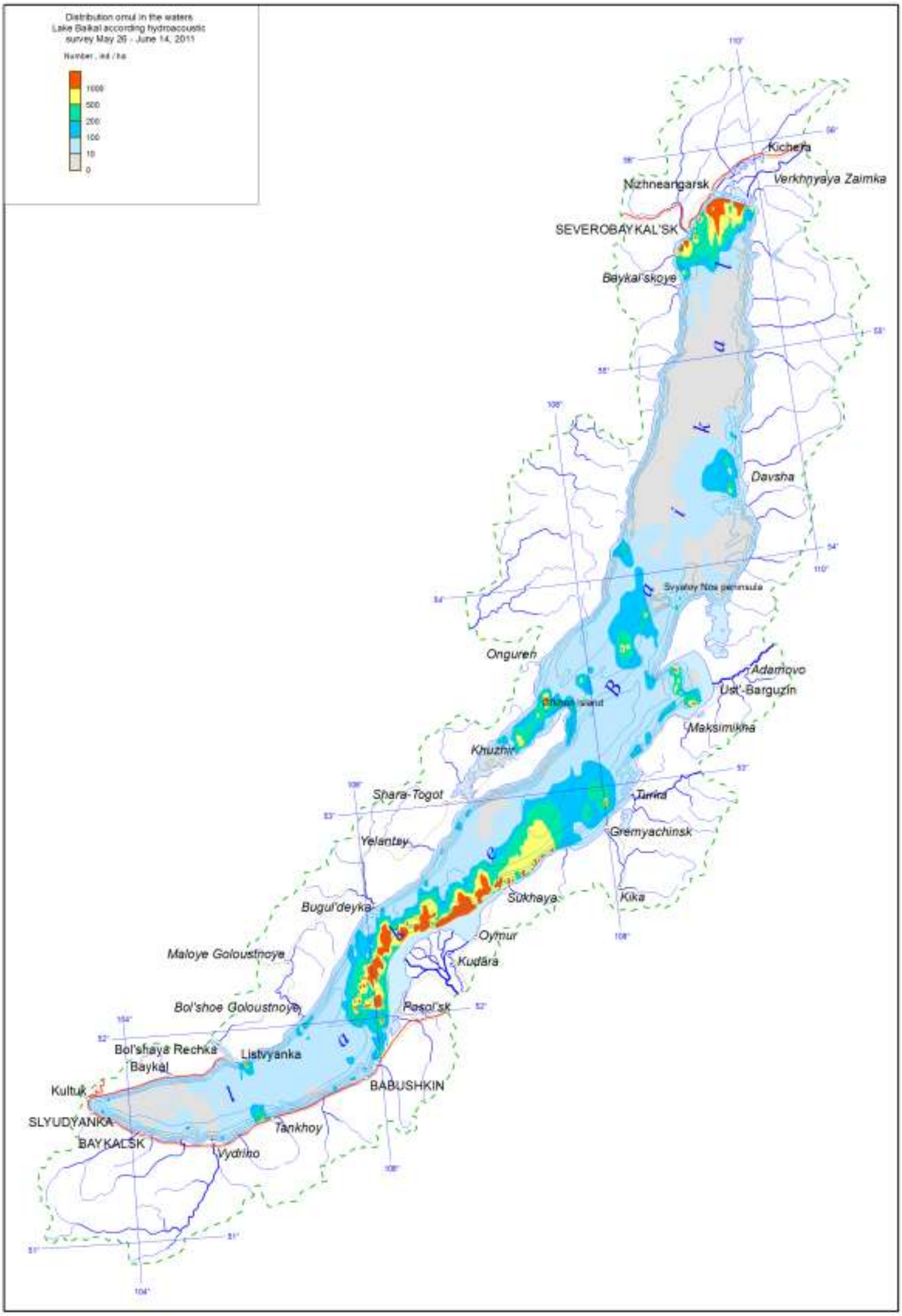
BUBBLE THE GAS OUTLET FROM THE BOTTOM SEDIMENTS




Distribution omul in the waters
Lake Baikal according hydroacoustic
survey May 26 - June 14, 2011
Number , ind / ha
1000
500
200
100
10
0
Kichera
Verkhnyaya Zaimka
Nizhneangarsk
SEVEROBAYKAL'SK
Baykal'skoye
Davsha
Svyatoy Nos peninsula
Onguren
Adamovo
Ust'-Barguzin
Maksimikha
Khuzhir
Shara-Togot
Turka
Gremyachinsk
Yelantsy
Sukhaya
Kika
Bugul'deyka
Oymur
Kudara
Maloye Goloustnoye
Bol'shoe Goloustnoye
Posol'sk
Bol'shaya Rechka
Listvyanka
Baykal
Kultuk
BABUSHKIN
SLYUDYANKA
Tankhoy
BAYKALSK
Vydrino

Baikalian Riviera: optimization of recreation conditions

Recreation can be thought of as the dialectical opposite and integrity alternative to work.

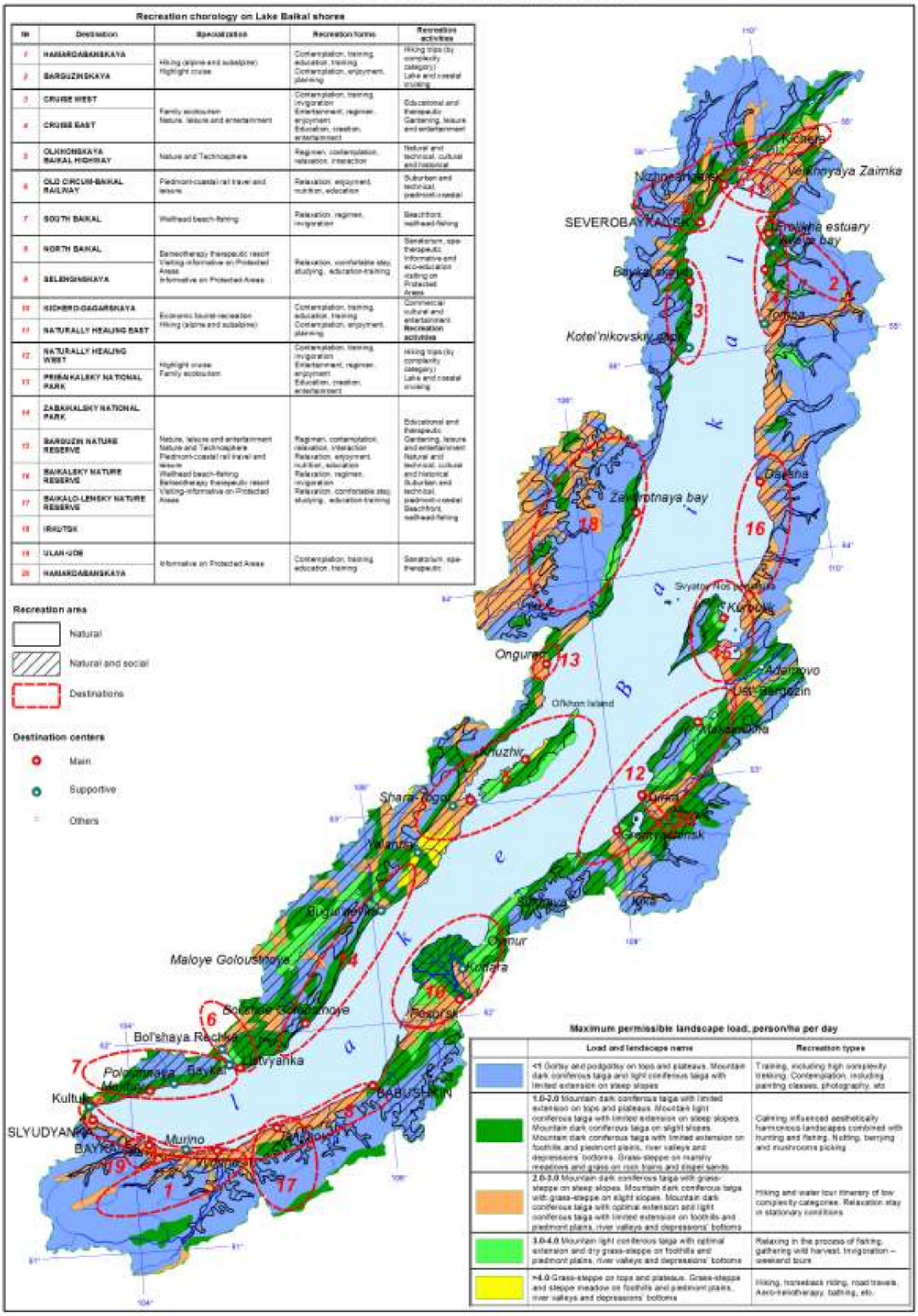
Map compilation used material of landscape-geomorphological mapping and landscape planning of the BNT CEZ, data on maximum permissible impacts on natural landscapes, topographic maps, publications in the form of monographs and articles, aerospace images, surveys differing in scale and time, and results of field route sketching as interpreted by the authors.

Territorialization of recreation on Baikal's shores

Recreation as an essential part of human life is mapped along the keyline in the unity of its forms. The degree of territorial development of recreation is depicted via zoning (*natural and natural-social recreation zones*), and the boundary of the zones is virtually coincident with the 1500 m isohypse. The contours are determined by the natural-landscape differentiation, and five levels of maximum allowable specific areal load (pers/ha per day) are highlighted.

Basic to the legend are regionalization and settlement alignment of recreation areas (main and auxiliary centers) with consideration for the typology of destinations (10 types), and for their specialization in forms and kinds recreational activities.

RECREATION ON LAKE BAIKAL SHORES



Recreation chorology on Lake Baikal shores

№	Destination	Specialization	Recreation forms	Recreation activities
1	HAMARDABANSKAYA	Hiking (alpine and subalpine) Highlight cruise	Contemplation, training, education, training Contemplation, enjoyment, planning	Hiking trips (by complexity category) Lake and coastal cruising
2	BARGUZINSKAYA			
3	CRUISE WEST	Family ecotourism Nature, leisure and entertainment	Contemplation, training, invigoration Entertainment, regimen, enjoyment Education, creation, entertainment	Educational and therapeutic Gardening, leisure and entertainment
4	CRUISE EAST			
5	OLKHONSKAYA BAIKAL HIGHWAY	Nature and Technosphere	Regimen, contemplation, relaxation, interaction	Natural and technical, cultural and historical
6	OLD CIRCUM-BAIKAL RAILWAY	Piedmont-coastal rail travel and leisure	Relaxation, enjoyment, nutrition, education	Suburban and technical, piedmont-coastal
7	SOUTH BAIKAL	Wellhead beach-fishing	Relaxation, regimen, invigoration	Beachfront, wellhead-fishing
8	NORTH BAIKAL	Balneotherapy therapeutic resort Visiting-informative on Protected Areas Informative on Protected Areas	Relaxation, comfortable stay, studying, education-training	Sanatorium, spa-therapeutic Informative and eco-education visiting on Protected Areas
9	SELENGINSKAYA			
10	KICHERO-DAGARSKAYA	Economic tourist recreation Hiking (alpine and subalpine)	Contemplation, training, education, training Contemplation, enjoyment, planning	Commercial cultural and entertainment **Recreation activities**
11	NATURALLY HEALING EAST			
12	NATURALLY HEALING WEST	Highlight cruise Family ecotourism	Contemplation, training, invigoration Entertainment, regimen, enjoyment Education, creation, entertainment	Hiking trips (by complexity category) Lake and coastal cruising
13	PRIBAIKALSKY NATIONAL PARK			
14	ZABAIKALSKY NATIONAL PARK	Nature, leisure and entertainment Nature and Technosphere Piedmont-coastal rail travel and leisure Wellhead beach-fishing Balneotherapy therapeutic resort Visiting-informative on Protected Areas	Regimen, contemplation, relaxation, interaction Relaxation, enjoyment, nutrition, education Relaxation, regimen, invigoration Relaxation, comfortable stay, studying, education-training	Educational and therapeutic Gardening, leisure and entertainment Natural and technical, cultural and historical Suburban and technical, piedmont-coastal Beachfront, wellhead-fishing
15	BARGUZIN NATURE RESERVE			
16	BAIKALSKY NATURE RESERVE			
17	BAIKALO-LENSKY NATURE RESERVE			
18	IRKUTSK			
19	ULAN-UDE	Informative on Protected Areas	Contemplation, training, education, training	Sanatorium, spa-therapeutic
20	HAMARDABANSKAYA			

Recreation area

- Natural
- Natural and social
- Destinations

Destination centers

- Main
- Supportive
- Others

Maximum permissible landscape load, person/ha per day

	Load and landscape name	Recreation types
(blue)	<1 Goltsy and podgoltsy on tops and plateaus. Mountain dark coniferous taiga and light coniferous taiga with limited extension on steep slopes	Training, including high complexity trekking. Contemplation, including painting classes, photography, etc
(dark green)	1.0-2.0 Mountain dark coniferous taiga with limited extension on tops and plateaus. Mountain light coniferous taiga with limited extension on steep slopes. Mountain dark coniferous taiga on slight slopes. Mountain dark coniferous taiga with limited extension on foothills and piedmont plains, river valleys and depressions' bottoms. Grass-steppe on marshy meadows and grass on rock trains and dispel sands	Calming influenced aesthetically harmonious landscapes combined with hunting and fishing. Nutting, berrying and mushrooms picking
(orange)	2.0-3.0 Mountain dark coniferous taiga with grass-steppe on steep slopes. Mountain dark coniferous taiga with grass-steppe on slight slopes. Mountain dark coniferous taiga with optimal extension and light coniferous taiga with limited extension on foothills and piedmont plains, river valleys and depressions' bottoms	Hiking and water tour itinerary of low complexity categories. Relaxation stay in stationary conditions
(light green)	3.0-4.0 Mountain light coniferous taiga with optimal extension and dry grass-steppe on foothills and piedmont plains, river valleys and depressions' bottoms	Relaxing in the process of fishing, gathering wild harvest. Invigoration – weekend tours
(yellow)	>4.0 Grass-steppe on tops and plateaus. Grass-steppe and steppe meadow on foothills and piedmont plains, river valleys and depressions' bottoms	Hiking, horseback riding, road travels, Aero-heliotherapy, bathing, etc.

Assessment of coastal landscapes for recreation

Natural pristine landscapes, i.e. unaffected by humans, meet directly and fully the requirements of physiologically necessary (unconscious-reflex) forms of recreation, such as contemplation, quieting, relaxing, etc. It is therefore essential that these landscapes (groups of landscapes) should be preserved. The most accessible part of Baikal's shores reveals one or other degree of transformation of the natural environment. Social-specific (purposefully deliberate) forms of recreation are dominant in these territories. The ever-increasing anthropogenic impact problems involve digression of the landscape sphere from its natural state, to the point of losing landscape diversity and becoming unfit for use in meeting the need for recreation.

The contours of the map display the types and subtypes of pristine natural landscapes within the boundaries of Baikal's CEZ, indicating the nature management zones which imply achieving the integrated goals of landscape-territorial planning (preservation, improvement, and development), and the territories which need protection and recultivation.

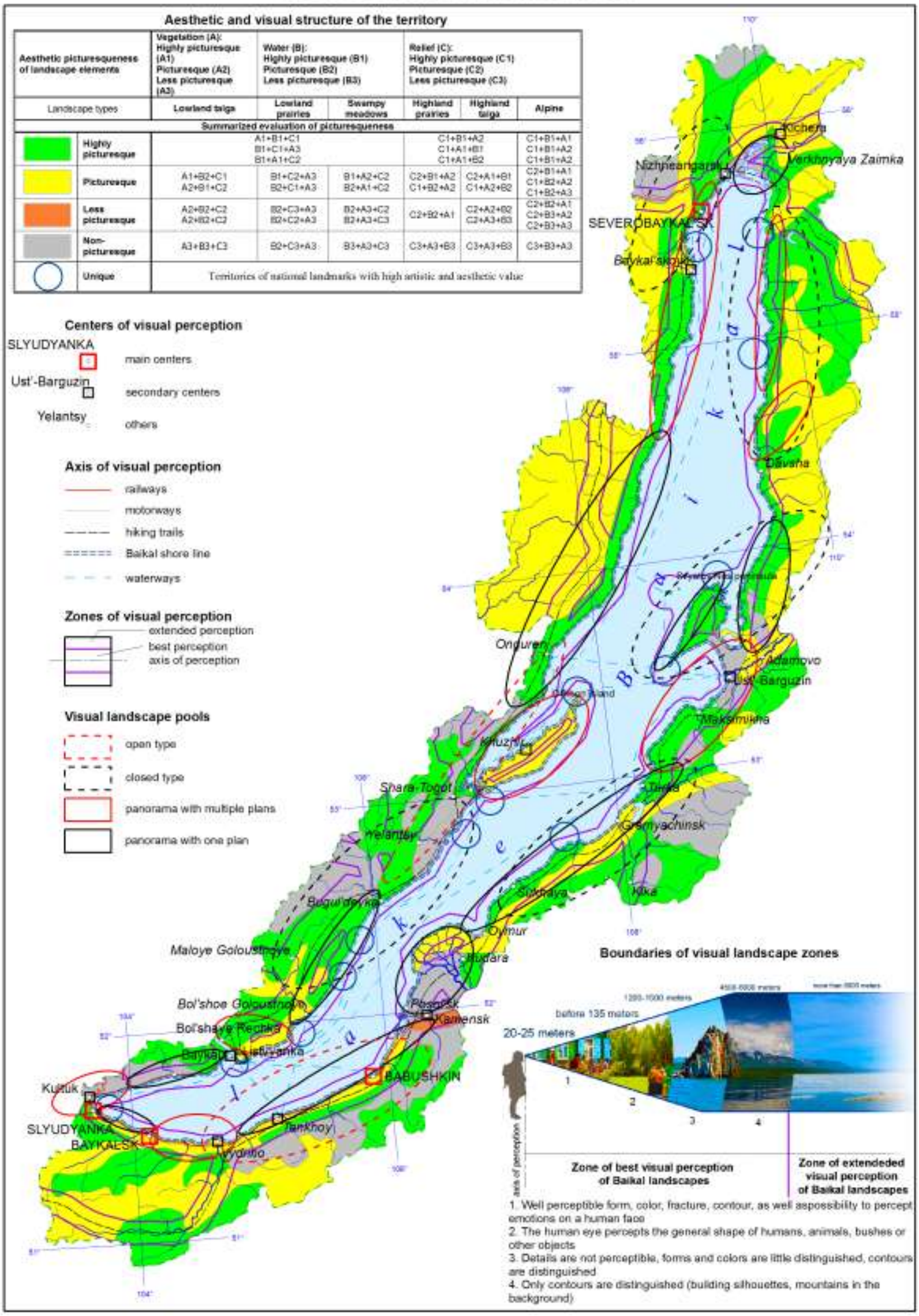
Landscape-aesthetic appearance of Baikal's shores

Riviera is an aesthetically integrally organized coastal territory which, with due regard for the peculiarities of visual perception, embodies the unity, beauty and picturesqueness of the spatial processes of interaction between settlements and the coast through the formation of cultural landscapes of recreation.

The map for the landscape-architecture-aesthetic organization of the coast has been generated as a result of the landscape-architecture assessment not only of the functional and utilitarian requirements reflecting the current transport-communications and settlement situation but also of the aesthetic, architectural-scenic (picturesque) qualities of landscapes and the conditions of their development in the strip of the best visual perception.

Structurally, this map is a system of architecture-landscape centers, axes, zones and basins. According to the legend, two zones are established in the strip of visual perception (about 8 km), namely the zone of the best visual perception, and the zone of visual perception development (map insert), including the main types of natural landscapes that are assessed according to their aesthetic value. Landscape-architectural basins are represented by segments of Baikal's shores which are relatively uniform visually within the boundaries of open and closed sectors of view from the centers-settlements, from definite sections of mass communication routes.

AESTHETIC IMAGE OF THE BAIKAL SHORE



Aesthetic and visual structure of the territory

Aesthetic picturesqueness of landscape elements		Vegetation (A): Highly picturesque (A1) Picturesque (A2) Less picturesque (A3)	Water (B): Highly picturesque (B1) Picturesque (B2) Less picturesque (B3)		Relief (C): Highly picturesque (C1) Picturesque (C2) Less picturesque (C3)		
Landscape types		Lowland taiga	Lowland prairies	Swampy meadows	Highland prairies	Highland taiga	Alpine
Summarized evaluation of picturesqueness							
	Highly picturesque	A1+B1+C1 B1+C1+A3 B1+A1+C2			C1+B1+A2 C1+A1+B1 C1+A1+B2		C1+B1+A1 C1+B1+A2 C1+B1+A2
	Picturesque	A1+B2+C1 A2+B1+C2	B1+C2+A3 B2+C1+A3	B1+A2+C2 B2+A1+C2	C2+B1+A2 C1+B2+A2	C2+A1+B1 C1+A2+B2	C2+B1+A1 C1+B2+A2 C1+B2+A3
	Less picturesque	A2+B2+C2 A2+B2+C2	B2+C3+A3 B2+C2+A3	B2+A3+C2 B2+A3+C3	C2+B2+A1	C2+A2+B2 C2+A3+B3	C2+B2+A1 C2+B3+A2 C2+B3+A3
	Non-picturesque	A3+B3+C3	B2+C3+A3	B3+A3+C3	C3+A3+B3	C3+A3+B3	C3+B3+A3
	Unique	Territories of national landmarks with high artistic and aesthetic value					

Ecological state of the Central Ecological Zone of the Baikal Natural Territory

The Central Ecological Zone of the BaikalNaturalTerritory (CEZ BNT) includes LakeBaikal itself with the islands, and the adjacent water protection zone and specially protected natural areas (SPNA) (Federal Law No. 94-FZ “On Protection of Lake Baikal” dated May 1, 1999). Its boundaries coincide with the boundary of the World Natural Heritage site “LakeBaikal” and follow the outer boundaries of the Baikalo-Lensky, Barguzinsky, and Baikalsky reserves (zapovedniks), Pribaikalsky, Zabaikalsky, and Tunkinsky national parks, Frolikhinsky, Pribaikalsky, Enkhaluksky, and Snezhinsky nature-sanctuaries (zakazniks), as well as the main watersheds of the Primorsky, Baikalsky, Verkhne-Angarsky, Barguzinsky, Golondinsky, Ulan-Burgasy, Morskoy, and Khamar-Daban ridges. The main function of the central ecological zone is to preserve the unique ecological system of LakeBaikal and to prevent the negative impact of economic and other activity on its state.

The main sources of the atmospheric impact on LakeBaikal are industrial enterprises located in the basin and on the shores of the lake, and sections of the Trans-Siberian and Baikal-Amur Mainline Railway. Air emissions from industrial enterprises and boiler stations of the towns of Baikalsk, Slyudyanka, Severobaikalsk, and Nizhneangarsk and villages located in the Baikal basin have the highest probability of falling into the lake. Air transport products from the Irkutsk-Cheremkhovo agglomeration constitute a much smaller part of the total air pollution over LakeBaikal because of the remoteness and a large number of calms and fogs. Emissions of sulfur dioxide, nitrogen oxides, hydrogen sulphide and hydrocarbon, methyl mercaptan, formaldehyde, and phenol, produced by coastal enterprises have a negative impact on the ecological situation.

On the northern shore of LakeBaikal a single zone of the atmospheric pollution ditribution, stretched along LakeBaikal, is formed. Its area for the town of Severobaikalsk amounts to approximately 150 km, and for Nizhneangarsk – to 60 km. Despite the fact that the content of certain impurities tends to decrease, the level of air pollution remains high.

The snow cover, having a high sorption capacity, is the most informative object in identifying the technogenic pollution of the atmosphere. According to the data of the Irkutsk Territorial Administration for Hydrometeorology and Environmental Monitoring, in the CEZ BNT there are several zones of technogenic pollution with the solids concentration in snow ranging from 0.5 to 10 g/kg. Mineralization of snow waters near the sources may 10 times exceed the background one. The maximum amount of solids in snow reaches 200 g/m^2. Zones with increased concentration of calcium, magnesium, sodium, and potassium were identified. Concerning the cations, which are soluble in snow, the predominance of sodium and potassium was revealed. The maximum values of the insoluble residue of snow associated with the operation of CHP plants, boiler stations, and stove heating, are registered in the vicinity of Kultuk and Sludyanka; as regards the soluble residue, its maximum values are recorded in the area around Baikalsk. The total area of snow pollution with chemical elements extends 60 km from the south-east to the north-west with a width of 10-15 km.

In connection with the spontaneous development of tourism on the shores of LakeBaikal in the CEZ BNT one of the most pressing issues is the problem of collecting, processing and recycling of solid household wastes. Most of the garbage goes to disposal sites, both approved and accidental.

Within the CEZ BNT, cement and quartz raw materials, facing and ornamental stones, and different kinds of building materials are produced with local environmental disturbances. Near settlements, roads, and tourist centers and camps significant anthropogenic changes of the natural environment (felled and burnt areas, etc.) are also observed.

In order to establish a long-term strategy for the organization of the use of the CEZ BNT, which would ensure a sustainable development, preservation of the unique ecological system of LakeBaikal through reducing the anthropogenic impact and preventing the damage, a technique and scheme of territorial planning of the CEZ BNT was developed [Plyusnin and Vladimirov, 2013].

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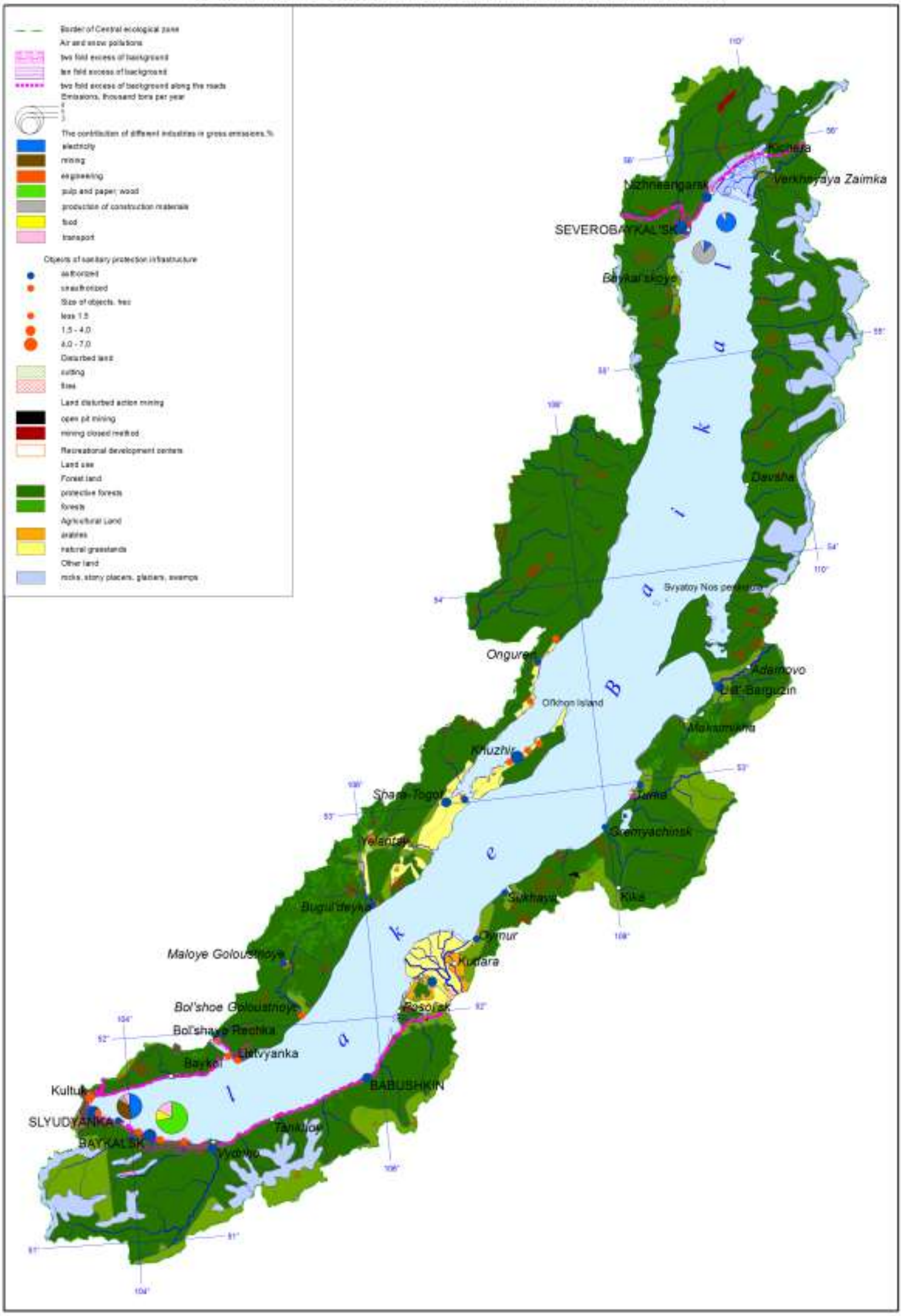
Empowered lives.
Resilient nations.

NATURAL MANAGMENT AND ENVIRONMENTAL CONDITION OF CENTRAL ECOLOGICAL ZONE OF BAIKAL NATURAL TERRITORY



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