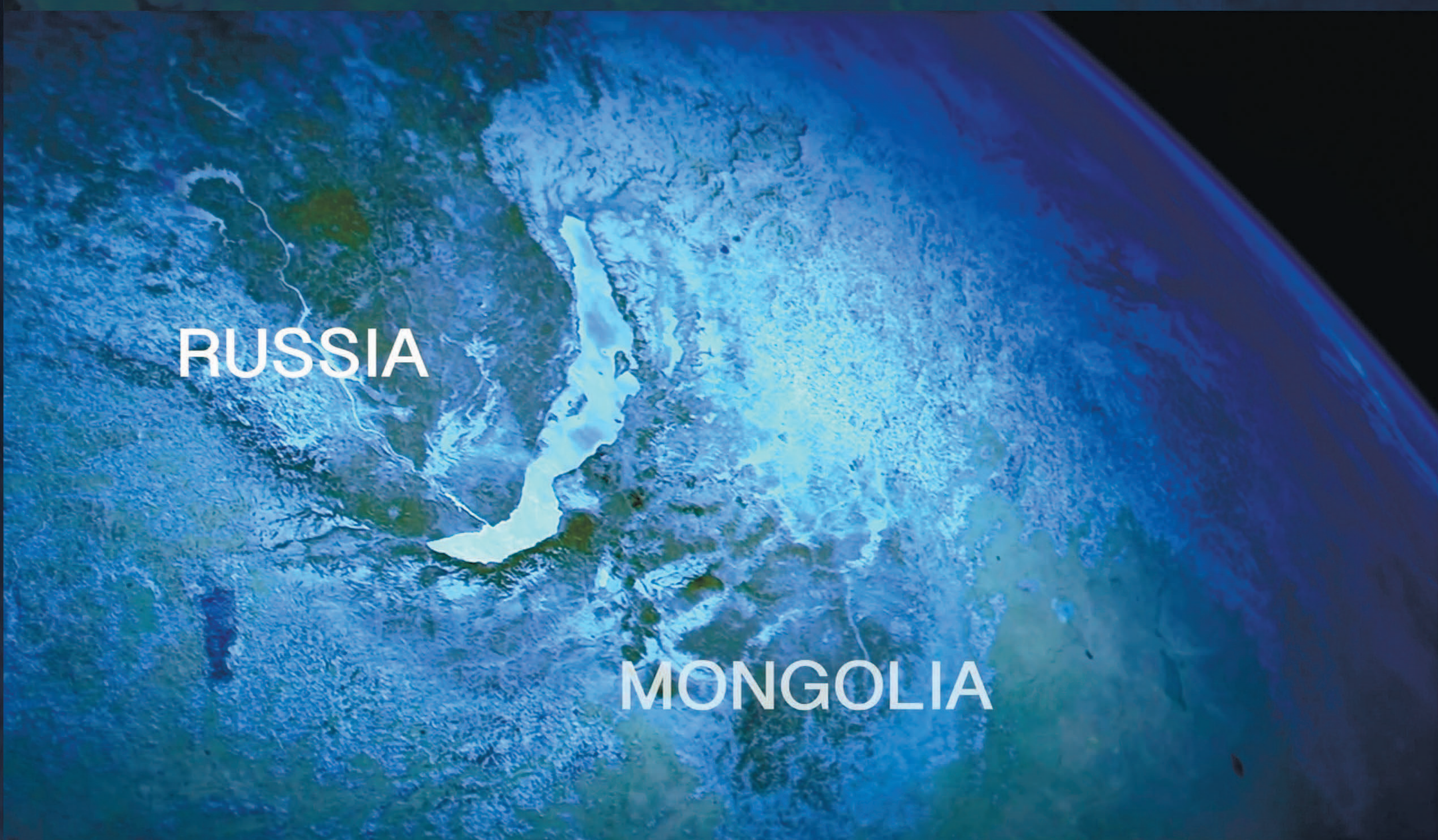
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT OF THE RUSSIAN FEDERATION

GOVERNMENT OF MONGOLIA

MINISTRY OF ENVIRONMENT AND GREEN DEVELOPMENT

UNDP

State of the Environment Report
The Lake Baikal Basin



2012-2013

UNOPS

STATE OF THE ENVIRONMENT REPORT

THE LAKE BAIKAL BASIN

2012-2013

CONTENT

ORGANISATIONS - PROJECT PARTICIPANTS

GEF: Global Environment Facility (donor) brings together 182 countries and international institutions, civil society organizations and the private sector to address global environmental issues concurrently supporting national sustainable development initiatives. Today the GEF is the largest institution supporting projects aimed at improving the state of the environment. As an independently functioning financial institution, the GEF provides grants for the projects related to biodiversity, climate change, international waters, land degradation, ozone layer and persistent organic pollutants. Since 1991, the GEF has achieved important results working with developed and developing countries by providing $9.2 billion in grants and leveraging $40 billion in co-financing for more than 2,700 projects in 168 countries. www.thegef.org

UNDP: United Nations Development Programme (client) is the UN's global development network facilitating positive changes in people's lives and helping nations withstand crisis and sustain the kind of growth that improves the quality of life for everyone. This is achieved through deep understanding of the local specifics and providing the member countries with access to knowledge, experience and resources. UNDP is on the ground in 177 countries, working with them on their own solutions to global and national development challenges. . www.undp.org

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Baikal Institute of Nature Management of the Siberian Branch of the Russian Academy of Sciences (executor). The main areas of research are the following: nature management issues – the interaction of natural and socio-economic systems; chemical elements and compounds in natural and artificial media; development of new materials and resource-efficient environmentally sound technologies, chemical aspects of the rational nature management; development of geographic information systems and geographic databases for integrated research. www.binm.ru, www.baikalgis.com

National Water Committee of Mongolia
(executor) - carries out state management of the use and protection of water resources, defines the mandate of water users. www.water.mn

Russian subteam

BESHENTSEV Andrew Nikolaevich,
Doctor of Sciences in Geography, Head of GIS laboratory, BINM SB RAS

PALITSYNA Susanna Semenovna,
PhD (Chemistry), Senior Researcher, BINM SB RAS

AYURZHANAEV Alexander Andreevich,
PhD (Technical sciences), Senior Researcher, BINM SB RAS

PAKHAKHINOVA Zorigma Zunduevna,
Leading Engineer, BINM SB RAS

LUBSANOV Alexander Alexandrovich,
Leading Engineer, BINM SB RAS

Mongolian subteam

PUNTSAGSUREN Choimpog,
Hydro Construction Engineering, Expert, National Water Committee

SERCHMAA Bold,
Integrated Watershed Management, Expert, National Water Committee

KHISHIGJARGAL Sukhbalsan,
Engineering in Water Treatment Technology, Expert, National Water Committee

BADAMDORJ Purev,
Senior Expert, Natioinal Water Committee

Consultants

TULOKHONOV Arnold Kirillovich,
Corresponding Member of the Russian Academy of Sciences, Doctor of Sciences in Geography, Member of the Science, Education and Culture Committee of the Federation Council of the Federal Assembly of the Russian Federation

GARMAEV Endon Zhamyanovich,
Doctor of Sciences in Geography, Acting Director, BINM SB RAS

MIKHEEVA Anna Semenovna,
Doctor of Sciences in Economy, Head of Laboratory of Nature Management Economy, BINM SB RAS

BADRAKH Tsend,
Director of Government Agency-Water Authority

OYUNTUGS Tserendendev,
Secretary, Orkhon River Basin Council

TSEDENBALJIR Yadamtsoo,
Engeneering

Translation

Tsydenova O.V.
Rabogoshvili A.A.
Khishigjargal S.
Tsedenbaljir Ya.

Photo

Andreev S.G.
Ayurzhanaev A.A.
Batotsyrenov E.A.
Beshentsev A.N.
Zhamyanov D.Ts.-D.
www.wikipedia.org

THE LIST OF ABBREVIATIONS

BINM	Baikal Institute of Nature Management
BNT	Baikal Natural Territory
BPPM	Baikalsk Pulp and Paper Mill
CEZ	Central Ecological Zone
FSA	Federal State Agency
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geo Information System
JSC	Joint Stock Company
LLC	Limited Liability Company
MECC	Mongolian Environmental Civil Council
MNT	Mongolian Tugrik
MPC	Maximum Permissible Concentration
NGO	Non-Governmental Organization
PM	Particulate Matter
SB RAS	Siberian Branch of the Russian Academy of Sciences
SEZ	Special Economic Zone
SPNT	Specially Protected Natural Territories
SPPM	Selenginsk Pulp and Paper Mill
UES	United Energy System
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organization

INTRODUCTION

Lake Baikal was included in the world heritage list by a UNESCO resolution in 1996. Thereby Russia and Mongolia together with the world community pledged to protect the lake. The lake and the adjacent area inhabited by more than 3 million people have all the necessary resources for the people in the region to be spiritually and materially wealthy. Therefore, a modern high-tech economy needs to be build that would support a high standard of living and environmentally sustainable development of the unique region. Among other measures aimed at achieving that, the local citizens and guests should be provided with reliable and objective information about the state of the environment, economy and social sphere in the region. The present report was written to serve the purpose.

An effective policy in the field of environmental protection and rational use of natural resources within the transboundary basin of Lake Baikal can be securely implemented only if a common information space is established over the two countries. The present report is the first attempt to combine information resources of the Russian Federation and Mongolia for creating a complete socio-natural picture of the great lake's geosystem.

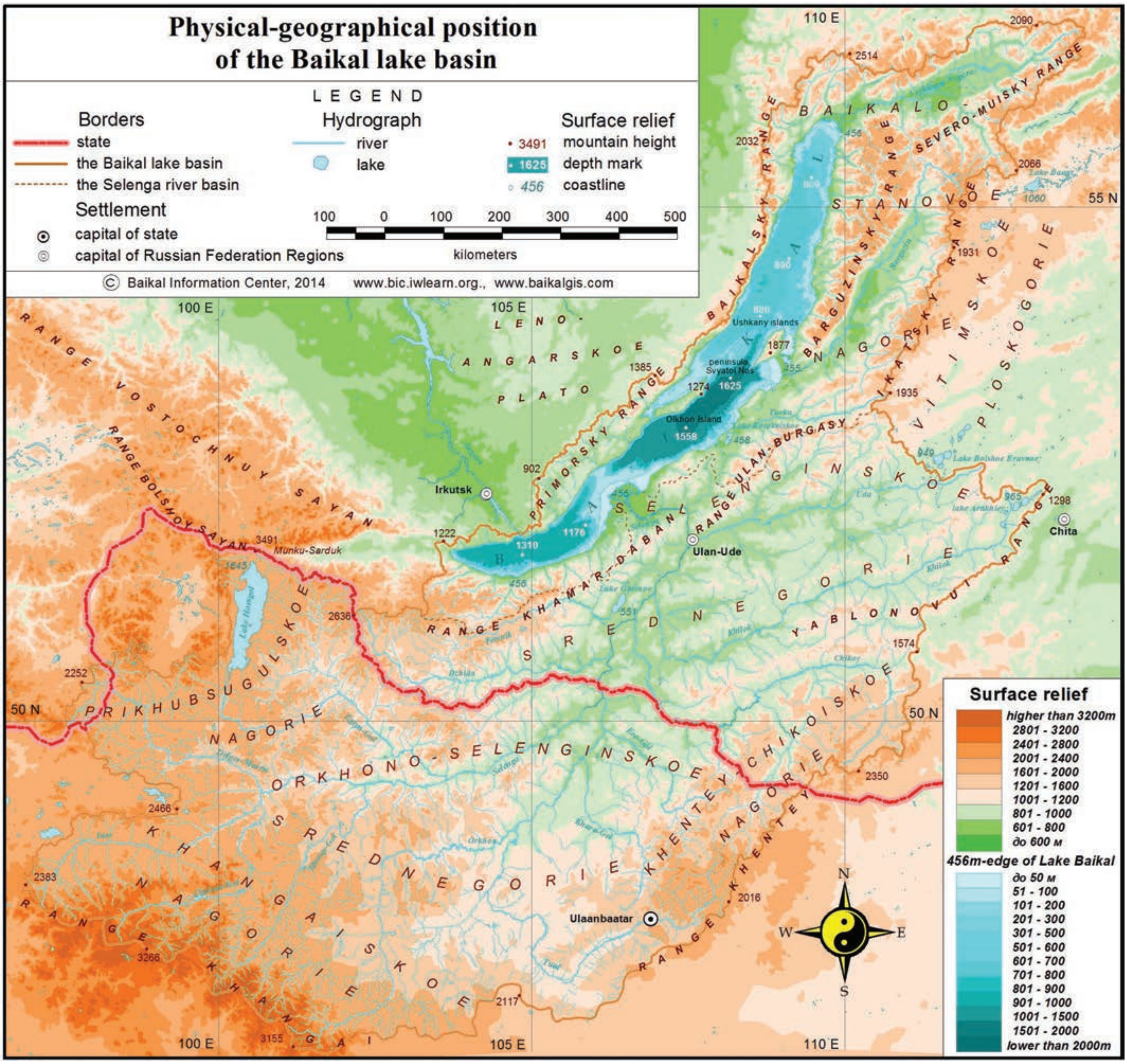
The report was created upon request and with the assistance from the United Nations Development Programme and Global Environment Facility aimed at facilitating the integrated management of natural resources within Lake Baikal basin for achieving ecosystem resilience and improving water quality within the wider context of sustainable development. With the purpose of creating the report, a Russian-Mongolian team was formed consisting of highly qualified researchers and government officials dealing with the issues of sustainable development of the transboundary area.

The content of the report is based on the Russian and Mongolian official documents published in 2012-2014 – state reports on the state of the environment, strategic reports - as well as fundamental and applied research conducted in the frameworks of the UNDP project «Integrated management of natural resources of the transboundary ecosystem of Lake Baikal».

CHAPTER I. GENERAL CHARACTERISTICS OF LAKE BAIKAL BASIN

1.1.1 PHYSICAL AND GEOGRAPHICAL POSITION

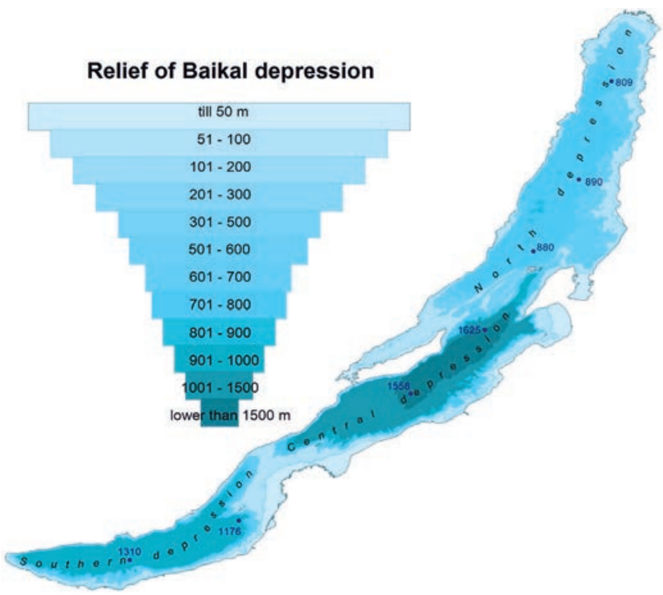
The transboundary basin of Lake Baikal is located on the boundary of North and Central Asia between 46º 28′ and 56º 42′ in the north-south direction and between 96º 52′ and 113º 50′ in the west-east direction. The longest stretch of the basin from south-west to north-east is 1470 km, from west to east it is 962 km, and its minimal length from west to east is 193 km. In the north, the basin is conterminous with the Lena river basin, bounded by the mountain range of Synnyr, Verkhneangarsk and Delun-Uransky. In the east, it is bounded by the Vitim uplands and the border is formed by the Ikatskiy mountain range. In the south-east, it borders the Amour river basin, where the water divide is constituted by the Yablonovy mountain range and is coextensive with the World watershed, separating surface waters of the Arctic Ocean and the Pacific Ocean, extending into the Khentei Mountains (World watershed). In the south, the basin is bounded by the inland drainage area of North Mongolia, while its south-western border is



Pic. 1.1.1 Physical and geographical position of Lake Baikal

the formed by the Khangai range (World watershed). In the west, it is conterminous with the upper stream of the Yenisei and Lena rivers. At this point, the watershed line is coextensive with the state border and the Khangarulsky range, traversing the Khamar-Daban Mountains and reaching the outlet of the Angara River along the shore of Lake Baikal, extending along the Primorski and Baikal ranges (pic. 1.1.1).

The territory of Lake Baikal is considerably elevated above sea level and is characterized with mid-mountain relief. The lowest elevation point is that of Lake Baikal - 456 m (Baltic system of altitude), and its highest point is Munku-Sardyk (3491 m). The land surface of the region is the ancient folded area, encompassing huge mountain ranges and vast, deep and in some cases isolated intermountain depressions. It is composed of ancient crystalline rocks, which are in some sections (predominantly in tectonic depressions) covered with a comparatively small (up to 0.5-2 km) layer of Mesozoic and Cenozoic deposits. Regional tectonics structure exerts considerable influence on the formation of relief and the regime of surface and ground waters. The rift area is the major element of the basin, incorporating the northern, central and southern depressions, filled with water and constituting the single Baikal depression (pic. 1.1.2). It is surrounded by mountain ranges, has a crescent-like form and stretches from the south-west to the north-east. The length of the lake is 636 km, and its width varies from 25 to 80 km. The average depth of the lake is 758 m, while its maximum depth is 1637 m.



Pic 1.1.2 Relief of Baikal depression

Flat surfaces on the territory of the basin can only be found in tectonic depressions and the valleys of big rivers, which can in turn be divided into two major types - intramountanous (depressions of Baikal type) and intermountanous (depressions of Trans-Baikalian type) [1]. The depressions of Baikal type (Baikal, Verkhneangarsk, Barguzin, and Khuvsgul), formed as a result of curved deformation of the earth crust, are comparatively deep and large in size. Their northern and north-western sides are usually steeper. The depressions are filled with Cenozoic sediments, accumulated under the conditions of crustal warping. It is for this reason that rivers, flowing across this territory, have well-shaped and broad flood plains. The most significant of them is the one of Lake Baikal as well as Verkneangarsk and Barguzin depressions.

The depressions of Trans-Baikalian type have predominantly a tectonic and erosion-accumulative origin, while their number is more than 50 (Gusinoozerk, Ust-Selenginsk, Tugnui-Sukharisnk, Ivolginsko-Udinsk etc). They are surrounded by plateau mountains, which have at their base flattened and gently rugged foothills, separated by proluvian valleys. The submontane strips of the valleys embrace isolated mountains, low conic hills and small mountain groups. Some sections of the Selenga basin at the sabulous and sandy sites incorporate a dense network of ravines and are dominated by the eolian relief (dunes and deflation basins) (pic. 1.1.3).

Pic. 1.1.3 Elements of eolian relief in Ivolginsk-Udinsk depression: ravines and deflation basins

Mid-level and high terrains in the Trans-Baikalian depressions are gone, low terrains are composed of gravel and sandy soil, while the terrain steps, cut by rivers, as well as subaerial deltas of tributaries and foothill shelves are composed of sandy and sabulous material. Trans-Baikalian depressions include the big fresh-water Lake Gusinoe – the third biggest lake in the basin in the center of Gusinoozersk depression, as well as the major rivers of the area (pic. 1.1.4).

Pic. 1.1.4 Lake Gusinoe

Of special significance is Ust-Selenginsk depression, located in the tectonic downwarp area, protruded into the south-eastern shore of Baikal rift zone (pic. 1.1.5). It is characterized with active neotectonic processes. The depression is filled with a huge layer of loose sediments, while its ground waters are connected with Lake Baikal water by a hydraulic way at the depth of 200-250 m.

Pic. 1.1.5 Ust-Selenginsk depression

According to the geographic zoning scheme of IG SB RAS, the northern part of Lake Baikal basin is situated on the territory of Baikal Dzhugdzhursky mountain-taiga area, the middle part – on the territory of South-Siberian mountain area and its southern part – on the territory of North-Mongolian semi-desert and grassland area [2]. The relief of the basin territory is constituted by the following geomorphological formations:

1. Baikal-Stanovoe uplands;
2. Selenga middle mountains;
3. Orkhon-Selenga middle mountains;
4. Khentei-Chikoi uplands;
5. Lake Khuvsgul uplands;
6. Khangai uplands.

Baikal-Stanovoe uplands incorporate those parts of the Siberian platform which are highly elevated and greatly dissected as a result of neotectonic movements. The heights of some mountain ranges range between 2000-2500 m, while the elevation of the depression bottom above sea level is 456 – 600 m. The highlands have significant traces of mountain-valley glaciation with the glacial forms of relief and a great number of lakes (pic. 1.1.6).

Pic. 1.1.6 Baikal-Stanovoe uplands (Landsat space image)

In the west, Baikal depression is bounded by the Primorsky range (with the heights ranging between 1100-1700 m), which does not have clear-cut water divide, but rather softly-shaped or flat peaks with incised valleys. To the north-east lies the heavily dissected Baikal range with mountain heights of 2000-2500 m. To the north, broadening in width to 80-100 km, it grows into the Ungdar highlands. Starting from the highlands, Verkhneangarski mountain range runs in the north-eastern direction (above 2000 m) (pic. 1.1.7) [3].

Pic. 1.1.7 Verkhneangarski range

In the east, parallel to the northern part of Baikal depression, run the Barguzin and Ikatsky ranges, between which lie Barguzin depression. The Barguzin range is the highest one among the highlands in the region (the height of some peaks reaches 2500-2840 m). Its distinctive feature is a strongly pronounced asymmetry: its southeastern slopes end abruptly towards Barguzin depression, and northwestern slopes run gradually to Lake Baikal (pic. 1.1.8).

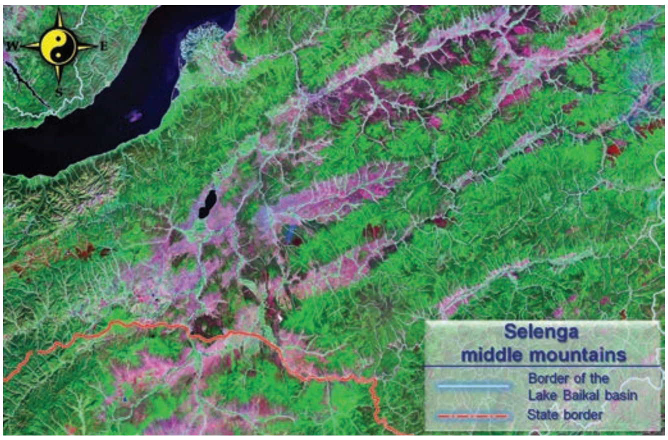
Pic. 1.1.8 Spurs of Barguzinsky range

Barguzin depression has the length of about 200 km, while its maximum width is 25-35 km. The bottom of the depression is characterized by a flat relief (with elevation of 470-600 m), at the foot of which runs a foothill terrace.

The southern part of the range belongs to the zone of the specific Trans-Baikalian pine-larch (more rarely – birch) mountainous forest-steppes. The northern part of the upland is a typical mountain-taiga area.

The whole territory is a permafrost area. The southern part of the depression belongs to the zone of insular permafrost, while the northern (in particular the intermountain basins) – to the glaciation zone with the width of up to 120 m. The upland is characterized by increased tectonic activity and high seismicity.

Selenga middle mountains are a huge lowered area between the Khamar-Daban, Ulan-Burgasy and Khentei-Chikoi ranges and bounded by the water divide of the Selenga basin (pic. 1.1.9) [1]. The peneplainized Khamar-Daban is a relatively flat plateau with the elevation of up to 1500 m, has the direction from the south-west to the north-east. The more prominent elements are massive round-shaped tops, exceeding 2700 m above sea level. To the south lies the middle-mountain Minor Khamar-Daban with the heights below 1700-1800 m, being heavily dissected by the many tributaries of the Dzhida River. The Dzhida range, made up of mid-level mountains with the maximum elevation of 1612 m above sea level, extends in the west as far as the Selenga river valley.



Pic. 1.1.9 Selenga middle mountains (Landsat space image)

The relief of the territory incorporates a considerable number of open, isolated and half-isolated depressions of Trans-Baikalian type, alternating with vast flat-topped ranges slightly varied in height (1300-1800 m). The intermountain depressions of Trans-Baikalian type are comparatively shallow, stretching in the same direction as the mountain ranges. The bottom of the depressions is at about 550-700 m above sea level in the western and central parts, and 700-850 m in the eastern part. The elevation fluctuates within 500-900 m. The depressions are relatively small in size, but their total area is rather large (pic. 1.1.10).

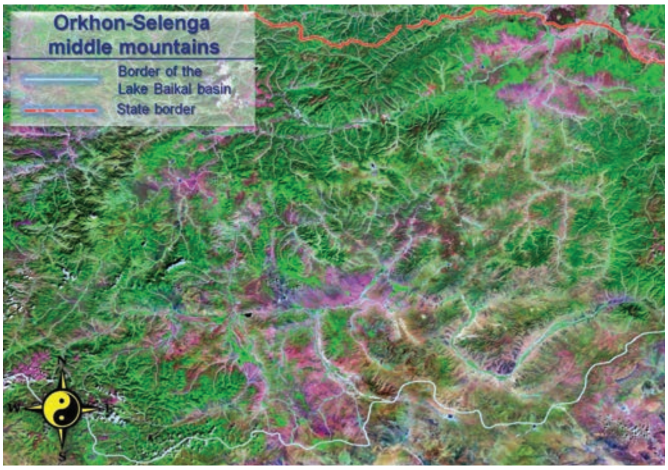
Pic. 1.1.10 Tugnuy-Sukharinskaya depression

Since intermountain depressions are bounded by the Khamar-Daban in the west, and the Khentei-Chikoi range in the east, and are open to the south, they receive just a small amount of precipitation, while their snow cover is thin and is not always formed in the driest regions.

The piedmont river fans, occupying a considerable part of the depressions' bottom, have in their western section steppe and dry-steppe environment, and in their eastern section – forest and steppe environment. The more widely distributed are dry sod grasslands on chestnut soil and less widely distributed – bunchgrass steppe as well as forb and grassland on leached chernozem. The grassland belt has the elevation of up to 900-1000 m, forest and grassland – from 900-1000 to 1200 m. The lowest belt of the vertical zonation is the grassland-forest of the Selenga delta.

The bottoms and slopes of the depressions house dry pine forests. Considerable in size, the fluvial meadow plains and terraces as well as meadow-swamp plains are characterized by salination. The slopes of the ridges, facing south, are commonly covered by pine and pine-larch south-taiga forests, which include meadow-grassland plots – "uburs". The northern slopes are grown by larch taiga, while the upper sections of the slopes (at the elevation of 1400-1600 m) one can find larch-cedar and cedar taiga. The middle mountains of the Selenga are the most economically advanced region of Lake Baikal basin.

Orkhon-Selenga middle mountains (Orkhon-Selenga erosion mountains) occupy a transitory area of the depression, located between the Khantai and Khentei-Chikoi mountains [4]. Territorially, this depression is coextensive with the heavily dissected basins of the Selenga and Orkhon rivers. The total length of the Orkhon-Selenga Mountains from east to west is about 1000 km, and its width – 300-350 km. This vast area consists for the most part of orographically branched and predominantly low mountains with unequal height. The area is dominated by low and narrow heavily flattened ridges and hills, separated by wide intermountain depressions and river valleys (pic. 1.1.11).

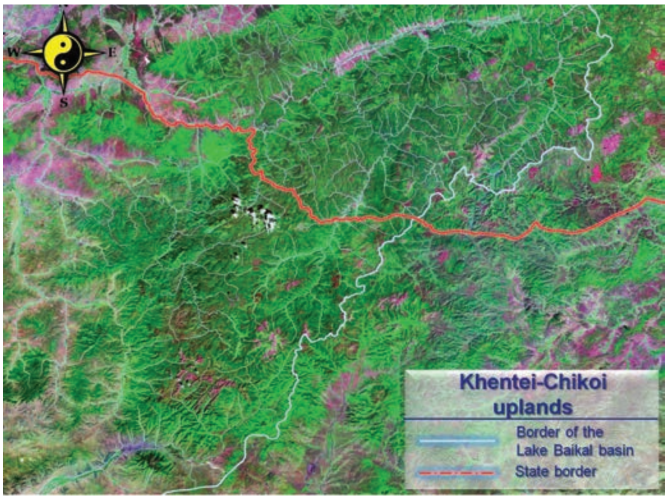


Pic. 1.1.11 Orkhon-Selenga middle mountains (Landsat space image)

The average height of the Orkhon-Selenga mountains is 1500-2000 m, and their maximum height is 2132 m (the Khantai range), while the bottom of depressions and valleys reaches the elevation of 800-1200 m. The landscape of low and heavily destructed mountains is dominated by the big range of the Khantai, Bulgan-Khan, Burin-Nuru and Burelyin-Nuru, with the heights up to 1600-2000 m. They occupy the extreme northeastern part of the Orkhon-Selenga mountains, adjacent to the Khentei range and extending in the same north-eastern direction. The other part of the Orkhon-Selenga mountains, gravitating towards the Khangai range, is considerably lower in elevation and is composed of heavily dissected low-height massifs, ridges and mountains (pic. 1.1.12).

Pic. 1.1.12 The Suvarga Khairkhan mountain, origin of the Orkhon River

Khentei-Chikoi uplands are on the Russian-Mongolian border and, for the most part in north-eastern Mongolia, where the ranges and depressions do not have considerable length [4]. Khentei-Chikoi uplands are typical low and flattened vault-like uphills with the barren relief on top of the vault (pic. 1.1.13).



Pic. 1.1.13 Khentei-Chikoi uplands (Landsat space image)

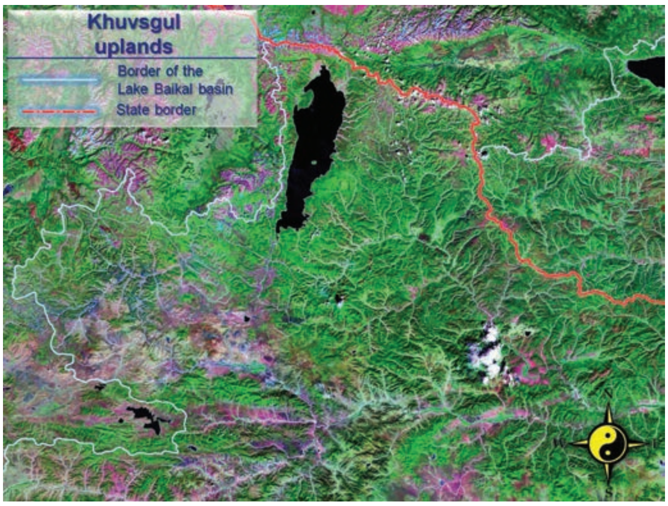
This area lacks the single pronounced orographic core, but instead has a zone of bald mountains which assume the functions of the orographic core. The latter takes up the most elevated central part of the highlands, located in the upstream of the Onon, Tuul, Iro, Kherlen and Menza rivers. The bare mountains and ridges are commonly huge and have round-shaped or flattened tops, while their slopes, round-shaped and asymmetric, are covered with stones (pic. 1.1.14).

Of particular interest is the fluvial network of the highlands. Even though the rivers, originating in the barren mountains, flow in different directions, but none of them flows beyond their realm to the south – drainless Central Asian basin. All of them flow either into the basin of the Arctic Ocean, or the basin of the Pacific Ocean. Apart from that, some of them form abrupt and characteristic meanders and loops close to the boundaries of the drainless basin (Tuul, Kherlen). The world water divide in Khentei is not always coextensive with the maximum relief elevation, being second to the local water divides and forming a sinuous line.

Pic. 1.1.14 Khentei mountain range

The area is dominated by mountain taiga. The lower sections of the hills are taken by larch forests with the underwood of Rhododendron dauricum. At the heights, exceeding 1200-1300 m, larch forests are supplanted by cedar and larch forests. Purely cedar forests are rare and found predominantly at upper edges of mountainous taiga and damp places. At the height of 1700-1800 m, the sparse forest and barren mountains come to the fore. The upper stream of the Chikoi River has separate sites, the formation of which has been facilitated by glaciers. The most elevated places may have snow fields. The highlands also have permafrost of the island type.

Lake Khuvsgul uplands form the southwestern node in the system of Baikal rift, ending without further visible extension [4]. The highlands protrude deeply into the mountain systems of Tuva and Eastern Sayans, forming a complex structural and orographic node, connecting their spurs with the spurs of the Khangai (pic. 1.1.15).



Pic. 1.1.15 Lake Khuvsgul uplands (Landsat space image)

Khuvsgul uplands are represented by a number of mountain ranges and intermountain depressions, occupied by the valley of the Uree-Gol River, Lake Khuvsgul depression and Darkhat depression. The position of these depressions and ranges is strictly conditioned by submeridional rift, cutting across the extension of the sublatitudinal formations of Khangai mountains. Lake Khuvsgul serves as the orographic center of the area (pic. 1.1.16).

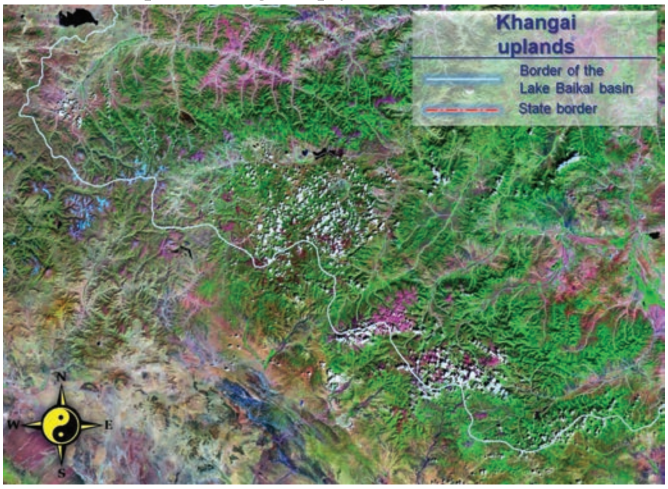
Pic 1.1.16 Lake Khuvsgul

North of the lake runs the borer-area range of Munku-Sardyk, whose tops are permanently covered with snow and small modern glaciers. Along the western shore of lake Khuvsgol lie the huge and hard-to-access ranges of Bayan-Ula (3002 m) and Khardyl-Sardyk (3189 m), forming the boundary of the basin here. For the most part they exceed the elevation of 2000 m and have a relative elevation up to 500 m. Lake Khuvsgul rift area is the only mountainous area in Mongolia, which has a well pronounced Alpine relief (pic. 1.1.17).

Pic. 1.1.17 Top of Munku-Sardyk

The slopes of the ranges, facing Lake Khuvsgul (Bayan-Ula range) and Darkhad depression (Khardyl-Sardyk range), form high and steep stone benches with the relative high elevation of up to 500-1000 m over Lake Khuvsgul. The southern part of the area has a mid-mountain relief, characterized with relatively flat tops of dividing ranges, comparatively flat and smooth slopes and wide valleys.

Khangai uplands are located in the southern part of the basin, forming the peculiar inland mountains of Mongolia. In the west, their slopes stop at the Great Lakes Depression, and in the south and the southeast at the Valley of the Lakes and the Central Gobi pereplain (pic. 1.1.18) [4]. The boundaries of the mountain area are clear-cut and distinct, conditioned by the deep faults of Dzabkhansky and Bayankhongorsky. The transition to valleys is marked either with benches, or the ridges of low mountains and hummocks, protruding deeply into their realm.



Pic. 1.1.18 Khangai mountains (Landsat space image)

The orographic core of the area is its main water divide range, which stretches in the northwestern direction for 700 km and is coextensive with the World water divide. It reaches the maximum elevation in the west, where there is the most powerful mountain plexus with the well-preserved ancient glacial relief. The largest of them is the mountain group of Otgon-Khairkhan-Nuru. Its top Otgon-Tenger, 4008 m high, permanently covered with snow, is the highest mountain of the Khangai (pic. 1.1.19).


Pic. 1.1.19 The Otgon Tenger Mountain, origin of the Ider River

The northern slope of the Khangai forms vast foothills, deeply indented with the dense river network. Apart from the washed-out and peneplainized spurs of the main range, the area abounds in closed lake depressions predominantly with small, and more rarely large water bodies, which imparts this indented and flattened area the character of lake plateau and lake peneplain. In the latitudinal direction it is traversed by the aforementioned asymmetric ranges of the Tarbagatai and Bolnai, which underwent a considerable elevation.

1.2 TERRITORIAL-ADMINISTRATIVE DIVISION

Administratively, the transboundary basin of Lake Baikal is situated on the territories of two states – Russian Federation and Mongolia (pic. 1.2.1).

The total area of the basin is 576,5 thousand km^2, of which 44,6 % are in Russia and 55,4 % are in Mongolia [20]. The Russian part of the basin incorporates the territory of four administrative units (federation subjects) of the Siberian federal district and in Mongolia – the territory of 12 aimags.

In terms of the administrative division, the south-eastern part of Lake Baikal basin belongs to Zabaikalsky Krai (ZK), the central and northern parts – to the Republic of Buryatia (RB) and the western part – to Irkutsk region (IR). On the side of Irkutsk region, the region includes Olkhon district with the biggest island on Lake Baikal and the shore territories of Irkutsk (north of the Angara River) and Slyudyanka districts. From the north-eastern part of Lake Baikal, the lake basin incorporates the following administrative districts of RB: Severobaikalsky, Barguzinsky, Kurumkansky district, the western part of Muysky district and Pribaikalsky district. A considerable part of the territory is part of the Central ecological zone of Baikal natural territory (BNT). The central part of the basin of Lake Baikal in RB includes 15 municipal units: Ulan-Ude city, Bichursky district, Dzhidinsky district, Zaigraevsky, Ivolginsly, Kabansky, Kizhinginsky, Kyachtinsky, Mukhorshibirsky, Selenginsky, Tarbagataisky, Khorinsky, Zakamensky districts, parts of Yeravnensky and Tunkinsky districts.

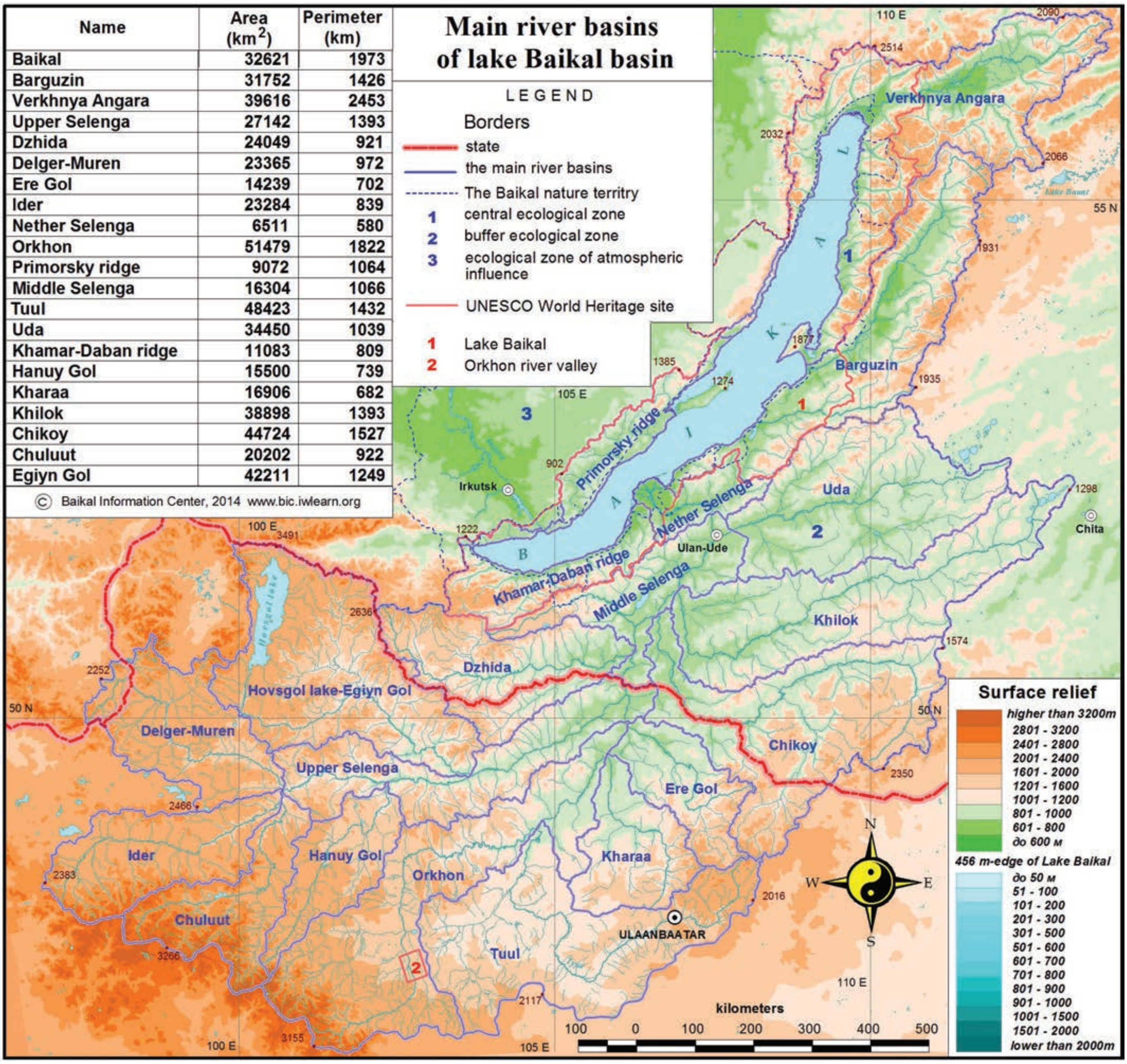
The western part of Lake Baikal basin is represented by ZK and includes 5 administrative districts: Krasnochikoisky, Petrovsk-Zabaikalsky, Khiloksky districts, part of Chitinsky and Uletovsky districts, located in the tributary area of the Khilok and Chikoi rivers (table 1.2.1).

Pic. 1.2.1 Administrative division of Lake Baikal basin

Table 1.2.1 Administrative units of Lake Baikal basin

Administrative unit	Area on the territory of the basin (km^2)	Center of the administrative unit
RUSSIAN FEDERATION		
Republic of Buryatia (districts)	**172140**	**Ulan-Ude city**
Ulan-Ude city	3476	
Severobaikalsky	110	Nizhneangarsk
Barguzinsky	18533	Barguzin village
Bichursky	6201	Bichura village
Dhidinsky	8600	Petropavlovka village
Yeravnensky (partly)	6080	Sosnovo-Ozerskoe village
Zaigraevsky	6605	Zaigraevo village
Zakamensky	15320	Zakamensk city
Ivolginsky	2663	Ivolginsk village
Kabansky	13470	Kabansk village
Kizhinginsky	7871	Kizhinga village
Kurumkansky	12450	Kurumkan village
Kyachtinsky	4684	Kyachta city
Muysky (partly)	2229	Taksimo village
Mukhorshibisrky	4532	Mukhorshibir village
Pribaikalsky	15472	Turuntaevo village
Severobaikalsky (partly)	41800	Nizhneangarsk village
Selenginsky	8269	Gusinoozersk city
Tarbagataisky	3300	Tarbagatai village
Tunkinsky (partly)	1058	Kyren village
Khorinsky	13431	Khorinsk village
Zabaikalsky Krai	**56193**	**Chita city**
Krasnochikoisky	28290	Krasniy Chikoi village
Khiloksky	14800	Khilok city
Petrovsk-Zabaikalsky	9110	Petrovsk-Zabaikalsky city
Chitinsky (partly)	2535	Chita city
Uletovsky (partly)	840	Ulety village
Irkutsk region	**12015**	**Irkutsk city**
Olkhonsky (partly)	14530	Yelantsy village
Irkutsky (partly)	5120	Irkutsk city
Slyudyansky (partly)	4942	Slyudyanka city
Tuva Republic	**2066**	**Kyzyl city**
Tere-Kholsky (partly)	2066	Kungurtug village
MONGOLIA		
Mongolia (aimags)	**296794**	**Ulan-Bator city**
Khuvsgul (partly)	69925	Murun city
Arkhangai	54952	Tsetserleg city
Bulgan	48785	Bulgan city
Tuv (partly)	43977	Zuunmod city
Selenge	41392	Sukhbaatar city
Zavkhan (partly)	15256	Uliastai city
Uvurkhangai (partly)	11516	Arvaikheer city
Ulanbaatar	3976	Ulaanbaatar city
Darkhan-Uul	3199	Darkhan city
Khentii (partly)	1585	Undurkhaan city
Bayankhingor (partly)	1230	Bayankhingor city
Orkhon	844	Orkhon city

The Russian territory of the basin is part of Baikal natural territory (BNT), divided into three ecological zones [5,6]. The central ecological zone covers the water area and the shore of the lake. Ecological buffer zone is coextensive with the Russian part of the lake basin. The zone of atmospheric effect occupies the eastern part of Irkutsk region, adjoining the western border of the basin (pic. 1.2.2).

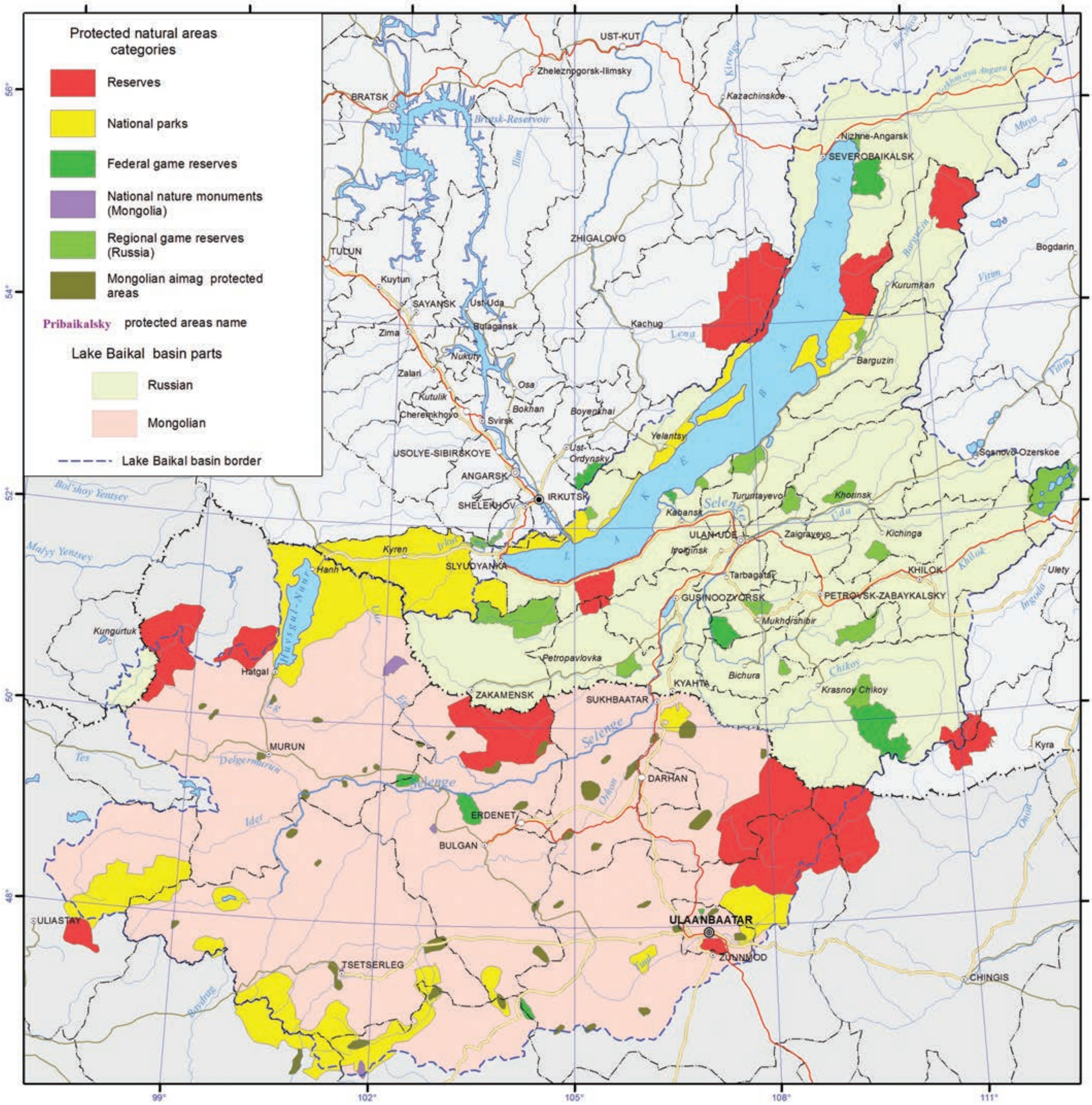


Name	Area (km^2)	Perimeter (km)
Baikal	32621	1973
Barguzin	31752	1426
Verkhnya Angara	39616	2453
Upper Selenga	27142	1393
Dzhida	24049	921
Delger-Muren	23365	972
Ere Gol	14239	702
Ider	23284	839
Nether Selenga	6511	580
Orkhon	51479	1822
Primorsky ridge	9072	1064
Middle Selenga	16304	1066
Tuul	48423	1432
Uda	34450	1039
Khamar-Daban ridge	11083	809
Hanuy Gol	15500	739
Kharaa	16906	682
Khilok	38898	1393
Chikoy	44724	1527
Chuluut	20202	922
Egiyn Gol	42211	1249

Pic. 1.2.2 Basins of the major rivers of Lake Baikal basin

1.3 SPECIALLY PROTECTED NATURAL TERRITORIES

At present, the Russian territory of the basin incorporates all the major categories of specially protected natural territories (SPNT) distinguished by the federal law «On specially protected natural territories» (1995): state nature reserves, national parks and wildlife sanctuaries of the federal and regional level as well as resorts and recreation locations, botanic gardens and monuments of nature (pic. 1.3.1) [3,4]. The total area of SPNT within Russian part of basin is 31252 km^2 (data of the digital topographic basis of BINM SB RAS). In 2013, the number of reported violations in protected areas compared with 2012 increased by 29% and amounted to 1 110 violations.



Pic. 1.3.1 The specially protected natural territories [1]

Reserves. Of the five state natural reserves three natural reserves are biospheric in accordance with the international UNESCO «Man and Biosphere» program: Barguzinsky (having a biospheric polygon), Baikalsky (pic. 1.3.2) and Sokhondinsky [3,4]. The boundaries of Barguzinsky reserve include a three-kilometer area along the coast of Lake Baikal. Sokhondinsky and Baikalsky reserves have protection zones – buffer territories, mitigating the transition from the strictly protected areas to the exploited areas. The reserves of the region preserve high-mountain taiga ecosystems: Baikal-Lena nature reserve preserves Baikal range; Barguzinsky reserve -Barguzinsky range, Baikalsky-Khamar-Daban mountains; Dzherginsky reserve – the juncture of Barguzinsky, Ikatskt and South-Muysky ranges; and Sokhondinsky reserve – Sokhondo mountains.

Pic. 1.3.2 The office of Baikal Reserve

The Baikal Natural Biospheric Reserve on the south coast of Lake Baikal is the major hub of the Eurasian ecological network and serves the research and nature conservation purposes. The biospheric reserve includes the Museum of Nature, which keeps its collection of animal and bird collection regularly updated (pic. 1.3.3).

Pic. 1.3.3 The Museum of Nature of Baikal Reserve

The reserve also provides premises to the "Ethno-town" complex with a total area of 0.25 ha. In 2012, the museum managers conducted 61 excursions, while the number of museum visitors was 633 persons. The territory of the reserve is traversed with 6 ecological trails. The «Khamar-Daban Wilderness Trail» with a length of 12 km (2.5 km of which are within the protected area) passes through the Osinovka River and offers a good view of the bald mountain landscape. The path is reconstructed and maintained by volunteers of the «Great Baikal Trail Association» (pic. 1.3.4). The second excursion trail is designed as an ecological trail along the Vydrinnaya River and has a length of 44 km (22 km of which are outside the protected area). In 2012, the territory of the reserve and the protected area within it were visited by 357 groups of a total of 4 thousand people, as well as 25 foreign groups totally numbering more than 100 people.

Pic. 1.3.4 The Great Baikal Trail

National parks. The region has four national parks being a type of specially protected natural territories more geared towards the development of tourism and recreational activities [3,4]. National parks are supposed to incorporate some of the following types of functional zones: a wilderness area, a specially protected area, a learning tourism area, a recreational area, and an area for historical and cultural objects. The functional zoning of national parks in Lake Baikal basin is different. For instance, in addition to the above-mentioned zones, Zabaikalsky National Park (pic. 1.3.5) has a defined water protection zone and a zone for traditional economic activities, where regulated fishing is allowed (6165 ha, or 2.7 %). Pribaikalsky park has a zone of traditional nature management (33 900 ha, or 8.1 %), but it does not have a specially protected area.

Pic. 1.3.5 The Zabaikalsky National Park (Google)

The territory of Pribaikalsky national park stretches over 600 km as a narrow strip along the southwestern coast of Lake Baikal. The park is composed of clusters of five separated sections: Olkhon Island, mainland Olkhon district area, Maritime range and Baikal range. The boundaries of Pribaikalsky national park embrace about 40 locations as well as 112 thousand ha of agricultural lands, some of which are disputed. In terms of agricultural land disputes, the situation is relatively successful at Zabaikalsky national park. Its territory is compact and access is easily regulated. A 2011resolution of the Ministry of Natural Resources and Ecology of the Russian Federation stipulated merging of Barguzinsky state reserve and Zabaikalsky national park into a single entity under the official name of «Zapovednoe Podlemorye».

Wildlife sanctuaries of the federal level. The territory of the three federation subjects have seven wildlife sanctuaries of the federal level, being located mainly on their peripheral part [3,4]. «Frolikhinskiy» wildlife sanctuary is situated on the northeastern coast of Baikal and on the western slope of Barguzinsky range. Lake Frolikha as a unique natural object, a habitat to endemic species of flora and fauna. Part of Lake Baikal coast, adjacent to the SPNT, belongs to the protected area of the sanctuary. The water-spa resort «Khakusy» is part of the wildlife sanctuary.

«Kabansky» wildlife sanctuary is located in the Selenga river delta and is recognized as a structural part of Baikal biospheric reserve (pic. 1.3.6). The sanctuary incorporates aquatic and semi-aquatic complexes of multiple water channels and wetlands. This area is considered as an internationally significant territory with the status of «key ornithological territory» recognized by the Convention on the Conservation of Migratory Species of Wild Animals as well as the Convention on Wetlands of International Importance (Ramsar Convention). The reason for that is that the sanctuary is the major node on the migration trajectory of the birds of passage, many of which are numbered as rare or endangered species (pic. 1.3.6).

Рис. 1.3.6 A trap for birds

«Altacheisky» wildlife sanctuary is at the confluence of the rivers Sulkhara and Khilok (right-hand tributary of the Selenga River) and represents a transition between middle-mountain pine forest and typical Selenga dry steppe area. The main protected species are roe deer, Siberian stag, bustard, demoiselle crane and Daurian hedgehog.

«Burkalsky» wildlife sanctuary is centrally located amid Khentei-Chikoi mountains and preserves cedar (Siberian larch) taiga. The population of Chikoi sable is endemic to this place, which unlike Barguzin sable has darker fur and is bigger in size.

Wildlife sanctuaries of regional significance. Irkutsk region numbers 12 wildlife sanctuaries of regional significance (nine of them are of comprehensive character, while Zulumaisky, Irkutniy and Kochegarsky are species-oriented). In the Republic of Buryatia, there are 13 sanctuaries all of which have the status of «state natural biological» entities. In Zabaikalsky Krai there are 15 sanctuaries [3,4]. This category of SPNT is affiliated with the special departments of the executive power of the federation subjects. According to the federal legislation, such sanctuaries are established for a definite period, after which the decision on the prolongation or abolition is to be made. It should be noted that at present all the wildlife sanctuaries of Irkutsk region have been made to exist for an unlimited period of time. In Irkutsk region, some wildlife sanctuaries (Irkutniy, Magdansky, Kochergatsky and Boyskiy wetlands) have been functioning this way from 2003, while all other sanctuaries assumes the status in 2008. The Republic of Buryatia abolished time limits for wildlife sanctuaries in 2005, and Zabaikalsky Krai in February 2009.

Most of the wildlife sanctuaries of Irkutsk region cover river valleys and lake depressions of the middle-height mountains as hubs on the migratory routes of hoofed animals, nesting places of commercial birds, including semi-aquatic and swimming birds. In Buryatia, coastal SPNTs near Lake Baikal include Verkhne-Angarsky (the Kichera and Upper Angara river deltas), Pribaikalsky and Enkheluksky wildlife sanctuaries; high mountain-taiga type SPNTs include Muyskiy, Snezhinsky, and Ulyunsky (serves as a protection zone for Zabaikalsky national park); mountain-taiga SPNTs include Angirsky, Kizhinginsky, Kondinsky, Uzkolugsky, and Khudaksky sanctuaries; steppe SPNTs are Tugnuisky and Borgoisky. In Zabaikalsky Krai mountain-taiga sanctuaries include Atsynsky, Butungarsky, Nikishinsky, Uldurginsky and Chitinsky. A significant part of Ivano-Arakhleisky wildlife sanctuary is made up of lake and wetland complexes.

Monuments of nature are the most numerous group of SPNTs, but these territories are insignificant in size and least protected legally [3,4]. In many cases, monuments of nature are seen as being supervised by non-existent organizations such as collective farms. Irkutsk region numbers 75 monuments of nature, including 4 of the federal level, 28 of the regional level and 43 of the local level. Out of the two latter groups, 23 monuments of nature are geological and geomorphological, 18 are hydrological, 9 are botanical, 4 are zoological, 5 are landscape monuments and 12 are complex. Monuments of nature also included archeological monuments, even though these objects are supervised by the state bodies responsible for the preservation of historical-cultural legacy but not by nature-protection bodies.

In the Republic of Buryatia, all the 152 monuments of nature have the regional status. The following types of them are distinguished: geological – 43, hydrological – 53, botanic – 19, zoological – 9, landscape – 19, complex (including natural-historical) – 9.

In Zabaikalsky Krai, the total number of monuments of nature of regional level is 66, including geological – 21, hydrological – 17, botanic – 9, zoological – 1, and complex (including recreational and natural-historical) – 18.

Mongolian Law on Specially Protected Areas provides for four categories of protected areas, such as «Strictly protected area» (SPA), «National conservation parks» (NCP) (pic. 1.3.1 and pic. 1.3.7), «Natural reserves» (NR) and «Monuments» (NM) [10].

Pic. 1.3.7 The National conservation park Gorhi-Terelj

As of 2012, 99 locations covering 27.2 million ha are considered as specially protected areas. These areas occupy 17.4% of the country's total territory and are to be further expanded to reach 30%. According to the classification of the specially protected areas, there are 20 Strictly Protected Areas occupying 12 402 429 ha of land, 32 Natural Conservation Parks spanning over 11 711 815 ha, 34 Natural Reserves covering 2 958 142 ha, and 13 Monuments over 126 848 ha. Mongolian Government further increases the number of Specially Protected Areas year by year [11].

Eleven Mongolian lakes and the areas surrounding them (wetlands, meadows, etc.) are registered under RAMSAR convention [14,24]. Among these, Lake Ugii (47°46′N 102°46′E) located in Ugii soum and Lake Terhyn Tsagaan (48°10′N, 99°43′E) located in Tariat soum of Arkhangai aimag were registered under RAMSAR convention in 1998.

The Orkhon valley with its numerous archaeological remains dating back to the 6th century was recognized as a World Heritage Site by UNESCO in 2004 [9]. Collectively the remains within the valley reflect the symbiotic links between nomadic, pastoral societies and their administrative and religious centers, and the importance of the Orkhon valley in the history of central Asia. The site includes Kharkhorum, the 13th- and 14th-century capital of Chingis (Genghis) Khan's vast Empire (pic. 1.3.8). Within the cultural landscape are a number of archaeological remains and standing structures, including Turkic memorial sites of the 6th-7th centuries, the 8th-9th centuries' Uighur capital of Khar Balgas. Erdene Zuu, the earliest surviving Mongol Buddhist monastery, Tuvkhun Hermitage, etc.

Pic. 1.3.8 The Erdenezuu monostery in Kharkhorin

1.4 CLIMATIC CONDITIONS

The location of Lake Baikal basin in the central part of the vast Eurasian continent and its mountain-depression relief have equally determined the particular and, in a sense, unique climatic conditions. The specific feature of the climate is its abrupt and frequent spatial variability due to the presence of mountain ranges of different heights and orientation, intermountain depressions and valleys, orographic forms, which produces a strong impact on the local circulation of air masses, changing abruptly the main orographic indicators and producing uneven climate.

The territory is characterized with extremely continental climate with considerable annual and daily fluctuations of air temperature and uneven distribution of precipitation by seasons [3]. The exception is a narrow strip along the lake, where the signs of maritime climate with cooler summer and milder winters as compared to the surrounding territories. Extremely continental climate is characterized with cold winters and hot summers. One of its specialties is that, during the cold period, the region faces a powerful northeastern extension of the Siberian anticyclone, which comes in September-October and disappears in April-May.

Low winter temperatures are easily tolerated due to dry air. Severe windless winter is followed by late windy and dry spring with night frost, lasting till the first decade of June. High summer temperatures can be felt only at noon hours, while the morning and evening hours are enjoyable for their cool temperature. Summer is short, its first half is droughty and second half (July-August) – rainy. Autumn is rather warm and lasts until Baikal is covered with snow.

Climatic conditions in Lake Baikal basin are determined by the character of atmospheric circulation and radiation regime as well as by the structure of the surface and the impact of water masses on the shore regions (table 1.4.1).

Table 1.4.1 Distribution of temperatures, precipitation, speed of winds in correlation with relief

Type of relief	Temperature (^{0}C)				Annual average amount of precipitation (mm)	Speed of wind (m/sec)	
	Average		Extreme				
	January	July	Max.	Min.		Jan	July
Lake Baikal shore	-18 -22	10-14	34	- 46	400-600	2-4	2-4
Depressions	-26-30	16-19	38	-57	200-400	1-2	<1
Wide valleys and plains	-22-27	17-19	40	-53	200-400	2-3	2-3
Foothills and mountain valleys	-25-30	15-17	32	-57	300-500	1-3	1-2
Middle mountains	-22-28	12-15	36	-55	600-800	2-3	2-4
High mountains	-20-25	8-11	27	-46	900-1200	2-3	3-6

Atmospheric pressure. In winter, the major atmospheric phenomenon is the Asian (Siberian) anticyclone with the center in the north-west of Mongolia, reaching its maximum power in January [3]. In spring, the power of the anticyclone subsides, which makes dominant the factors of zonal circulation, conditioning the west-east transfer. Apart from the transfer of atmospheric entities from west to east, spring is marked with the arrival of cyclones from Central Asia. In summer, circulatory processes are characterized with the weakening of the west-east transfer. On the land surface, the baric field of reduced pressure with weak winds prevails (pic. 1.4.1).

Pic. 1.4.1 A clouds over the Mongolian steppe

When the blocking warm anticyclone is located over the central regions of Yakutia, southern cyclones come from Mongolia to the area of Lake Baikal, moving subsequently to the west or north-west. Central forms of summer circulation occur under the intensive development of pressure ridges and troughs. Circulatory conditions in autumn are characterized with the formation of the general west-east transfer, interrupted by meridional intrusions of cold masses from the north. Siberian anticyclone is at the stage of inception. In comparison with the spring season, autumn west-east movements of baric systems occur slower. The final transition to winter conditions of circulation is due in mid-November, when the Siberian anticyclone becomes rather stable.

Air temperature. Within the territory of Baikal depression, climatic conditions of the surrounding areas are heavily influenced by Lake Baikal [3]. While climate of the inland territories of Irkutsk region, Republic of Buryatia, Zabaikalsky Krai and Mongolia can be considered as extremely continental, local climatic conditions of Baikal shore area are close to maritime climate. Temperature of winter months on the shore of south Baikal is on the average 5 °C higher, and in summer months is as much lower than in the central areas. In summer time, temperature inversions are observed above the lake surface, impeding the ascending movements. The totality of radiological and circulatory factors and local conditions determine the peculiarities of the thermal regime.

In winter, due to the prevalence of anticyclone weather, air temperature depends mainly on the radiological conditions and air is cooled considerably above the surface. In summer, radiological factors play the dominant role in the formation of the temperature regime as well. The average long-term air temperature on most of the territory is below zero. The stations, located on the shore of Baikal, enjoy higher temperatures than the inland stations located on the same latitudes. The coldest month is January, the hottest month is July.

Spatial differentiation of temperature indicators within the basin is essential. Average daily temperature in the uplands does not reach 10 ^{0}C, and its total value varies from 2400 ^{0}C in the south of the basin to 500 ^{0}C on the north-eastern shore of the lake (табл. 1.3.2).

Table 1.4.2 Monthly averages of air temperature, °C (by meteorological station)

Meteorological observation station	Months												Annual average
	I	II	III	IY	Y	YI	YII	YIII	IX	X	XI	XII	
Kyahta	-22.0	-24.0	-7.0	-2.0	9.7	16.6	21.0	18.6	10.2	4.1	-7.5	-20.1	-0,20
Barguzin	-28.4	-29.8	-9.8	1.0	9.1	16.1	20.4	17.1	9.1	2.2	-11.1	-26.6	-2,56
Ulan-Ude	-23.6	-23-9	-7.1	2.1	10.3	17.1	21.1	18.4	10.1	3.4	-7.3	-20.8	-0,69
Irkutsk	-17.7	-20.7	-5.5	2.5	9.9	16.1	20.2	16.9	9.9	4.8	-5.8	-18.2	1,03
Kura	-23.3	-22.5	-6.5	1.9	9.1	16.2	18.0	17.1	9.2	2.3	-9.0	-18.4	-0,49

Atmospheric precipitation. The patterns of precipitation formation and distribution on the research territory are considerably influenced by the peculiarities of mountainous relief [3]. The altitude of the area and, more specifically, the location of mountains in relation to the moisture-carrying air currents make the distribution of precipitation highly uneven. The same altitudes of mountain ridges are characterized with different amount of precipitation (pic 1.4.2).

Pic 1.4.2 Snow on the mountain pass Mandrik

The maximum amount of precipitation is typical of the north-western and western slopes of the ridges, primary towards the prevalent air currents and bounding Lake Baikal – up to 1400 mm on the wind-faced slopes of the secondary ridges and in the interior regions of the uplands – 400-700 mm. In the grassland area of the western shore of Lake Baikal and its islands the amount of precipitation is 200-250 mm, in the intermountain depressions and valleys of the Uda and Selenga rivers – up to 300 mm (table 1.4.3).

Table 1.4.3 Monthly and Annual precipitation, mm (by meteorological station)

Meteorological observation station	Months												Sum
	I	II	III	IY	Y	YI	YII	YII	IX	X	XI	XII	
Kyahta	4	4	4	40	49	58	36	38	64	5	5	2	309
Barguzin	14	1	4	18	7	53	42	41	15	54	21	42	312
Ulan-Ude	9	1	2	22	8	48	83	24	20	8	13	12	250
Irkutsk	13	5	4	57	36	114	97	82	32	26	15	13	494
Kura	1	3	1	9	24	124	92	22	46	0	2	2	326

Snow cover. Snow cover is formed unevenly [3]. Its height decreases from the north-east of Lena-Angara plateau (50-80 cm) to 5-10 cm on the vast plains of Transbaikalia and Mongolia. This is conditioned by the interaction of powerful northeastern air currents with the weakened Pacific currents as well as the rising amount of precipitation with increasing ratio of solid particles. This is why the snow level in valleys is not high, and in the mountains of Lake Baikal and Stanovoi mountain ridge rises up to 60-100 cm. Uninterrupted snow cover is characteristic of the whole basin of Lake Baikal, but because of the snow-storm transfer, it is distributed unevenly inside the depressions with inversions, on the windward and leeward slopes of mountains. On the windward slopes, the height of snow cover rises by 70 cm at 1500 m and by 125 cm – at 2000 m. On the leeward slopes of barren mountains snow cover constantly decreases to 7-12 cm at 2000 m. On the plains and coast of lake Baikal, its average altitude varies within the range of 30-40 см (pic. 1.4.3). The exception is the Mongolian plateau, where in February-March the snow level does not exceed several centimeters. One should note regional specificity of the snow cover formation. It is determined by the confrontation of humid air masses with the surface of mountain slopes. Passing over water surface, air masses are additionally saturated with water and enhance the amount of snow on the slopes.

Radiation regime. Meridional position of the sun changes in winter from 3º in the north to 17º in the south, and in summer from 50 to 64º; the duration of solar illumination varies from 4 hours in the north to 8 hours in the south, and in the south (due to the duration of day in high latitudes) from 21 to 16.5 hours [3]. The duration of solar illumination in Cis-Baikalia and on the shore of Lake Baikal is 1500 hours per year in the north to 2600 hours in the south, whereas in Transbaikalia – from 1770 to 3000 hours, respectively.

Pic. 1.4.3 Snow on the lake Baikal

At the bottom of depressions, bounded by mountain ranges, in which the recurrence of fogs is significant, the duration of solar illumination diminishes by 300-500 hours. In this respect, the territory of Transbaikalia surpasses all the regions on these latitudes and even the well-known resorts of the Caucasus (in Kislovodsk – 2000 hours). The minimal amount of solar illumination is observed in November-December (22-100 hours) and the maximum amount – in May-June (240-280 hours), when the concentration of clouds is insignificant. The ratio of the observed solar illumination to the potential amount of illumination is 60-80% in February-March, 50-55% in July-August, 25-30% in November-December. Therefore, the sunniest period is the latter half of winter and spring, while the least sunny days are at the end of autumn and beginning of winter.

Biological impact of ultra-violet radiation on humans is only possible in the periods when the position of the sun exceeds 25-30º from February to October in the south of the territory. With the position of the sun exceeding 45%, the period of intense ultra-violet radiation occurs (75 days in the north and 165 days in the south), when under the excess of sunshine overheating of the human organism, sunburns are possible.

Overall amount of radiation in the south is 100-110 kk/sm²·year. The maximum value for radiation is in June (14-16 kk/sm²·month), and the least is in December. According to Budyko et al, theoretical values of radiation for these latitudes under the conditions of cloudless sky are considerably higher – in June 22-23 kk/sm². Thus, high concentration of clouds diminishes radiation by 60-65%. In addition to the natural rise of radiation from north to south, one can observe some decrease in its intensity from west to east due to the increased intensity of clouds in Transbaikalia in the second half of summer.

Mongolia has an extreme continental climate with significant fluctuations of daily and seasonal temperatures [7]. The winter is typically long and cold, while the summer is warm and short. The central and northern parts of Mongolia are elevated above the sea level by about 1,580 m. The region is mountainous and Khangai and Khentii mountains located here as well as the mountains around Lake Khuvsgul constitute part of Syberian Great Taiga. The weather is bright on most of the days (pic. 1.4.4).

Pic. 1.4.4 The sun over Khuvsgul

In 2012, the maximum recorded temperatures were 38.1-31.4°C and were recorded near the Ider River, in Khuvsgul mountainous region, Darkhad depression, Orkhon and Selenge river basin area [8]. The coldest temperatures observed in Orkhon and Selenge river basin were between -43.9 and -38.1°C, in Ider river basin, Khuvsgul Mountainous region and Darkhad depression the range was between -50.0 and -45.1°C, and from -41.5 to -32.5°C in other areas. The average air temperatures observed at meteorological stations in Selenge river basin are shown in table 1.4.4.

Table 1.4.4 Monthly averages of air temperature, °C (by meteorological station)

Meteorological observation station	Months												Annual average
	I	II	III	IY	Y	YI	YII	YIII	IX	X	XI	XII	
Murun	-21.0	-17.0	-7.3	2.2	9.9	15.3	16.6	14.4	8.2	0.1	-10.6	-18.5	-0.64
Tsetserleg	-14.9	-13.6	-6.8	1.1	8.7	13.0	14.3	12.8	7.5	0.6	-7.6	-12.9	0.2
Khujirt	-20.8	-18.2	-8.7	0.6	8.2	13	14.5	12.8	6.9	-0.8	-11.1	-18.3	-1.8
Bulgan	-20.3	-18.2	-8.6	1.1	9.1	14.2	16.0	13.9	7.2	-0.9	-10.9	-17.9	-1.3
Erdenet	-16.8	-14.8	-7.7	1.1	9.0	13.8	15.5	13.9	8.3	0.8	-8.7	-14.6	0.0
Ulaanbaatar	-21.6	-16.6	-7.8	2.0	10.0	15.6	18.0	16.0	9.2	0.7	-11.3	-19.1	-0.4
Orkhon /Bulgan/	-24.9	-21.4	-9	2.8	10.7	16.6	18.6	16.2	9.2	0.5	-11.3	-21	-1.1
Eruu	-27.1	-20.3	-8.6	3.5	11.2	17.5	20.0	17.4	9.6	-0.3	-13.3	-23.7	-1.2
Darkhan	-19.5	-16.4	-7.6	3.2	10.7	17.1	19.7	17.4	10.7	1.2	-10.4	-19.3	0.6
Sukhbaatar	-23.1	-19.3	-7.4	3.0	10.9	17.0	18.9	16.8	9.8	1.0	-10.7	-18.9	-0.2

The annual average precipitation is around 200-350 mm in Khangai, Khentii and Khuvsgul mountainous region and Orkhon and Selenge river basins (pic. 1.4.5) [8]. The sum of the monthly and total annual precipitation recorded at meteorological stations in Selenge river basin are shown in the table 1.4.5.

In 2012, the annual precipitation was 339.5-559.5 mm in Khuvsgul, Bulgan area and Orkhon and Selenge river basins. The surface water evaporation over the country is significant, particularly in forest steppe zones where evaporation reached 300-400 mm. In 2011, the annual average humidity was 64-79% in Khangai, Khentii and Khuvsgul mountainous region.

Pic. 1.4.5 Rain in the Orkhon River Basin

Table 1.4.5 Monthly and Annual precipitation, mm (by meteorological station)

№	Meteorological observation station	Months												Sum
		I	II	III	IY	Y	YI	YII	YII	IX	X	XI	XII	
1	Murun	1.5	1.3	3.6	6.9	17.4	69.9	95.2	81.5	24.4	9.3	2.2	1.9	315.0
2	Tsetserleg	2.0	2.8	6.1	16.9	32.7	69.0	90.4	82.6	27.3	13.5	6.0	2.8	352.1
3	Kharkhorin	3.9	3.0	7.4	13.2	28.9	60.0	79.7	49.8	24.4	13.2	5.6	4.0	293.1
4	Khujirt	1.2	2.0	3.9	10.1	24.9	53.5	91.5	73.4	25.6	7.4	3.5	2.2	299.2
5	Bulgan	1.4	2.1	3.2	10.7	25.5	57.7	108	81.8	32.4	12.5	3.9	2.0	341.2
6	Erdenet	2.0	1.7	5.0	13.8	23.7	70.7	100.5	81.3	41.2	13.0	7.6	3.3	363.8
7	Ulaanbaatar	2.7	2.6	3.7	9.5	18.3	50.0	65.3	72.4	32.3	8.1	6.1	4.0	275.0
8	Orkhon /Bulgan/	3.4	1.9	3.2	6.1	19.2	69.0	77.2	72.0	41.8	8.3	5.8	4.5	312.4
9	Sukhbaatar	3.2	2.6	3.1	11.6	18.9	49.0	84.7	74.7	35.9	14.3	6.1	3.1	307.2

Annual average wind speed was 0.8-0.9 m/s in Bulgan area and 1.2-3.8 m/s in other areas, and the maximum wind speed reached 14 m/s in Jargalant area of Khuvsgul, Altanbulag area of Tuv aimag, and 15-34 m/s in other areas [8].

In Selenga River basin, prevailing winds change depending on the season. The winds from the north and west-north prevail in spring season (27%), winds from the east, north and west north are about 17-25% of winds in summer, while the east, west-north and south winds blow in autumn (16-20%). Winds from other directions are very rare. There are almost no winds in winter. In spring, summer and autumn, the average wind speeds are 3.0-6.9 m/s, depending on the direction. The annual average of wind speed is 2.7 m/s, not considering the direction.

Climate change. According to Ulan-Ude weather station over 103 years the warming of the climate is estimated by the *air temperature* growth by 2.5° C (pic. 1). At the same time in Novoselenginsk the average annual air temperature rose by 1.8° C, while in Kyakhta it rose by 1.6° C [15].

Global changes reflect in the length of seasons (pic. 2). Increases of spring, summer and autumn and, consequently, decrease of the winter period were established. If in the early 1970 the length of seasons with positive and negative temperatures was approximately equal to 180-185 days, in the early 2000 the length of period with temperatures exceeding 0° C amount to over 200 days [15].

According to the data of the Limnological Institute of the Siberian Branch of the Russian Academy of Sciences annual air temperature growth at Lake Baikal (1.2° C over 100 years) turned out to be twice higher than the globe's average (0.6° C). This corresponds to the known fact of intensification of warming pace from low to middle to high latitudes. It may be expected that the annual air temperature at Lake Baikal by 2025 will rise by 2° C, and by 2100 by 4° C [17].

Reconstruction of hydrological regime show that over the recent 250 years the **dynamics of precipitation** and water level did not undergo significant (trend) changes. A growth of winter temperatures has not yet led to a drastic changes of hydrological budget of the Transbaikalian territory, where natural changes prevail. [15]. Cyclicity is the most characteristic part of the longstanding regime of annual run-off of the rivers of the Baikal region and changes in atmospheric precipitation.

From the middle of the last century average duration of *snow cover* in Transbaikalia shortened approximately by 5 days. This was caused by an increase of warm period duration connected with the increase of air temperature. The most significant decrease of the duration of snow cover is observed in the regions adjacent to Lake Baikal. On the contrary, in eastern regions the increase prevails. At the same time some precipitation enhancement during the cold season of the year results in a growth of snow cover depth. A tendency to increase is exposed in the longstanding changes of snow cover depth by 2-4 cm in average since the mid-1960 [13].

Climate change influences **ice conditions** on the lake. It is manifested in delayed freezing time and earlier breaking up of ice. At this time the change of freezing time in 1896-2000 was higher (by 11 days over 100 years) than for break up (7 days over 100 years) due to more active late autumn warming – early winter (November-December by 1.6° C) in comparison with the second half of spring (in April-May by 0.9°). The duration of an ice-free season increased, while that of the ice season decreased by 18 days. According to the observations, in 1949-2000 a maximum ice thickness in winter decreased by 2.4 cm over 10 years in average [16]. During the observation period from 1950 to 2007 a steady decrease of maximum ice-thickness on Lake Baikal amounts to 15-24 cm by different points. The duration of ice-formation decreased from 12 to 25 days for various areas of Lake Baikal and, consequently, the duration of ice-free period increased by 12-25 days [12].

According to forecasts the maximum ice-thickness on Lake Baikal will decrease to ~ 50 cm by 2050 and ~ 31 cm by 2100 [12]. Meanwhile the duration of ice season will decrease by 1 and 2 months respectively and by the end of the century will total 56-60 days on South and Middle Baikal and 76 days on North Baikal. It may be expected that in the end of the century in southern and middle areas of the lake there will be winters with short or unstable ice-formation [16].

The global warming affects **Mongolia** stronger in comparison with other regions of the globe. According to the data of 48 meteorological stations evenly spread on the territory of Mongolia, over past 70 years the average annual temperature in Mongolia rose by 2.14ºC. At the same time, in the period from 1990 to 2006 a small (-0.119ºC/year) temperature fall has been observed [18]. In the period from 1940-2004 winter air temperature rose by 3.6ºC, air temperature in spring rose by 1.4ºC, summer air temperature rose by 0.6ºC and autumn air temperature rose by 1.9º C. Climatic forecasts show that the territorial average monthly temperature of a warm season is expected to rise by 1.2-2.3ºC in 2010-2039, by 3.3-3.6ºC in 2040-2069 and by 4.0-7.0ºC in 2070-2099 [19].

Nowadays a gradual increase of evaporating capacity from the ground surface it taking place practically in all natural zones of Mongolia: in semi-arid and steppe and desert zone by 3.2-10 per cent, while in the highland and taiga areas by 10-15 per cent. Over the last 65 years the gross precipitation amount region-wise decreased by 8.7 – 12.5 per cent. Simultaneously, an annual redistribution of precipitation by seasons occurred. The winter precipitation amount rose while the precipitation amount in the warm season insignificantly fell. The amount of autumn precipitation rose by 5.2 per cent, winter precipitation rose by 10.7 per cent, while summer and spring rainfall, contrastingly, fell by 3.0 and 9.1 per cent respectively. This dynamics of humifying and the increase of the average annual temperature contributes to climate aridization [18]. Changes in rainfall will fluctuate approximately within ± 4% or 6-17 mm in the course of 2010-2039 with the expected rise by 7-8 per cent (27-33 mm) in 2040-2069 [19].

According to the research data gathered over the recent years changes in ice formation on rivers and lakes are concerned with the dates of ice cover formation and deterioration of condition and thickness of ice.

1.5 WATER LEVEL OF LAKE BAIKAL

In the average long-term water budget of Lake Baikal, the inflow components are:

- surface water inflow (57.77 km^3/year – 82.4 %);
- precipitation (9.26 km^3/year – 13.2%);
- ground water inflow (3.12 km^3/year – 4.4 %) [6].

The outflow components are the following: surface water outflow – the Angara River (60.89 km^3 – 86.8 %) (pic. 1.5.1); and evaporation (9.26 *км*^{3} – 13.2 %).

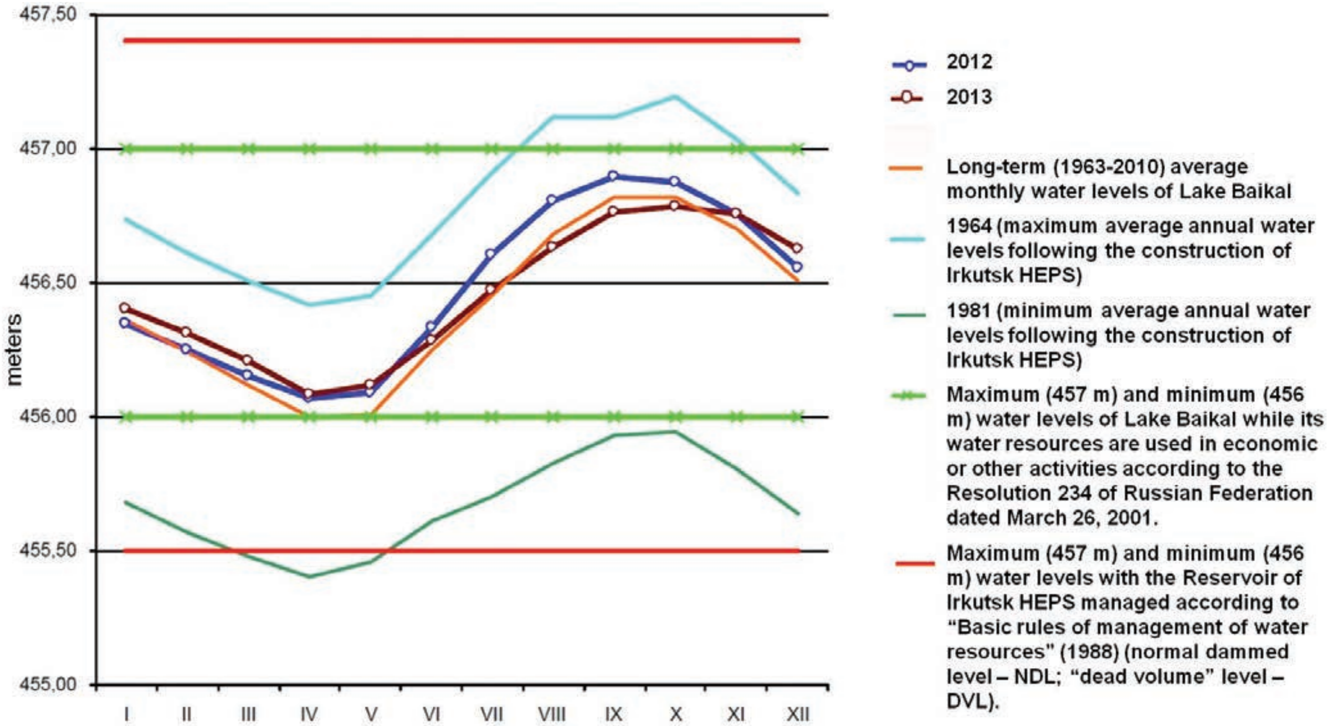
Pic. 1.5.1 The Angara River in Irkutsk city

The water level in the lake depends on the operating modes of Irkutsk Hydroelectric Power Station (HEPS), Bratsk HEPS and Ust-Ilimsk HEPS, all working interdependently. Boguchanskaya HEPS has been in commercial operation since December 1, 2012, and filling of its water reservoir began in summer 2012 and finished in 2014. After construction of the dam of Irkutsk HEPS (44 m high and 2.5 km long) (pic. 1.5.2) 70 km downstream of the Angara River source and filling of Irkutsk Reservoir (1956-1958), the backup water reached Lake Baikal in 1959 and caused its long-term water level to rise by 1.3 m (456.8 m) in 1964.

Pic. 1.5.2 The dam of Irkutsk HEPS

Further, the average long-term regulated water level of the lake (equal to the water level of Irkutsk Reservoir) was maintained at 1 m above the average water level prior to the construction of HEPS. This allowed using a part of the lake volume for controlling outflow by artificially regulating the water level on a seasonal and long-term basis. With its outflow backed up, the annual changes in Lake Baikal water level remained generally close to its natural values. The artificial regulation of the lake level resulted in increased amplitude of level fluctuations (from 80 to 113 cm) and a shift towards delayed in time maximum discharge of water and filling of reservoir. The annual changes in the level of Lake Baikal are characterized by a gradual rise until the levels become close to the normal dammed levels (in May-September), stabilization of maximum levels in October and a decrease during November to April.

As of January 1, 2013, the average water level of Lake Baikal was 456.46 m, which was 0.07 higher than in the previous year and 0.03 m higher than the long-term average (456.43 m) (pic. 1.5.3) [6]. In 2013, during the period when the lake was filled up, the water levels were within the range of long-term values, as a result of smooth regulation of discharge without abrupt fluctuations. The amplitude of level fluctuations was 0.76 m in 2013.



Pic. 1.5.3 Average monthly water levels of Lake Baikal in 2012 and 2013 compared with the years of the highest (1964) and lowest (1981) levels and long-term values.

1.6 LAKE BAIKAL – UNESCO WORLD HERITAGE SITE

In December 1996, Lake Baikal was listed as a UNESCO world heritage site by the resolution of the 20th session of UNESCO World Heritage Committee, which took place in a Mexican city of Merida [5,6]. The major objective of the world heritage list is to make widely known and to protect unique natural and historic sites. For this purpose, assessment criteria have been established. The first six criteria are in place from 1978 and identify cultural heritage, while the four criteria for natural heritage sites were introduced in 2002. From 2005, all the 10 criteria are put together in a single list. Out of thousands of natural heritage sites included in the list, about ten sites match all the four criteria, and Lake Baikal is one of them (pic. 1.6.1).

Pic. 1.6.1 The lake Baikal

In the UNESCO resolution it was stated that «Lake Baikal is a classic world heritage site, matching all the four criteria for natural sites. The lake itself is the centerpiece of the site and its largely unseen underwater features are the core of its value to both science and conservation. The late is surrounded by a system of protected areas that have high scenic and other natural values» (pic. 1.6.2).

Pic. 1.6.2 The coast of Baikal lake

Baikal was formed in the Mesozoic period as a result of the tectonic activities at the rift fault. Tectonic processes are still ongoing, which is manifested in the relatively high seismicity of Baikal region. Lake Baikal is the most ancient and the deepest lake on the Earth with the age of several tens of millions years. It is situated in a huge depression bounded by faults in the earth crust and continuing to expand with a rate of about 2 cm per year. Lake Baikal is a mountainous lake with the water level of between 455.4 m and 455.9 m (the Selenga river delta) above the sea level. The bottom of the lake is about 1200 m below the sea level. The layer of lake sediments reaches 10 km at some places. The sediments inside the lake contain “ciphered” information on climate change and geological history of Asia over the last 25-30 million years.

Baikal water is extraordinarily clean, transparent and saturated with oxygen. The high transparency of Baikal water is due to numerous aquatic organisms purifying the water and making its hydrochemical parameters very close to those of distilled water. Baikal is the biggest fresh-water reservoir on the Earth which makes it a truly unique phenomenon.

The volume of water in the lake is about 23 thousand km^3, which constitutes 20% of the world and 90% of the Russian fresh water reserves. Annually, Lake Baikal ecosystem reproduces around 60 km^3 of transparent and oxygen-rich water. East Siberia has an extremely continental climate, but the huge amount of water in Lake Baikal and its mountain surroundings produce a specific microclimate. The lake serves as a big heat stabilizer; it is warmer in winter and cooler in summer around the lake as compared to the areas farther away from the lake. The difference in temperatures is about 10 degrees C. This effect is largely caused by the forests growing along the lake shores. Because evaporation of cold water from the lake surface is rather insignificant, clouds do not usually form over the lake. Besides, the air masses bringing clouds from land are heated and the clouds get dissipated. As a result, the sky over the lake is clear most of the time.

Evolution of aquatic species, lasting over a long period of time, led to the formation of the unique endemic flora and fauna, which are of significant value for the study of evolution. Lake Baikal is one of the most biologically diverse lakes on the planet and the habitat of 1340 species of animals (745 endemic species) and 570 species of plants (150 endemics) (pic.1.6.3).

Pic.1.6.3 The endemic crayfish (*Eulimnogammarus* sp.)

Occasionally, scholars discover new species in the lake, which suggests that we know just 70-80% of all the species inhabiting the lake. On top of the trophic pyramid in the lake ecosystem is Baikal seal (nerpa), whose ancestors were Arctic seals, which arrived here through the Lena and Yenisei rivers. Forests around the lake have 10 plant species, recorded by the Red book of the International Union for Conservation of Nature and the area includes a full range of typical boreal forests.

The lake is surrounded by mountain-taiga landscapes and specially protected natural territories preserved in their natural state and having an additional value. More than a half of the lake’s shoreline is protected as state reserves, national parks and wildlife refuges. There are three nature reserves located immediately on the shore of the lake - Barguzinsky, Baikalo-Lensky and Baikalsky (the reserve has its own museum); two national parks - Pribaikalsky and Zabaikalsky; 6 wildlife refuges of the federal level - Frolihinsky, Kabansky, Pribaikalsky, Stepnodvoretsky, Verkhneangarsky and Enkheluksky.

The area of Lake Baikal can be considered as a tourist multi-functional zone possessing considerable recreational resources where all types of tourism are possible. It incorporates unique monuments of nature, while its flora and fauna are rich and variegated. The picturesque locations around Baikal depression with mountain ranges, boreal forests, tundra, lakes, islands and grassland form beautiful landscapes. Traditional types of tourism in the area include hunting and fishing. Recent years saw an increasing interest in sport hunting from local and foreign tourists. Other types of tourism in the area include diving, horse riding, trekking, rafting, sports hunting and fishing, and ecotourism.

While nominating Baikal as a world heritage site, the following recommendations were forwarded to the government of Russia:

- to pass a federal law on Lake Baikal
- to re-orient Baikal pulp-and-paper mill with the purpose of eliminating it as a source of pollution;
- to reduce the discharge of pollutants into the Selenga river;
- to improve the resource provision to nature reserves and national parks adjacent to the lake;
- to provide support to scientific research and surveys on Lake Baikal.

By now, the law on Lake Baikal has been adopted and, in December 2013, Baikal pulp-and-paper mill ceased its operation. The territory of the closed plant has been transformed to host the expo center “Nature reserves of Russia” [6].

The conservation of Lake Baikal for the future generations as a world source of clean fresh water and as a natural site with the original landscapes and unique fauna and flora is the most important task of the Russian government and the most important condition for the sustainable development of Baikal region.

BIBLIOGRAPHY

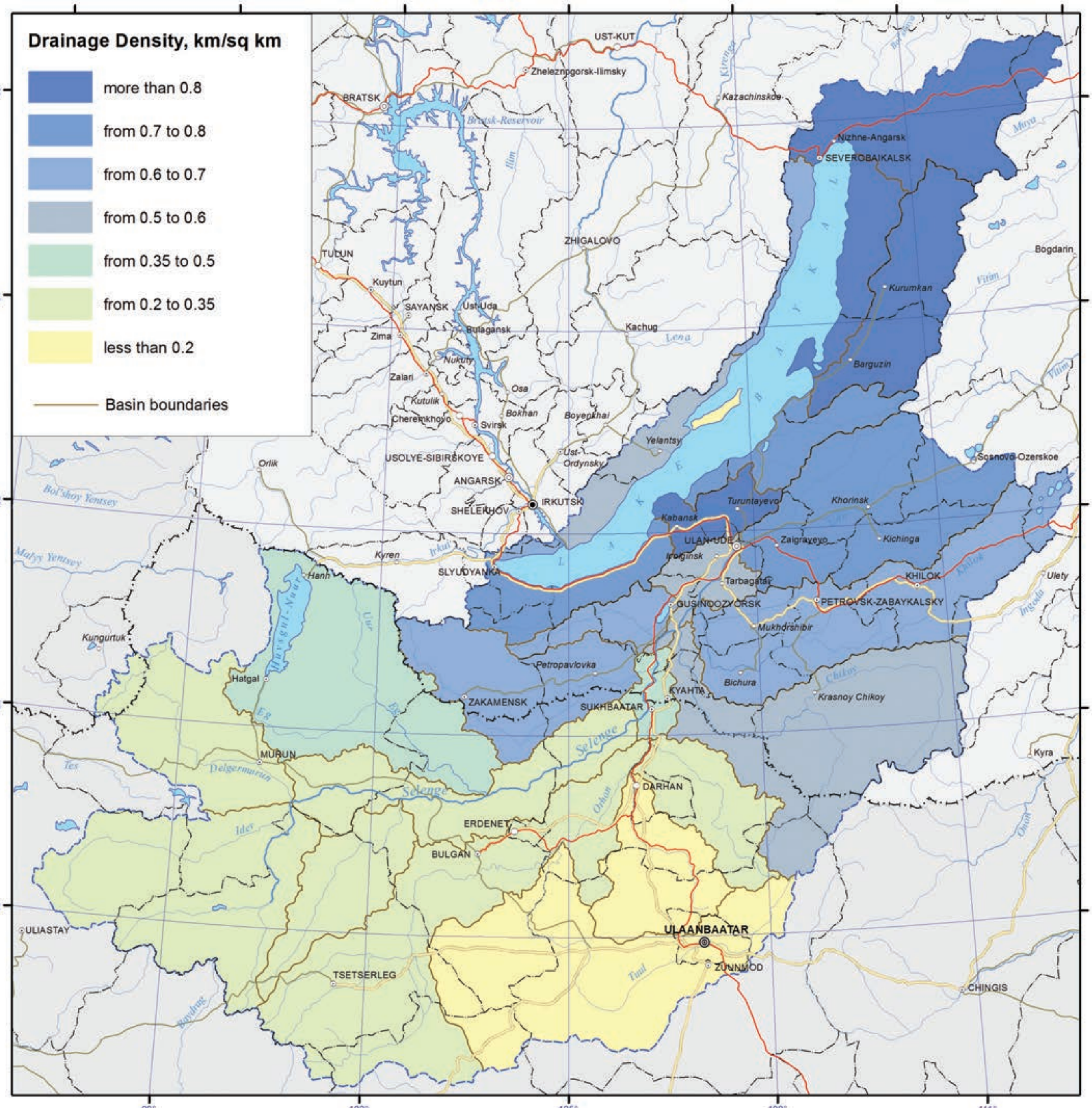
1. Batuev A.P., Buyantuev A.B., Snytko V.A. Geosystems and cartography of ecological and geographycal situations of the Selenga river hollows of the Baikal region – Novosibirsk: SB RAS Publishing House, 2000. – 164 pp.
2. Mikheev V.S., Ryashin V.A. Landscapes of the south of East Siberia (Maps). Head Office of Geodesy and Cartography, Moscow, 1977.
3. The scheme of integrated use and conservation of the water bodies within the basins of the rivers of the southern, middle and northern parts of Lake Baikal. –http://www.enbvu.ru/
4. Geomorphology of the Mongolian People's Republic. Florensov N.A., Kozhuhov S.S. (eds). "Nauka" Publishing, Moscow, 1982, 258 pp.
5. State report "On the state of Lake Baikal and measures for its conservation in 2012" - Irkutsk. Siberian branch of "Rosgeolfond", 2013. - pp. 436. http://www.mnr.gov.ru/regulatory/list.php?part=1258 (in Russian)
6. State report "On the state of Lake Baikal and measures for its conservation in 2013" - Irkutsk. Siberian branch of "Rosgeolfond", 2014. - pp. 462. http://www.mnr.gov.ru/regulatory/list.php?part=1258 (in Russian)
7. National Action Programme on Climate change (NAPCC) of Mongolia, approved by Parliament resolution №02, 2011.01.06 http://www.legalinfo.mn/law/details/6709?lawid=6709
8. MEGD, «State of the Environment Report Mongolia, 2011-2012», UB city 2013
9. MEGD, «Strengthening Integrated Water Resource Management in Mongolia» project, «Orkhon River Basin integrated water resources management assessment report», UB city 2012, http://www.tuulgol.mn/dmdocuments/reports/orkhon_r_b_report_english.pdf
10. Mongolian Law on Special Protected Area, 1994.11.15, (http://www.mne.mn/mn/880, Law of Mongolian on Special Protected Area, Word file by English, unofficial translation)
11. MEGD, «State of the Environment Report Mongolia, 2011-2012», UB city 2013
12. Kuimova K.L., Sherstyankin P.P. Analiz izmenchivosti kharakteristik ledovogo rezhima ozera Baikal I Arktiki po materialam nablyudenii s 1959 g. // Izmenenie klimata Tsentral'noi Azii: sotsial'no-ekonomicheskie i ekologicheskie posledstviya: materialy Mezhdunarodnogo simposiuma. – Chita: Izd-vo ZabGGPU, 2008. [The Variability Analysis of Ice Conditions Characteristics of Lake Baikal and the Arctic since 1950]
13. Obyazov V.A. Prostranstvenno-vremennaya izmenchivost' atmosfernykh osadkov v yugo-vostochnom Zabaikal'e. – Izv. RGO, vyp. 2, 1996. – s. 73-80. [The Space-Time Variability of Atmospheric Precipitation in the Southeast Transbaikalia]
14. Obyazov V.A. Adaptatsiya k izmeneniyam klimata: regional'nyi podkhod // Geografiya i prirodnye resursy. – 2010. – № 2. [Adaptation to Climate Changes: A Regional Approach]
15. Smirnova I.I. Vliyanie prirodnykh faktorov na produktivnost' agrosistem v usloviyakh krioaridnogo klimata (na primere Zapadnogo Zabaikal'ya): avtoreferat diss. na soiskanie uchenoi stepeni kandidata geografich. nauk. – Ulan-Ude. -2001. [The Effect of Natural Factors on the Productivity of Agrosystems in the Conditions of A Cryoarid Climate (A Case Study of West Transbaikalia].
16. Shimraev M.N., Sinyakovich V.N., Kuimova L.M., Troitskaya E.S. Tendentsii izmeneniya klimata i gidrologicheskikh protsessov v ozere Baikal v usloviyakh global'nogo potepleniya // Analiz i stokhasticheskoe modelirovanie ekstremal'nogo stoka na rekakh Evrazii v usloviyakh izmeneniya klimata / Materialy mezhdunarodnogo seminara. – Irkutsk: Izd-vo Instituta geografii SO RAN, 2004. – s. 213-220. [Tendencies and Climate Changes and Hydrologic Processes in Lake Baikal during the Global Warming].
17. Shimaraev M.N., Kuimova L.N., Sinyukevich V.N., Tsekhanovskii V.V. O proyavlenii na Baikale global'nykh izmenenii klimata v 20 stoletii // Doklady Akademii nauk, 2000. – T. 383. - № 3. – S. 397-400. [On the Manifestation of Global Climate Changes on Lake Baikal in the 20th Century].
18. Mongolia Assessment Report on Climate Change (MARCC, 2009), Ulaanbaator. – 2009 – 228 p.
19. Gunin P.D., Kazantsev T.I., Baja S.N., Danzhalova E.V., Drobyshev Y.I. Environmental effects of exposure to arid climate on ecosystems Central Mongolia // Climate Change in Central Asia: the socio-economic and environmental impacts: Proceedings of the International Symposium - Chita Univ ZabGGPU, 2008 - p. 77-83. [Gunin P.D., Kazantseva T.I. et al. Ecological Consequences of Climate Aridization Influence on the Ecosystems of Central Mongolia. In Russian]
20. Ecological atlas of the Lake Baikal basin – Irkutsk: Institute of Geography SB RAS. 2014. http://bic.iwlearn.org/ru/atlas/atlas

CONDITIONS OF NATURAL ENVIRONMENT

2.1 SURFACE AND GROUND WATERS

In the north of the Russian part of the basin, the biggest rivers are the rivers Angara, Barguzin and Turka. The middle part of the basin includes Selenga River with its major tributaries – the rivers Uda, Khilok, Chikoi and Dzhida. In the Mongolian part of the basin, the biggest rivers are the rivers Selenga, Ider, Chuluut, Khanui, Orkhon, Eruu, Kharaa, Tuul, Egiin-Gol, and Delgermurun.

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 [1]. 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



Pic. 2.1.1 River network density [1]

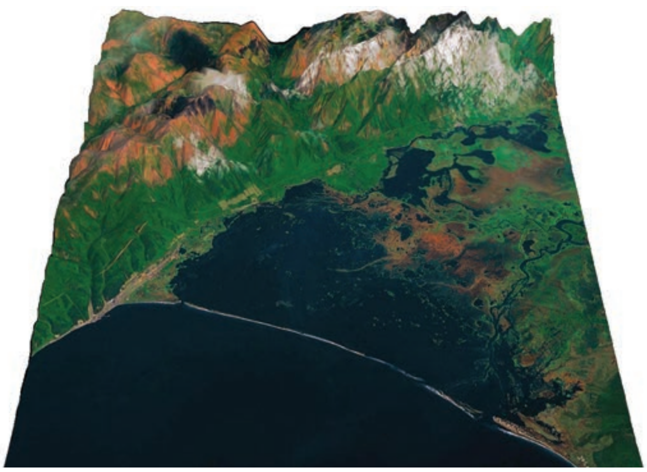
the Barguzin, and to the development of the river network. The highest density is specific to the western slopes of the Barguzinsky (0.92 km/km^2) and Khamar-Daban ridges (0.69 km/km^2). Among the plain territories, the most watered areas are the Barguzinskaya valley (0.89 km/km^2) and the area of the Selenga river delta (0.68 km/km^2) (pic. 2.1.1).

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 Khuvsgul, represents a forest-steppe with the high-mountain depression terrain, and is characterized by a lower river network density ranging from 0.32 km/km^2 for the Delgermurun 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.

Because of the disintegration of relief and a considerable contrast in the precipitation regime of the depressions and mountain ranges in the Russian part of basin, the average amount of annual runoff varies to a great extent – in the depressions it is seldom less than 2.5 l/s·km^2, that is including some sites without an outflow, while the runoff on the range slopes exceeds 25 l/s·km^2, averaging 5-10 l/s·km^2 for the most part of the territory. The regime of most of the rivers is of Far East type with the maximum runoff in the rainy period and rain alimentation in the second half of summer. Many medium-sized rivers freeze in winter thereby contributing to the issue of winter water supply.

In the North of basin **the Verkhnyaya Angara River** flows from the southern slope of the Delun-Uransky mountain range and falls into Angarsky Sor bay, located in the northern part of Lake Baikal. The river forms a vast delta with a great number of river channels and lakes (pic. 2.1.2).



Pic. 2.1.2 The delta of Verkhnyaya Angara River (digital relief model, BINM SB RAS)

The length of the river is 438 km, water catchment area is 21400 km^2, the general fall is 120 m. The total number of tributaries is 2291 with the overall length of 10363 km (0.45 km/km^2). The average long-term water discharge is 265 m^3/s (8.4 km^3/year) [3,4].

The Barguzin River originates at the spurs of the South-Muysky mountain range; falls into the Bay of Barguzin of Lake Baikal. The length of the river is 480 km, water-catchment area is 21100 km^2, the general fall is 1344 m (pic. 2.1.3). The number of rivers within the basin is 2544 with the total length of 10747 km (0.51 km/km^2). During the high water period, the river is navigable at the extent of 250 km and has a great significance for fishing. The basin economy is based on agriculture, and in particular irrigational agriculture. The average long-term water discharge is 130 m^3/s (4.1 km^3/year) [3,4].

Pic. 2.1.3 The Barguzin River

The Turka River originates in the southern slopes of Ikatsky range at the elevation of 1430 m and falls from the east into the middle part of Lake Baikal, 140 km to the north-east of the Selenga delta. The length of the river is 272 km, water-catchment area is 5870 km^2, and general fall is 975 m. The lower part of the basin includes Lake Kotokelskoe with an area of 68.9 km^2. The river has a great significance for fishing industry. The upper stream of the river is the center of exploration works for placer gold. The average long-term water discharge is 1.6 km^3/year [3,4].

The Selenga River of Mongolian part takes its origin from the confluence point of the rivers Delgermurun and Ider. The total basin area of the Selenga river is 445 272 km^2, among this 67% is located in Mongolia. The Mongolian part of the Selenga river basin spans over 6 aimags - Bulgan (46.3%), Selenge (27.6%), Khuvsgul (25.3%), Arkhangai (0.7%) and Orkhon (0.04%) [2].

The Selenga River in the Russian part flows across the middle-mountain heavily indented location. The channel slope is 0.36 ‰. The width of the river valley varies from 2 to 25 km. In narrow places the river consists of one slightly meandering channel, in the wider parts the river channel divides into arms. The main channel and the river arms are meandering, at the abrupt turns the shores are intensely eroded (pic. 2.1.4). The width of the river in the low-water period is 100-150 m, depth at the river pool is 4-5 m, at the bar area is 0.5 – 1 m, at shallow places – 0.5 m. The velocity of current in the low-water period is 1 m/s, at disparate bars rising to 2-2.5 m/s. The bottom of the river is predominantly composed of pebble, or pebble and sand. The height of the shores is 1-2 m.

Pic. 2.1.4 The Selenga River

The Selenga has a delta with the area of about 1120 km², made up of river channels and islands, formed of river sediment (pic. 2.1.5).

Pic. 2.1.5 The delta of Selenga river

Annually, the Selenga river discharges about 2.7 million of sediment load, increasing the area of the delta [3,4]. It is the delta area which has the shortest distance between the two shores of the lake – 26 km. The Selenga section of Lake Baikal is the area of accumulative shores, having the maximal length and consisting of the external part of the Selenga delta and bars, separating the lake from the bay: Bay of Proval, located to the north-east of the Selenga delta the bay of Sor Cherkalov, located to the south and south-west of it. Analysis of multi-temporal cartographic and space-image materials, fieldwork data suggest that the delta area grows disproportionately at its disparate parts. The maximal growth of the delta takes place in the north-eastern section, adjacent to the Bay of Proval, in particular, in the area of Lobanovsky water channel, reaching several tens of meters per year in some periods. The western sector of the Selenga delta, adjacent to the Bay of Sor Cherkalov protrudes with less velocity. Relatively stable in terms of growth is the northern section of the delta, located between the Srednyaya and Northen Ust' channels [5].

The Dzhida River originates on the southern slope of the Khangarulsky mountain range. The upper part of the basin has an average absolute elevation of more than 1500 m, as the river flows through a ragged heavily indented location (pic. 2.1.6). The average slope of the river is 2.7 ‰, in the middle stream – 1 ‰, slopes - 200–300 ‰. The Dzhida river is the fourth largest tributary of the Selenga river (12.5 % of the Selenga river basin), the amount of the river runoff is 15 % of the overall amount within Russia [3,4]. The ratio of water influx from the area of 4920 km² from Mongolia is 25 % (0.61 km³). The river is fed primarily through rains, the inundation stage does not exist, the ratio of winter runoff to underground alimentation is 6%. The upper, north-western part of the basin lies in the zone with episodic freezing, and the lower – with annual freezing. Some sections of the Dzhida River are characterized with karst rocks, but in general the impact of karst phenomena on the river flow is insignificant.

Pic. 2.1.6 The Dzida river

The Temnik River rises on the northern slope of the Khamar-Daban mountain range. The river basin is predominantly mountainous, since only the lower part of the basin has grassland landscapes. The average slope of the river is 3.6 ‰. The river is fed through rains, and inundations are observed from May to September. The specific runoff is 7 %, of the flow into the Selenga on the Russian territory. The ratio of winter runoff is 7 %, the river freezes in an episodic way, once in five years.

The Chikoi River is the biggest in terms of the basin area and the amount of water runoff among the Selenga tributaries, while its water catchment is about 10 % of the Selenga basin and 31 % of the catchment in Russia (pic. 2.1.7). About 25 % (2.14 km³) of the runoff comes from Mongolia. The average slope is 1.65 ‰, in the middle stream – 1.2 ‰ and lower stream – 0.58 ‰, mountain slopes - 200–300 ‰. The average river runoff, formed in Russia, accounts for 40 % of the water influx into the Selenga. The conditions of runoff formation in the upper and lower parts of the Chikoi basin as well as on the water catchment area of the left-bank and right-bank tributaries are quite different. The river alimentation comes from rains, inundation due to the spring snow melting is rare and constitutes no more than 20 % of the annual runoff, winter runoff – 6 %, on tributaries - 2 – 3 %. The upper part of the basin lies within the zone of non-freezing or rarely freezing rivers, the middle part in the zone of episodic freezing and the lower part within the zone of annual freezing. In terms of the specific runoff, the Chikoi river ranks second place among the major tributaries of the Selenga following the Temnik [3,4,6].

Pic. 2.1.7 The Chikoi river

The Khilok River originates from Lake Shakshinskoe to flow through the bottoms of prolonged intermountain depressions at the elevation of 500-800 m, between the chain of mountain ridges with flattened forms and absolute marks of 1300–1800 m. Slopes of the basin valleys are covered mainly with mountain and taiga vegetation, while the bottoms of the valleys tend to be taken up by grassland and forest-grassland sections. The average slope is 0.52 ‰. The area of the river basin is 26 % of the Selenga basin within Russia and the amount of water influx is 19 %. River alimentation is from rain, the stage of spring snow melting is weakly manifested and does not exceed 20% of the annual runoff. Winter runoff is less than 6 % for the mouth part, while in the upper and middle part of the Khilok River there is no runoff as a result of freezing. The specific runoff indicators are 1.5 times less than those for the Dzhida River, and more than 2 times less than for combined runoff for the Temnik and Dzhida rivers.

The Uda River originates in the south-western part of the Vitim plateau at the elevation of 1055 m, flows into the Selenga on the right side, 156 km off its mouth (pic. 2.1.8).

Pic. 2.1.8 The Uda river empties into the river Selenga (Google)

The length of the river is 467 km, water catchment area is 34800 km^2, general fall of the river is 583 m. Average absolute elevation of the upper part of the Uda basin is 900 –1100 m. The average fall of the river is 1.2 ‰, in the lower stream – 0.7 ‰. The river basin is the third largest among the tributaries of the Selenga (23% of the water catchment area of the Selenga in Russia) and fourth largest in terms of the amount of water influx (13.4 %). The river network in the basin area is moderately developed, average value of density coefficient is equal to 0.39 km/km^2. The upper part of the basin has vast spaces of wetlands as well as a great number of small lakes with the surface area of less than 1 km^2) [4,7].

The modulus of flow is 2.0 l/s km^2, the lowest as compared to other five largest tributaries of the Selenga. The river alienation is from rain, but as a result of spring snow melting water runoff reaches 30 % of the annual amount (pic. 2.1.9). The inundation stage manifests itself in the low-water years and the medium-water years. The ratio of the winter runoff of 10 – 12 %, formed due to the flow of non-freezing right-hand tributaries in the middle and lower parts of the basin. The tributaries of the upper part of the basin and the Uda itself in the middle stream freeze on the annual basis, while the left-bank tributaries in the middle and lower part of the basin freeze occasionally [2].

Pic. 2.1.9 The Uda river in Ulan-Ude

The Eruu River originates in the high reaches of the Khentii mountain range. The Sharlan River joins the Hongi River, and the Eruu River starts from the junction point of these two rivers (pic. 2.1.10). The river basin spans over four aimags, namely Selenge (69.1%), Tuv (23.8%), Khentii (7.0%), Darkhan-Uul (0.1%), and has a total area of 22 282 km^2. The Eruu river basin authority is located in the center of Eruu soum in Selenge aimag.

Pic. 2.1.10 The Eruu river

The **Bayan River** takes its origin from the south-western branch of Khentii mountain range. The river's confluence point with the Sognogor River is the source of the **Kharaa River** (pic. 2.1.11). The area of the Kharaa river basin is 17 667 km^2 and extends over Tuv (41.5%), Selenge (36.6%), and Darkhan-Uul (17.2%) aimags and several districts of Ulaanbaatar city (4.8%) [8,9].

Pic. 2.1.11 The Kharaa River

The Tuul River takes its origin at an elevation of 2 000 m above sea level at the Chisaalai mountain. The river source is the confluence point of the rivers Namya and Nergui. The total area of the Tuul river basin is 50 074 km² and the basin spans over 5 aimags, i.e. Tuv (59.2%), Bulgan (20.5%), Uvurkhangai (7.3%), Arkhangai (5.0%), and Selenge (1.7%), as well as 7 districts of Ulaanbaatar city(6.3%). The capital city of Mongolia, Ulaanbaatar, is located in the river basin; the central part of the basin is, therefore, a densely populated urban area (pic. 2.1.12) [8,10].

Рис. 2.1.12 The river Tuul in Ulaanbaatar (Google)

The Orkhon River originates in the east-northern part of the Khangai mountain range and flows northward joining the Selenga river in Sukhbaatar city in Selenge aimag. The total basin area of the Orkhon River, including basin areas of its tributaries - Tuul, Kharaa and Eruu, is 143 479.3 km², 48.0% of which is part of the Selenga River basin. The biggest waterfall of Mongolia – Ulaantsutgalan – is located in the upstream of the Orkhon river (pic. 2.1.13). The river basin spans over 8 aimags - Arkhangai (38.2%), Bulgan (21.9%), Selenge (18.5%), Uvurkhangai (15.9%), Tuv (1.9%), Bayankhongor (1.6%), Orkhon (1.6%) and Darkhan-Uul (0.4%) [8,11].

Pic. 2.1.13 The biggest waterfall of Mongolia – Ulaantsutgalan.

The Khanui River takes its source in the Khan-Undur mountains, which are in the central part of the Khangai mountain range. The river flows about 421 km towards the east-north before joining the Selenga River. The total area of the river basin is 15755 km², which is divided between 3 aimags - Arkhangai (77.1%), Bulgan (22.7%) and Khuvsgul (0.1%) [8].

The Chuluut River originates in the western part of Gurvan-Angarkhai mountain in the Khangai mountain range. The Chuluut River flows 415 km till its confluence with the Ider river. The total river basin area is 20078 km² that span over 4 aimags - Arkhangai (95.7%), Khuvsgul (3.8%), Bayankhongor (0.4%), and Zavkhan (0.2%) [8].

The Ider River takes its source at the north side of Otgontenger mountain in the Khangai mountain range. There are several small and big tributaries, including the rivers Suman and Chuluut. The length of the river is about 465 km from its source to the mouth – its confluence with the Selenge River. The total area of the river basin is 23061 km², which covers parts of Zavkhan (65 %), Khuvsgul (32.1%) and Arkhangai (2.9%) aimags of Mongolia [8,12].

The Delgermurun originates in Ulaantaiga mountain in Khuvsgul aimag. The river flows about 445 km till its confluence with the Ider River, together forming the Selenga River. This river basin area is 23324 km² extending over Khuvsgul (98.5%) and Zavkhan (1.5%) aimags of Mongolia [8].

Lakes are distributed unevenly across the Selenga basin which is due to the diverse relief, climate and water alimentation. The greatest number of large natural water objects is concentrated in intermountain depressions. The Selenga river basin has 5549 lakes with a total area of 616 km². The density of lakes in the basin is less than 1 %. The more prevalent are small water objects with an area of 0.5 km², and only 17 lakes have the area from 1 to 10 km² and 4 lakes with the area of more than 10 km². The biggest lake in the Selenga river basin is Gusinoe with an area of 163 km². The biggest lakes are Kotokel (pic. 2.1.14), Shakshinskoe and Arakhlei (with surface areas of 52.6 and 58.5 km², respectively) located in the outlet of the Khilok River [3,4].

Pic. 2.1.14 The Lake Kotokel

Lake Khuvsgul is the largest lake in Mongolia that contains 3/4 or 74.6% of the total surface water supply (380 km³) in Mongolia (pic. 2.1.15) [9,13].

Pic. 2.1.15 The Lake Khuvsugul

The water level in Lake Khuvsgul have increased by 1 m since 1963, the exact reason for which is unknown. However, it might be related to melting of permafrosts, increased precipitation, decreased outflow due to accumulation of sand an the bottom of the Eg river, water temperature decline and, thus, reduced evaporation from the lake surface, etc. In 1979 and 1995-1996, the water level in the lake declined significantly. It was attributed to the lower amount of precipitation during these years (table 2.1.1).

Table 2.1.1 Morphometric characteristics of lakes within the Mongolian part of Baikal basin [8,9].

№	Aimag	Lake	Elevation above sea level, m	Area, km²	Length, m	Width, km		Depth, m		Volume, km³
						medium	maximum	medium	maximum	
1	Arkhangai	Terkhyn tsagaan	206	61.0	16.0	4.0	6.0	6.0	20.0	0.369
2		Ugii	1 337	25.7	7.9	3.4	5.3	6.6	15.3	0.171
3		Khuduu	2 061	10.9	5	2.1	3.2	1.8	3.1	0.02
4		Ikh	1 504	7.9	7.5	1.1	2.4	2.5	4.4	0.019
5		Shirgedeg	1 091	7.9	7.3	1.0	1.9	0.6	1.5	0.005
6		Duruu tsagaan	1 712	7.8	7.2	1.3	3.3	3.7	7.8	0.029
7	Bulgan	Khargal	1 071	13.6	4.9	2.8	4.4	9.3	15.6	0.127
8		Sharga	608	13.8	6.2	2.2	3.4	0.8	1.4	0.011
9		Tsetseen	1 522	7.2	5.7	1.3	1.7	2.5	4.8	0.018
10		Airkhan	936	5.0	4.4	1.1	2.9	1.3	2.0	0.006
11	Zavkhan	Oigon	1 664	61.0	18.0	3.0	8.0	3.5	8.0	0.207
12		Hukh/Otgon	2 455	11	5.4	2.0	2.9	1.6	4.3	0.018
13		Tsegee	1 882	7.7	5.2	1.4	2.4	4.1	8.0	0.032
14		Baga	1 132	7.6	3.9	2.0	2.7	0.8	1.7	0.006
15		Khuduu/Khunt	1 940	7.4	4.0	1.8	1.9	2.0	3.0	0.014
16		Khag	2 038	7.1	7.4	1.0	1.5	1.2	2.8	0.009
17		Baga	1 970	6.9	6.2	1.0	2.0	7.4	17.0	0.051
18		Takhilt	1 842	5.1	2.9	1.8	2.1	1.0	2.0	0.005
19	Uvurkhangai	Shiree lake	2 470	3.4	8.5	0.9	1.3	6.0	16.0	0.02
20		Gun	1 753	1.2	1.4	0.8	6.9	1.5	3.2	0.002
21		Khaya khutagt	1 356	4.6	4.0	1.1	2.5	1.0	2.1	0.004
22		Dombon	1 325	2.0	3.4	0.6	0.8	1.0	2.0	0.002
23		Shavkhalt	1 110	2.1	2.9	0.8	1.2	1.1	2.0	0.002
24		Ulaan	1 520	6.9	3.9	1.7	2.6	0.6	1.1	0.004
25	Selenge	Tsagaan/Tushig	680	5.8	3.5	1.6	1.7	0.6	1.5	0.004
26	Tuv	Tuhum	1 261	9.8	5.3	1.8	3.5	1.0	2.0	0.009
27		Khagiin khar	1 820	2.0	2.5	0.8	1.1	11.0	25.0	0.022
28	Khuvsgul	Khuvsgul	1 645	2 760.0	136	20.8	36.5	138	262	380.7
29		Dood Tsagaan	1 538	64.0	18.0	4.0	7.0	6.0	14.0	0.384
30		Tunamal	1 874	20.8	7.2	2.7	5.0	6.5	9.9	0.112
31		Zuun nuur	2 006	17.6	7.0	2.6	3.8	6.3	17.6	0.146
32		Erkhel	1 544	13.2	5.0	2.6	5.0	0.9	2.0	0.012
33		Tsets/Tsotson	1 539	7.5	4.3	1.7	4.1	1.4	3.0	0.01
34		Emt	1 540	5.0	3.8	1.2	2.3	1.1	2.5	0.006

Wetlands in the Selenga river basin are comparatively rarely to be found. In most cases, wetlands are to be found in the river valleys and river mouths as well as on the shores of lakes. In the river valleys and river mouths, the most widely spread are sedge and moss types while the more drained parts have bushy wetlands. In the wetland depressions, located in the Khamar-Daban mountains (the Dzhida and Temnik river basins) there are some areas covered with sphagnum (pic. 2.1.16).

Pic. 2.1.16 A swamp on Khamar-Daban range

Large places of swampy valleys are found nearly everywhere in all the valleys. The density of wetlands varies within the range of 1 – 5 %. The most significant wetlands are found in the Khilok basin (about 10% of the catchment area) [5,14].

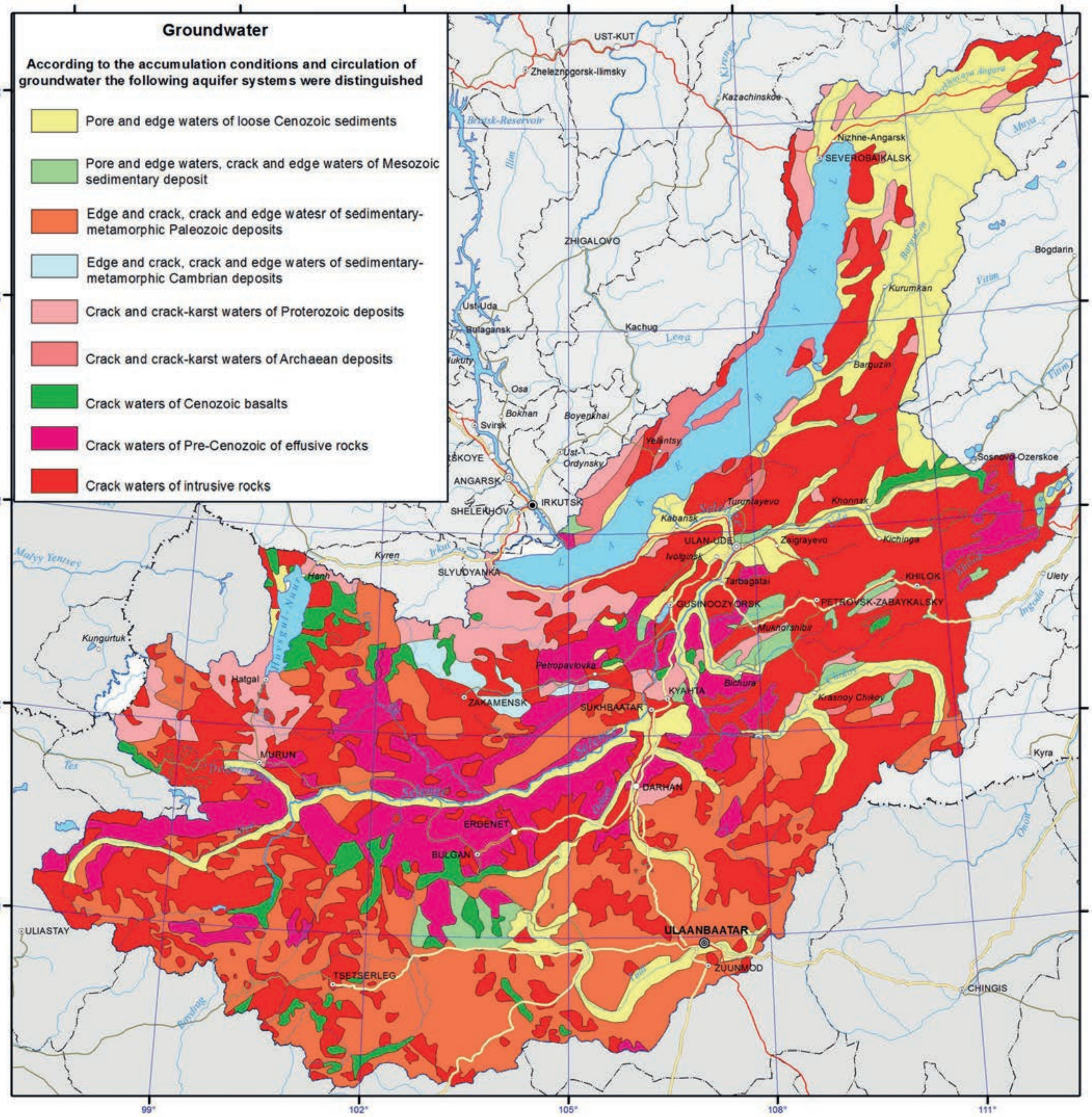
Ground waters are quite varied in terms of chemical composition and are subject to certain geochemical zonality. Artesian basins occupy intermountain depressions, composed of loose rocks of sedimentary cover and crystal rocks. They are characterized with porous zones of active water circulation. Hydrogeological massifs are composed of crystallic rocks of mountain-infolded framing and contain interstitial waters of exogenic fracture pattern. The capacity of active water exchange zone does not exceed 100-150 m. The most water-abundant are karstified carbonate rocks as well as zones of tectonic dislocations, cutting the basal complex or stretching alongside the contacts with sediment-metamorphic formations with erupted and metamorphic rocks. They are often traced by the rising water load of both cold and thermal waters. Fault waters of mountain ridges are ultra-fresh waters (with salinity of 0.03 to 0.05 g/l). In artesian basins of Baikal type (Barguzin, Verkhneangarsky), the water salinity does not exceed 0.5-1 g/l up to the depth of 2000 m, while the composition of water is mainly of hydrocarbonate-sodium and calcium-sodium type (pic. 2.1.17).

The major way of ground water alimentation is through infiltration of atmospheric precipitation and melted waters. Permafrost plays a significant role in the formation of ground water reserves and their regime. The replenishment of reserves takes place in the warm season, when the amount of infiltration exceeds the amount of unloading. In the course of the cold period, their unloading happens and their water levels decrease in this period. The amplitude of fluctuations during the year does not exceed 1.5-2 m.

Ground alimentation of rivers relies on both the ground water and pressure artesian waters. Ground water flow on the considered territory is quite significant in scope. Deep compartmentalization of surface, dense river network, considerable gradients facilitate intensive ground flow (table 2.1.2).

Table 2.1.2 Groundwater reserves in the river basins Russian part of Baikal basin

Administrative unit	Area, km²	Renewable reserves, th.m³/day	Exploitable reserves, th.m³/day	Potential reserves, th.m³/day
Bichursky	6201	0,7286	7,1	2818,9
Dhidinsky	8623	1,92703	2,3	8141,3
Yeravnensky	25646	0,79761	21,6	196,3
Zaigraevsky	6603	13,32849	12,97	1020,5
Zakamensky	15323	8,25202	17,3	475,3
Ivolginsky	2663	3,26155	201,1	8567
Kabansky	1347	16,1796	15,86	8352,6
Kizhinginsky	7874	1,85237	17,6	145,2
Kyachtinsky	4673	3,47972	179	9671,3
Mukhorshibisrky	4539	19,74775	98,7	605,5
Pribaikalsky	15472	2,4173	24,4	8838,4
Selenginsky	8269	1,41836	29,3	18437,9
Tarbagataisky	3304	1,17302	5,5	6270,2
Khorinsky	13431	1,8026	12,8	1138,1
Ulan-Ude city	352	145,27753	617,88	2593,4



Pic. 2.1.17 Groundwater of Lake Baikal basin [1]

In terms of availability of ground water, three groups of regions can be distinguished in the territory: with good availability, medium availability and little availability. The first group includes ground waters of intermountain depressions of Baikal type with virtually unlimited reserves – up to 3-5 m^3/s and more. The second group includes artesian basins of Transbaikalian type with the amount of fresh water sampling up to 1.0 m^3/s. The third group includes ground fault-veined waters of mountain ranges with limited (up to 5-10 m^3/s) exploitation resources [3,4].

The territory of middle-sized and northern rivers of Lake Baikal has almost all the known types of curative mineral waters (thermal, cold carbon, hydrogen sulphide, radon, ferriferous). Thermal nitrogen-siliceous waters of Goryachinsk resort, located on the eastern shore of Lake Baikal, are used to treat the diseases of nervous system, skin diseases and other ailments (pic. 2.1.18).

Barguzin valley has a number of resorts of the local level, such as Garga, Alla and Kuchiger. High temperature of thermal waters makes it possible to use them for acquiring thermal and electric energy. Thus, waters with the temperature of 40-70 C can be used for greenhouse planting and hot water supply. In terms of curative properties, these waters are fit for curing the diseases of the locomotor system, peripheral nervous system and other diseases [3,4].

Pic. 2.1.18 A hot springs of resort Goryachinsk

In **Mongolia**, groundwater is the main source of drinking water and water used for domestic and industrial purposes. According to some estimates, 95% of the domestic and industrial water demand is supplied by groundwater (pic. 2.1.17).

In the Selenga River basin, surface water mainly is used for irrigation but, in recent years, groundwater consumption has increased. In addition, most of mines and industries remove groundwater from exploration fields (during open pit and underground mining) to keep it dry. Industries located in cities usually use water from centralized water supply networks or own groundwater wells. Seosonal groundwater level decrease in Ulaanbaatar city is due to the fact that the rate of groundwater extraction is higher than the rate of its replenishment.

According to the Integrated Water Resource Management Plan of Mongolia [8], it is estimated that the renewable groundwater reserves are 8.1 million km^3/year, the potential exploitable groundwater reserves are about 3.6 million km^3/year and, in the Selenga River basin, the potential reserves are 316.7 million m^3/year. However, these estimates should be treated as approximate. The groundwater reserves in each river basin were estimated based on hydrological data for the region, the type of geological formation in the area, estimates of groundwater recharge, regional field surveys (including test drilling), etc. (table 2.1.3)

Table 2.1.3 Groundwater reserves in the river basins Mongolian part of Baikal basin

№	River basin	Catchment area, km^2	Groundwater reserves				
			Renewable reserves		Exploitable reserves		Potential reserves
			Million m^3/year	*L/sec/km^2*	*Million m^3/year*	*L/sec/km^2*	*Million m^3/year*
1	Selenge river	31 395	1 104.0	1.13	697.0	0.71	90.3
2	Eruu river	22 280	1 516.0	2.19	239.0	0.34	0.6
3	Kharaa river	17 697	381.0	0.69	182.0	0.33	52.6
4	Tuul river	50 074	960.0	0.62	641.0	0.41	142.8
5	Orkhon river	53 455	1 448.0	0.87	842.0	0.50	26.7
6	Khanui river	15 755	131.0	0.27	96.0	0.20	0.2
7	Chuluut river	20 078	296.0	0.47	86.0	0.14	0.1
8	Ider river	23 061	507.0	0.71	129.0	0.18	0.5
9	Delgermurun	23 324	435.0	0.60	229.0	0.32	2.7
10	Khuvsgul lake-Eg river	41 871	1 276.0	0.98	432.0	0.33	0.2
Total for the Selenga basin		**298 990**	**8 054.0**	**0.85**	**3 573.0**	**0.35**	**316.7**

2.2 SOILS

The great distance of the Lake basin from south to north determines latitudinal changes of the thermal factor and the related soil and vegetation cover. In addition to these main regularities, there is also the influence of exposition, meridional and mountain zonality. Of great significance is the role of permafrost, heterogeneity of soil-forming rocks, complex evolution of landscapes in the past and their transformation as a result of anthropogenic impact. The prevalence of mountain relief led to the domination in the region of East-Siberian mountain-taiga landscapes. A considerable part of the territory is covered with mountain taiga, while portions of grassland landscapes, associated with intermountain depressions, run far into the northern regions.

Lake Baikal basin is characterized with two types of soil: soils of mountain territories and soils of intermountain depressions [3,4]. Soils of mountain territories are thin and formed as a rule on eluvium and eluvium-deluvium of intrusive mountain rocks and to a lesser extent – on eluvium and eluvium-delivium of effusive, sediment and metamorphic rocks. Soils of intermountain depressions are formed on different loose sediments, on sandy and clay layers (pic. 2.2.1).

Pic. 2.2.1 Soil profile in the Valley of Verkhnyaya Angara River

In the north of the territory, the upper part of the taiga belt is dominated by mountain permafrost soils containing iron, among which there are certain types with the signs of gleization. The latter manifest themselves most clearly on the sites with a more powerful (5-8 cm) organic horizon in form of a condensed and constantly wet layer of lichen and moss. In the zone of bald mountains, soils are widespread on the sites of fine earth. The places covered with large-block stony deposits and outcrops of solid rocks and do not have soils (pic. 2.2.2).

Pic. 2.2.2 Stone deposits and rock outcrops

Verkhneanagrskaya depression and mountains are dominated by bleach alluvium-ferriferous soils, while the slopes of mountains are dominated by permafrost-taiga soils. The latter are characterized with slight differentiation of soil profile and high concentration of mobile form of iron and shape on loose sediments of small thickness. The major property, uniting all the types of soils in the northern part of the basin, is their cryolithic character.

The area showing the simultaneous features of continuous and intermittent permafrost, embrace more than 90% of land resources. The geocryological feature of the territory is the correlation between permafrost and the lowering of relief. Soils in the bottoms of valleys and depressions have a lower temperature and the permafrost has the greatest thickness. Permafrost meadow-chernozem soils occupy flat or slightly sloping valleys on deluvium clay and sandy areas and ancient lake sands. Permafrost-taiga soils and ash gray soil are shaped at the elevation from 1000 to 1300 m. The most fertile are permafrost meadow-chernozem soils which yield the highest amount of harvest. These soils are characterized with a high concentration of humus and nitrogen as well as average concentration of sodium. Out of permafrost soils, the least productivity is observed on permafrost grey forest soils. Of intermediary importance are permafrost meadow soils.

The permafrost is related with other cryosolic processes and phenomena such as frost mold, thermokarst, soilfluction, polygon form of relief and ice [3,4]. Frost molds are associated mainly with the powerful layer of loose sediment. Seasonal frost molds are shaped in January and February on the sites of permanent springs, while their height can be 3 m and their diameter - 20-50 m. Thermokarst processes are well developed on the west shore of Lake Baikal, in the Barguzin river valley and at some portions of trough valleys. Thermokarst manifests itself through the formation of thermokarst lakes, swampy lowlands and funnels. The size of thermokarst depressions varies from 10-20 to 150-200 m. The high-mountain belt has well-developed forms of soilfluction: overmoistened melted soil float up from the places free of vegetation. Not infrequently soilfluction covers entire blocks of mountain rocks, sometimes with big trees. In the medium mountains area this phenomenon is slightly manifested and is observed mainly on the northern slopes.

The area of mountain taiga incorporates soils with eluvium-illuvium and non-differentiated profiles (pic. 2.2.3). Baikal range and Severobaikalsky uplands are dominated by ashen-grey and podzolized brown soils with the admixture of peat-brown soils. They are characterized with small thickness of profile, which in the layers of ashen-grey soil can be 30 cm, and in the mountains of Baikal region is about 40 cm. The thickness of brown soils, which can be seen as being at the incipient stage of soil-formation, is even smaller.

Pic. 2.2.3 A mountain taiga

The soils of piedmont dry grasslands of Baikal region are widespread on Olkhon Island, the adjacent area and in the southern part of the basin (pic. 2.2.4). The formation of dry steppe landscapes with chestnut soils is related with arid mountain zonality. Lack of precipitation is exacerbated by high water permeability of loamy soils. Low bio-productivity is a consequence of the extreme natural-climatic conditions. Agroecosystems are in the state of crisis here while the vegetation cover degrades.


Pic. 2.2.4 A dry grasslands

The high-mountain part of the Khamar-Daban, Muysky, Verkhneangarsky and Barguzinsky ranges the main types of soil are petrozems, peat-lithozem. Hard-humus, humic and humic-dark humus soils are formed underneath sub-Alpine meadows. Brown gley soils are formed on the northern slopes in relatively lowered parts of relief and the sections composed of soil-forming elements of heavier granulometric composition.

Kryozems (hard humus), peat-kryozems are well-developed in the zone of bald mountains, being located in a comparatively narrow strip close to the upper margin of the forest. Soils of taiga area have frequently zones of permafrost as well as seasonal permafrost, kryoturbation phenomena and soilfluction.

The structure of soil cover in mountain-taiga zone is heterogeneous and is related with vertical zonality, slope exposition and permafrost. The major types of soils are brown soils, ashen-grey soil, sod-ashen-grey soil, sod-brown soils, grey humus, humic and other soils. The upper part of taiga belt is dominated by kryozems and brown soils, followed by peat –lithozems. Mountain taiga has steppe “islands” with the soils of black humus earth. They can be found on the abrupt slopes of southern exposition, facing wide sections of intermountain depressions.

The steppe zone is dominated by grey metamorphic soils, formed on the foothill parts of depressions and northern slopes of hills inside intermountain depressions or lower parts of deforested slopes, facing steppe depressions. Most of the territory is occupied by these soils in the southern part of Selenginsky uplands. The forest and steppe belt of light coniferous and grass facies can have dark humus metamorphosed soils found mainly on the southern slopes of hills. Grey humus soils were formed on carbonate rocks under the vegetation cover. This combination of soils, inherent to different ecological conditions is the main property of the soil cover at the juncture of taiga and steppe.

In the steppe landscapes of Lake Baikal basin soil cover is represented mainly by black humus soil. It is formed under the meadow steppes. The main portions of these soils are located in Tugnui-Sukharinskaya depression – on Tugnuisky range and southern slopes of Zagansky range, northern slopes of Kudarinskya mountain chain, Minor Khamar-Daba, Monostoiskiy, and Borgoisky ranges. In the north, black humus soil is formed in disparate spots on the north-western slopes of Unegetei range and the Uda and Itantsa river valleys.

The soil cover of dry steppe area is dominated by chestnut soils. They take up a vast territory of Udinsky, Priselenginsky and Borgoiskaya steppe, wide and flat terraces widespread on the southern slopes of hills. The watershed of high ridges can have lithozem soils. On the aeolian deposits of sand of the dry steppe zone, particularly in the areas between the Selenga and Chikoi rivers and Chikoi and Khilok rivers, humus psammozem soils are formed.

Soils of river valleys in the basin are represented mainly by alluvial humus-gley soils, peat-gley soils, dark humus, grey humus and dark humus quasi-gley soils. Within the structure of the soil cover of the upper and middle reaches of the rivers, alluvial layered soil can be found. In steppe and particularly in the dry steppe zone of Baikal region, saline soils and sodium soils are formed in river beds. They are found mainly in the lake depression and lower parts of flat slopes, adjacent to the flood plains where the zone of accumulation of water flow enriched with dissolved salts or the emission of mineralized ground waters to the surface. The most widespread types of salification include sulphate-sodium, sodium-sulphate, sulphate and chloride-sulphate.

Vast areas of saline soils are widespread in Borgoiskaya steppe and lake depressions of Verkhnee and Nizhnee Beloe lakes. Their role is rather significant in Ivolginskaya depression. Also saline forms of relief are observed in the lake depressions of Bichursky district and Tugnui steppe. The Selenga river delta, the Barguzin and some other large portions of land are taken by swamps where peat eutrophic and peat eutrophic gley soils are shaped.

Soils of swampy meadows and lake-wetland complexes are formed in fluvial plains on elevated places, in deltas and the progression cones of temporary water flows (pic. 2.2.5). Alluvial gley soils are formed under the conditions of additional humidity. The elevated parts of mountain rivers on the sand and pebble deposits have alluvial grey humus and layered soils. Alluvial peat-gley (peat mineral) soils are shaped in relatively low locations of river bed under the conditions of lengthy surface and ground moistening as well as on the fringes of the water bodies overgrowing with wetland vegetation. Humus-hydrometamorphic soils are shaped in the central plain of rivers. The lake part of the depression havs predominantly hydrometamorphic permafrost soils.


Pic. 2.2.5 Swampy meadow in the Selenga River delta


Pic. 2.2.6 A deflation


Pic. 2.2.7 A water erosion

Soils of the basin are subject to destructive processes: wash-away, erosion and deflation (pic. 2.2.6) [3,4]. As a consequence of these processes the loss in harvest production is annually 15-20 %. Agrohydrological properties of soils are determined largely by their mechanical composition. The greatest amount of productive dampness is characterized by sandy soils (90-105 mm). Following an increase in the concentration of smaller fractions, the amount of productive dampness rises reaching 160-190 mm for light loamy soils and 215 mm for heavy loamy soils. The coefficient of water-yielding capacity is around 65-75%.

According to observation data, in spring the reserves of productive dampness in the meter-deep layer of soil is on the average 80 mm, for sandy soils and for loamy soils it is 100 and 160 mm, respectively. In summer, in July and August, they shrink for sandy soils up to 60 mm and for loamy soils up to 100 mm. Due to the low concentration of productive dampness in the soils of light mechanical composition and their insufficient moistening in the vegetation period, the acquisition of stable harvests is only possible through irrigation. Of great significance are agrotechnical devices aimed at preserving dampness in soil and the protection of soil from water and wind erosion (pic. 2.2.7).

The reduced anthropogenic impact on ecosystems of the Lake Baikal basin during the last decade contributes to the restoration of natural landscapes and the lowered rate of aridification. Therefore, desertification is not observed within the Russian part of the basin, in contrast to Mongolia [23].

Scientists have identified 34 types of soils in **Mongolia.** The most common type of soil - brown soil - comprises 40.4% of the total territory, of which 22.6% is located in mountainous areas and 17.8% is in plain areas (pic. 2.3.2). The brown soil is further classified into three sub-types, including dark brown, genuine brown and light brown soil. The most widespread is dark brown soil (17.6%), followed by genuine brown soil (11.9%), and light brown soil (10.9%) [15].

The Law on Soil Protection and Prevention of Desertification introduced a classification of the extent of soil degradation and desertification, categorizing it as «weak», «medium» and «strong» [16]. «Weak» extent of soil degradation implies that less than 5% of the soil is polluted or eroded; «medium» extent of degradation implies that 5-25% of soil is polluted or eroded; and «strong» extent of degradation implies 20-50% of soil is polluted or eroded.

In Mongolia, precipitation increases from the central part to the north following the changing relief and climate, and steppe landscape is replaced by meadow-steppes, meadows, swamps, forests and taiga-forests. In the mountainous region in the north of the country, the soil moisture is relatively higher due to more precipitation as well as humidification by big and small rivers and multi-year permafrost.

In the wide valley between the Khangai and Khentii mountain ranges, arid plain soil and desert-plain soil are spanning till the Tagna mountain range. Arid-steppe brown soil covers a significant area of the valleys located in Orkhon-Selenge basin. The Orkhon and Tuul river basins have mountain dernotaiga soils, low mountain chestnut soils, steppe valley brown and dark brown soils, while meadow and river valley soils are dominant (table 2.2.1).

Table 2.2.1 Percentage of soil sub-types in the Orkhon and Tuul river basins

№	Soil sub-type	Percentage of soil sub-type, %	
		Orkhon River basin	Tuul River basin
1	Mountain soil	65.2	56.3
2	Soil of low mountains and rolling hills	6.3	8.3
3	Soil of steppes, valleys and depressions	16.1	26.2
4	Soil of damp areas (meadows)	9.9	6.6
5	Floodplain soil	1.5	0.1
6	Saline soil	0.7	1.1
7	Other soils and bare land	0.3	1.4

The extent of land degradation can be defined as «weak» for 35.3% of lands, «medium» and «strong» for 25.9% and 6.7% of lands, respectively (pic. 2.2.8) [17]. The desertification maps created by Geoecological Institute of Mongolian Science Academy in 2006 and 2010 were compared, and it was revealed that distribution of the areas with «strong» desertification changed during the period, i.e. numerous new desertification hotspots have formed [15]. For instance, new desertification hotspots were observed in the north of Bayankhongor aimag and Orkhon river basin. However, along the border of Uvurkhangai and Dundgobi aimags the area of lands affected by desertification have reduced (Table 2.2.2).


Pic. 2.2.8 A soil degradation

Table 2.2.2 Extent of desertification in the aimags within the Selenga River basin (%)

№	Name of aimag	Forests, lakes, high mountains	Not categorized	Weak	Medium	Strong	Very strong
1	Arkhangai	19.1	19.2	38.6	13	3.5	3.7
2	Bayankhongor	0.6	16.6	41.1	30.8	4.8	6.2
3	Bulgan	21.6	59.2	11.9	2.3	2.2	2.8
4	Darkhan-Uul	43.5	4.1	17.1	3.6	14.3	17.4
5	Orkhon	38.9	43.4	7.2	6.3	2.6	1.7
6	Uvurkhangai	2.7	16	43.8	24.4	7	6.1
7	Selenge	63.5	2.7	12	10	6.1	5.7
8	Tuv	22	13.1	37.1	18.9	4.6	4.2
9	Khuvsgul	30.9	16.2	26.1	12.9	5.8	8.1
10	Khentii	21.6	15.2	36.6	16.5	3.3	6.8
11	Zavkhan	3.4	27.8	38.9	21.7	3.8	4.6
12	Ulaanbaatar	21.5	5.8	27.7	21.1	8.1	15.8

Increased logging, forest fires, vegetation damage by pests, mining (mineral extraction) and unauthorized tree-cuttings cause imbalance in forest ecosystems and facilitate desertification processes. The Law on Soil Conservation and Prevention of Desertification approved by State Great Khural in 2012 established incentive measures for individuals and organizations conducting soil conservation and desertification prevention activities (pic. 2.2.9).


Pic. 2.2.9 A hotbed of desertification

2.3 VEGETATION

The territory of Lake Baikal basin is part of the forest-steppe and forest taiga zone [3,4]. However, a considerable degree of territorial disintegration and the presence of intermountain depressions determined vertical zonality in the distribution of the vegetation cover. Within the area of the basin the following belts are distinguished: steppe, forest-steppe, mountain-steppe, goltsy-forest with cedar shrubs and goltsy belt.

Goltsy belt stands out clearly on the ranges of Baikal mountain chain. The height of the lower level of the belt varies from 1100—1500 m in the north to1600—2000 m in the south. The goltsy belt is dominated by high mountain and wilderness landscapes. Vegetation of high mountain wilderness is represented by sparse low heather grass and lichen as well low heather shrubs. A characteristic feature of the goltsy belt is wide distribution of stone placers without vegetation (pic. 2.3.1). Comparatively small areas embrace portions of mountain tundra with shrub-lichen and small shrub-lichen vegetation. Barguzinsky range is abundant in the areas with mountainous sub-Alpine meadows (in the lower part of goltsy range). They do not constitute considerable land mass but alternate with the sections of mountain rocks and cedar forests, being located on the bottom of kar and in the upper part of trough valleys. Mountain meadows are characterized with dense and high grass (up to 40-60 cm) consisting of aquilegia, anemone and other species. Among sub-Alpine meadows one can observe portions of sedge-sphagnum and sedge wetlands.

Pic. 2.3.1 Goltsy belt of vegetation, Barguzinsky range

Belt of goltsy forest and cedar shrubs is found above mountain taiga at the elevation of 1000-1500 m in the north and 1500-2000 m in the south. It takes comparatively small territory on the mountain ranges having flattened contours and flat tops, rising above the upper boundary of the forest. The mountain slopes are covered by cedar forests with a height from 0.5 to 2 m and goltsy sparse forest on the flattened sides. The latter is a sparse and depressed larch and cedar-larch forest with cedar shrubs, dwarf birch and other shrubs (pic. 2.3.2). The soil cover is dominated by lichen and occasionally moss (pic. 2.3.3). In some areas, where considerable and stable inversions of air temperature are observed, goltsy forests are found within the mountain-taiga belt (on the northern slopes of mountains, facing narrow shadowed valleys, on river and lake terraces.

Pic. 2.3.2 Belt of goltsy forest and cedar shrubs on the Khamar-Daban range

Pic. 2.3.3 Lichens on the Barguzinsky range

Mountain taiga is the most widespread landscape on the considered territory [3,4]. It takes up to about 70% of the Russian part of Lake Baikal basin and constitutes a bulk of its vegetation cover. The mountain taiga is mainly comprised by coniferous trees – Dahurian and Siberian larch as well as pine, cedar and in rare instances silver-fir and fir-tree. Of deciduous trees the most widespread species are birch and aspen. Depending on the latitudinal position of the place, the mountain-taiga belt occupies different altitudinal position. In the north, in the Verkhnyaya Angara basin, taiga is situated at an elevation of 460-600 to 1000-1500 m, and in the south at an elevation of 1000-1400 to 1500-1800 m. Along the coast of Lake Baikal, the lower boundary of taiga runs till the edge of water. The altitudinal position of the upper boundary of taiga depends on the exposition of mountain slopes. On the western slope of Barguzin range, facing Lake Baikal, the upper boundary of the forest is located at an elevation of 900-1400 m and on the better warmed eastern slope rises to 1400-1800 m.

Mountain-taiga zone is divided into three altitude belts, corresponding to the southern, middle and northern taiga. Southern taiga is located to the south of 52° N below 1100-1200 m. It includes sparse larch-pine and pine forests with addition of birch. The underbrush is sparse and is dominated by dahurian rhododendron and spiraea. The soil cover incorporates shrubs and grass (pic. 2.3.4). Middle taiga is most widely spread. The major kind of tree is larch, other important species include pine, cedar and birch. In some portions, especially on the slopes of hills facing Lake Baikal, aspen, silver fir and fir can be found. The stand of trees is rather sparse, the underbrush is well developed and includes dwarf birch and dahurian rhododendron. The soil cover includes dense shrubs of red bilberry, blueberry and foxberry. Moss can also be found but it does not form a continuous cover.

Pic. 2.3.4 A mountain taiga, the Khamar-Daban range

The composition of tree stand and underbrush changes depending on the slope exposition. Northern slopes have sections with depressed tree stand and dense underbrush of alder and cedar with a continuous moss cover. On the southern slopes, the tree stand is always better, pine tree is widespread, grass and shrubs are dominant in the soil cover. The belt of northern taiga is characterized by sparse and depressed tree stand, consisting of larch with the mixture of cedar. The underbrush always has cedar and dwarf birch trees as well as small-leaf rhododendron and alder. The grass and shrub layer includes wild rosemary, blueberry, red bilberry and sedge. The soil cover is dominated by moss while flat water-divide mountain tops have sphagnum. Forests in the mountain taiga zone protect soils from being washed away during snow melting and summer rain floods. Taiga protects soil from wind erosion, exerting a great impact on the conditions of snow cover formation. On the abrupt slopes, taiga reduces the risk of avalanches taking place.

Forest-steppe areas are usually bounded by the places with steppe vegetation (pic. 2.3.5). Baikal forest and steppe zone is commonly characterized by the alternation of steppe sections, lying on the southern slopes of mountains, with the deforested sections on the northern slopes [3,4]. The forest and steppe zone does not form a continuous belt and consists of disparate portions separated by mountain-steppe and mountain-taiga vegetation clusters. The sections of forest-steppe vegetation are located at an elevation of 900-1200 m. Forests of this belt are primarily sparse and are made up of pine, larch and birch; the underbrush is weakly developed or is gone. Steppe and forest-steppe areas are widely used in agriculture as plough lands, hay-making ground and pastures.

Pic. 2.3.5 A forest-steppe, Valley of Tugnui River

Steppes do not form a continuous landmass but incorporate separate sections, related with tectonic depressions and river valleys [3,4]. Two groups of formations are clearly distinguished – steppes of mountains and steppes of foothills, elevated plains and hummocky topography. In each of them one can distinguish two large ecological-morphological groups – meadow and dry steppes. For each of such groups one can distinguish separate regional steppe complexes – South Siberian, North Mongolian and Central Asian formations (pic. 2.3.6).

Pic. 2.3.6 The North Mongolian steppe

The upper border of the steppe does not rise above 900-1100 m. Dry steppes with hazel soils are characterized by the presence of low plants (average height is from 10-15 to 25-35 cm) and sparse density (with the project cover of 60-70%). Black humus soils have steppes with different herbs characterized by denser and higher grass level. Steppe plants have well developed root systems reaching the depths from 10 to 70 cm. Vegetation groups are quite diverse. Of gramineous plants, the most widely spread plants are mat-grass, cleistogenes, sheep fescue, meadow grass, and june grass [4,18]. Of wild grasses, widely present ones are tansy, potentilla, oxytrope, astragal, sedge, wormwood, pea shrub, etc. Saline soils typically have jiji grass and flag-leaf as well as salt grass and saltwort (pic. 2.3.7).

Pic. 2.3.7 A area of salinity in the Mongolian steppe

Forests. The total area of forested land within the Russian part of the Lake Baikal basin is 191982.5 km², of which 169118.7 km² is under the jurisdiction of the federal government and 22863.9 km² is managed by individual land users (data of the digital topographic basis of BINM SB RAS) (table. 2.3.1).

Table 2.3.1 Forest area within the Russian part of the Lake Baikal basin by administrative districts, km²

№	Administrative unit	Total forest area	Forest area under federal and regional jurisdiction	Forest area managed by individual land users
1	Barguzinsky	10176,5	9878.0	298.5
2	Bichursky	4553,7	3311.4	1242.3
3	Dhidinsky	4560,9	3247.3	1313.6
4	Yeravnensky (partly)	4875,1	3922.9	952.2
5	Zaigraevsky	4988,2	4190.0	798.2
6	Zakamensky	13715,6	10861.9	2853.7
7	Ivolginsky	2043,9	1480.1	563.8
8	Kabansky	6493,8	5601.6	892.2
9	Kizhinginsky	5999,9	5285.9	714.0
10	Kurumkansky	9044,2	8677.7	366.5
11	Kyachtinsky	2037,5	925.0	1112.5
12	Muysky (partly)	1244,4	1244.4	0.0
13	Mukhorshibisrky	2237,6	1578.0	659.6
14	Pribaikalsky	12087,4	11101.5	985.9
15	Severobaikalsky (partly)	26667,5	26352.7	314.8
16	Selenginsky	4874,7	3589.6	1285.1
17	Tarbagataisky	2652,4	1211.0	1441.4
18	Tunkinsky (partly)	773,0	773.0	0.0
19	Khorinsky	11813,3	10640.8	1172.5
20	Irkutsky (partly)	2924,9	2809.7	115.2
21	Olkhonsky (partly)	5249,6	4913.5	336.1
22	Slyudyansky (partly)	2805,8	2805.8	0.0
23	Krasnochikoisky	26415,4	23799.6	2615.8
24	Petrovsk-Zabaikalsky	8184,0	6757.4	1426.6
25	Chitinsky (partly)	1762,6	1332.9	429.7
26	Uletovsky (partly)	760,7	746.2	14.5
27	Khiloksky	12985,2	12026.1	959.1

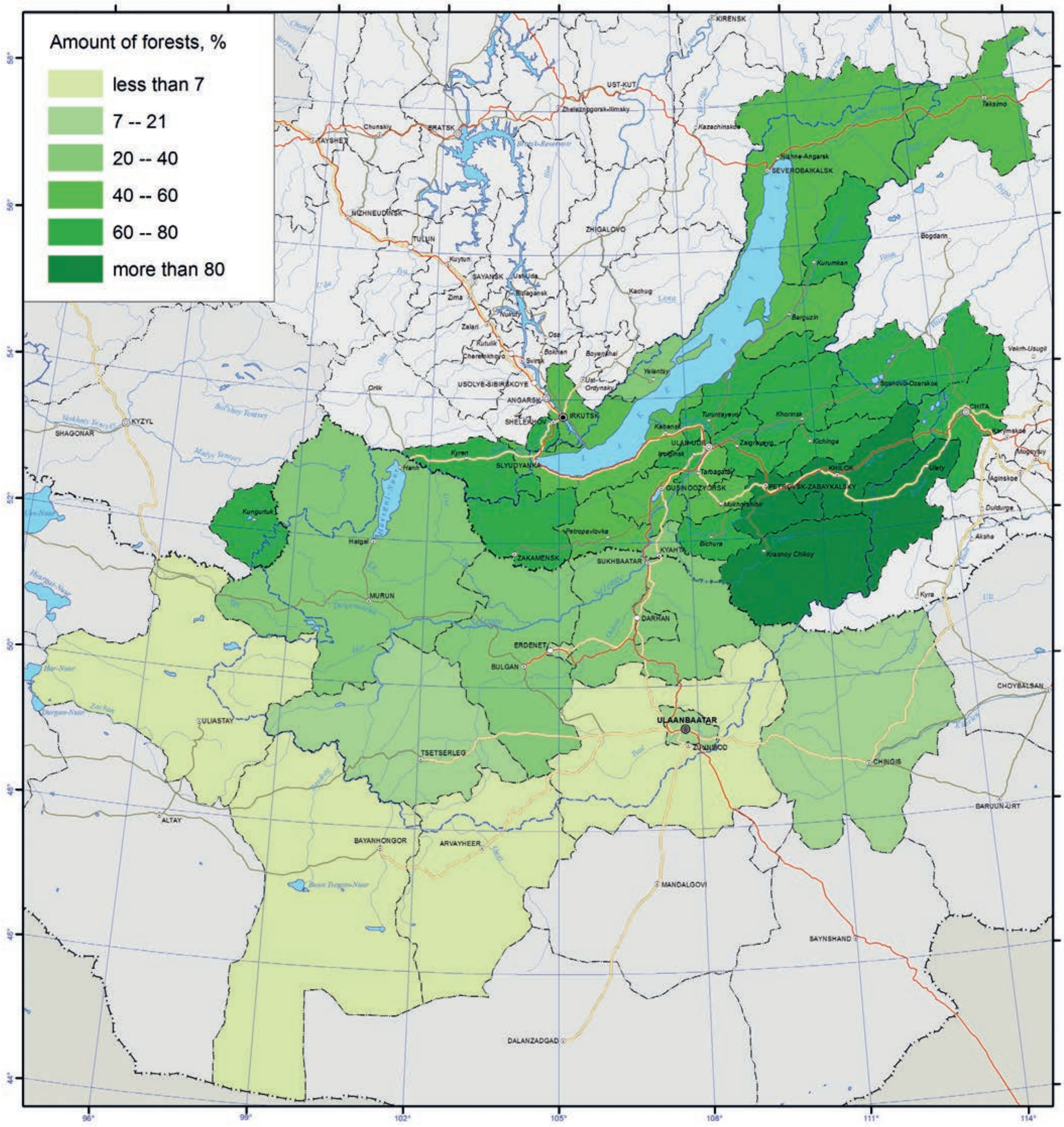
The total area of lands covered by forests in the Republic of Buryatia, including forest fund lands and other land categories, was 29638.4 thousand ha or 84.4 % of the total land area as of 01.01.2013 (pic. 2.3.8) [4,7].

The Republic Forest Agency is responsible for supervising the forests of the forest fund with the total area of 27010.3 thousand ha or 91.1% of the entire forest lands in Buryatia. In terms of use, forests are divided into 3 major categories: protected forests occupying 9308.1 thousand ha, exploited forests occupying 9436.4 thousand ha, and reserve forests occupying 8265.8 thousand ha.

Forests, not included in the forest fund, are the forests located on lands of other categories: forests located on the specially protected natural territories affiliated with the Ministry of natural resources and ecology of the Russian Federation – 2065.1 thousand ha (7% of all forests); forests, not included in the forest fund of the republic, are represented by the lands within human settlements with a total area of 29.6 thousand ha (0.1% of the forests), lands of other categories (lands of the water fund, land occupied by industries, reserve lands) with a total area of 85.1 thousand ha (0.3% of all forests) [7].

Mongolia's forests are located in the transitional zone between the great Siberian taiga and the Mongolian plateau of grassland steppe (pic. 2.3.9). These forests play a critical role in preventing soil erosion and land degradation, in regulating the water regime in mountain areas, maintaining permafrost distribution, providing habitats for wildlife and preserving biodiversity. Even though Mongolia is a country with limited forest resources, there are more than 140 species of trees and shrubs and forests cover 12.9 million ha, which is about 8.2% of the total area of the country (pic. 2.3.8). According to the Law on Forestry approved in 2012, the lands already covered by forest and required for forest extension are determined as the forest fund [18,19].

Pic. 2.3.9 A coniferous forest in Mongolia



Pic. 2.3.8 Forest density in Lake Baikal basin [1]

Forests are classified as strictly protected forests, protected forests, and utilization forests (pic. 2.3.10). Utilization forests are designated primarily for commercial timber harvest with contracts and the payment of fees required. The strict zone forest consists of sub-alpine forests, pristine and conservation zone forests within strictly protected areas, and special zone forests within national conservation parks.

The protected zone category is much broader, consisting of four sub-zones including certain forests within specially protected areas - national conservation parks, nature reserves, and monuments - as well as green zones around towns and villages, prohibited strips along riparian zones, national roads, and railways, and locally protected forests (pic. 2.3.10). Locally protected forests may consist of areas containing different forest types, including saxaul forests, oases, forest stands covering up to 100 hectares, forest groves, shrubs, sun-exposed forest areas, and forests on slopes steeper than 30 degrees.

Pic. 2.3.10 A locally protected forest

Pic. 2.3.11 The forest on Lake Khuvsgul

By 2012, the total area occupied by Mongolian forest fund was 18 592.4 thousand ha, of which 12 552.9 thousand ha were covered by forests. 75.4% of the total forest fund area is covered by coniferous and deciduous forests (pic. 2.3.11) and 24.6% by saxaul forests. 15.3 million ha of the forest fund area is the protected forest zone, and 10.8 million ha of this zone are covered by coniferous and deciduous forests and 4.5 million ha by saxaul forests. Every year the Government Implementation Agency reports the total forest fund area by administrative regions based on information from Geodesy and Cartography Agency and National Statistics Committee (table 2.3.2) [18,19,20].

Table 2.3.2 Forest fund area in aimags within the Selenga river basin (2013)

№	Aimag	Area in the Selenga basin,%	Total	Forest fund area				
				Area covered by forest	Area cleared of forest	Tree breeding area	Forest growth extension area	Non-specified use area
			Ha					
1	Arkhangai	99.8	1 080 455.8	845 795.0	2 758.5	0.0	0.0	231 902.3
2	Bayankhongor	0.8	2 645.4	2 390.9	33.8	0.0	0.0	220.7
3	Bulgan	100.0	1 905 008.7	1 425 665.7	7 887.0	45.3	468 410.7	0.0
4	Darkhan-Uul	100.0	71 995.4	71 392.7	415.0	187.7	0.0	0.0
5	Zavkhan	18.7	91 766.4	86 624.9	942.3	9.4	0.0	4 189.7
6	Orkhon	100.0	15 610.3	15 576.0	0.0	17.3	0.0	17.0
7	Uvurkhangai	19.4	29 245.2	25 097.0	1 157.8	17.6	2 562.5	410.4
8	Selenge	100.0	1 534 113.5	1 376 662.0	20 645.0	98.6	27 119.9	109 588.0
9	Tuv	58.5	318 539.1	288 348.8	1 979.6	4 394.6	906.2	22 909.8
10	Khuvsgul	71.6	2 867 872.1	2 422 840.9	26 101.8	35.8	40 862.1	378 031.5
11	Khentii	2.0	22 653.9	19 617.1	31.0	0.2	1 584.0	1 421.6
Total amount			**7 939 905.7**	**6 580 011.0**	**61 951.7**	**4 806.6**	**541 445.4**	**748 691.0**

The Selenga River basin in the northern part of Mongolia is covered by mixed forests (pine, larch, and cedar) and grassy plants (pic. 2.3.13). During the summer of 2013, Ministry of Environment and Green Development conducted a research expedition to catalogue endangered and beneficial plants. The expedition covered 17 aimags and various natural zones - forest steppe, steppe, and semi-desert steppe. The researchers have found and recorded 188 species of beneficial and 70 species of endangered plants growing in Khovd, Gobi-Altai, Uvurkhangai, Bayankhongor and Umnugobi aimags and 54 species endangered plants in Selenge, Orkhon, Bulgan, Arkhangai, Zavkhan and Tuv aimags. Among all these endangered plants, 23 were found and recorded in Khangai region.

According to the Mongolian vegetation list, there are more than 2 800 plant species in the country [19]. Among them, 382 species of plants can be used for food and drug manufacturing (pic. 2.3.12), 195 species of them need to be protected. Researchers have presented a list of 102 plants that have commercial value and recommended the ways the plants could be used. Ten species, such as licorice, ephedra, etc., are liable to illegal plant trade, eight more species were added into Mongolian endangered plant list, and 37 species require to be further inspected.

Pic. 2.3.12 Hemerocallis minor, the upper river Tuul

In Mongolia, there are 75 endangered species of medicinal plants, 20 species of which are on the brink of extinction [21]. Furthermore, in danger of extinction there are 11 species of food plants, 6 species of which are on the brink of extinction; 16 species of technical plants; and 55 species of ornamental plants, 5 species of which are on the brink of extinction.

2.4 ANIMAL WORLD

A considerable number of natural landscapes in Lake Baikal basin determine a great diversity of animal species there. The region has 446 vertebrate species, including:

- 348 bird species of 18 orders (4% of the world avifauna);
- 85 mammal species of 7 orders (23% of the world theriofauna);
- 7 vermigrade species of one order (0.1% reptiles of the world);
- 6 amphibian species of 2 orders [3,4,22].

Mongolian fauna consists of 138 species of mammals, 75 species of fish, 22 species of reptiles, 6 species of amphibians, 472 species of birds, 13 000 species of insects, 516 species of mollusks and protozoa [21].

On the Russian territory of the basin, **brown bear** (Ursus arctos) inhabits the coastal and northern districts, large forests, in particular, in Eastern Pribaikalie and the Khamar-Daban (pic. 2.4.1) [3,4]. Among different habitats it prefers cedar forests. The brown bear is dormant in winter, digging lairs on dry slopes with sandy and sabulous soil, sometimes under rocks. He starts hibernation in the latter half of October, usually before the first big snow and leaves the lair in April or May. The oestrum period is in June or July, cubs are born in January-February. The number of cubs is1-3, most commonly 2. It feeds on vegetation and animal food. In the years of poor harvest of berries and nuts, insomniac bears may wander around. The bears wander alone on an area of about 70-400 km^2. The number of brown bears is growing at present – from 2690 animals in 2001 to 4878 in 2010.

Pic. 2.4.1 The brown bear

By taxonomic parameters, **the reindeer** (Rangifer tarandus) inhabiting the Russian territory of the basin, is identified as Rangifer tarandus (pic. 2.4.2) [3,4]. Today, reindeers dwell in the disparate sections of mountain areas, including Ulan-Burgasy, Ikatsky, Barguzinsky, Severobaikalsky, Vitimsky and Muysky mountain ranges. Since the reindeer inhabits isolated and remote places, the assessment of the present-day number is based not only on the data of winter route tracking, experts emphasized gathering survey data from forest managers of natural protected territories and hunters. The number over the last five years was 16-19 thousand animals. The results of the winter route tracking in 2012 revealed the number of 18417 animals, which is in agreement with the assessment by forest managers and hunters.

Pic. 2.4.2 The reindeer

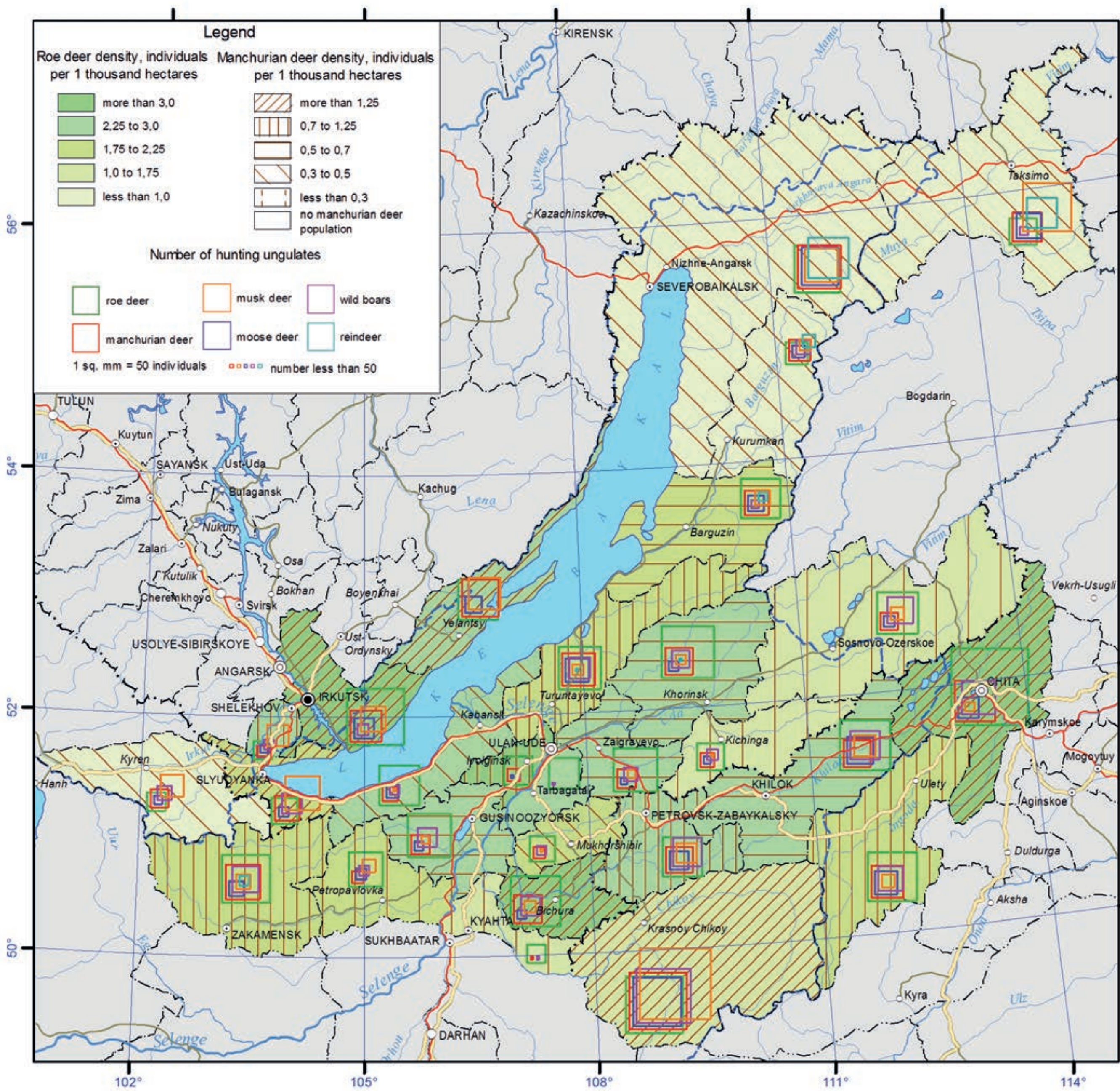
Red deer (Cervus elaphus xanthopygus) migrates seasonally from the zone of bald mountains to the foothills of mountain ranges, concentrating in the area of little snow with ample fodder reserves and minimal disturbing factors (pic. 2.4.3) [3,4].

Pic. 2.4.3 The red deer

According to the assessment of forest managers, the lengthy and high snow cover in the winter period of 2010-2012 caused forced migration of the red deer to the hitherto uncharacteristic areas of little snow, more favorable habitats (pic. 2.4.4). Thus, forced migration of the red deer led to the growth in number of intersections on the permanent routes, which impacted the winter route tracking assessment in 2011-2012 and made it difficult to assess the number of animals.

The bore (Sus scrofa) is widely spread on the Russian territory of the basin (pic. 2.4.5) [3,4]. The distribution areal of the bore has been influenced by agricultural practices. The poorly harvested crops in some areas produced a good fodder basis for the bore and allowed it proliferate in the hitherto less available places. In the dynamics of the last ten years the number of bores rose from 4 to 8 thousand animals. At present, the number tends to grow and according to the 2012 data the number of bores is estimated at 8508.

Pic. 2.4.5 The bore



Pic. 2.4.4 Hunting resources [1]

Musk deer (Moschus moschiferus) was listed by the International Union for Conservation of Nature (2003) as an «endangered» species due to the considerable amount of international trade in products derived from it (pic. 2.4.6) [3,4]. Considering these circumstances, the counting of musk deer is conducted based on the methods adapted to the biological peculiarities of this animal. According to the winter route tracking of 2012, the number of musk deer was 16.4 thousand animals, which is higher than the average long-term number over the last ten years. These data suggest stability in the number of animals, even though the musk deer population is affected by forest cutting and frequent forest fires.

In Mongolia found in Khentii, Khuvsgul, and Khangai mountain ranges, some mountain forests in the southern part of Mongol Altai.

Pic. 2.4.6 The musk deer

Siberian roe deer (Capreolus pugargus) is the most widely spread animal among large mammals in Buryatia (pic. 2.4.7). The area of distribution covers the whole territory of the Russian part of the basin. In spring, following the boundary of snow melting roe deer migrate from valleys to mountains and elevated wetlands, which serve them as protection, providing less sources of disturbance and simultaneously a good fodder basis and ample water sources [3,4]. Thus, watershed ranges provide home not only to the roe deer, but also all the hoofed animals. In autumn, starting from the end of August, roe deer migrate to their winter habitats in small groups of 2-4. Migration is usually started by females with calves born in the year, while males migrate later on. The period of autumn migration is usually from September to December, and spring migration is from March to May. According to the assessment of 2012, the number of roe deer was 42873 animals.

Pic. 2.4.7 The Siberian roe deer

The territory of the basin is the habitat of one of the four biggest mammals in the country – East Siberian **elk** (Alces alces) (pic. 2.4.8). Seasonal migrations of the elk are determined by the availability of fodder [3,4]. The habitat of elk is usually dominated by young coniferous forests, pine, larch, aspen trees and elks particularly tend to dwell in burnt-out places, in the thickets of low-height birch, shrubs, meadows and river valleys. In summer, life of the elk is closely related with lakes and rivers. In addition to the availability of fodder, the areal distribution of elk is also determined by snow cover and anthropogenic impact. The number of animals over the last ten years varies from 6 to 8.5 thousand animals, which has to do with the above mentioned biotic and abiotic factors. According to 2012 assessment, the number of elks in the republic was 7851 animals. Widespread in northern Mongolia

Pic. 2.4.8 The elk

The territory of the basin is home to **squirrel** (Sciurus vulgaris), which inhabits mountain larch forests of Dahurian larch as well as cedar, pine and larch-pine forests (pic. 2.4.9). The dynamics of squirrel number over the five years varies within 145-170 thousand animals [3,4]. According to the data of the winter route tracking in 2012, the number of squirrels was estimated at 161.6 thousand animals. The number tends to fluctuate in cycles depending on solar activity and the fodder productivity.

Pic. 2.4.9 The squirrel

Dynamics in the number of **mountain hare** has a cyclic character with the decade-long growth cycles (pic. 2.4.10). The major causes influencing the reproduction of the species are climatic conditions in spring-summer period, having to do with the birth of the young and their first days of life [3,4]. The dynamics of the species within the last ten years vary within 37 to 95 thousand animals. According to the assessment of 2012, the number of mountain hare showed a decreasing trend and was estimated at 43.5 thousand animals, which is higher than the figure for 2011, yet lower than for the previous 5years.

Pic. 2.4.10 The mountain hare

The habitat of **sable** (Martes zibellina) on the territory of the basin is cedar forests on the stony soil, cedar elfin wood, old burned places with coniferous and deciduous trees, larch-fir and pine-cedar forests with stony deposits (pic. 2.4.11). The number of sable over the last ten years has varied considerably across years. According to the assessment of 2012, the number of animals was 22.5 thousand, which is about the same for the preceding year [3,4]. In the winter period, both in 2011 and 2012, there were no signs of considerable vertical migrations of sable. Considering the ten-year dynamics, the number of sable in 2012 remained above the average level.

Pic. 2.4.11 The sable

Ermine (Mustela erminea) inhabits mountain-taiga, forest-steppe biotopes, on stony deposits. Forest cutting is advantageous for the ermine [3,4]. However, it has been clearly identified that in dark coniferous forests and pure cedar forests ermine is rarely observed. It is virtually not to be found in the area with the high concentration of sable. Within the last ten years, the number of sable has varied from 9 to 15 thousand animals which is typical for fur-bearing animals. According to the 2012 assessment, the number of ermine is estimated at around 10 thousand animals, which is higher than their number in the previous 2 years.

Siberian weasel (Mustela sibirica) is widely spread [3,4]. In taiga, forest-steppe and mountainous areas it can be observed in the river valleys, brooks, stony deposits, overgrowing burned places, river banks and shores of lakes and shrubs. It can be seldom found in dark coniferous forests and mixed taiga, as its main competitor here is the sable. It does not dwell on barren mountains and dry steppes. According to the state monitoring, the number of Siberian weasel was 7310 in 2012, which is above the level for the previous four years. There is no specifically organized hunting of the weasel, as the reproduction of weasel runs in parallel with the reproduction of other animals.

Fox (Vulpes vulpes) is spread across the whole territory of the basin, however, the distribution is uneven [3,4]. During the ten years preceding 2012, the number of foxes has risen, particularly in the last three years, reaching 5290 animals in 2012. The amount of production through hunting also varies from 100 to 800 animals, which is explained by the high demand for the fur on the market and price politics. Due to shrinking demand and low purchasing cost for the fur over the last four years, the amount of production dropped and averaged at no more than 200 animals per year.

The wolf (Canis lupus) is widely distributed, inhabiting all the districts of the basin. In the course of many years, the state authorities of the Buryat Republic have taken measures to regulate the population of wolves [3,4]. On average, the amount of production was 300-400 animals annually during 1995-2005. In 2006-2007, the amount dropped to110-140 animals. In most cases, guns are used for hunting. According to the assessments, the number of wolves was 2517 animals at the beginning of 2012, which testifies to the efficiency of regulation measures. At the same time, some further regulation measures are required, considering frequent migrations of wolf packs from the neighboring regions and Mongolia, to reduce possible damage to agriculture and hunting grounds.

The state of **lynx** (Felis lunx) habitat in the region can be considered satisfactory [3,4]. The most typical landscape habitats include mountains, pine and larch forest-steppe, pure and mixed forests, lowlands on the slopes of hills, sometimes intersected by cut or burned area, where young aspen and birch trees grow. During the last ten years, the number was stable and varied from 630 to 1300 animals. In 2012, the number of lynx was estimated at 1258, which was higher than for the previous year but about the same as during the preceding six years.

The distribution area of **Siberian marmot** (Marmota sibirica) on the Russian part of the basin is 32.3 thousand ha [3,4]. There are around 20-30 thousand marmots. The number of animals may vary. Spring counting of 2012 was conducted on the territory of steppe and forest-steppe districts of the republic, where the number of marmot was estimated at 20166.

Wild **Przewalski's horse** (Equus ferus przewalskii) that inhabits semidesert steppe and steppe. Found in Hustai mountain range located in Altanbulag soum of Tuv aimag (pic. 2.4.12) [23].

Pic. 2.4.12 The Przewalski's horse

Birds are the most diverse group of fauna on the Russian part of the basin [3,4]. Of 348 species, 260 are breeding birds, 34 are birds of passage, 7 wintering, 1 is flying and 46 are vagrant.

Grouse as a typical forest bird, leading a secluded way of life and spending most of the time, especially in summer, on land. In the period of collecting gastorolites, when the birds come to the sand bars and roads, grouse is rarely found. The number of grouse in the republic is recovering now after the forest fires of 2003-2004 and was estimated at 150.5 thousand in 2012. The winter period of 2012 was good for the grouse and it did not affect the number and reproduction conditions of the bird.

According to the assessment of 2011, the number of **black grouse** reached 311.8 thousand [3]. According to the state monitoring data, there were 252.7 thousand animals in 2012, which is comparable to the level of 2009-2010 and can be considered as the most plausible estimation. The analysis revealed that black grouse hunting is of little significance in the republic and the bird is hunted simultaneously during hunting for other animals. Overall, thanks to the favorable conditions during the last five years, the number of black grouse rose significantly.

Hazel grouse is a typical forest bird leading a secluded way of life and spending most of the time on the land. The number of the bird is subject to cyclic fluctuations. Based on the assessments of 2004, 2006 and 2008, the number of hazel grouse has been on the decline and was estimated to be 55-65 thousand birds. According to the same assessment, the number of hazel grouse rose in 2009-2012. Hazel grouse hunting is not practiced, it is concurrently done while hunting fur-bearing animals. The exception is hunting with the use of the call.

Dahurian partridge is sedentary species making short-distance and non-regular migratory trips [3]. The number of partridge has been declining during the last 3 years after reaching its maximum in 2009. According to the state monitoring of 2012, the number of Dahurian partridge was 78.4 thousand. The number has been about the same during the last 15 years.

Short-toed snake-eagle (Circaetus gallicus). Found in the west-south part of Khentii mountains during reproduction period. Generally inhabits Selenga river valley. During summer and laying of eggs, mostly found in Umnugobi aimag, Gobi desert (pic. 2.4.13) [23].

Pic. 2.4.13 The short-toed snake-eagle

Greater spotted eagle (Aguila clanga). A scarce summer visitor and passage migrant, presumably breeding in the taiga and/or forest-steppe of northern Mongolia. Was recorded in Khentii mountains and taiga or forest-steppe area along the Selenga river, in Zavhan, Bulgan, Arkhangai and Tuv aimags [23].

Pallas's Sea(fish)-Eagle (Haliaeetus leucoryphus) Found along banks of rivers and lakes. Have been spotted near the lakes Khuvsgul, Achit, Khar Us, Khar, Dorgon, Hyargas and Uvs, and the basins of the rivers Zavkhan, Kharaa, Tuul, and Orkhon [23].

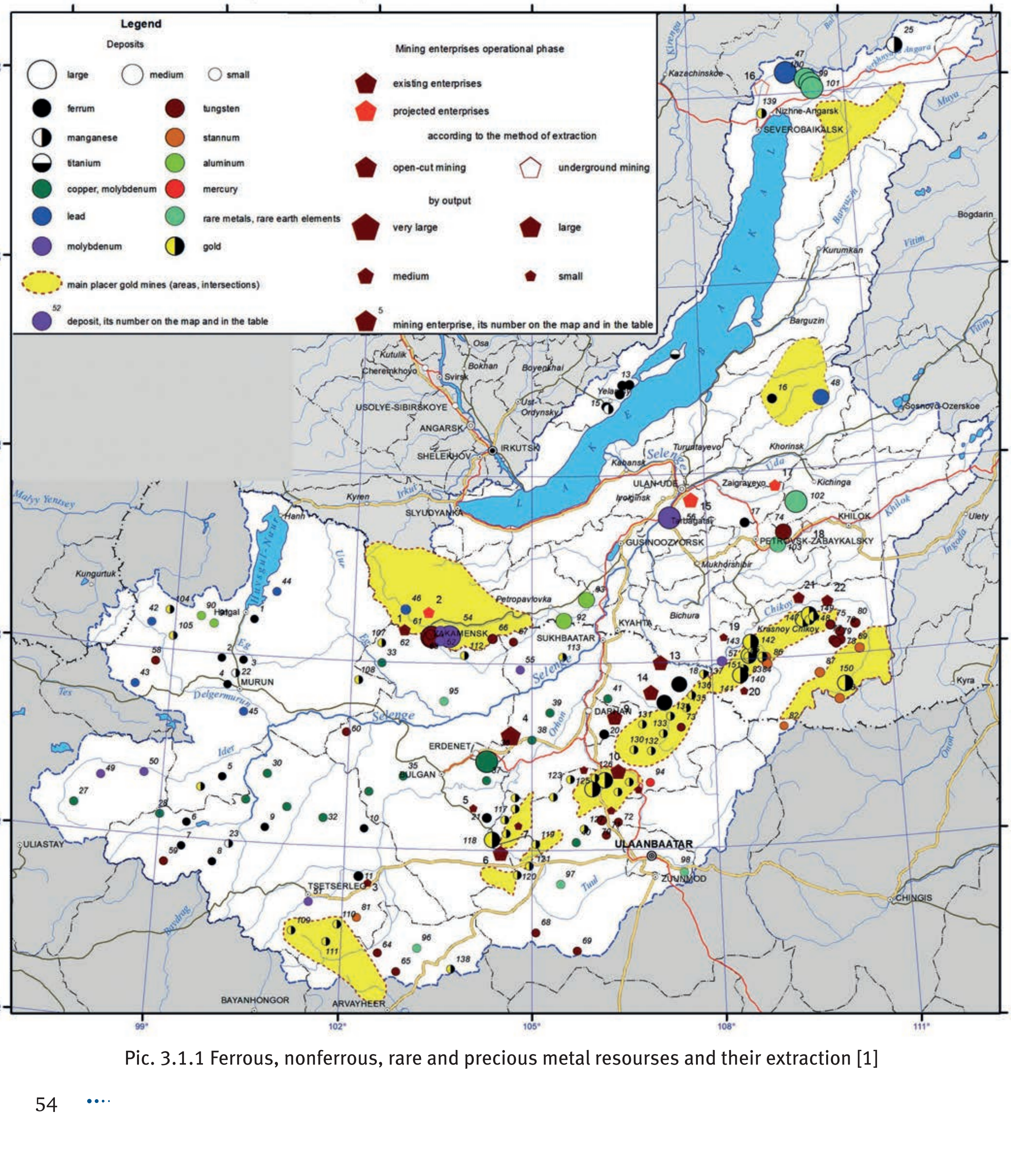
BIBLIOGRAPHY

1. Ecological atlas of the Lake Baikal basin – Irkutsk: Institute of Geography SB RAS. 2014. http://bic.iwlearn.org/ru/atlas/atlas
2. Garmaev E.Z., Khristoforov A.V. Water resources of the rivers within Lake Baikla basin: basis for their use and protection. Novosibirsk: "Geo" Academic Publishing, 2010. 231 pp.
3. State report "On the state of Lake Baikal and measures for its conservation in 2012" - Irkutsk. Siberian branch of "Rosgeolfond", 2013. - pp. 436. http://www.mnr.gov.ru/regulatory/list.php?part=1258 (in Russian)
4. State report "On the state of Lake Baikal and measures for its conservation in 2013" - Irkutsk. Siberian branch of "Rosgeolfond", 2014. - pp. 462. http://www.mnr.gov.ru/regulatory/list.php?part=1258 (in Russian)
5. Tulokhonov A.K., Plyusnin A.M., Namsaraev B.B. et al. The Selenga river delta – the natural filter and indicator of the state of Lake Baikal. Novosibirsk: SB RAS Publishing, 2008. 314 pp.
6. State report "On the state of the environment and its proptection in the Republic of Buryataia in 2012". http://minpriroda-rb.ru/upload/iblock/9cb/frmoytmrq2013.pdf (in Russian)
7. State report "On the state of the environment and its proptection in the Republic of Buryataia in 2013". http://minpriroda-rb.ru/upload/iblock/26b/gocdoclad_2013.pdf (in Russian)
8. MEGD, «Strengthening Integrated Water Resource Management in Mongolia» project, «Integrated Water Management Assessment Report, Volume I», http://www.tuulgol.mn/dmdocuments/reports/national_report_volume1_english.pdf
9. Water resource of Mongolia http://www.travelnews.mn/index.php?songolt=content&task=content_item&id=833&menu_id=579
10. MEGD, «Strengthening Integrated Water Resource Management in Mongolia» project, "Tuul River Basin integrated water resources management assessment report", UB city 2012, http://www.tuulgol.mn/dmdocuments/reports/tuul_r_b_report_english.pdf
11. «Mongolian water forum-ushelts» NGO, «Baseline study on Socio-economic and ecological conditions of Ider river basin», UB city 2013
12. «Mongolian water forum-ushelts» NGO, «Baseline study on Socio-economic and ecological conditions of Khuvsgul lake-Eg river basin», UB city 2013.http://baikal.iwlearn.org/en/project/project-tender-reports-2012/010-eg-sub-basin-watershed-management-plan-mongolia
13. Performance report on the convention on wetlands of international importance,especially as water fowl habitator RAMSAR convention, 2012.
14. The Institute of Geography of Mongolian Academy of Science, the National Atlas of Mongolia, 2009
15. Mongolian Law on Soil Protection and Desertification Prevention, 2012.05.17, http://www.legalinfo.mn/law/details/8664?lawid=8664
16. The Environmental Information Center, Desertification database, http://www.eic.mn/DLDbase/, eic.mn/DLDbase/upload/2013/tadesertcontent/jpg/20131021_8432.jpg
17. Mongolian Law on Natural Vegetation, 1995.04.11, http://www.legalinfo.mn/law/details/76?lawid=76
18. Plant and Forest Conservation, https://mn.wikipedia.org/wiki/Ургамал_ой_хамгаалал
19. National Statistical Office of Mongolia, «Mongolian Statistical Yearbook», UB city, 2013
20. MEGD, Mongolian Red book, UB city 2014
21. Red book of the Republic of Buryatia. Rare and endangered species of animals, plants and fungi. - 3rd edition, revised and enlarged. Ulan-Ude, BSC SB RAS Publishing house, 2013, 687 pp.
22. The National Program for endangered animals and rare animals, Appendix of the resolution № 277 of the Government in 2011, legalinfo.mn/annex/details/2927?lawid=5500
23. Voloshin A.L. Geoekologicheskie osobennosti sovremennykh ekzogennykh rel'efoobrazuyushchikh protsessov mezhgornykh kotlovin Selenginskogo srednegor'ya. Avtoreferat diss. Na soiskanie uchenoi stepeni kandidata geograficheskikh nauk. – Ulan-Ude. – 2011. [The Geoecological Peculiarities of Contemporary Exogeneous Landscape Forming Processes of Intermontane Hollows of the Selenga Mid-Mountains]

USE OF NATURAL RESOURCES

3.1 MINERAL RAW RESOURCES

Mining industry within the basin is based on the extraction of non-ferrous and precious metals, coal, chemically pure limestone and uranium (pic. 3.1.1). The overall gross value of the explored mineral reserves in Buryatia is almost $135 billion. Two thirds of this are accounted by fuel and energy resources, precious and rare metals, including rich fields of nepheline ores, fluorite, phosphates, brown coal, potassium and iron ores. Geological surveys have discovered 228 deposits of alluvial gold along the tributaries of the Verkhneya Angara and Barguzin rivers, valleys of the Dzhida, Temnik and Chikoi rivers. Buryat Republic possesses large deposits of uranium, coal, fluorite, lead, zinc, tungsten, apatite and granular quartz situated within the 140-200 km zone of Lake Baikal [1,2].



Pic. 3.1.1 Ferrous, nonferrous, rare and precious metal resourses and their extraction [1]

Works for the extraction of metallic minerals						
№№ п/п	№№ on the map	Subsoil user / develop the field	mineral resource	operational stage	The size of the mining enterprise	extraction method
1	9	Non data / Tumurtolgoy	Iron	Acting	Large	Open
2	13	Non data / Tumurtey	Iron	Acting	Large	Open
3	14	Non data / Bayangol	Iron	Acting	Large	Open
4	5	Non data / Zahtsag	Iron	Acting	Small	Open
5	3	Non data / Tamir goal	Iron	Acting	Small	Open
6	4	Erdenet JV / Erdenetiin ovoo	Copper, Molybdenum	Acting	Очень Large	Open
7	16	Ltd. InvestEvroKompani / Kholodninskoye	Lead, zinc	Projected	Large	underground
8	15	Ltd. Pribaikalskiy Mining / Zharchihinskoe	Molybdenum	Projected	Large	Open
9	18	Ltd. mining communities Quartz / Bom Gorhonskoe	Tungsten	Acting	Middle	underground
10	11	Non data / Tsagaan Davaa	Tungsten	Acting	Small	Open
11	2	ZAO Tverdosplav / Inkurskoe, Holtosonskoe	Tungsten	Under construction	Middle	Open
12	1	ZAO Zakamensk / Barun-Naryn, placer r.Inkur	Tungsten	Acting	Middle	Open
13	17	Ltd. YARUUNA INVEST / Ermakovskoe	Beryllium, fluorite	Under construction	Middle	Open
14	8	Non data / Narantolgoy	gold ore	Acting	Small	Open
15	20	ZAO Sludyanka / r.Chikokon	Gold placer	Acting	Small	Open
16	19	Ltd. Sirius / r.Hilkotoy	Gold placer	Acting	Small	Open
17	21	Ltd. Taiga / Aca-Kunaleyskoe	Gold placer	Acting	Middle	Open
18	22	Ltd. ZAS Vertical / r.Kunaley	Gold placer	Acting	Middle	Open
19	12	Non data / Gachuurt	Gold placer	Acting	Small	Open
20	7	Non data / Nariyn goal	gold ore	Acting	Small	Open
21	10	Boroo Gold (Centerra Gold) / Boroo	gold ore	Acting	Large	Open
22	6	Bumbat Gold Fields (Mongolia Gold Resources, Ltd) / Bumbat	gold ore	Acting	Large	Open

Legend to the pic. 3.1.1

In Irkutsk part of the basin, mining industry is based on the extraction of marble. There is a considerable number of discovered, but yet unexplored deposits, including quartz deposits in Olkhon district, and deposits of syenites, lazurites, wollastonite in Slyudyansky district [4]. Slyudyansky, Irkutsky and Olkhonsky districts of Irkutsk region, lying within CEZ, have 29 registered mineral deposits, including 16 deposits of technical and chemical materials and gemstones (none is being exploited) and 13 deposits of construction materials (6 of them are being exploited). Among the 6 exploited deposits, the biggest deposits are Pereval (Slyudyanskoe), which produced 902 and 776 thousand tons of marble and 311 and 266 thousand m^3 of limestone in 2012 and 2013, respectively, and Angasolskoe, which produced 505.8 and 447.9 thousand m^3 of gravel in 2012 and 2013, respectively [3,4].

The major exhaustible energy sources within the Russian part of the basin are coal and oil. Considerable coal reserves are located within the Selenga river basin. Oil and natural gas were discovered in Lake Baikal basin as early as in the XVII century; however the exploitation of these reserves is impossible as they are located within the CEZ BNT.

In 2012, 5 deposits of brown coal and 2 deposits of bituminous coal were being exploited in the Republic of Buryatia (pic. 3.1.2).

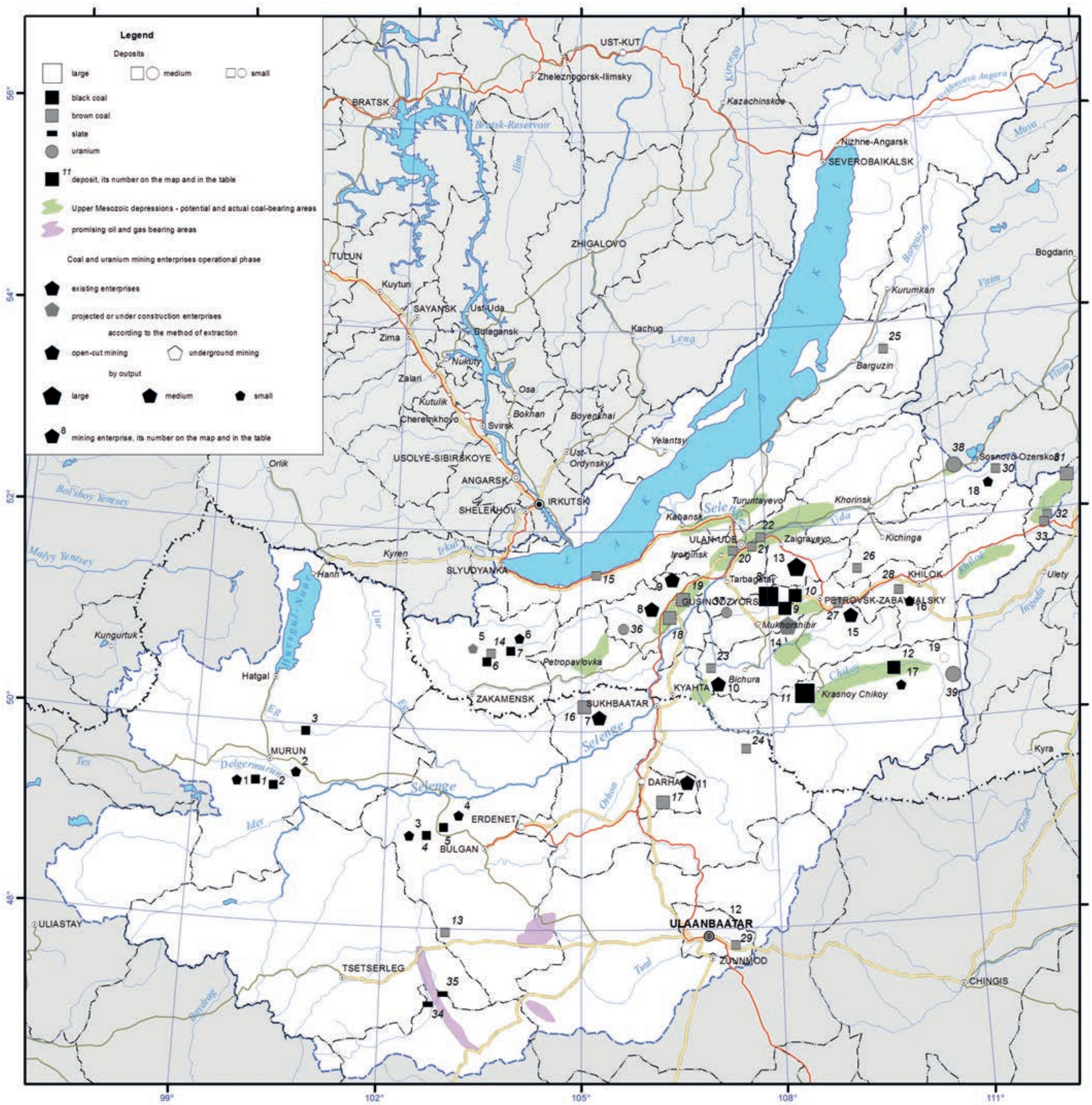
In 2012, the coal company «Bain-Zurkhe» extracted 932.1 thousand tons of coal, which was 146% of 2011 level. 1,150 thousand tons of coal were extracted in 2013. The company «Coal razrez» extracted 1,200 (2.6 times more than in 2011) and 1,650 thousand tons in 2012 and 2013, respectively. The company «Buryat Coal» extracted 255.6 and 298.3 thousand tons in 2012 and 2013, respectively. The company «Tuguniskiy razrez» extracted 12.5 million tons of coal in 2012 [3,4].

The amount of extracted placer gold in 2012 was 1.35 tons, and in 2013 it was 1.56 tons, 15.6% more than in 2012. About 4.6 tons of lode gold were mined in 2012, 4.4 tons were mined in 2013. The biggest gold-mining enterprises in 2012 were «Buryat Gold Company» and the «Western gold-mining cooperative».

In Zakamensky district there are 4 tungsten deposits. Dzhida tungsten and molybdenum plant was exploiting Inkurskoe and Kholtosonkoe deposits on the right bank of the Dzhida river. After the closing down of the plant, there remained a tailing dump with the area of more than 1 km^2, which is the anthropogenic Barun-Naryn deposit with the tungsten trioxide reserves of 21 thousand tons. From 2010 «Zakamensk» Company started the exploitation of this anthropogenic deposit, setting up new production sites, building a modern ore-processing factory, a hydrometallurgical unit for processing of tungsten concentrates [3].

In Zakamensky district there are also registered reserves of molybdenum of the Malo-Oynogorsky deposit. Zharchikhinskoe deposit of molybdenum ores (Tarbagataisky district) and Ermakovskoe deposit of fluorite-phenacite-bertrandite ores have been included in the state fund of distributed mineral reserves.

In 2012 and 2013, within the Republic of Buryatia several deposits of nonmetallic mineral resources were exploited,



Pic. 3.1.2 Energy resources and their development [1]

among which the major ones in terms of the production amount were Tatarskiy Kluch with 209 and 82 thousand tons, respectively, of limestone, Tarabukinskoe with 160 and 122 thousand tons, respectively, of dolomite (Zaigraevskiy district), Cheremshanskoe with 202 and 223 thousand tons, respectively, of quartzite (Pribaikalskiy district), Timluyskoe with 35 and 31 thousand tons, respectively, of cement clay loam, as well as Oshurkovskoe deposit of apatite ores (Ivolginskiy district) and Tarakanovskoe deposit with 602 thousand tons of limestone (Kabansky district). JSC "Khiagda" exploits the Khiagda ore field and extracts uranium in its pilot plant. In 2012, it extracted 331.7 tons of uranium, which was 124.5% of the level in 2011 (266.4 tons) [11,12]. In 2013, the company further increased the amount of extracted uranium to 440 tons, which was 33% more than in 2012 [13,14]. In total, the production output of the mining enterprises in the Republic of Buryatia was worth 13.8 billion rubles in 2012, which was 106.4% of 2011 value. In 2013, the production output was estimated at 13.4 billion rubles [5,6].

The territory of Zabaikalsky Krai incorporates enterprises of different forms of property and types of economic activity (table 3.1.1) [6,7].

Enterprise for the production of fuel-energy resources						
№№	№№ on the map	Subsoil user / develop the field	mineral resource	operational stage	The size of the mining enterprise	extraction method
1	1	non data / Nuurestein am	coal	acting	Small	Open
2	2	non data / Julchig bulag	coal	Acting	Small	Open
3	3	non data / Sayhan ovoo	Coal	Acting	Small	Open
4	4	non data / Ereen	Coal	Acting	Small	Open
5	5	non data / Sanginskoe	Coal	Planned to resume production	Small	Open
6	6	Zakamensky PMK / Khara Huzhirskoe	Coal	Acting	Small	Open
7	13	Tugnuisky Mine / Olon-Shibirskoe	Coal	Acting	Large	Open
8	14	Tugnuisky Mine / Nikolsky	Coal	under construction	Large	Open
9	17	Zashulansky Mine / Zashulanskoe	Coal	Acting	Small	Open
10	7	Prophessy coal / Улаан овоо	brown coal	Acting	Middle	Open
11	8	Bain-Zurhe Mine / Gusinoozerskaya	Brown Coal	Acting	Middle	Open
12	9	Buryatugol / Zagustayskoe	Brown Coal	Acting	Middle	Open
13	10	Coal Mine / Okino-Kliuchevskoe	Brown Coal	Acting	Middle	Open
14	11	Sharyn goal	Brown Coal	Acting	Middle	Open
15	12	non data / Nalayha	Brown Coal	Acting	Small	underground
16	15	Tigninsky Mine / Tarbagatajsky	Brown Coal	Acting	Middle	Open
17	16	Burt / Burtuysky Mine	Brown Coal	Acting	Small	Open
18	18	Buryatugol / Daban-Gorhonskoe	Brown Coal	Acting	Small	Open
19	19	ZAO uranium mining company Mining / Mining	Uranus	projected	Small	underground

Legend to the pic. 3.1.2

Table 3.1.1 Enterprises and organizations recorded in the statistic register according to the type of economic activity (as of January 1, 2013)

Municipal district, urban district	Number of enterprises and organizations	Distribution according to the type of economic activity			
		Agriculture, hunting and forestry	Processing industries	Mining	Construction
Krasnochikoisky	192	39	9	9	4
Petrovsk-Zabaikalsky	175	53	3	2	5
Uletovsky	168	21	6	2	9
Khiloksky	250	43	6	3	9
Chitinsky	749	136	22	3	56

The total output of the enterprises of Krasnochikoisky, Petrovsk-Zabaikalsky, Uletovsky, Khiloksky and Chitinsky districts in such sectors as rock mining, processing industry, production and redistribution of energy, gas and water amounted to 26.2 billion rubles. The leader among the districts is Petrovsk-Zabaikalsky district with its share of 22.1 billion rubles.

In 2012, the enterprises of the Khilok river basin (Petrovsk-Zabaikalsky and Khiloksky districts) were entitled to 10 licenses for extraction of mineral resources, while the enterprises in the Chikoi river basin (Krasnochikoisky district) to 16 licenses. Petrovsk-Zabaikalsky district is rich in the bituminous and brown coal reserves. At «Tugnuiskiy Razrez», Oblon-Shibarkoe deposit 13 million tons of bituminous coal were mined in both 2012 and 2013, while at Tarbagataiskiy brown coal deposit of «Tugnuiskiy Razrez», 260 and 227 thousand tons of brown coal were mined in 2012 and 2013, respectively.

Krasnochikoisky district possesses 14 primarily small deposits of placer gold. Some enterprises, such as Khikotoi, Gutai, «Taiga» Ltd, Kunalei, Fedotovka, and Dauriya, extracted up to 200 kg of gold. Nonmetallic mineral deposits, located in Khiloksky district, include Kholinskoe deposit with the amount of extracted zeolite of 0.6 thousand tons in 2012 and Zhipkhegenskoe with 380 thousand tons of granite per year.

Mining industry is the leading sector of **Mongolia's** economy accounting for 22% of GDP, 94% of gross export value and 85% of foreign direct investment in 2012, according to figures from the National Statistics Office [9]. Mongolia's main proven reserves include coal (pic. 3.1.2 and pic. 3.1.3), copper, hard-rock and placer gold, silver, iron, molybdenum, fluorspar, zinc, tungsten, lead, tin, uranium and rare earths.

Pic. 3.1.3 Brown coal opencast in the area Tevshin Nuruu

In Khangai region, there are discovered and expected reserves of 15 types of mineral resources. There are 89 deposits of 9 types of mineral resources and other minerals are encountered is occurrences. Among the deposits, there are 46 gold, 22 phosphor and 15 coal deposits and mixed deposits of gold, silver, copper, iron, manganese, and fluorite.

As of 2013, 4.6% of working age people or 50.3 thousand people were officially employed in mining industry in Mongolia. Another 40 thousand people were illegally working in mining of coal, gold, tungsten, gravel, sands, gypsum, etc. Among the illegal miners, about 90% is working on exploitation of abandoned gold deposits. The illegal mining is prominent in Zaamar soum of Tuv aimag, Buregkhangai soum of Bulgan aimag and Tsenkher soum of Arkhangai aimag, all located in the Selenga river basin. The illegal mining has an adverse impact on the environment and, in recent years, rehabilitation of the lands has been underway.

During 1992-2005, the Government of Mongolia implemented Programme «Gold» aimed at developing gold mining industry. Between 1992 and 2005 the amount of extracted gold increased from 773.6 to 21,900 kg, i.e. more than 28.3 times (3.1.4).

Pic. 3.1.4 Industrial gold mining (Zamaar sum, Tuv aimag)

Boroo gold deposit is located in Mandal soum of Selenge aimag. In 1982-1990, a Mongolian and Eastern Germany joint geological expedition carried out a detailed exploration and estimated geological reserves of gold at 42.56 tons. In March 2004, an ore processing factory was put into operation with capacity of 1.8 million tons per year, and till 2013 the factory produced 1,628,000 ounces or 46.15 tons of gold. Boroo gold deposit is exploited by the Canadian mining company «Centerra gold». The company has also received permission to exploit Gachuurt gold deposit located in Mandal soum of Selenge aimag. As of December 2010, the proven gold reserves of this deposit are 1.8 million ounces and prognostic reserves are 491,000 ounces. The exploitation of the deposit has not yet started.

The major metal ore deposits being exploited are the Tumurtologoi deposit in Tuvshruulekh soum of Arkhangai aimag («Beren» company), another Tumurtologoi deposit in Khongor soum of Darkhan-Uul aimag («Darkhan steel factory»), Bayangol iron deposit in Eruu soum of Selenge aimag («Boldtumur Eruu Gol» company), and the deposits Khust Uul and Tumurtei («Darkhan steel factory»). The main ore mineral of these deposits is skarn magnetite and content of iron in ore varies from 51.2 to 55.8%, while content of sulfur varies from 0.1 to 3.8%.

In Altanbulag soum of Tuv aimag, Darkhan soum of Darkhan-Uul aimag, Saikhan soum of Bylgan aimag, districts neighboring Ulaanbaatar (such as Khan-Uul), and along the rivers Tuul, Orkhon and Kharaa, citizens and organizations mine mineral materials such as sands, gravel and rocks, limestone, and gypsum. The activities, often unauthorized, have negative impact on the environment [15].

Metallurgical enterprises of Mongolia are Darkhan steel factory built in 1994 year and Erdenet copper-molybdenum concentration factory (pic. 3.1.5). Darkhan steel processing factory has built a new concentration facility using dry magnet concentration method at the Tumurtei deposit.

Pic. 3.1.5 Erdenet ore-processing plant

A Mongolian-Russian joint venture, the ore-processing plant «Erdenet» started its operations in 1978. About 25 million tons of sulfide ore of complex mineralogical composition are processed per year yielding about 530 thousand tons of copper and 3 thousand tons of molybdenum concentrates (pic. 3.1.6) [2]. Enrichment tailings and pyrite concentrate are accumulated in the combined tailing ponds that, on one hand, pose a significant threat to the environment and, on the other hand, are a resource for extracting valuable components such as copper, iron, precious metals. The ore reserves of Erdenetiin-Ovoo deposit are 1,060,367 tons, copper and molybdenum reserves are estimated at 4.632 million tons and 125,414 tons, respectively. Explorations conducted recently have discovered new reserves of copper (3 million tons) and molybdenum (55 thousand tons).

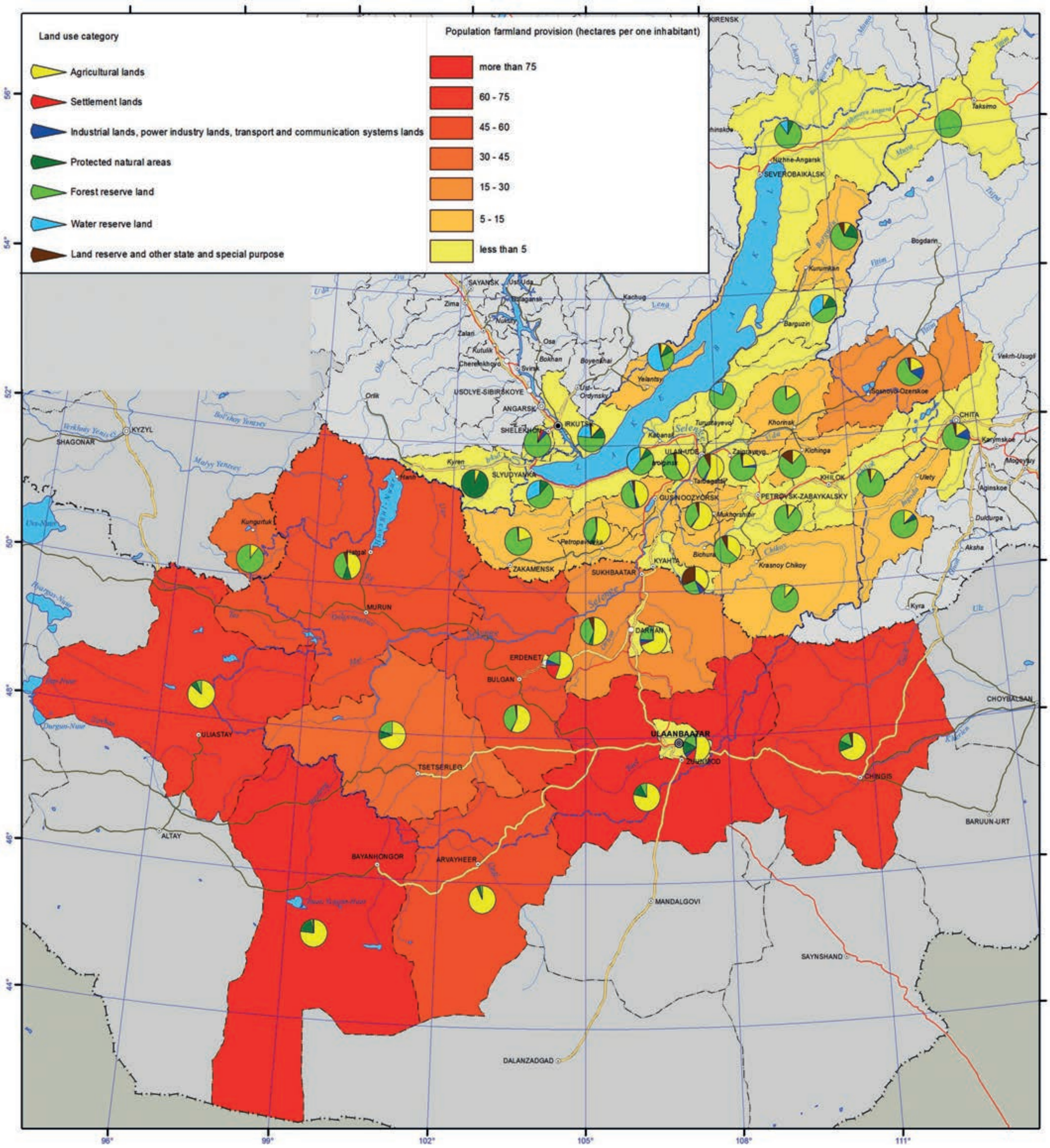
Pic. 3.1.6 The Erdenet open cast mine

Since 1997, «Erdmin» LLC produces cathode copper using tailings of the ore-processing plant «Erdenet». Over the years the company expanded the range of its products and now produces rolled copper and various types of copper wires.

3.2 LAND RESOURCES

The Republic of Buryatia has the major share in the agricultural production in Lake Baikal basin (around 80%) [3,4]. In the Republic of Buryatia, the area of agricultural lands compared to 2011 rose by 0.883 thousand ha (pic. 3.2.1). In Severobaikalsky district, 0.003 thousand ha were transferred to the category of specially protected lands.

Agriculture is concentrated in the southern and central parts of the district and carried out by farms of different forms of property (table 3.2.1).

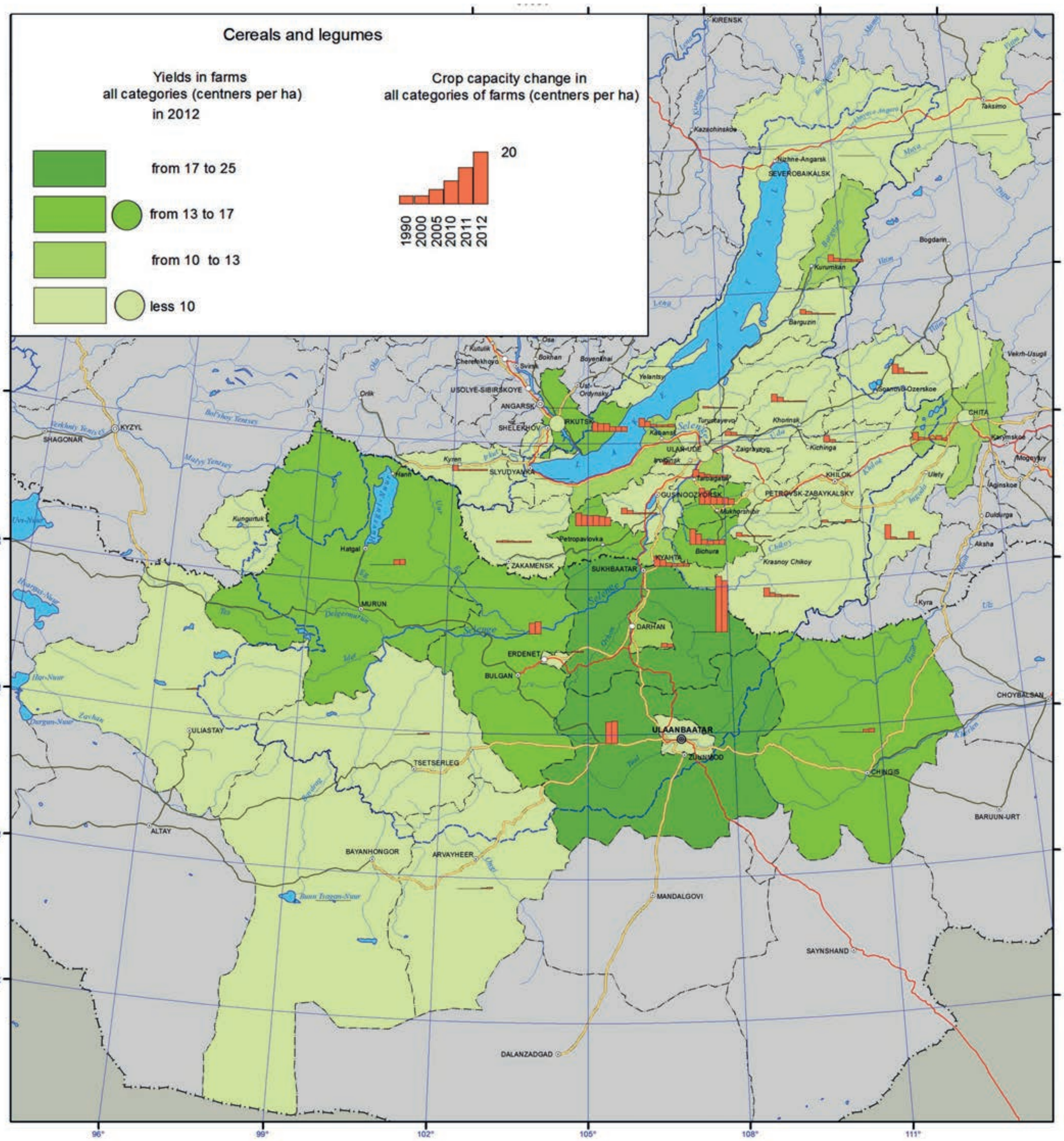


Pic. 3.2.1 Population - weighted farmlands in Baikal basin [1]

Table 3.2.1 Structure of agricultural products by the categories of farms
(in the existing prices and percentage of the total amount)

	2011	2012	2013
Farms of all categories, including	100	100	100
Agricultural organizations	20.2	21.3	21.3
Individual household farms	74.8	74.1	74.1
Small-scale collective farms*	5.0	4.6	4.6

** Including individual entrepreneurs.*



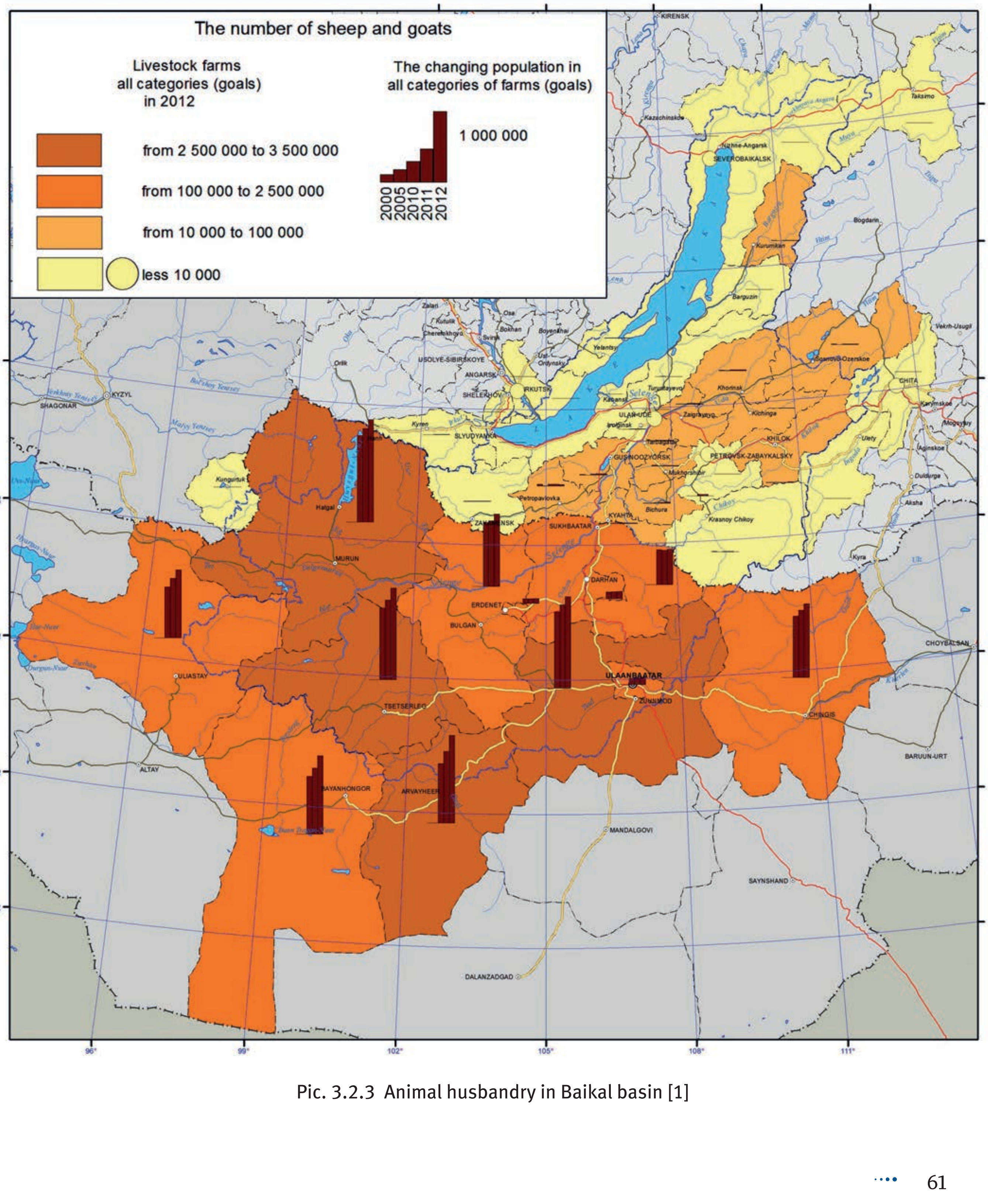
Pic. 3.2.2 Crop cultivation in Baikal basin [1]

The leading sectors of agriculture in the Republic of Buryatia are cattle rearing, production of crops and vegetables. Agriculture in Buryatia has an extremely low productivity.

The yield of grain was 1.28 and 1.24 tons of grain/ha in 2012 and 2013, respectively (pic. 3.2.2).

The agricultural output of all the agricultural producers in Lake Baikal basin (agricultural organizations, individual households, small collective farms) was 13.6 and 13.8 billion rubles in 2012 and 2013, respectively. The grain harvest was 125.7 and 112.6 thousand tons in 2012 and 2013, respectively. Individual households play a leading role the agriculture [10].

The number of livestock in the Republic of Buryatia tends to grow, which is reflected in the data of the Buryat Statistic Bureau [10] for 2013 (pic. 3.2.3) (table 3.2.2).



Pic. 3.2.3 Animal husbandry in Baikal basin [1]

Table 3.2.2. Number of livestock (as of January 1, owned by farms of all categories in thousand animals)

Years	Cattle stock	Cows	Pigs	Sheep and goats
2011	363.1	148.5	74.9	262.9
2012	385.0	167.0	78.2	288.0
2013	394.7	168.1	77.9	290.6

In 2012 and 2013, 51.6 and 54.6 thousand tons of meat, respectively, were produced. 227.9 and 225.8 thousand tons of milk were produced (overall yield) in 2012 and 2013, respectively (table 3.2.3).

Table 3.2.3 Production of major livestock products (by farms of all categories)

	2011	2012	2013
Cattle and poultry (live weight), thousand tons	48.8	51.6	57.3
Cattle and poultry (dead weight), thousand tons	28.7	30.2	33.7
including:			
cattle	18.3	20.5	20.5
pigs	7.5	7.2	7.2
sheep and goats	1.2	1.3	1.3
poultry	0.2	0.2	0.2
milk, thousand tons	227.3	227.9	223.2
eggs, million pieces	65.0	71.9	72.4
wool (weight), tons	499	471	491

Meat and meat products produced in the Republic do not meet the local demand. The demand for meat products in 2011-2012 was equal to 74.6 and 80.0 thousand tons, respectively, and more than 50% of this amount was supplied through import of the products. About 28% of milk and milk products are imported.

In Irkutsk Region, agricultural production in Lake Baikal basin is relatively insignificant and does not have commodity basis [3,4].

In Mongolia, 113,309.9 thousand m^2 were used for agriculture in 2013, among that 112,738.5 thousand m^2 were pasture/untouched land and 571.4 thousand m^2 were occupied by crops/vegetables (pic. 3.2.1 and pic. 3.2.4) [9].

Pic. 3.2.4 A wheatfield, somone Baruunburen, Selenge aimag

Agricultural output decreased by 0.5% in 2011, then increased by 21.6% in 2012 and decreased by 13.5% in 2013. There were 15.7 million head of cattle within the Selenga river basin in 2012, the number increased to 16.7 million head in 2013 (table 3.2.4).

Table 3.2.4. The area of agricultural land and number of livestock of all categories in the Selenga River Basin

Name of aimag	Within Selenga river basin		2013 (thousand head)					
			Total	Including				
	Area (m^2)	Rate (%)		Horse	Cow	Camel	Sheep	Goat
Western region	**15,381.0**	**5.2**	**391.9**	**28.4**	**29.0**	**0.3**	**208.6**	**125.6**
Zavkhan	15,381.0	18.7	**391.9**	28.4	29.0	0.3	208.6	125.6
Khangai region	**189,944.8**	**63.6**	**11,329.2**	**756.3**	**1,066.2**	**4.6**	**1,944,074.0**	**1,131,782.0**
Arkhangai	55,181.6	99.8	**3,772.3**	268.2	427.2	1.1	1,944.1	1,131.8
Bayankhongor	917.4	0.8	**315.1**	18.9	53.3	0.1	125.6	117.2
Bulgan	48,732.7	100.0	**2,757.2**	225.7	221.0	1.1	1,449.6	859.8
Orkhon	844.0	100.0	**179.0**	11.6	21.6	0.1	79.9	65.7
Uvurkhangai	12,179.4	19.4	**1,013.4**	87.5	59.5	0.7	508.3	357.4
Khubsugul	72,089.7	71.6	**3,292.3**	144.6	283.5	1.5	1,570.5	1,292.3
Central region	**87,725.7**	**29.4**	**4,555.9**	**246.3**	**331.1**	**173.4**	**2,265.0**	**1,540.0**
Darkhan-Uul	3,275.0	100.0	**379.8**	19.2	53.0	0.2	193.0	114.5
Selenge	41,152.7	100.0	**1,314.2**	0.5	71.5	171.5	624.2	446.6
Tuv	43,298.0	58.5	**2,861.9**	226.6	206.7	1.7	1,447.8	979.0
Eastern region	**1,567.1**	**0.5**	**50.4**	**3.2**	**6.9**	**0.0**	**24.0**	**16.3**
Khentii	1,567.1	2.0	**50.4**	3.2	6.9	0.0	24.0	16.3
Ulaanbaatar region	**3,988.1**	**1.3**	**329.0**	**30.2**	**64.6**	**0.1**	**134.6**	**99.5**
Ulaanbaatar city	3,988.1	84.8	**329.0**	30.2	64.6	0.1	134.6	99.5
Total	**298,606.7**	**100.0**	**16,656.3**	**1,064.4**	**1,497.8**	**178.4**	**1,946,706.3**	**1,133,563.4**

In 2013, only 0.5% of agricultural land was used for crop farming. About 90% of the crop lands were located within the Selenga river basin. In 2013, agricultural produce was grown over an area of 415.4 thousand m^2, of which 293.3 thousand m^2 were occupied by wheat, 15.5 thousand m^2 by potato, 8.3 thousand m2 by vegetables, 14.4 thousand m^2 by fodder crops and the remaining 83.9 thousand m^2 were used to cultivate oil plants and fruits (pic. 3.2.5).

In 2013, 368.4 thousand tons of wheat, 191.6 thousand tons of potato, 101.8 thousand tons of vegetables, 42.6 thousand tons of fodder crops, 41.7 thousand tons of oil seeds, 1.6 thousand tons of fruits and berries were harvested (pic. 3.2.2 and table 3.2.5).

Pic. 3.2.5 A private farm, somon Shaamar, Selenge aimag

Table 3.2.5 Crop harvest in the Selenga river basin

Region/aimag	2013											
	Cultivation area (thousand ha)						Yeild (thousand ton)					
	Total	Crop	Potato	Vegetable	Fodder crop	Oil and fruit plant	Crop	Potato	Vegetable	Fodder crop	Oil plant	Fruits and berries
Mongolia	**415.4**	**293.3**	**15.5**	**8.3**	**14.4**	**83.9**	**387.0**	**191.6**	**101.8**	**42.6**	**41.7**	**1.6**
Khangai region	**60.0**	**48.3**	**2.3**	**1.0**	**2.5**	**5.9**	**71.8**	**20.7**	**10.9**	**8.3**	**4.1**	**0.1**
Arkhangai	**3.6**	2.1	0.4	0.2	0.7	0.2	2.0	3.8	1.4	1.8	0.1	0.0
Bulgan	**33.5**	28.0	0.8	0.3	0.5	3.9	40.7	8.5	4.2	0.9	2.7	0.0
Orkhon	**2.5**	1.7	0.4	0.2	0.0	0.2	3.3	2.0	2.0	0.0	0.1	0.0
Uvurkhangai	**3.8**	1.6	0.3	0.2	0.8	0.9	1.3	3.7	2.1	4.3	0.6	0.1
Khubsugul	**16.7**	14.9	0.4	0.2	0.5	0.7	24.4	2.7	1.2	1.3	0.5	0.0
Central region	**286.6**	**211.5**	**10.3**	**4.5**	**8.0**	**52.3**	**279.7**	**133.1**	**60.8**	**19.2**	**36.6**	**0.4**
Darkhan-Uul	**18.4**	9.1	1.2	1.2	0.1	6.8	11.7	8.4	15.3	0.1	4.8	0.1
Selenge	**173.3**	140.1	4.1	2.3	1.6	25.1	187.0	56.0	35.5	4.5	17.6	0.2
Central	**95.0**	62.3	5.1	0.9	6.3	20.4	81.0	68.7	10.1	14.5	14.3	0.1
Ulaanbaatar region	**1.2**	**0.0**	**0.5**	**0.4**	**0.4**	**0.0**	**0.0**	**4.1**	**3.0**	**1.7**	**0.0**	**0.2**
Ulaanbaatar city	**1.2**	0.0	0.5	0.4	0.4	0.0	0.0	4.1	3.0	1.7	0.0	0.2
Total Selenge basin	**347.9**	**259.8**	**13.1**	**5.9**	**10.9**	**58.2**	**351.4**	**157.9**	**74.7**	**29.2**	**40.7**	**0.7**

In 2011, irrigation systems was built covering 46.5 thousand ha, 49.0% or 22.8 thousand ha of which are located in the Selenga river basin (pic. 3.2.6) [11]. The new irrigation infrastructure was used for irrigating 6.4 thousand ha of crops, 8.1 thousand ha of potato, 5.3 thousand ha of vegetable, 1.8 thousand ha of fruit, 1.1 thousand ha of fodder crops.

Pic. 3.2.6 A irrigation canal

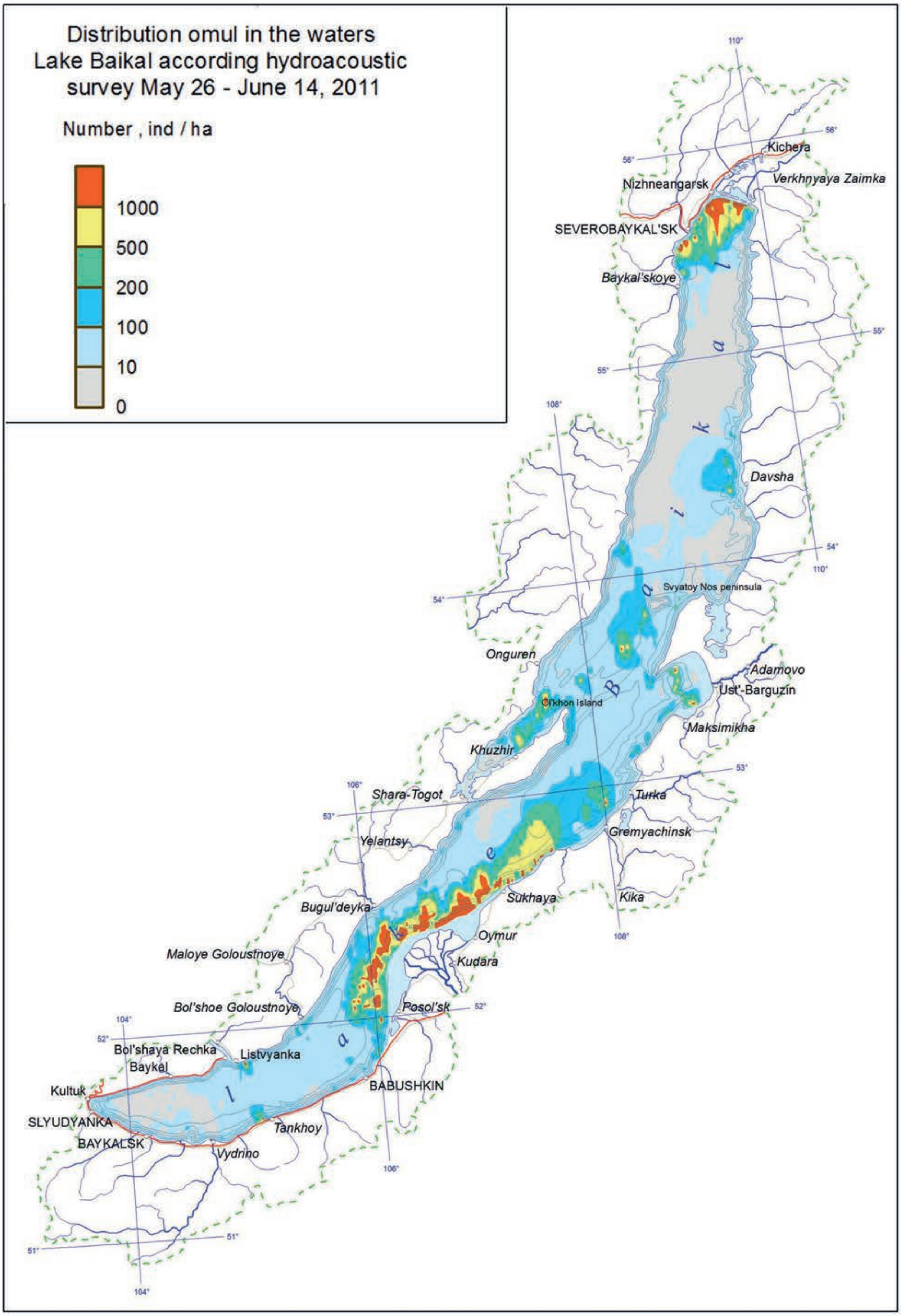
3.3 AQUATIC BIOLOGICAL RESOURCES

Commercial fishing (pic. 3.3.1) and restoration of natural fish reserves is carried out in Lake Baikal and other water bodies of its basin, especially rivers.

Fishing in Lake Baikal is conducted along its coastal zone over the area of 377 thousand ha, which is 12% of the total water surface. The territory includes the coastal zone of the Selenga river delta (145 thousand ha), Pribaikalsky district (31 thousand ha), Barguzin village (84 thousand ha), Severobaikalsk city (62 thousand ha) and Olkhon district of Irkutsk region (55 thousand ha) (pic. 3.3.2) [2,4].

The major species of fish, having a commercial value, are Baikal omul, roach, perch, carp, nerfling, burbot and pike (pic. 3.3.3). Omul and cisco are in high demand on the market, which led to shrinking of the reserves and introduction of quotas for fishing.

Pic. 3.3.1 Commercial fishing



Pic. 3.3.2 Distribution of the Baikal omul [1]

Pic. 3.3.3 Winter fishing (Kabansky district, village Istomino)

In the Republic of Buryatia, there were 48 organizations and private companies engaged in the fishing industry. The production index dropped and was to 80.1% of the previous year value (which was, in turn, 115.7% of 2010 value). In 2009, the total commercial catch was 3,136 tons, which substantially declined in the subsequent years and reflected in the indicators for 2010-2012 (table 3.3.1) [12].

Table 3.3.1 Production of fish and aquatic bio-resources by the districts of the Buryat Republic within Lake Baikal basin (tons)

	2010	2011	2012
Republic of Buryatia	2246	2600	2082
Ulan-Ude	66	83	90
Severobaikalsk	-	15	-
Barguzinsky district	748	810	598
Yeravnensky district	305	251	257
Ivolginsky district	-	22	56
Kabansky district	543	530	408
Kurumkansky district	-	1	-
Pribaikalsky district	-	13	9
Severo-Baikalsky district	331	568	386
Selenginsky district	238	274	223

In 2013, the total catch of fish and other aquatic resources in the Republic of Buryatia was 2,190.4 tons. The official catch of omul was 1.140 tons in 2013, 67 tons less than in 2012. However, the actual catch of omul in 2012 and 2013 was higher than the official figures by 39% (1,870 tons) and 37% (1,900 tons), respectively. This was due to illegal catch (pic. 3.3.4). The official catch of Baikal grayling in 2013 was 9.3 tons (in 2012 -7.0 tons). In the same year, the official catch of cisco was 4.6 tons (in 2012 – 3.7 tons). The species of fish are highly subject to illegal catch, the amount of which often nears the total allowed catch [4].

Pic. 3.3.4 A spontaneous market selling omul (settlement Listvyanka)

The Republic exports fish and sea food – 944.4 and 1,292.1 tons in 2011 and 2012, respectively. Consumption of fish and fish products per capita in the Republic of Buryatia was 9.7, 10.4, and 10.8 kg/year in 2010-2012, respectively. The reserves of commercially valuable fish in Lake Baikal and its tributaries are getting depleted, therefore fish-breeding has been conducted for decades. The major enterprises in the Republic of Buryatia are Bolsherechensky fish- breeding plant (capacity – 1.25 billion fish eggs), Selenginsky fish-breeding plant (capacity – 1.5 billion fish eggs of omul and 2 billion fish eggs of Baikal sturgeon), Barguzinsky fish-breeding plant (capacity – 1 billion fish eggs). In Irkutsk region, there are Burduguzsky fish-breeding plant (capacity – 100 million fish eggs) and Belskoe fish-breeding department of Irkutsky fish- breeding plant on the Belaya river (capacity – 150 million fish eggs) breeding cisco [2,4].

The objective of the artificial reproduction of omul (pic. 3.3.5) is maintaining a stable amount of catch of 3 thousand tons. In 2013, 1.03 billion fish larva were released by fish-breeding plants. The number was comparable to that in 2012, but lower than the full capacity of the fish-breeding plants. Federal state funding of omul breeding has been continuously decreasing, and in 2012-2013 there was no funding at all. The fish larva and the young fish are released into many lakes and water reserves of Russia, Mongolia (Lake Khovsgol), China and Japan.

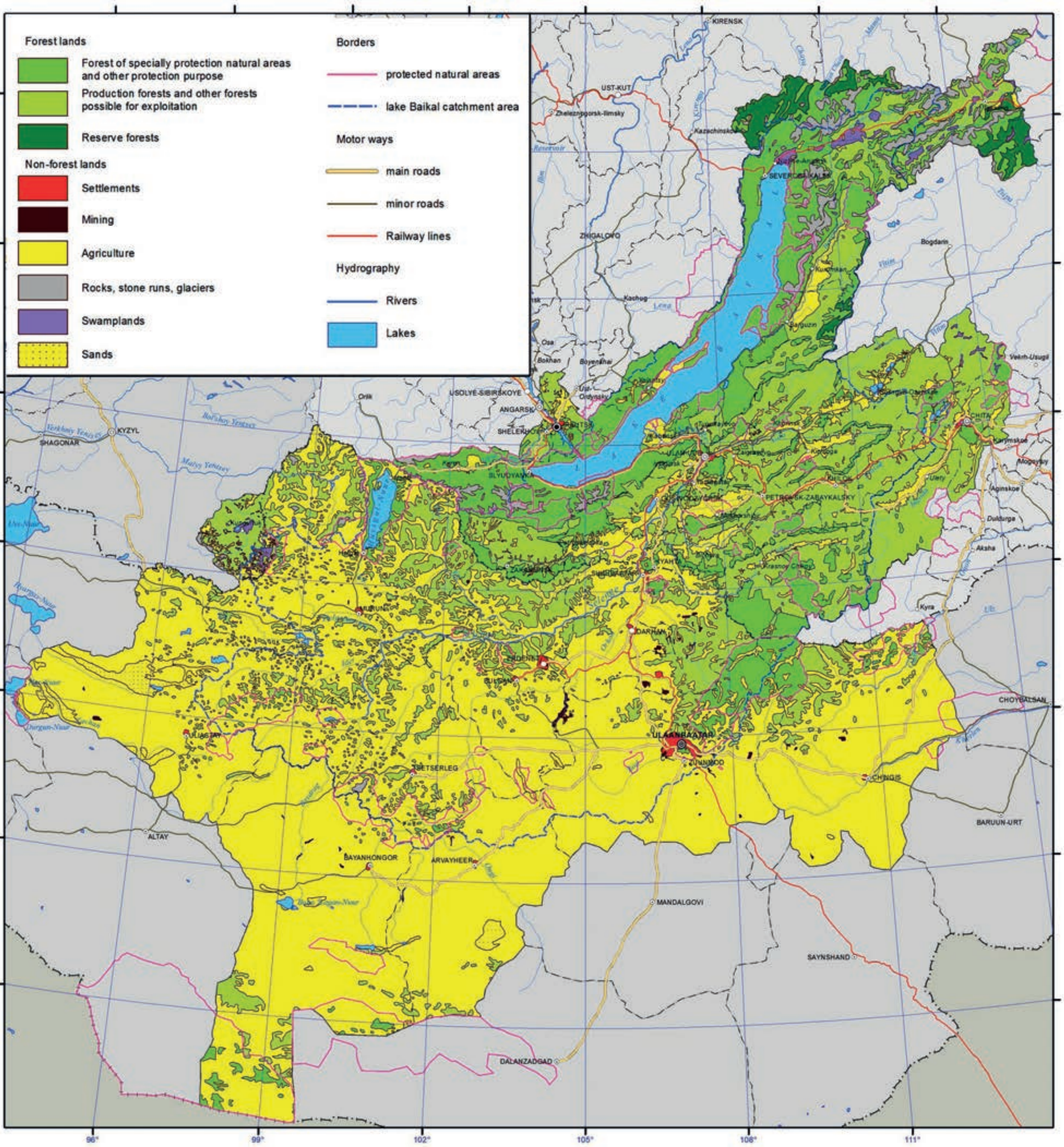
Pic. 3.3.5 The Baikal omul

3.4 FOREST RESOURCES

The major bulk of forests in Lake Baikal basin is to be found in the Russian part of the water catchment area, where 38 forestry services are operating (pic. 3.4.1) [3,4]

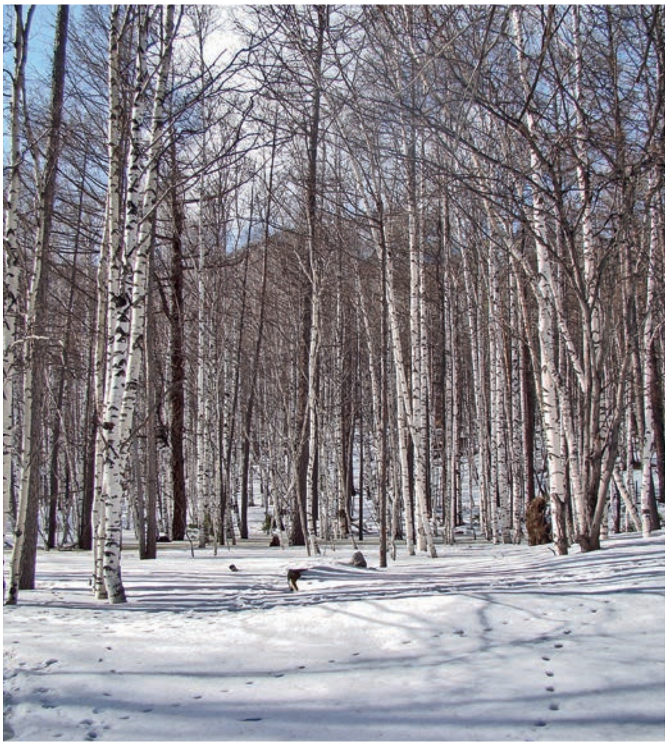
Forests are mainly represented by two groups of trees - coniferous and deciduous trees. Among the coniferous forests, pine (Pinussilvestris) and larch (Larix) are represented equally – and account for 25% of forests (pic. 3.4.2). Cedar forests are widely represented (Pinussibirica) - 17%.

Pic. 3.4.2 A coniferous forest



Pic. 3.4.1 Forest resources and their use in Baikal basin [1]

Among the deciduous forests, birch (Betula) prevails - 17% (pic. 3.4.3). Shrubs in the high-mountain zone are formed by dwarf cedars, and in the river valleys – by dwarf birch thickets as well as willow shrubs. Forests areas are covered mainly by coniferous trees (more than 70%). They include larch, pine, cedar, birch and aspen.



Pic. 3.4.3 A birch forest

Irkutsk region. The area of land, covered with forest vegetation (forest lands – forest fund, specially protected natural territories) within the confines of BNT (does not overlap with Lake Baikal basin) is 8,626 thousand ha (in 2012 – 8 ,623.0 thousand ha), of which 95% is covered by forests and 5 % by shrubs [3,4].

The rated wood cutting of mature forests within BNT in 2013 was 8597.2 thousand m^3 (in 2012 – 8,893.2 thousand m^3). During 2013, about 2,304.3 thousand m^3 of forest was cut down (in 2012 – 2,133.2 thousand m^3), which equals to 27 % of the rated wood-cutting. The area of wood cutting was 1.9 thousand ha (in 2012 – 1.8 thousand ha). Sanitary cutting was undertaken on the area of 4.5 thousand ha (in 2012 – 4.8 thousand ha).

Forest restoration within BNT was undertaken in 2013 on the area of 11.9 thousand ha (in 2012 - 7.9 thousand ha), including forest planting over the area of 1.3 thousand ha (in 2012 – 1.2 thousand ha). Young trees were transferred onto 14.7 thousand ha (in 2012 – 14.2 thousand ha) of forest fund area covered with forest vegetation.

Forests in this part of the basin are subject to fires because of the frequent draughts and strong winds. In 2013, the part of Irkutsk region within BNT had 327 registered forest fires (in 2012 – 201 fires), 5.4 thousand ha (in 2012 – 1.5 thousand ha) of land were affected by forest fires. As a way to speed up detecting and extinguishing forest fires, forest lands of the total area of 9,562.1 thousand ha were divided into the zones of fire hazard monitoring – a zone of terrestrial monitoring (717.6 thousand ha), a zone of aircraft monitoring (8,125 thousand ha), and a zone of the 2nd level space monitoring (719.5 thousand ha). The fire prevention activities were undertaken, including construction and maintenance of roads – 1,050.3 km (839.9 km in 2012); setting up and maintenance of fire-protection barriers – 2,041.5 km (1,787.5 km in 2012); conducting controlled burning – 21,878 ha (11,485 ha in 2012).

In 2013, the employees of forest services located within BNT organized 1,959 raids (2035 in 2012) to forestall illegal wood cutting and illegal trade in wood in the region, 520 of the raids were conducted jointly with police. The damage to the forest fund of Irkutsk region was estimated at 217 million rubles. Damages amounting to 9.7 million rubles were awarded by court rulings. The use of forests by the renters of forest sites is undertaken strictly in accordance with the projects of forest management based on the state environmental expertise. The renters of forest sites, who failed to elaborate their forest management project by the established procedure, are not allowed to work.

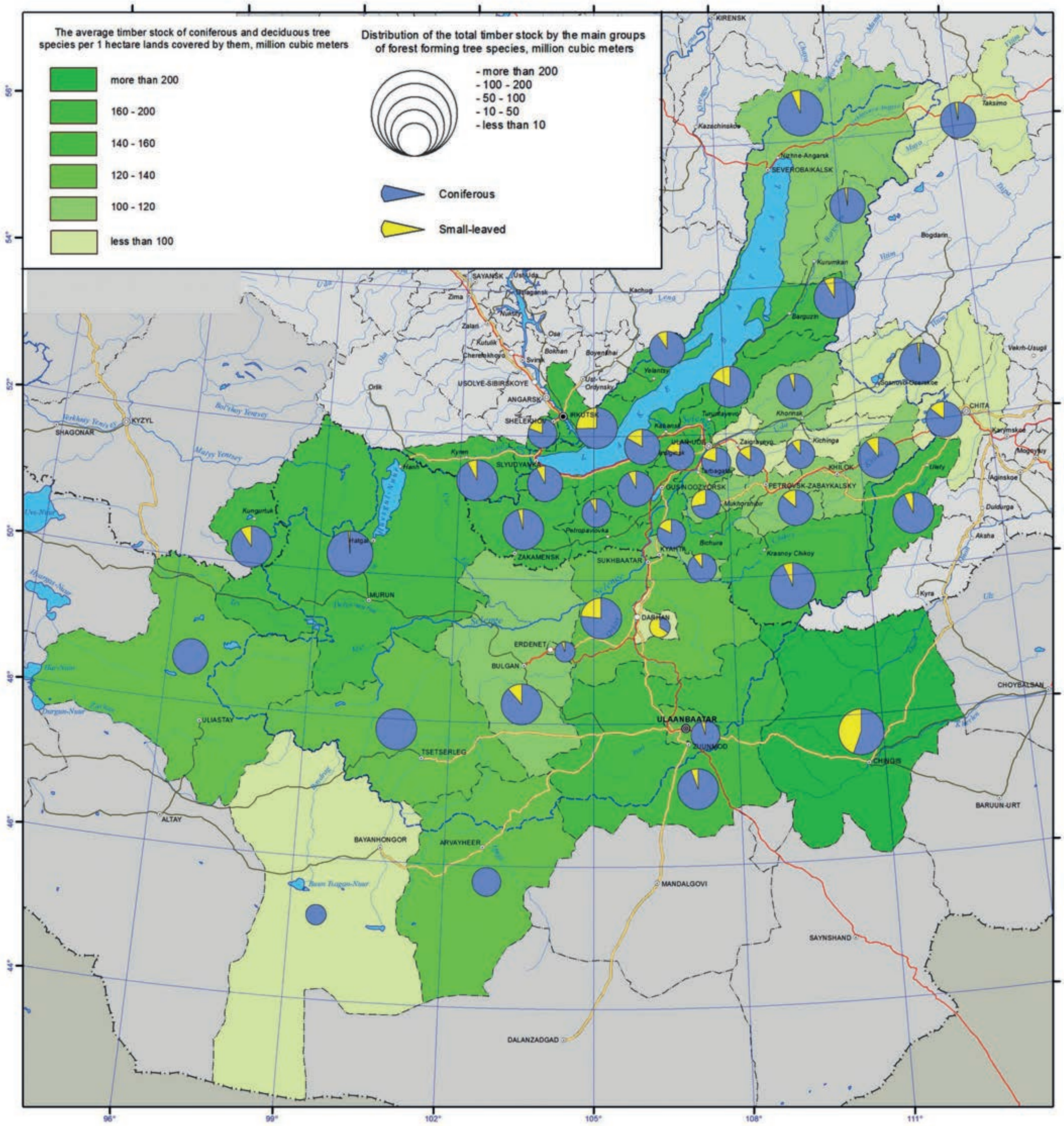
Republic of Buryatia. The area of land, covered with forest vegetation (forest lands – forest fund, specially protected natural territories) within the confines of BNT in 2012 equals to 11,891.7 thousand ha. The species of trees covering the area are represented by coniferous trees (75.4%), soft-wood trees (8.8%), hard-wood trees (0.001%) and shrubs (15.8 %) (pic. 3.4.4) [3,4].

The biggest forest areas are in Zakamensky (forest density – 86.6%), Khorinsky (81.5%), Pribaikalsky (80.8%), Zaigraevsky (74.1%) and Kizhinginsky (70.2%) districts of Buryatia. The least number of forests is in Kabansky (32.1%), Kyachtinsky (32.1%) and Mukhorshibisrky districts (41.8%) [2].

Forest management in the republic is conducted in accordance with the Forest plan of the Republic of Buryatia, approved by the resolution of the BR Government and by the regulations of the forest services. As a way to implement the resolution of the RB Government on “The investment projects in the field of forest management”, the Forest plan of the Republic of Buryatia has been equipped with sections concerning the implementation of investment projects.

The rated wood cutting area of mature forests decreased by 1% compared to 2012 and amounted to 4,794.3 (4,841.4 thouand m^3 in 2012). During 2013, 891.9 thousand m^3 of wood were cut (930.3 thousand m^3 in 2012), which is 19% of the rated wood cutting. In 2013, cutting of mature forests dropped by 4 % compared to 2012. Maintenance cutting in 2013 dropped by 29% compared to 2012 and equaled to 23,1 thousand ha. Sanitary cutting was conducted on the area of 7.0 thousand ha (8.4 ha in 2012).

In 2013, forest restoration was conducted on the area of 11.6 thousand ha (20 thousand ha in 2012), trees were planted over 2.1 thousand ha of the area (2.1 thousand ha were used for the purpose in 2012). The area of young forests transferred to the category of lands covered with forest vegetation was 18.9 thousand ha in 2013 (24.8 thousand ha in 2012) (pic. 3.4.5).



Pic. 3.4.4 Timber stock of the main groups of forest forming tree species [1]

Pic. 3.4.5 Forest restoration (Tarbagataisky district)

In 2013, the territory covered by forest services had 474 registered forest fires (641 in 2012). Compared to 2012, the number of fires decreased by 26%. The forest land area affected by fires was 20.5 thousand ha, which was 83% less than in 2012 (117.73 thousand ha) (pic. 3.4.6).

Pic. 3.4.6 Forest fire (Pribaikalskiy district)

As a way to speed up detecting and extinguishing forest fires, forest lands of the total area of 13,146 thousand ha were divided into the zones of fire hazard monitoring – a zone of terrestrial monitoring (2,388 thousand ha), a zone of aircraft monitoring (7,455 thousand ha), and a zone of the 1st level space monitoring (3,303 thousand ha). The fire-prevention activities were held, including controlled burning (260 thousand ha), setting up of mineralized strips (2,488.67 km), and maintenance of mineralized strips (4,339.72 km) (pic. 3.4.7).

Pic. 3.4.7 Mineralized strip for fire protection (Ivolginsky District)

The Agency for Forest Resources of the Republic of Buryatia has concluded inter-departmental Agreements on cooperation in combating forest fires with the State Forest Service of Irkutsk region, the chief branch of the Ministry of the Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters in the Republic of Buryatia, central base of the aviation forest air protection.

In 2012, the Federal budget allocated 73.9 million rubles of subsidies, while the Republic budget allocated 3.9 million rubles for purchasing fire-control equipment. At the same time, 37 units of fire-control equipment were put into operation.

As a way to enhance the efficiency of forest reproduction activities, the decision was made on the construction of a forest seed-selection center. The project was developed, for implementation of which the amount of 6.5 million rubles was allocated.

With the purpose of using the uncultivated forest resources, three investment zones (Northern, Eastern and Southern) with a total area of 2.8 million ha were identified. The total annual timber production within the three zones is 1.09 million m^3, including 1.04 million m^3 of coniferous trees. The forest zones for geological exploration and mining (1.225 ha), for recreational purposes (213 ha) and other purpose areas were identified.

During 2012, 3 auctions selling the right for concluding forest site lease treaties were conducted, including land leases for recreational and agricultural activities, producing food from forest resources, etc. On the basis of the auctions, 22 forest sites of a total area of 9,462.2 ha were leased out [13].

In 2012, the lease holders procured 825.6 thousand m^3 of wood, which was 39% of the allowed 2,107.3 thousand m^3. Only those lease holders, who provided their forest-management projects, received positive assessment by the state expertise and submitted forest declarations, were allowed to procure wood [3].

In 2013, the Government of the Republic of Buryatia approved and enforced guidelines regarding preparation to the fire danger season of 2013 and methods of extinguishing fires. Specialized forest fire departments received licenses for fire extinguishing activity. 157 firefighters were trained to oversee/coordinate fire extinguishing activities.

The level of forest management and successful exploitation of forest resources are to a great extent determined by the presence of transportation infrastructure in forests. The length of roads of all-year operation is 2.1 km per 1000 ha. The Forest plan of the Republic provides for the construction of forest roads with the total length of 840 km till 2017 [6].

Zabaikalsky Krai. The area of land covered with forests within Lake Baikal basin is 4,715.4 thousand ha (in 2011 – 4,715.9 thousand ha). The area of lands covered with forest vegetation increased by 0.1% in 2013.

The rated wood cutting of mature forest plantings within Baikal Natural Territory in 2013 changed slightly compared to 2012 and equaled to 2,483.9 thousand m^3 (2,484.0 thousand m^3 in 2012). In 2013, 543.0 thousand m^3 of timber was produced (628.3 thousand m^3 in 2012), which accounts for 21.9 % of rated wood cutting. The volume of maintenance cutting dropped by 16% compared to 2012 and amounted to 0.6 thousand ha. Sanitary cuttings were undertaken on the area of 2.5 thousand ha (3.4 thousand ha in 2012).

Forest restoration was carried out in 2013 on the area of 5.8 thousand ha (9.2 thousand ha in 2012). Trees were planted on the area of 0.9 thousand ha (1.1 thousand ha in 2012). Young saplings were transferred onto the area of 15 thousand ha (13.4 thousand ha in 2012) that belongs to the category of lands covered with forest vegetation.

In 2013, the territory of Zabaikalsky Krai had 187 registered fires. Compared to 2012, the number of forest fires decreased by 25% (249 fires in 2012). The area affected by forest fires reduced 6.8 times and amounted to 7.3 thousand ha.

Zabaikalsky Krai is implementing the long-term goal-oriented program "Forest protection from fires (2011-2014)" [3,4]. The program has funded the production and installation of visual aids (posters, panel pictures), shooting of video clips dedicated to the theme of fire combating, and holding the activities on state contracts. The state contract activities were the following: the instruction courses for two aircraft observers and forest fire managers (103 persons) were held, the project of forest-fire zoning was designed; 4 specialized forest-fire equipment (semitrailers) were purchased; the first stage of the forest-fire equipment project was designed; the clearing of waste along the roads was undertaken.

The Government of Zabaikalsky Krai approved the long-term goal-oriented program «Forest restoration in Zabaikalsky Krai (2012-2015)». The main activities of the program include: procurement of seeds, fitting out the nursery with the new equipment and increasing the amount of planting material. In 2012-2013, 624 kg of coniferous tree seeds were prepared. All the seeds were checked for sowing quality and were of the 1st class of quality. In 2012-2013, 3,096.5 thousand seedlings of the main forest comprising tree species were grown.

The Government of **Mongolia** has formulated its National Forest Policy and Master Plan of Forest Management (pic. 3.4.8) [9].

Pic. 3.4.8 Forest area on the river Tuul, a suburb of Ulaanbaatar

The use of saxaul for fuel is banned in areas with saxaul forests. Nationally, a total of 37,211.5 thousand ha of land was forested and reforested between 2008 and 2011, and windbreaks were established on 1,000 ha. Within the framework of Green Belt Programme, windbreaks were established on 367 ha in 2005, 461 ha in 2006, 300 ha in 2007, 426 ha in 2008, 271.4 ha in 2009, 253 ha in 2010 and 365 ha in 2011. The afforestation and reforestation measures generated permanent and temporary jobs for 6,798 people in 2011.

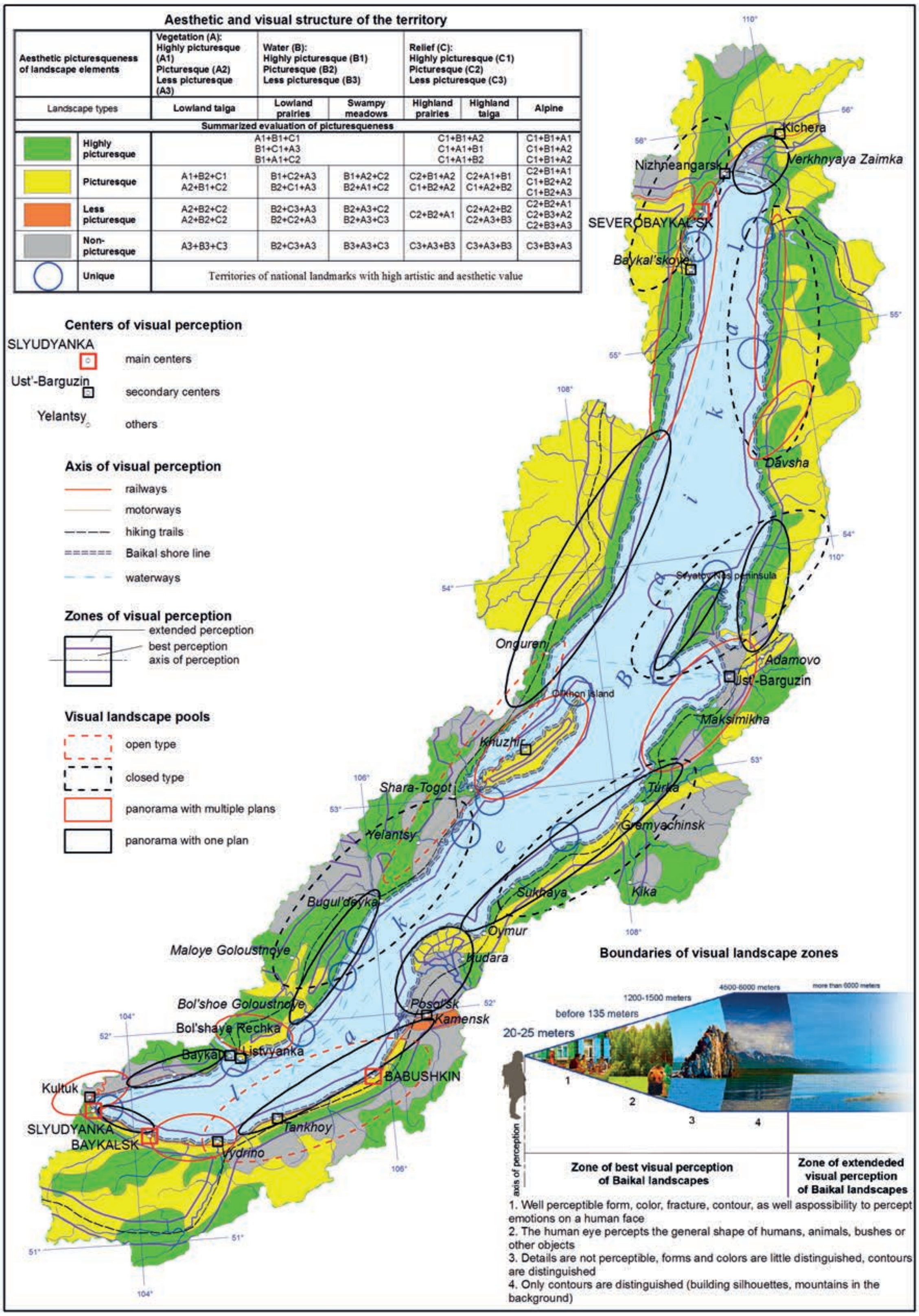
In order to ensure the quality of forestation and reforestation efforts, the guidelines on "Purchasing and Accounting of Afforested Areas" have been issued. In accordance with the regulation, 194.3 ha of afforested land, managed by citizens for more than three years, were purchased by the State and registered in the national forest fund (56 ha in 2008, 77 ha in 2009 and 61.3 ha in 2010). Hentii aimag has generated good practices in implementation of the regulation that can be replicated to other aimags.

Ministry of Environment and Green Development defined the maximum limits for timber harvest as 1,128.464 m^3 and 1,058.239 m^3 for 2013 and 2014, respectively. For the Selenga river basin area, the maximum limits were 627.542 m^3 and 601.167 m^3 for 2013 and 2014, respectively. Maintenance cuttings were conducted over 13.900 ha and 13,180 ha in 2011 and 2012, respectively.

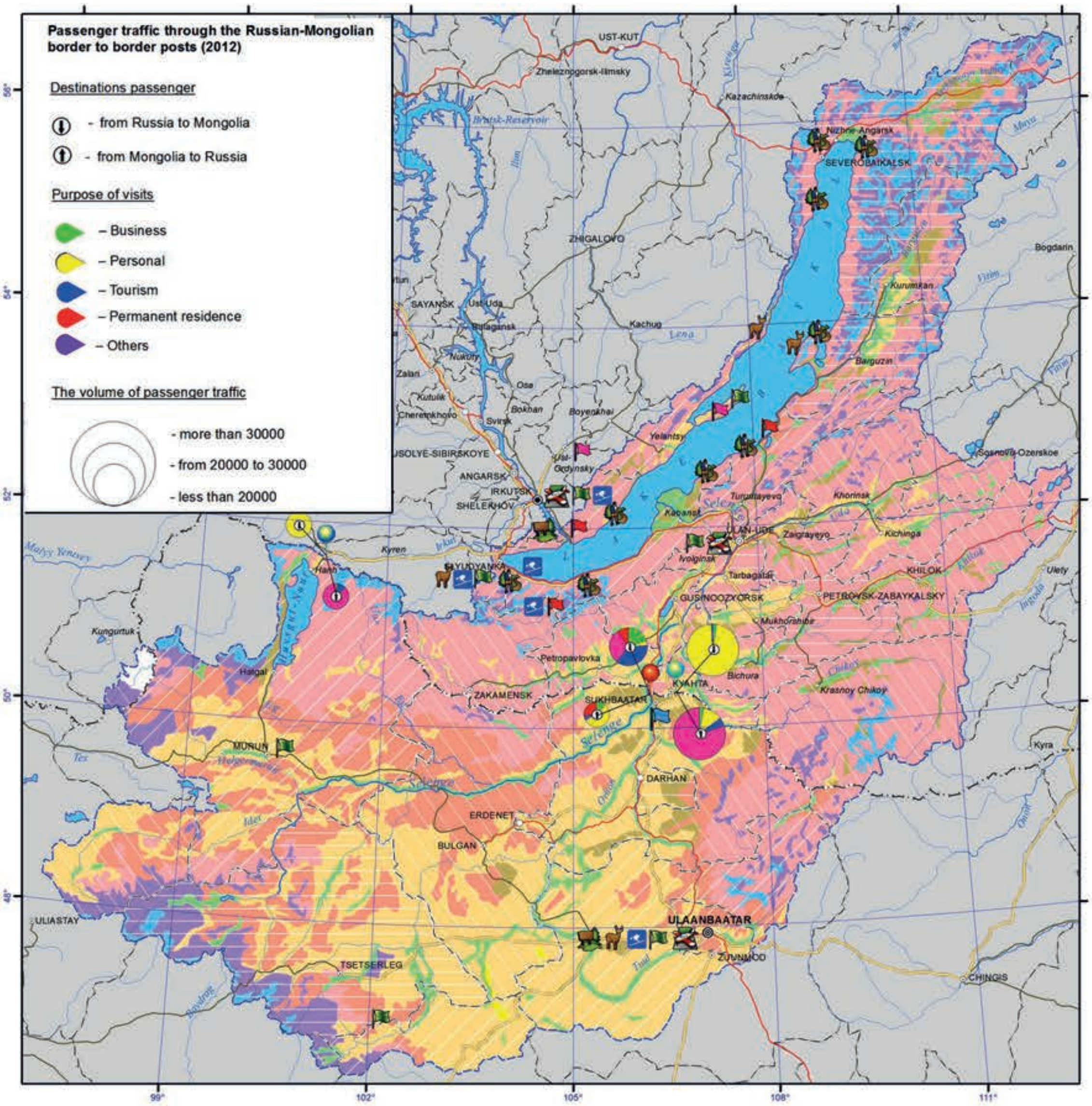
Despite the above achievements, the risks of forest degradation persist and the extent of forest depletion and degradation is still at an alarming rate urging immediate attention. Latest statistics indicate that approximately 1,395.661 ha of forest were affected by fire and 950.000 ha were damaged by insects [15].

3.5 RECREATIONAL RESOURCES

In terms of tourism development, Lake Baikal basin can be considered as an insufficiently developed territory, which nevertheless has preserved a great diversity of natural landscapes, objects of cultural and historical legacy. Lake Baikal and the adjacent territory has been a traditional destination for tourists, but the share of tourism in regional economy is still insignificant and makes up not more than 1%.



Pic. 3.5.1 Aesthetic image of the Baikal shore [1]



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 - Favorable 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 toursm, 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 psammophile biocenoses. Attractive for tourists in view of exoticism and peculiar aesthetics. - Spared regime of the use for nature-educational and ecological excursions in the presence of necessary constructions, making easier hiking on sandy ground. Alternative restricted using for some extreme kinds of tourism associated with overcoming barriers.

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

Criteria for evaluation			Entry tourist flows		
			International	National	Regional
			H	M	L
Dominating accommodation facilities and tourist services	Hotels, inns, motels and resorts with special medical care, special economic zones recreation	H	H	H	M
	Tourist centers, jurt-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)
- Kyahta - Altanbulag
  Motor road international
- Naushki - Suhe-Baatar
  Railway international

Pic. 3.5.2 Tourism in Baikal basin [1]

Recreational resources of the basin are concentrated primarily along the shore of the lake with the total length of about 2 thousand km, of which 70% are only accessible by water transport. There are also unique landscapes as well as sites suitable for setting up recreational facilities (pic. 3.5.1). The shore area has 26 mineral springs of recreational significance, 128 monuments of nature and 94 historical-cultural objects. The expansion of tourism industry in the region hinges upon infrastructural development [2].

The number of tourists, visiting Baikal, is increasing each year. In 2012, Irkutsk region and the Republic of Buryatia saw the arrival of 1,529 thousand officially registered tourists, 80.1 thousand of them were foreign tourists. In 2013, the number of tourists decreased by 3% and was 1,479 thousand, including 88.1 thousand foreign tourists (pic. 3.5.2). In 2012, the number of tourists rose in Irkutsk region by 4.4% and in the Republic of Buryatia – by 34.9%, in comparison with the previous year. In 2013, the number of tourists in Irkutsk region fell by 16%, while in the Republic of Buryatia rose by 10%. Among the foreign tourists, most of the guests are from PRC, Germany, Mongolia, Korea, France, the USA, UK, Poland and Japan. The tourist services were estimated at 10,130 million rubles in 2012 and 10,235 million rubles in 2013. The number of people engaged in the sphere of tourism was 20.5 thousand in 2012 and 21.2 thousand in 2013 [4].

The most widespread kinds of tourism in Lake Baikal region are:

- learning: routes along the Circum-Baikal Railroad, ethnographic excursions to the “Taltsy” museum, excursions to Baikal museum and other historical-cultural routes;
- ecological: routes on the ice surface of Lake Baikal, cruises and leisure trips on the lake, walking, horse and bicycle routes along the Great Baikal path, skiing tours; canoe tours, kitesurfing, kiteboarding, freeride, speleological tourism;
- hunting tourism: trophy hunting for animals and game, summer and winter ice fishing, gathering wild herbs;
- curative and recreational: sanatoria and recreation resorts with treatment, health resorts, balneological tourism;
- organized recreation: recreation camps, camping, tourist bases, recreation facilities, hotels, motels, rooms for rental. The accommodation capacity of all the recreation facilities on Lake Baikal is about 20 thousand tourists, which makes it possible to provide service to about 300 thousand visitors in the period from June to September.
- non-organized recreation, tourism is developing on the territory of SPNT.

One of the major directions of tourism on Lake Baikal is water cruises and trips, introducing the most picturesque locations on the lake (pic. 3.5.3). This is the most ecologically-friendly kinds of tourism, even though its prospects for development are restricted. In 2012-2013, there were more than 80 vessels, with the total capacity of more than 1640 people, offering a ride on the lake.

Pic. 3.5.3 A cruise ship

In 2007, the Russian Government made a decision to set up special economic zones (SEZ) of tourist type in Irkutsk region and the Republic of Buryatia with the purpose of developing tourism and recreation on Lake Baikal through establishing partnership between public and private sectors and attracting investment for the infrastructural development [3,4].

The boundaries of the zone in Irkutsk Region were defined around Bolshoe Goloustnoe with the total area of 1590 ha. In 2010, the Russian Federation Government decided on the establishment of the SEZ on the territory of Slyudyanka municipal district (mountain skiing resort «Mountain Sobolinaya» and «Mangutai»). For the implementation of the project, in 2013 the Government of Irkutsk Region developed and approved the Long-term goal-oriented program «Construction of infrastructure objects for the improvement of the special economic zone of tourist-recreation type on the municipal district of Slyudyanka» for 2012-2015.

Work at the widening of the SEZ boundaries was continued through the inclusion of the adjacent territories of Listvyanka – Port Baikal – Circum-Baikal Railroad. Tourist agencies, working on the territory of the southern shore, can use well-developed infrastructure and provide services to a stable flow of tourists.

Apart from that, there exists a real chance for enhancing economic attractiveness and efficiency of the project by means of including into the zone of the cluster with the central points of Irkutsk – Listvyanka – Port Baikal – Circum-Baikal Railroad – Baikalsk – Republic of Buryatia (Baikal ring).

The status of recreation-oriented localities was granted to five territories of the Republic of Buryatia, including «Baikal Priboi – Kultushnaya» (pic. 3.5.4) and «Lemasovo» (pic. 3.5.5) in Kabansky district, «Severo-Baikalskaya» in Severobaikalsk district, «Barguzin shore of Baikal» in Barguzinsky district and «Lake Scuchie» in Selenginsky district.

Pic. 3.5.4 The recreational terrain «Baikalskiy priboy»

Pic. 3.5.5 The recreational terrain «Lemasovo»

A similar SEZ with the name «Baikal Harbor» was set up on the territory of Pribaikalsky district as well to incorporate the sites «Turka», «Sands», «Goryachinsk», «Bezymyannaya Bay», «Mount Bychya» with the total area of 3,284 ha. All the sites are united through the single concept of development and disposition of tourist objects (pic. 3.5.6).

Pic. 3.5.6 Office of SEZ «Baikal harbor»

The development of the sites «Turka» and «Sands» is designed along the following directions: construction of hotels, congress complex, SPA-center, port with harbors, cottage village for tourists, open and closed sports facilities, restaurants etc. The construction of infrastructural objects is almost completed (pic. 3.5.7).

Pic. 3.5.7 The site «Turka»

The site «Mount Bychya» is promoted as a «year-round mountain resort». The place has favorable climatic conditions – up to 200 sunny days annually. In 2012, the project of the site design was elaborated and the list of engineering and transportation infrastructural objects was drawn up.

The site «Goryachinsk» is promoted as «curative SPA resort», which will specialize in the use of mineral, thermal waters and therapeutic mud (pic. 3.5.8). In 2012, the Supervisory Board of SPZ «Baikal Harbor» approved the development plan for the site «Goryachinsk». The plan was developed by the consulting company KPMG. The total capital expenditures of investors and the state on the realization of the plan will amount to 3.6 billion rubles (in prices of 2012). From 2013 to 2017 the recreation complex «Baikal» and scientific-cultural thematic park will be built. The period from 2017 to 2020 will the construction of the family-entertainment resort of Center Parcs type. The bases for extreme types of sport (windsurfing, ice diving), a fishing base and a camping site will be constructed as well. In accordance with the development plan, by 2020 the number of organized tourist traffic to Lake Baikal can reach 2 million people annually. Among them, the number of tourists bound for the site «Goryachinsk» will be about 50 thousand people annually.

Pic. 3.5.8 The resort «Goryachinsk»

The resort «Bezymyannaya Bay» is the most remote site in SEZ and is designed for VIP-tourists on Lake Baikal. In 2013, the Supervisory Board of SPZ considered business plans of the companies - potential residents of the SPZ. During 2008-2013, the amount of expenses on the project «Baikal Harbor» totaled 4.1 billion rubles.

Since 2012, implementation of 4 large investment projects under the federal goal-oriented program «Development of domestic and international tourism in the Russian Federation (2011-2018 years)» has commenced.

The projects are the tourist recreation cluster «Podlemorie» (Kabansky district), 3 auto-tourist clusters – «Kyachta» (Kyachtinsky district), «Baikalsky» (Ivolginsly district), and «Tunka valley» (Tunkinsky district) [6,14].

The government of **Mongolia** aims at developing tourism as one of the leading sectors of economy. «National Programme on Tourism» has been developed with the view of facilitating infrastructure development, creation of a favourable environment for investment, establishment of tourism complexes and adoption of optimal marketing policy. Seven regions of the country have been recommended for tourism development [9]:

- Ulaanbaatar – the capital of Mongolia founded in 1639. The center of Buddhism in the country has grown to reflect a mix of ancient traditions and modern lifestyle (pic. 3.5.9).
- Khuvsgul region – Mongolia's alpine area with snow-covered and crystal clear lakes. Lake Khuvsgul is one of the deepest in the world (pic. 3.5.10).
- Orkhon Valley – the site of the ancient Karakorum, or throne of the Khans. The famous Erdene Zuu Monastery, the first temple in the country, is still functioning, and has numerous monuments and historical relicts (pic. 3.5.11).
- Gobi desert – the largest and best known desert in Asia. Not a sand dessert like Sahara, it has a rich biodiversity with many fascinating plant and animal species.
- Mongolian Steppes – the vast, flat, treeless plains were the site of many ancient battles, and refuge of horse thieves. In some areas, caves lead underground into huge water-filled caverns.
- Khentii aimag – the birth place of Chingis Khan. Set amongst beautiful scenery are monuments to the emperor, as well as museums displaying his life history and achievements (pic. 3.5.12).

Pic. 3.5.9 The Ulaanbaatar - the center of Buddhism in Mongolia

Pic. 3.5.10 Highland Lake Khuvsgul

Pic. 3.5.11 Orkhon River Valley

Pic. 3.5.12 The monument of Chinggis Khan

About 70-80% of tourists visiting Mongolia stay for 10-11 days and engage in fishing, hunting, horse riding, sightseeing, go in walking and auto tours (pic. 3.5.13).

Pic. 3.5.13
A horse riding station

During the three years between 2009 and 2011, the number of foreign tourists grew by 11%, accordingly revenues increased by 32.5 percent. In 2011, 460 thousand tourists visited Mongolia generating 25 thousand jobs in the sector and 4% of GDP.

In 2013, among the tourists visiting Mongolia 42.7% were from China, 17.8% from Russia, 10.8% from South Korea, 4.4% from Japan, 3.5% of the USA, 2.7% from Kazakhstan, 2.3% from Germany, the rest were from other countries.

In recent years, a rapidly increasing number of domestic tourists undertake travel within the country. No statistical data are available for domestic tourism. Popular destinations are Bogd Khan-Uul, Terelj (pic. 3.5.14), Erdene zuu, Kharkhorun, Ulaan thutgalan, Tsenkheriin, Ugii nuur, Khuvsgul nuur, Naiman nuur, Khorgiin togoo and Terkhiin tsagaan nuur.

Pic. 3.5.14 Terelj National Park

In 2013, in Khuvsgul aimag within the Selenga river basin there were 53 tourist camps, 33 ger-hotels, 15 resorts, 5 hotels, and 18 motels, with a total capacity to accommodate 3000 tourists. In the Orkhon river basin, there are more than 40 registered tourist camps, among them 34.1% in Arkhangai aimag, 31.7% in Selenge aimag, and 26.8% on Uvurkhangai aimag. In the Tuul river basin, there are more than 70 tourist camps, with majority of them (70%) working in special protected area Gorki-Terelj. They have capacity to receive 4000 tourists.

Mongolia promotes health tourism as well. Major destinations for health tourists are locations of geothermal springs, cold mineral springs, mud lakes having medicinal properties. In Mongolia, there are about 40 geothermal springs and 50 cold mineral springs [15].

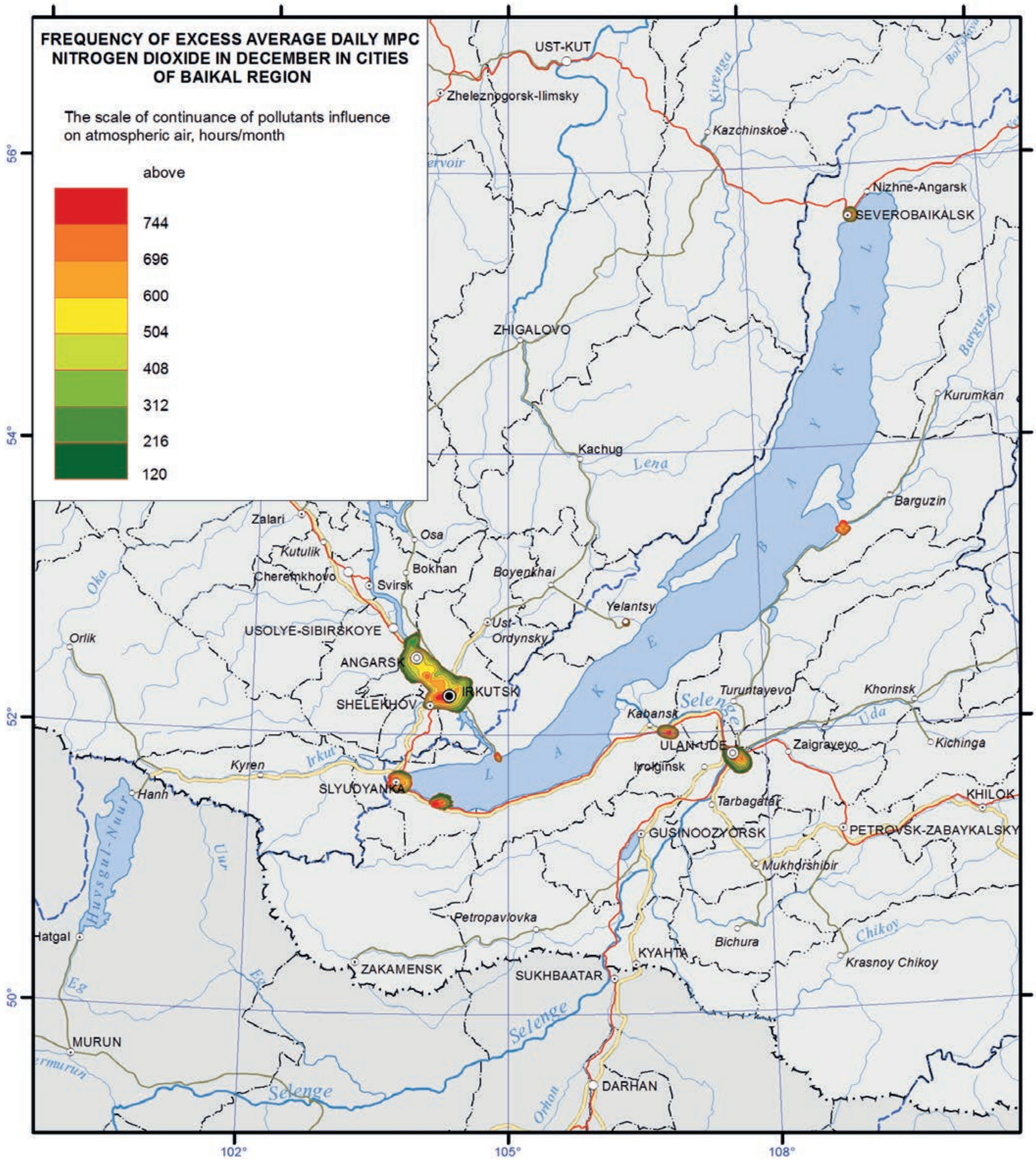
Within the Selenga river basin there are about 20 resorts, such as «Orgil», «Khujirt», «Elma-Khujirt», «Ar Janchivlan», «Ovor Janchivlan», «Galt khaluun us», etc. [16]. «Orgil» resort is located in Bogd Khan-Uul Mountains in Khan-Uul district. The mineral spring water is hydrocarbonate-calcium-potassium water of low mineralization and low acidity. The spring water is used to treat digestive tract disorders. The resourt have a capacity of accommodating 250 patients. «Khujirt» resort is located in Khujirt soum of Uvurkhangai aimag, within the Orkhon river basin. It is a mountainous location at an elevation of 1600 meters above sea level, between Shunkhlai, Gua, and Shiveet mountains of Khangai ridge. The water of the geothermal spring is rich in carbonate, sulfur, calcium and fluoride. Mud therapy is also available. The spring water and mud are used in treating skin diseases, blood pressure problems, rheumatic fever and diseases affecting the nervous system. The resort's accommodation capacity is 350-600 patients. «Khasu-Shivert» resort complex is located in Battsengel soum of Arkhangai aimag. The resort complex is built around natural hot springs, and boasts a wide range of facilities - outdoor pools, natural treatment centers, sports facilities, etc. Water of the geothermal springs is rich in sulfur. Mud from Lake «Hokhoi unadag» is used for therapeutic purposes.

BIBLIOGRAPHY

1. Ecological atlas of the Lake Baikal basin – Irkutsk: Institute of Geography SB RAS. 2014. http://bic.iwlearn.org/ru/atlas/atlas
2. Transboundary diagnostic analysis of the Lake Baikal basin. http://Baikal.iwlearn.org
3. State report "On the state of Lake Baikal and measures for its conservation in 2012" - Irkutsk. Siberian branch of "Rosgeolfond", 2013. - pp. 436. http://www.mnr.gov.ru/regulatory/list.php?part=1258 (in Russian)
4. State report "On the state of Lake Baikal and measures for its conservation in 2013" - Irkutsk. Siberian branch of "Rosgeolfond", 2014. - pp. 462. http://www.mnr.gov.ru/regulatory/list.php?part=1258 (in Russian)
5. State report "On the state of the environment and its proptection in the Republic of Buryataia in 2012". http://minpriroda-rb.ru/upload/iblock/9cb/frmoytmrq2013.pdf (in Russian)
6. State report "On the state of the environment and its proptection in the Republic of Buryataia in 2013". http://minpriroda-rb.ru/upload/iblock/26b/gocdoclad_2013.pdf (in Russian)
7. Zabaikalkraitrast http://chita.gks.ru
8. Socio-economic state of the municipal districts of Zabaikalski Krai / Zabaikalkraitrast. - Chita, 2013. – 149 pp.
9. National Statistical Office of Mongolia, «National statistics yearbook of Mongolia», 2013
10. Buryatia in figures. 2014. Statistical book / Buryatstat. Ulan-Ude, 2014.-107 pp.
11. Integrated water management plan of Mongolia, 2013.
12. Statistical Yearbook. 2013.Statistichesky collection / Buryatstat.Ulan-Ude, 2013, 514 p.
13. Report on the execution of the Law of the Republic of Buryatia "On the programme of socio-economic development of the Republic of Buryatia in 2011-2015" in 2012 www.egov_buryatia.ru/uploads/tx_npa/3477docx
14. www.baikaltravel.ru
15. MEGD, "Strengthening Integrated Water Resource Management in Mongolia" project, "Integrated Water Management Assessment Report", Volume III, UB city, 2012
16. "National programme for Spa Resort development", Appendix №1 of the Mongolian Government Resolution № 251, http://www.legalinfo.mn/annex/showPrint/1416

NATURAL AND ANTHROPOGENIC CHANGES IN THE ENVIRONMENT

4.1 AIR POLLUTION



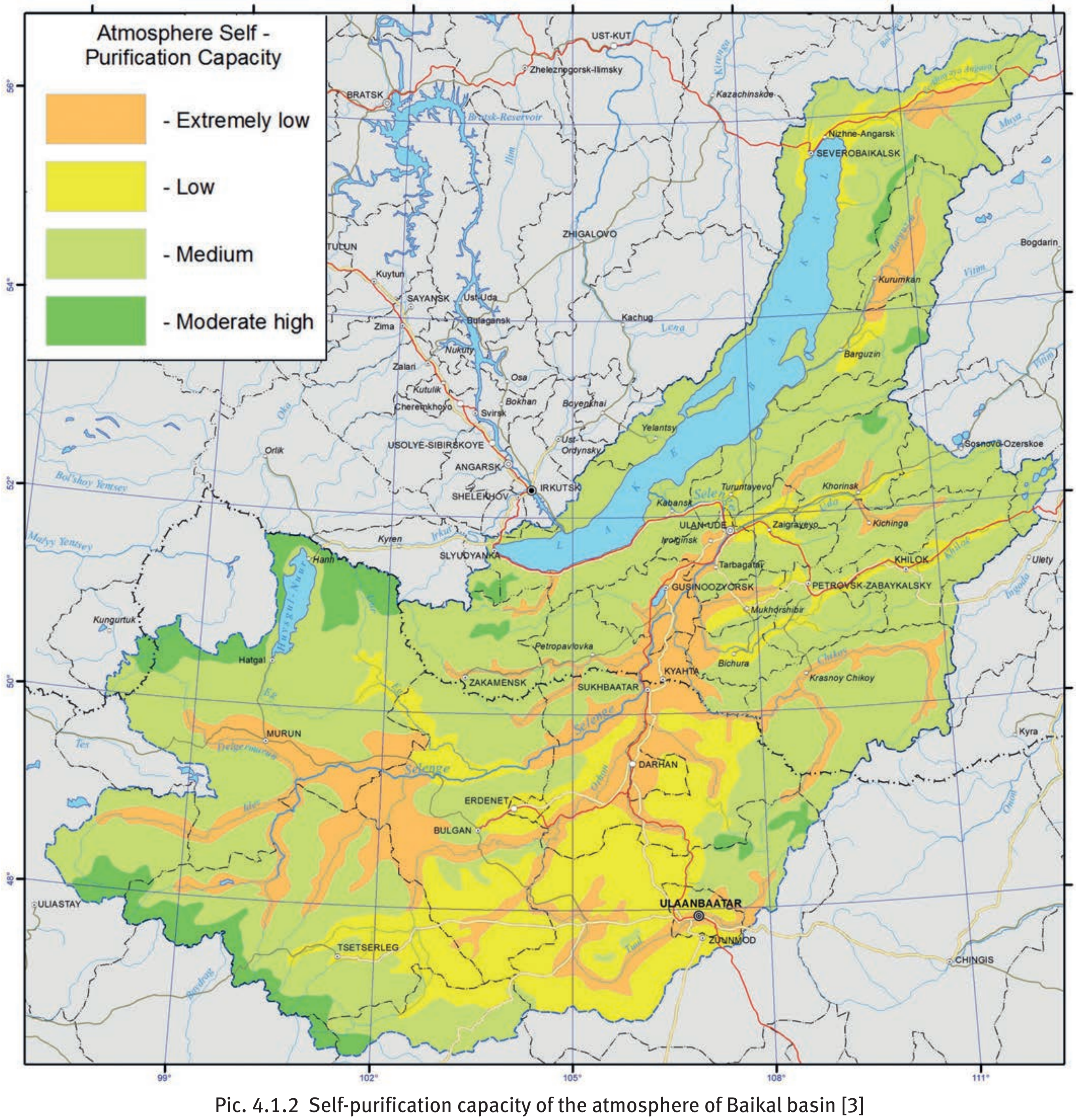
Pic. 4.1.1 Atmospheric air condition [3]

The status of atmospheric air pollution over the Russian part of the Lake Baikal basin is defined by the regional transboundary transfer and redistribution of pollutants, as well as the impact of anthropogenic emission sources [1,2]. Industries and transport of Irkutsk-Cheremhovo industrial hub have the main impact on the air quality within the Irkutsk part of the Lake Baikal basin (pic. 4.1.1).

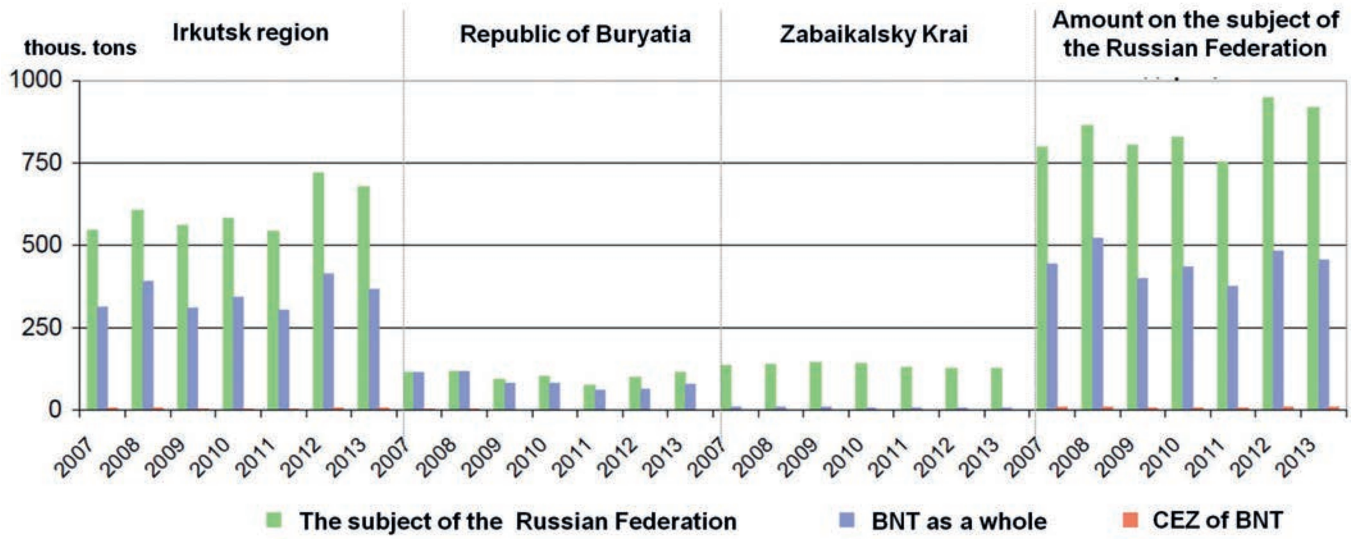
Climatic and geographical features of the region, i.e. its continental location, frequent anti-cyclones in winter, low temperatures and low precipitation during winter, significantly reduce the ability of the atmosphere to clean itself.

The indicators characterizing the speed of dispersal of impurities over the basin area are 2-3 times lower than the same indicators, for example, for European Russia. Frequent recurrences of adverse situations characterize the cold half of the year, when strong temperature inversions combined with weak winds contribute to high levels of pollution in cities and industrial centers. The conditions also lead to the reduced intensity of regional air transfer processes (over distances greater than 80-100 km), which, in turn, reduces the area affected by the emission sources.

The assessment of levels and trends of atmospheric air pollution is made on the basis of regular observations by the Federal Agencies «Irkutsk Center for Hydrometeorology and Environmental Monitoring» («Irkutsk CHEM») and «Buryat Center for Hydrometeorology and Environmental Monitoring» («Buryat CHEM»). Among

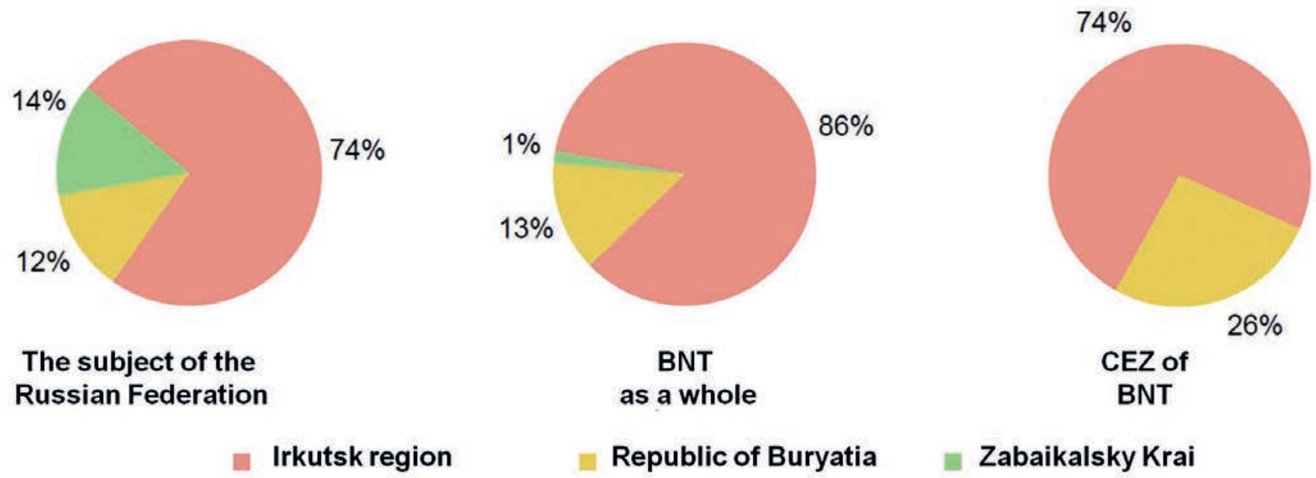


Pic. 4.1.2 Self-purification capacity of the atmosphere of Baikal basin [3]



Pic. 4.1.3 Dynamics of pollutant emissions into the atmosphere by the subjects of the Russian Federation for 2007-2013

the parameters defining the magnitude of air pollution are the concentrations of particulate matter, benzopyrene, carbon monoxide, nitrogen oxides, sulfur dioxide and formaldehyde, as well as specific pollutants - hydrogen sulfide, methyl mercaptan, hydrogen fluoride and chlorine (pic. 4.1.3 and 4.1.4).

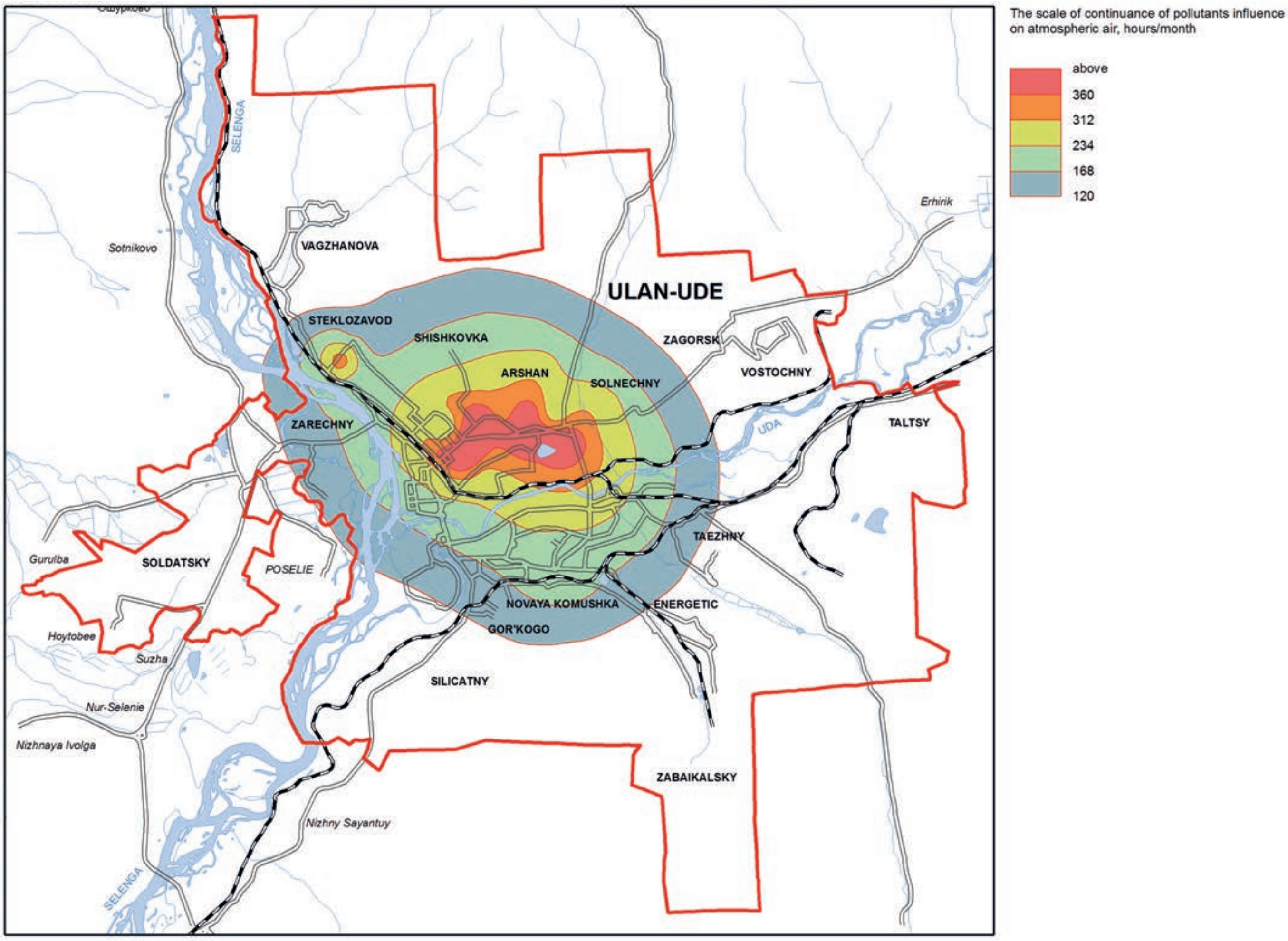


Pic. 4.1.4 Emissions of air pollutants on the subjects of the Russian Federation in 2013

In 2013, the atmospheric air quality within Lake Baikal Natural Territory did not change significantly compared with 2012 [2]. The air pollution level in the settlements within the Central Ecological Zone of the Lake Baikal Natural Territory – Baikalskoe, Slyudyanka, Kultuk, and Listvyanka – remained low. Within the Buffer Ecological Zone of the Territory, the air pollution levels in Ulan-Ude city and the village of Selenginsk were defined to be «very high» (in 2012, the level was as «very high» in the village of Selenginsk and «high» in Ulan-Ude city).

Within the Irkutsk part of the basin, the air pollution monitoring is routinely conducted in four settlements – Baikalsk, Slyudyanka, Kultuk and Listvyanka. The level of air pollution in Baikalsk was characterized as low (API = 1) in 2012, similarly to the previous year. The average annual level of benzopyrene exceeded its Maximum Permissible Concentration (MPC) by 1.6 times (in 2011, the threshold was exceeded 1.6-fold). The highest average monthly concentration of benzopyrene reached 3.0 MPC (in 2010, the level also reached 3.0 MPC). The maximum one-time concentration of hydrogen sulfide reached 1.3 MPC (in 2011 the level was 1.1 MPC), while the maximum one-time concentration of carbon disulfide was 3.0 MPC (in 2011 the level was 3.0 MPC). The maximum one-time concentration of methyl mercaptan did not exceed the MPC. Thus, the air pollution in Baikalsk increased moderately in 2012.

The level of air pollution in the settlements Sludyanka, Listvyanka and Kultuk was found to be low, similar to the previous years. The average annual concentrations of particulate matter exceeded the sanitary threshold in Sludyanka (by 1.2 times) and Kultuk (by 1.3 times), while the average annual concentration of nitrogen dioxide in Listvyanka exceeded the threshold by 1.2 times. The maximum one-time concentrations of particulate matter in



Pic. 4.1.5 Frequency of daily MPC exceedances for nitrogen dioxide in Ulan-Ude in December [3]

Kultuk and Slyudyanka exceeded the MPC by 2.8 and 3.4 times, respectively. The maximum one-time concentration of nitrogen dioxide in Listvyanka exceeded the MPC by 3.8 times. The maximum one-time concentrations of carbon monoxide, sulfur dioxide and heavy metals within the Central Economic Zone (CEZ) did not exceed the MPCs in 2011. In Listvyanka, the maximum one-time concentrations of nitrogen dioxide increased between 2011 and 2012 when they were equal to 1.3 MPC and 3.8 MPC, respectively.

In the Republic of Buryatia, in the north-eastern part of the basin, surveillance of air pollution is carried out in four settlements (Ulan-Ude, Gusinoozersk, Kyahta, and Selenginsk), where 7 fixed stations of the air pollution monitoring network are located. The observation results show that the level of air pollution is characterized as «very high» in Selenginsk, «high» in Ulan-Ude city (pic. 4.1.5) and «low» in the towns of Kyahta and Gusinoozersk. Average annual concentrations of particulate matter in Ulan-Ude, Gusinoosersk and Kyahta were higher than the MPC. In the village of Selenginsk, the levels of benzopyrene, formaldehyde and phenol exceeded the MPC, while in Ulan-Ude city the exceedances were observed for benzopyrene, nitrogen dioxide, and formaldehyde. The concentrations of sulfur dioxide, carbon monoxide, nitrogen oxide remained below the MPC everywhere. In all the settlements, the maximum concentrations of three or more pollutants exceeded the MPC.

In the village of Selenginsk, the average annual concentration of benzopyrene was equal to 4 MPC and the maximum one-time concentration was equal to 10.4 MPC. In Ulan-Ude, the same parameters were equal to 2.8 MPC and 8.2 MPC, respectively. The high level of air pollution is due to emissions from industries, thermal power stations, emissions from motor vehicles, as well as natural dust. Climatic and topographic conditions of the two locations are very unfavorable for dispersion of pollutants and facilitate their accumulation in the lower layers of atmosphere.

Over the five-year period between 2008 and 2012, concentrations of the following pollutants increased: benzopyrene, formaldehyde and particulate matter in Selenginsk; suspended solids, nitrogen dioxide and carbon monoxide in Kyahta; particulate matter and nitrogen dioxide in Gusinoozersk.

According to the annual State Reports «On the State and the Environment of the Russian Federation», until 2010, Ulan-Ude city had been included in the so-called Priority List of the Russian cities with the highest level of air pollution. Since 2010, Ulan-Ude is not in the list. The main sources of air pollution in Ulan-Ude are the industries, such as the thermal and electric power generating enterprise «Generation Buryatia» of JSC «TGC-14» with its two central heating plants CHP-1 and CHP-2 (pic. 4.1.6); Ulan-Ude locomotive and carriage repair plant - branch of «Zheldorremmash», and JSC «Ulan-Ude Aviation Plant», as well as rail and road transport.

Pic. 4.1.6 Air pollution from CHP-1in Ulan-Ude city

In Selenginsk, the high level of air pollution is mainly due to emissions from JSC «Selenginsk Pulp and Paper Mill» (SPPM) (pic. 4.1.7) and rail transport. The main air polluters in the town of Gusinoozersk are JSC «Gusinoozersk Electric and Thermal Power Station», heating plants, rail and road transport. The main sources of air pollution in the town of Kyahta are a cantonment with its own infrastructure, heating plants, and road transport.

Pic. 4.1.7. Infrastructure of Selenginsk Pulp and Paper Mill

In Zabaikalskiy Kray, monitoring of air pollution is carried out in the town of Petrovsk-Zabaikalskiy. In 2012, the air pollution level was characterized as high. Benzopyrene concentrations were notably high with the annual average concentration exceeding the MPC by 3.3 times and the maximum of the monthly averages exceeding the MPC by 6.2 times. The levels of other monitored pollutants were not so high. The maximum one-time concentrations of carbon monoxide and particulate matter exceeded their MPCs by 2.8 and 2.2 times, respectively.

Thus, in 2012, the air quality in large settlements of the Russian part of the Lake Baikal basin did not change significantly when compared with 2011.

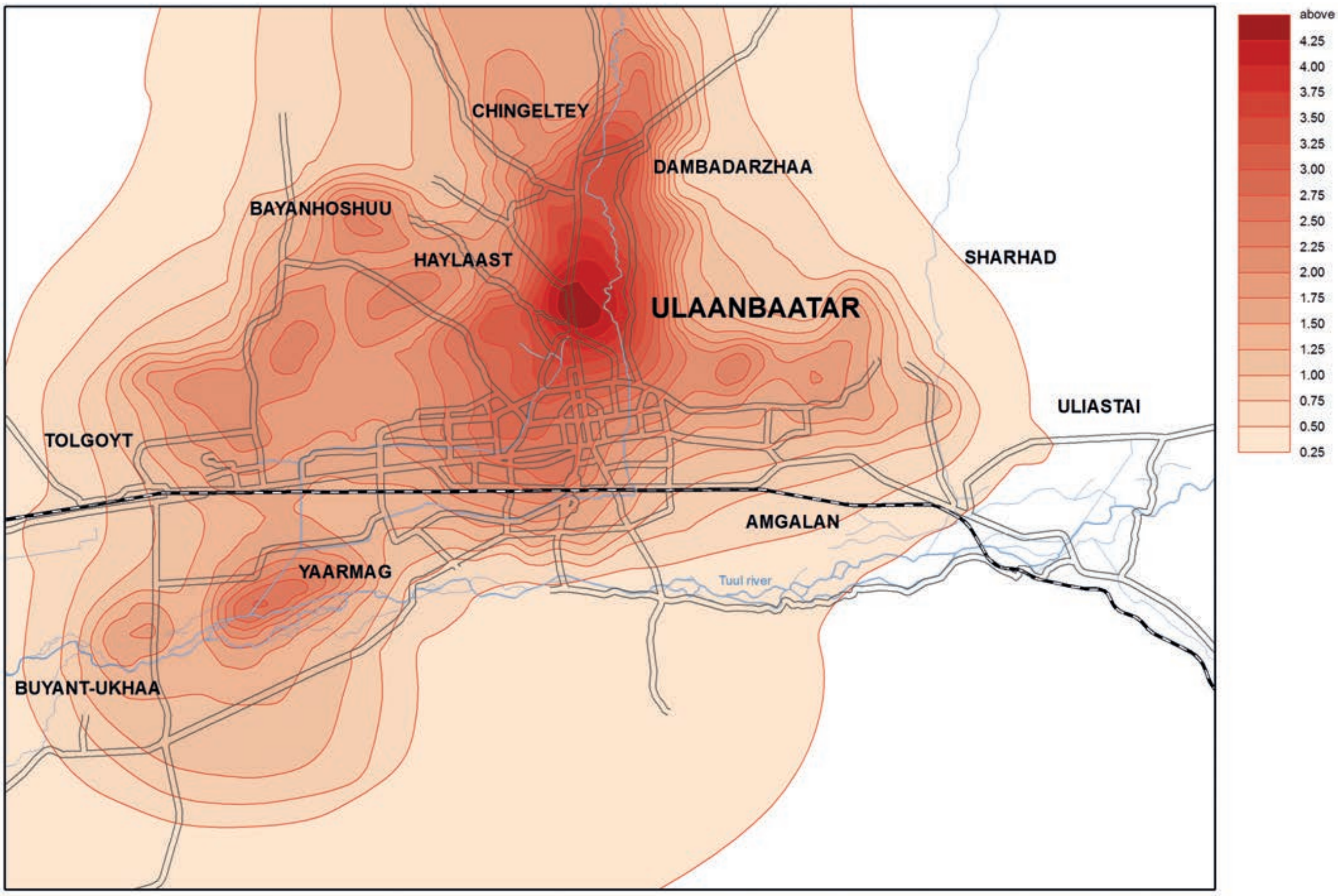
Since 2011, the national air monitoring network of **Mongolia** consists of 36 monitoring posts located in Ulaanbaatar city and aimag centers (table 4.1.1) [2].

Table 4.1.1 Pollutants monitored at monitoring posts of the national air quality monitoring network.

№	Pollutants	Monitoring posts where the pollutant is monitored
1	Sulfur dioxide (SO_2)	All posts of the air monitoring network
2	Nitrogen dioxide (NO_2)	All posts of the air monitoring network
3	Particulate matter (PM_{10})	UB-2, UB-4, UB-5, UB-7, UB-8, Murun, Darkhan, Khovd, Ulgii, Bayankhongor, Sukhbaatar
4	Fine particulate matter ($PM_{2.5}$)	UB-2, Arvaikheer, Erdenet
5	Carbon monoxide (CO)	UB-2, UB-4, UB-5, UB-7, UB-8, Sukhbaatar, Murun, Erdenet, Arvaikheer, Darkhan, Ulaangom, Khovd
6	Ozone (O_3)	UB-4, UB-5, UB-8 posts
7	Mercury (Hg)	Central environmental laboratory, Arvaikheer, Tsetserleg, Bayankhongor, Murun, Sukhbaatar
8	Heavy metals (Pb, Cu, Co, etc.)	Central environmental laboratory

In Mongolia, 65.4% of the country's population lives within the Selenga river basin. There is notable air pollution in the big settlements within the basin - Ulaanbaatar, Darkhan, Erdenet, Buren, Tsetserleg, Bulgan, and Sukhbaatar. The air pollution in Ulaanbaatar city is particularly significant (pic. 4.1.8).

The main sources of pollution are about 180 thousand gers in the city that use wood and coal for cooking and heating (pic. 4.1.9). The transport is the fasted growing sector contributing to the air pollution – in 2013, there were 257 498 vehicles registered in Ulaanbaatar city, more than 70% of which were 10 or more years old. Other large



Pic. 4.1.8 Dust pollution in Ulaanbaatar city [3]

Pic. 4.1.9 Gers in Khoroolol of Ulaanbaatar city

sources of pollution are coal-fueled power plants, heating stations, brick kiln operations, and dust emissions from unpaved roads, open soil surfaces and construction works.

National Agency for Meteorology, Hydrology and Environmental Monitoring is responsible for air pollution monitoring in Mongolia. Its tasks include identification of the problems, collection of all data/information from the air quality monitoring network, and creation of an integrated database for analysis and information sharing.

The most typical urban pollutants include suspended particulate matter (SPM), sulfur dioxide (SO_2) (table 4.1.2), volatile organic compounds, lead (Pb), carbon monoxide (CO), carbon dioxide (CO_2) and nitrogen oxides (NOx). Among these pollutants, particulate matter (PM) represents the greatest threat to human health.

The air pollution in the city of Ulaanbaatar is particularly severe in winter, when coal and wood are burned for heating. The topography of the city further exacerbates the problem. Ulaanbaatar is situated in a valley, surrounded by mountains (Bogd Khan mountain in the south, Songinokhairkhan mountain in the west, Chingeltei mountain in the north, and Bayanzurkh mountain in the east), which limits the dispersion of pollutants. In addition, frequent temperature inversions occur whereby cold air near the ground is trapped by warmer air above, sometimes for several days, keeping the pollution trapped [2].

The city's annual average level of fine particulate matter ($PM_{2.5}$ – particles with an aerodynamic diameter of less than 2.5 μm) is the highest in the world [4]. Average levels of $PM_{2.5}$ in Ulaanbaatar regularly exceed 300 $\mu g/m^3$ during winter. The corresponding levels of respirable suspended particles (PM_{10} – particles with an aerodynamic diameter of less than 10 μm) are second highest among 1099 cities from 91 countries. Fine particulate matter can penetrate deep into the lungs and has been shown to contribute to adverse health outcomes, particularly conditions related to the cardiovascular and respiratory systems.

Table 4.1.2 Average annual levels of sulfur dioxide and nitrogen dioxide within the Selenga river basin in 2013

№	City/aimag center	Pollutant level, mg/m^3	
		Sulfur dioxide, SO_2	Nitrogen dioxide, NO_2
1	Tsetserleg	0.010	0.021
2	Bulgan	0.005	0.015
3	Darkhan	0.008	0.030
4	Erdenet	0.008	0.058
5	Arvaikheer	0.013	0.027
6	Sukhbaatar	0.005	0.016
7	Zuun mod	0.004	0.011
8	Murun	0.008	0.050
9	Ulaanbaatar	0.019	0.069
MNS 4585:2007*		**0.010**	**0.030**

** National standard of Mongolia*

A legal environment has been formed to establish a separate fund for protecting atmosphere. The «Clean Air Fund» became operational since January 1, 2011, after the endorsement of Law on Air by State Great Khural in 2010. Measures for improving air quality in Ulaanbaatar are being taken, such as provision of improved fuel and fuel-saving stoves to the households with individual stoves, establishment of green zones along the valleys of the rivers Tuul, Selbe and Uliastai, expansion of small parks in the city center, promoting use of gas for heating and cooking in *ger* districts, reduction of pollution from vehicles, and raising the public awareness on importance of reducing air pollution.

4.2 WATER POLLUTION

Within the Russian part of the Lake Baikal basin, surface water pollution is monitored at 41 established monitoring stations in 34 locations covering 24 rivers and one lake. The hydrochemical monitoring network covers the major tributaries of Lake Baikal, i.e. the rivers Selenga, Upper Angara, Barguzin and Turka, and the smaller rivers Tyya, Maksimikha, Kika, Davsha and Bolshaya Rechka (4.2.1).

In 2013, concentrations of the following pollutants in Lake Baikal water occasionally exceeded water quality standards:

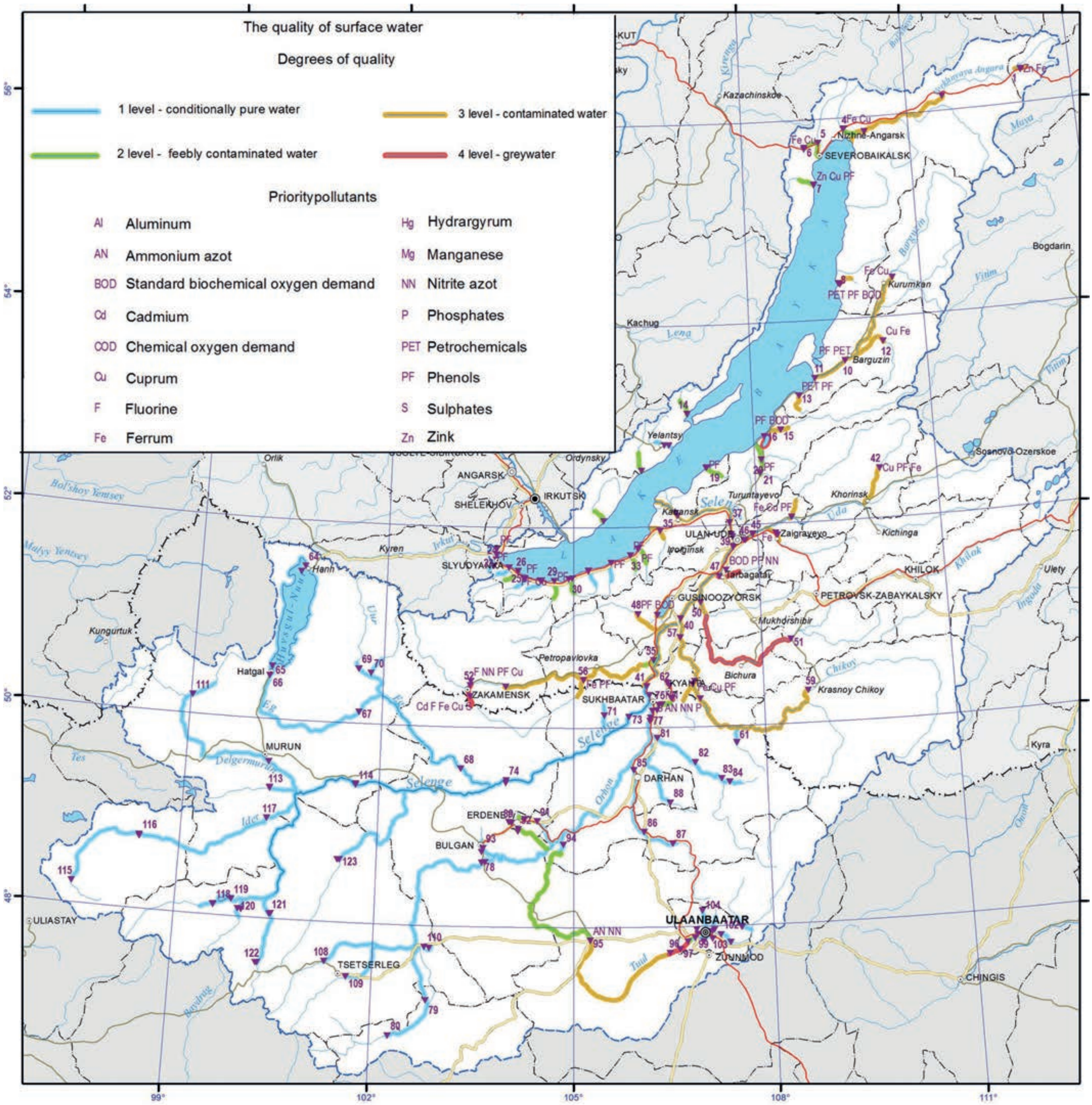
- chloride ions (up to 1.2 MPC in March and August);
- suspended matter (up to 1.1 MPC in January);
- volatile phenols (2-3 MPC continuously during the period from January to September).

In 2013, pollution by non-sulfate sulfur in Lake Baikal water declined significantly compared with 2012 – the maximum concentration was 0.23 mg/l (observed in January), while the maximum concentration in 2012 was 0.53 mg/l (observed in February). As compared with 2012, the pollutant concentrations were lower and the number of MPC exceedances was less during 2013. Volatile phenols were an exception with 5 times more MPC exceedances in 2013 than in 2012. In 2013, thus the quality of Lake Baikal water was found to have improved compared with 2012.

In 2013, the input of easily oxidizable substances and oxidation-resistant substances into the lake decreased compared with 2012, concurrently with decreases in water levels on large rivers. The input of volatile phenols, synthetic surfactants and copper into the lake decreased significantly. The input of dissolved mineral substances, suspended matter and petrochemicals increased by 12 %, 24 % and 31%, respectively [1].

An expedition of Limnological Institute SB RAS to the northern part of Lake Baikal in 2013 discovered an excessive proliferation of filamentous macroalgae of the genus *Spirogyra* unusual to Lake Baikal [5]. Waves hitting the shores threw out black-green mass of dead algae, which formed long foul-smelling heaps stretching for hundreds of meters (pic. 4.2.2).

Pic. 4.2.2 Filamentous macroalgae of the genus *Spirogyra* deposited on the shore of northern Lake Baikal (photo by V. Korotkoruchko)



Pic. 4.2.1 The quality in surface water of Baikal basin [3]

An expedition conducted in September 2014 discovered water blooming along the entire perimeter of Lake Baikal. At some places, the weight of the decaying algae deposited on the shore reached 100 kg/m^2. The large algae clusters were accompanied by «cemeteries» of thousands of gastropod shells (pic. 4.2.3). Incidents of epidemics and mass mortality of Baikal sponges – unique water-filtering organisms – have been recorded previously.

Pic. 4.2.3 Dead gastropods on the shore of northern Lake Baikal. (photo by V. Korotkoruchko)

This phenomenon was observed throughout Lake Baikal. It was found that the sponges were infected by cyanobacteria of the genus *Formidium* that infects weak organisms.

Scientists established that the reason for the algae proliferation was the long-term discharge of untreated or inadequately treated sewage rich in nitrogen and phosphorus into the lake. The sources of sewage discharge are the sewage treatment facilities of the coastal settlements, many of which were built during the Soviet times. Furthermore, in many of the locations where tourism-related infrastructure has been or is being built, sewage treatment facilities are non-existent. Other sources of sewage are the numerous ships cruising Lake Baikal [5].

The results of water quality monitoring in 2013 are described below.

Rivers of the Baikal-Amur Mainline Area. In 2012, water in the rivers was slightly alkaline with pH ranging between 7.52 and 7.79. Dissolved oxygen content in the rivers was satisfactory during all phases of the hydrological regime. The minimum recorded oxygen saturation was 75%. During the year, water in the rivers had a low salinity in winter and very a low salinity in summer, satisfactory oxygen content, and slightly alkaline pH. The rivers Tyya and Upper Angara showed the highest salinity with the amount of ions ranging from 42.7 to 142 mg/dm^3 depending on the season, while the Goudzhekit river had the lowest salinity (10.2-24.6 mg/dm^3). Organochlorine pesticides were not detected. Synthetic surfactants and petrochemicals were detected at concentrations not exceeding the MPCs. Nutrient content was low. MPC exceedances were recorded for copper, zinc, iron, and phenols. No cases of high pollution or extremely high pollution were recorded. Discharges of wastewater into the rivers Tyya and Upper Angara were taking place in the towns of Severobaikalsk and Uoyan, respectively [1].

Compared with the preceding five-year period, in 2012-2013 an unfavorable trend of increasing concentrations of mineral nitrogen, phosphate phosphors and total phosphorus was noted for the Tyya river (a small tributary of the lake) at a monitoring station 1 km downstream of the town of Severobaikalsk. In 2013, the input of total phosphorus increased to 0.05 thousand tons, while before the average annual input was 0.022 thousand tons. The input of mineral nitrogen increased to 0.26 thousand tons (the average annual input was 0.12 thousand tons). The estimates provide evidence of the increased load of mineral nitrogen, phosphate and total phosphorus into the ecosystem of the Tyya river downstream of the town of Severobaikalsk in 2013 [1].

Monitoring of the Upper Angara River covered its stretch between the settlements Uoyan and Upper Zaimka. Salinity of the river water varied during the year from 45.9 mg/dm^3 to 125.0 mg/dm^3. The maximum salinity was recorded near Upper Zaimka. MPC exceedances were observed for 5 monitored pollutants. Based on frequency of MPC exceedances, the river pollution by total iron, copper and zinc was defined as «characteristic», while pollution by oxidation-resistant organic substances and phenols was defined as «unstable». The highest concentrations of several pollutants were recorded near Upper Zaimka, i.e. total iron concentration reached 4.6 MPC (May 23), copper concentration reached 6.0 MPC (Oct. 26), zinc concentration reached 1.6 MPC (Oct. 26), and concentration of oxidation-resistant organic substances reached 1.2 MPC (May 23).

Water quality monitoring of the **Barguzine River** was done at three monitoring sites, covering the section of the river between village of Mogoyto (background site) and the river mouth in the village of Ust-Barguzin. Water in the river had satisfactory oxygen content throughout the monitoring period. pH values varied from neutral to slightly alkaline. Salinity of water varied from low to medium during different phases of hydrological regime. Overall, MPC exceedances were recorded for total iron, copper, zinc, oxidation-resistant organic substances, phenols, and petrochemicals in 100%, 90.0%, 59.1%, 36.4%, 18.2%, and 13.6% of samples, respectively. Based on integrated pollution indicators, pollution by total iron, copper and zinc was defined as «characteristic», pollution by oxidation-resistant organic substances was defined as «persistent», and pollution by phenols and petrochemicals was defined as «unstable». The maximum concentrations of total iron (10.5 MPC) and copper (4.6 MPC) were registered in Mogoyto on May 31st, during the period of spring flooding., maximum In samples taken at the monitoring site in Barguzin, the maximum concentrations exceeding MPCs were recorded for petrochemicals (1.4 MPC on Sep. 14) and oxidation-resistant organic substances (2.3 MPC on May 28). Near the village of Ust-Barguzin the maximum concentration of phenols (3 MPC) was recorded on June 30. Wastewater was not discharged into the river in any of the locations [1].

The rivers Turka, Maksimikha and Kika are tributaries of Lake Baikal. Throughout the monitoring period, the rivers had satisfactory oxygen content and low salinity levels. During the year, pH varied from neutral to slightly alkaline. Among the rivers, Maksimikha had the highest salinity (pic. 4.2.4). For the river, MPC exceedances were observed for 5 out of 13 monitored pollutants. Based on integrated pollution indicators, the pollution by total iron, copper, zinc and oxidation-resistant organic substances was defined as «characteristic», while pollution by phenols as «unstable». High concentrations exceeding MPCs were recorded for zinc (1.5 MPC on Oct. 29), total iron (8.1 MPC on Jul. 30), phenols (2 MPC on May 29), copper (6.7 MPC on Oct. 29), and oxidation-resistant organic substances (3 MPC on May 29).

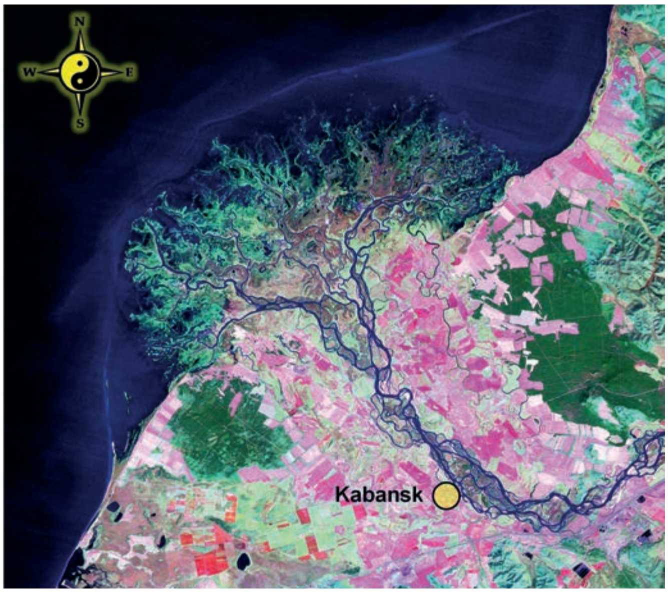
Pic. 4.2.4 Estuary of the Maksimikha River

For the Turka River, PMC exceedances were recorded for 6 (for 7 in 2011) monitored pollutants (pic. 4.2.5). Concentrations exceeding MPCs were recorded for total iron, copper, phenols, zinc and oxidation-resistant organic substances in 100%, 66.7%, 44.4%, 33.3%, and 11% of the samples, respectively. The maximum concentrations recorded were 1.4 MPC for easily oxidizable organic matter (Apr. 24), 2.1 MPC for oxidation-resistant organic substances (Apr. 24), 5.7 MPC for total iron (Jun. 6), 7.0 MPC for copper (Jun. 6), 1.4 MPC for zinc (Dec. 19) and 3 MPC for phenols (Jul. 10).

Pic. 4.2.5 Estuary of the Turka River

In water samples from the Kika River, total iron, copper, phenols, easily oxidizable organic substances and oxidation-resistant organic substances were detected in concentrations exceeding the MPCs. Exceedances of MPCs were recorded for 5 out of 13 monitored pollutants. The maximum concentrations recorded were the following: 1.4 MPC for oxidation-resistant organic substances (May 15), 2.5 MPC for total iron (May 15), 3.8 MPC for copper (May 15), 1.1 MPC for easily oxidizable organic substances (Oct. 3), and 2 MPC for phenols (Mar. 26, May 15, Jul. 10) [1].

The Selenga River. Monitoring of water quality of the Selenga River, the main tributary of Lake Baikal, was conducted at 9 monitoring stations located between the village of Naushki, which is on the border with Mongolia, and the village of Murzino in the river delta (pic. 4.2.6). Throughout the monitoring period, the river water had satisfactory oxygen regime. Oxygen saturation varied in the range of 45-106%. The minimum oxygen saturation was noted at Kabansk monitoring station (0.5 km downstream of the village of Kabansk). Water pH varied from neutral to alkaline during the year.



Pic. 4.2.6 Delta of the Selenga river (Landsat)

At the Naushki monitoring station, MPC exceedances were recorded for 9 out of 17 monitored pollutants. In addition, fluorides, aluminum, manganese and nickel were also detected. MPC exceedances were observed for manganese in 100% of the collected samples, while levels of copper, total iron, and zinc exceeded the PMCs in 77.8%, 71.4% and of 55.6% of the samples, respectively. For these pollutants, water pollution was defined as «characteristic». Contamination by oxidation-resistant substances was defined as “stable”, while contamination by nickel, aluminum, phenols and petrochemicals as “unstable”. The maximum concentrations recorded were the following: 21.38 MPC for total iron (Jul. 24), 4.0 MPC for copper (Sep. 23), 1.3 MPC for zinc (Dec. 4), 1.5 MPC for nickel (May 17), 9.1 MPC for manganese (Dec. 4), 1.7 MPC for oxidation-resistant organic substances (Aug. 20), 2.0 MPC for phenols (Sep. 23), 1.2 MPC for petrochemicals (Feb. 20, Jun. 20). Compared with the last year, there was an increase in maximum concentrations of total iron, zinc and nickel. Concentrations of oxidation-resistant organic substances, copper, aluminum, manganese, and petrochemicals have reduced.

At a monitoring station near the village of Novoselenginsk, MPC exceedances were observed for 6 (7 in 2011) pollutants out of 13 monitored. Based on the frequency of MPC exceedances, the water pollution by total iron and copper was defined as «characteristic», the pollution by zinc and oxidation-resistant organic substances was defined as “stable”, and the pollution by easily oxidizable organic substances and phenols as «unstable». The maximum concentrations recorded were the following: 1.5 MPC for zinc (Dec. 6), 23.5 MPC for total iron (Jun. 27), 2 MPC for phenols (Apr. 26, May 22), 7.0 MPC for copper (Jul. 25), 1.9 MPC for oxidation-resistant organic substances (Jul. 25), and 1.3 MPC for easily oxidizable organic substances (May 22) [1].

Around Ulan-Ude city, the Selenga river water quality was monitored at 3 monitoring stations: 1) 2 km upstream of the city (background site); 2) 1 km downstream of the city (control site); and 3) near Mostovay railway station. Wastewater discharges were carried out by the municipal sewage treatment plant «Vodokanal», namely by its treatment facilities located on both banks of the river. The discharged wastewater was graded as «insufficiently treated». The effect of sewage on the quality of the Selenga river water was indicated by concentrations of suspended solids, sulfates, nutrients and some metals. Out of 17 monitored pollutants, guideline threshold exceedances were observed for 8 pollutants at the background site, 10 pollutants at the control site and 9 pollutants at Mostovaya monitoring station. Water pollution by total iron, copper, zinc, and manganese was defined as «characteristic», while pollution by aluminum, phenols, oxidation-resistant and easily oxidizable organic substances was defined as «unstable». The maximum concentration of easily oxidizable organic substances (1.4 MPC) was detected at a monitoring station upstream of the city on November 20. The maximum concentrations of nitrite nitrogen (2.2 MPC on Feb. 20), manganese (10 MPC on Feb. 20), copper (5.6 MPC on Dec. 20), aluminum (1.7 MPC on Jul. 19), and petrochemicals (1.6 MPC on May 21) were detected downstream of Ulan-Ude city. At the monitoring station near Mostovaya railway station, the maximum concentrations of total iron (9.5 MPC) and oxidation-resistant organic substances (2.2 MPC) were detected on May 22, during a spring flooding, while maximum zinc concentrations (2.4 MPC) were recorded on April 20 [1].

Near the village of Kabansk, monitoring was done at three monitoring stations: 1) 23.5 km upstream of the village (background site); 2) 19.7 km upstream of the village (control site); and 3) 0.5 km downstream of the village (river gauge). Sewage was discharged into the river by a local utilities department. MPC exceedances were recorded for 6 out of 13 monitored pollutants at the background site, for 7 pollutants at the control site, and 9 pollutants at the monitoring station near the river gauge. Based on frequency of MPC exceedances, the water pollution by oxidation-resistant organic substances, total iron, zinc, copper and manganese was defined as «characteristic», pollution by easily-oxidizable organic substances as «resistant», and by nickel, aluminum and phenol – «unstable».

The Selenga River remained the major supplier of controlled substances into the lake. In 2013, the river brought 87.6% of suspended solids, and 78.0% each of dissolved minerals, oxidation-resistant and easily oxidizable organic substances [1].

The Dzhida River was surveyed at two sites near the villages of Khamney and Dzhida. Water hardness varied from soft to moderately hard, while salinity varied from low to medium [1]. The maximum salinity was observed in winter near Khamney (pic. 4.2.7). pH was slightly alkaline, and oxygen regime was satisfactory throughout. Based on MPC exceedance frequency, pollution by copper was graded as «characteristic», by iron and zinc as «stable», by easily oxidizable and oxidation resistant organic substances and petrochemicals as «unstable». The maximum concentrations of oxidation-resistant organic substances (1.2 MPC on Aug. 24), easily oxidizable organic substances (1.1 MPC on Aug. 24), total iron (1.9 MPC on Dec.21), zinc (1.3 MPC Dec. 21), and petrochemicals (2.6 MPC on Mar. 21) were recorded near Dzhida village. The highest copper concentration (3.6 MPC) was recorded near Khamney on June 17.

Fig. 4.2.7 The middle reaches of the Dzhida river

The Chikoy River was surveyed at two sites within Buryatia, near the villages of Chikoy and Povorot (pic. 4.2.8). Oxygen regime was satisfactory, the river water had a low salinity [1]. The maximum salinity was observed in the winter period near Chikoy. At both the monitoring sites, MPC exceedances were observed for 6 pollutants out of 13 monitored. MPC exceedances were observed for total iron, zinc, copper, phenols, easily oxidizable organic substances, petrochemicals, and oxidation-resistant organic substances. Based on frequency of MPC exceedances, pollution by iron, copper and oxidation-resistant organic substances was defined as «characteristic», by zinc and phenols as «stable», and by easily oxidizable organic substances as «unstable». The maximum concentrations of zinc (1.6 MPC on Oct. 28) and petrochemicals (1.4 MPC on Sep. 20) were recorded near Chikoy village. The maximum concentrations of oxidation-resistant organic substances (2.6 MPC on May 22), total iron (15.4 MPC on May 22), easily oxidizable organic substances (1.4 MPC on Oct. 22), copper (7.4 MPC on Jul. 25), and phenols (3 MPC on Apr. 27, May 22) were recorded near Povorot [1].

Pic. 4.2.8 The Chikoy river near the village of Povorot

The Khilok River was surveyed within the Republic of Buryatia in its mouth area near the village of Haylastuy. The river water had a low salinity. Threshold exceedances were observed for 6 pollutants (7 in 2011). Pollution by total iron, oxidation-resistant organic substances, copper and phenols was «characteristic». Moreover, total iron concentrations exceeded the MPC in 100% of the samples. Pollution by easily oxidizable organic substances and zinc was graded as «stable». The maximum recorded concentrations of pollutants were the following: 3.3 MPC for oxidation-resistant organic substances (May 24), 1.5 MPC for easily oxidizable organic substances (Sep. 13), 16.6 MPC for total iron (May 24), 4.9 MPC for copper (Jul. 26), 1.5 MPC for zinc (Sep. 13), and 2 MPC for phenols (Feb. 15, May 24, Jun. 28, Sep. 13) [1].

The Uda River water quality monitoring was carried out at two sites around Ulan-Ude city: 1 km upstream of the city (background site) and 1.5 km upstream of the river mouth (control site). The river receives wastewater discharges from the wastewater treatment facility of Ulan-Ude Central Heating Plant (pic. 4.2.9). The river had satisfactory oxygen regime throughout the observation period. pH varied from neutral to slightly alkaline. Water salinity was moderate during all phases of the hydrological regime, the maximum salinity values were observed in winter. Cases of high or extremely high water pollution were not registered.

Pic. 4.2.9 The wastewater treatment facility of Ulan-Ude Central Heating Plant

MPC exceedances were observed for 11 pollutants (7 in 2011). The water quality was generally better at the background site than at another site located downstream. Similar to the previous year, concentrations of iron and manganese consistently exceeded the MPCs in 100% of samples. Water pollution by total iron, manganese, copper and zinc was defined as «characteristic». The maximum concentrations recorded were: 6.6 MPC for total iron (Apr. 20), 4.1 MPC for copper (Sep. 20), 2.3 MPC for zinc (Apr. 20), 2.4 MPC for oxidation-resistant organic substances (May 21), 1.5 MPC for nickel (Oct. 19), 1.3 MPC for aluminum (Apr. 20), 8.7 MPC for manganese (Apr. 20), 1.2 MPC for petrochemicals (Mar. 21). Downstream of the city, water pollution by copper, zinc, iron and manganese was «characteristic», by phenols – «stable», by easily oxidizable and oxidation-resistant organic substances, nickel, aluminum and fluoride – «unstable». The maximum concentrations recorded were: 5.8 MPC for iron (May 21), 4.1 MPC for copper (Aug. 21), 2.3 MPC for zinc (Apr. 20), 2.5 MPC for oxidation-resistant organic substances (May 21), 1 4 MPC for nickel (Oct. 19), 1.1 MPC for aluminum (Jul. 19), 7.7 MPC for manganese (Apr. 20), 1.8 MPC for petrochemicals (Mar. 21), and 1.3 MPC for fluoride (Feb. 20).

Lake Gusinoe. Observations were made near the railway station Gusinoe Ozero. The lake water salinity was average during the year, with the highest values recorded during winter [1]. The total hardness of water varied from soft to moderately hard. The lake had satisfactory oxygen regime throughout the observation period. pH was slightly alkaline. MPC exceedances were observed for total iron and easily oxidizable organic substances. Water pollution by the pollutants was defined as «characteristic». The maximum concentrations recorded were: 2.1 MPC for oxidation-resistant organic substances (Mar. 19), 1.5 MPC for easily oxidizable organic substances (Jun. 14), 1.6 MPC for total iron (Jun 14), 4.0 MPC for copper (Dec. 20), 1.3 MPC for zinc (Oct. 10), 2.0 MPC for phenols (Jun. 14, Oct. 10), and 3.2 MPC for petrochemicals (Mar. 19).

In 2013, no significant changes were observed in the underground hydrosphere of the Lake Baikal basin compared with 2012 [1]. In 2013, increased concentrations of petrochemicals were recorded within Ivolga-Uda basin and in the Selenga river valley. Significant sources of pollution continue to exist within the Ulan-Ude industrial hub, those that present a particularly high risk are the sedimentation reservoir of the locomotive and carriage repair plant (pic. 4.2.10), petroleum storage depots in Steklozavod neighborhood and facilities of aviation plant. Within the frameworks of the Federal Target Program «Lake Baikal protection and socio-economic development of Baikal Natural Territory during 2012-2020», the implementation of the activity no.8 «The elimination of subsoil accumulation of petrochemicals polluting the Selenga river in the vicinity of Steklozavod, Ulan-Ude city – remediation of the polluted lands, protection of the surface water and groundwater» began in 2013.

Within Irkutsk region, groundwater quality remained largely in its natural state. Within the impact zone of human settlements, groundwater might be contaminated by nitrogen compounds. Groundwater pollution, including pollution by petrochemicals, was observed at Kultuk petroleum storage depot, below its storehouse for light petroleum products. In 2013, concentrations of petrochemicals were the lowest during the entire observation period and did not exceed 0.08 mg/l (in 2012, the maximum concentration was 0.15 mg/l). Thermal and chemical pollution of groundwater by the facilities of the former Baikalsk Pulp and Paper Mill (production sites, manufacturing workshops, lignin landfills, etc.) remained significant.

Pic. 4.2.10 The sedimentation reservoir of the locomotive and carriage repair plant (Google)

Within the Khilok river basin in Zabaikalsky Krai, water quality in groundwater wells of the town of Petrovsk-Zabaikalsky remained unsatisfactory, with nitrate concentrations exceeding the MPC for water for drinking and household needs.

The Lake Baikal basin in **Mongolia** covers the most economically developed northern and central regions of the country. About 70% of the country's population lives in within the Lake Baikal basin [2]. Furthermore, about 80% of industrial and 60% of agricultural output comes from the area. About 34% of all the entire livestock population (11 million heads) live and graze within the basin area.

Sources of water pollution within the Lake Baikal basin in Mongolia are waste waters from a number of enterprises belonging to the three large industrial hubs around the biggest settlements – Ulaanbaatar, Erdenet and Darkhan (pic. 4.2.1).

In recent years, the development of mining sector and livestock product processing sector lead to increased wastewater discharges by the industries (pic. 4.2.11). Untreated or inadequately treated sewage is another source of pollutants. Sewage treatment facilities of Ulaanbaatar (5 sewage treatment plants), Erdenet and Darkhan discharge treated sewage into the Selenga River. Over the last decades, the loads of pollutants have increased and for some pollutants the concentrations exceed the thresholds defined in the national water quality standard MNS 4586:1998 [6].

Pic. 4.2.11 Tail dumps and wastewater discharge point of a goldmining enterprise (Zamaar soum, Tuv aimag)

Water pollution monitoring is routinely conducted by National Agency for Meteorology, Hydrology and Environmental Monitoring [2]. The monitoring results are published in annual reports on the state of the environment. Water pollution index is estimated based on measured concentrations of dissolved oxygen, easily oxidizable organic substances, mineral nitrogen, phosphorus, chromium and copper. In 2012, water pollution index was estimated for 85 rivers and 13 lakes based on monitoring data measured at 120 monitoring posts (Table 4.2.1 and 4.2.2)

In the country, there are more than 120 sewage treatment facilities operating. However, most of them have been in operation for several decades and use outdated equipment and technologies (pic. 4.2.12). The facilities produce inadequately treated effluents that are discharged into rivers. The national standard MNS 4943:2011 defines criteria for treated sewage discharged into the environment [6].

Table 4.2.1 Surface water quality characteristics for the rivers within Lake Baikal basin in Mongolia

№	River	Quality grade	Salinity (mg/l)	pH	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	$Na^{+}+K^{+}$ (mg/l)	HCO_3^- (mg/l)	SO_4^{2-} (mg/l)	Cl^- (mg/l)
1	Selenga	II	253.7	7.8	34.9	10.3	15.6	157.8	18.6	5.9
2	Tuul	IY	216.4	-	24.6	4.8	37.3	76.6	30.6	42.5
3	Orkhon	II	226.1	7.6	26.6	8.9	25.7	142.7	18.5	10.8
4	Kharaa	II	262.7-275.6	7.9-8.22	38.1	10.9	18.9	176.9	20	10.7
5	Eruu	II	128.9	7.7	14.5	4.8	10.5	75.7	10.8	4.4
6	Ider	II	162.2	7.5	25.2	6.8	14.0	104.6	14.1	7.9
7	Delgermurun	II	254.5	7.7	39.3	9.2	10.0	170.0	17.9	3.6
8	Eg	II	234.6	7.7	33.2	11.4	9.8	160.0	12.9	3.9
MNS4586:1998				**6.5-8.5**						

Table 4.2.2 Pollution of the rivers within Lake Baikal basin in Mongolia

№	River	Name of points	NH_4	NO_3	PO_4	Si	MnO_4^{2-}	BOD	O_2	$Ca^{2+}+Mg^{2+}$ (hardness)
			mg/l							
1	Selenga		0.190	0.265	0.037	5.9	3.2	2.1	9.6	2.4
2	Tuul	Uubulan	-	0.28	0.002	-	-	1.8	-	-
		Songino	30.83	15.48	1.808	-	-	159.0	-	-
		Altanbulag	6.74	0.13	0.347	-	-	15.8	-	-
3	Orkhon		0.247	0.357	0.040	5.8	3.5	2.7	10.4	2.1
4	Kharaa		0.200	0.200	-	-	5.3	-	-	2.8
5	Eruu		0.224	0.311	0.030	6.7	4.0	1.5	11.1	2.6
6	Ider		0.170	0.280	0.015	4.1	3.2	1.5	-	1.9
7	Delgermurin		0.110	0.150	0.021	2.6	2.7	2.2	8.7	2.8
8	Eg		0.107	0.190	0.024	2.9	3.2	1.9	-	2.4
MNS4586:1998				**9.0**	**0.1**			**3.0**		

Pic. 4.2.12 Sedementation reservoirs of the enterprise "Erdenet", Erdenet city

Garbage collection campaigns are organized around lakes, rivers and creeks during autumn and spring. In 2011, such campaigns were conducted in 21 aimags and involved 1409 water bodies and wells. In 2012, the number of water bodies was 1107. In 2013, the campaigns were organized in 10 aimag and 988 water bodies were covered in the activity (323 rivers, 31 lakes and ponds, 388 springs, 13 mineral water springs, 233 wells).

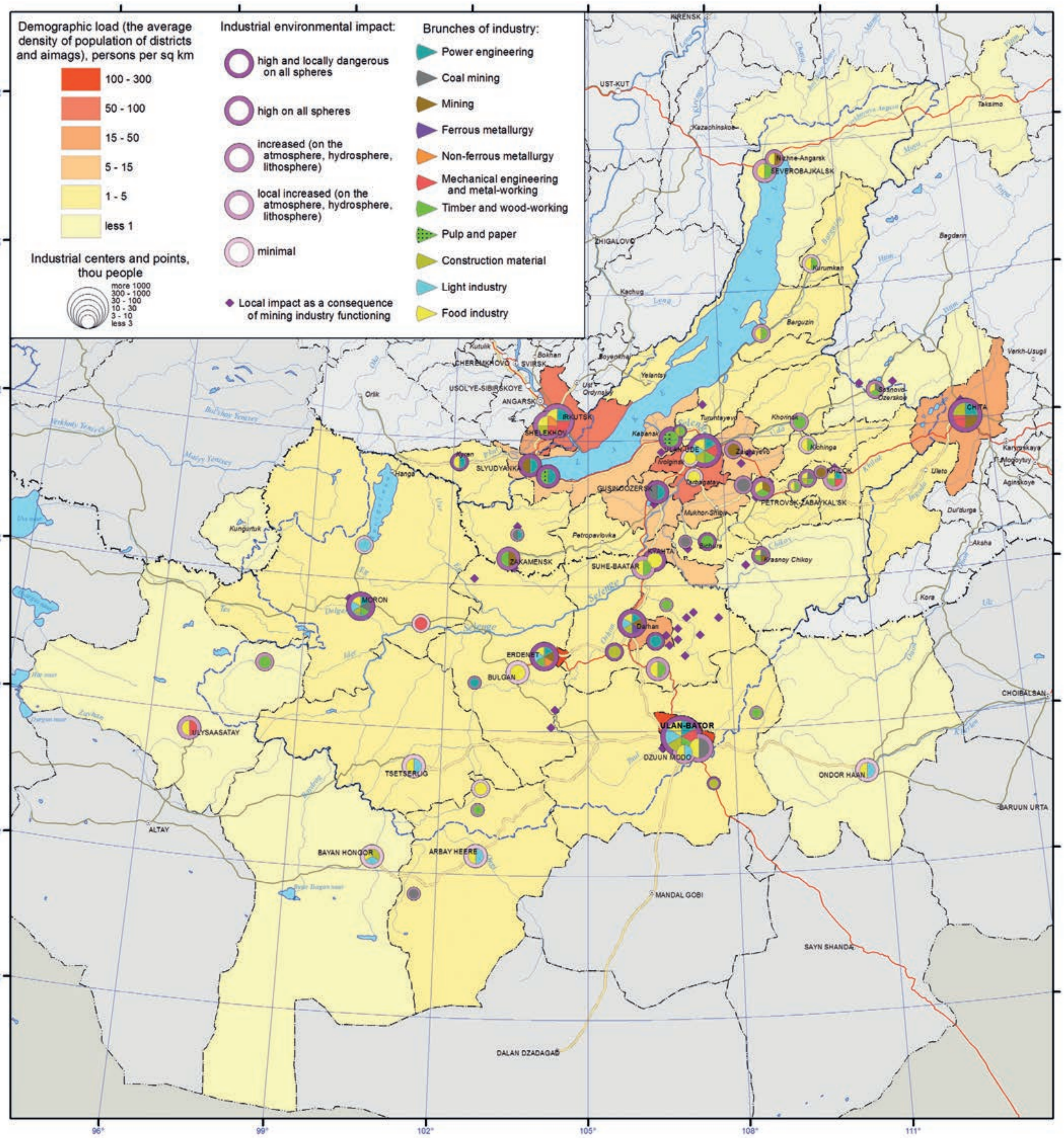
4.3 ANTHROPOGENIC POLLUTION HOTSPOTS AND THEIR IMPACT ON THE ENVIRONMENT

Severobaikalsk industrial hub covers part of the district Severobaykalsky and stretches in the latitudinal direction along the Baikal-Amur Mainline (BAM) (pic. 4.3.1). The region has been developed since 1974. Around the time, Severobaykalsk was built on the northern coast of Lake Baikal, and the large settlements New Uoyan, Angoya and Yanchukan were built to the east of it. In the district, 176 quarries have been developed and only 30% of them are partially remediated. Construction of BAM has led to the rapid population growth in the region (from 6.5 to 80 thousand). Construction of the settlements has often preceded construction of wastewater treatment facilities, landfills for industrial waste and dry garbage, etc. Currently, permanent residents of the settlements Nizhneangarsk, Dushchakan, Holodnoe and Uoyan are facing environmental issues and a lack of adequate waste treatment infrastructure [1].

Pic. 4.3.1 Severobaikalsk industrial hub (Google)

In Severobaykalsk, the major air polluters are construction industry enterprises «Nizhneangarskstroy», «LenBAMstroy» and a plant producing asphalt and cement. Only 3% of all emissions by the plants is caught and contained, the rest is emitted into the environment. A considerable input to atmospheric pollution comes from 26 heating stations. Annually, 2.5 thousand tons of ash, 0.5 thousand tons of sulfur dioxide and 2.3 thousand tons of nitrogen oxides are emitted into the atmosphere (pic. 4.3.2). The contribution of transport to air pollution is approximately 26%. In recent years, emissions from stationary and mobile sources are continuously increasing. As a consequence, air pollution over Lake Baikal is worsening [1].

In the town of Nizhneangarsk, the total pollutant emissions have stabilized in recent years and are about

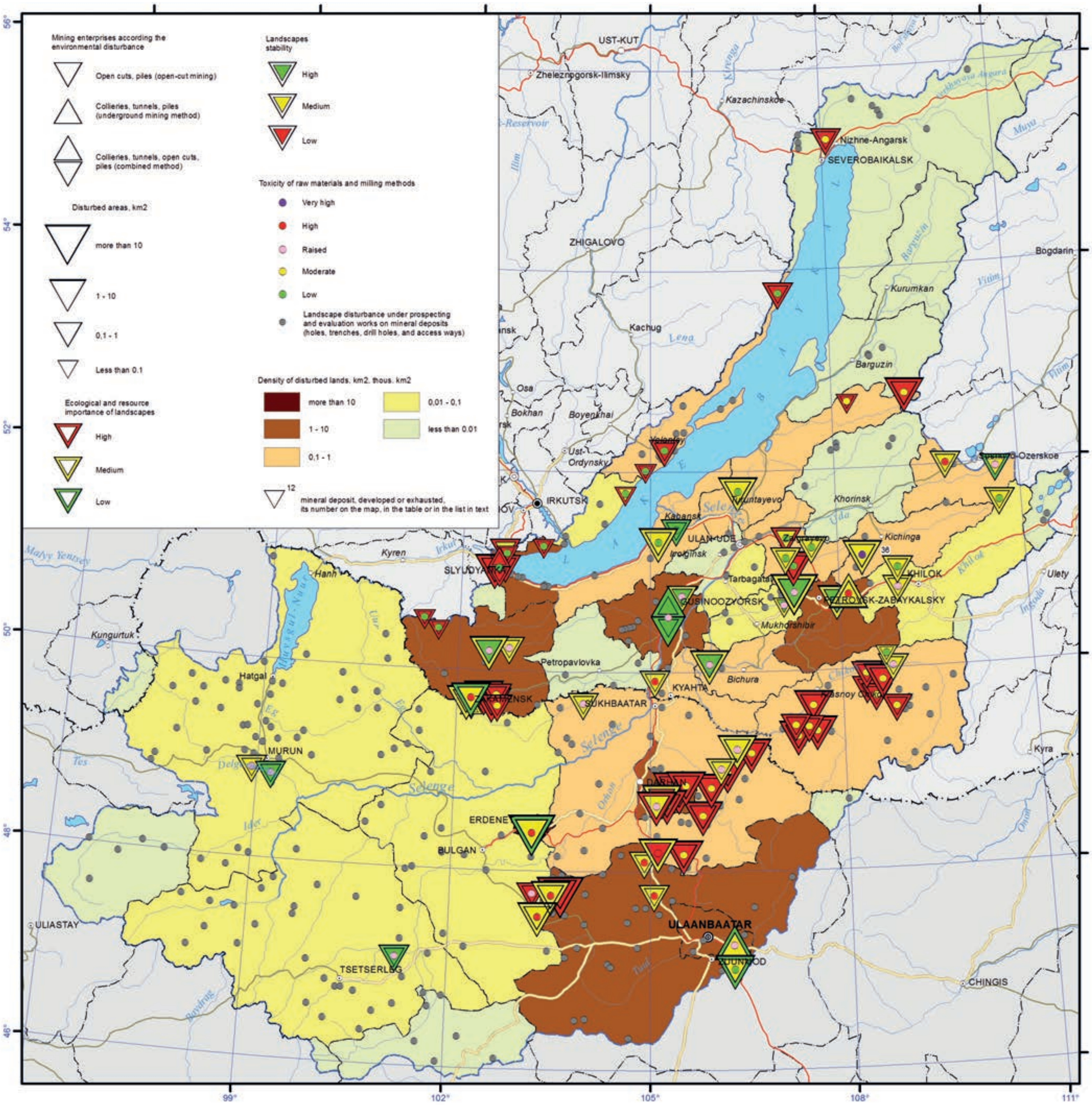


Pic. 4.3.2 Industries and their environmental impact on Baikal basin [3]

3 thousand tons per year. During winter, 22 coal-fired heating stations work in the village. With the annual consumption of about 18 thousand tons of coal, the stations emit 5.3 tons of ash, 2.5 tons of carbon monoxide and 1.3 tons of sulfur dioxide into the atmosphere every day. Thus, a zone of emission and dispersal of atmospheric pollutants forms over the northern shore of Lake Baikal. The zone stretches along Lake Baikal and its area for Severobaikalsk is approximately 100 km^2, while for Nizhneangarsk it is 26 km^2.

Nizhneselenginsk industrial hub is located in the western part of the district Kabansky of the Republic of Buryatia and stretches along the left bank of the Selenga river. There are major industrial centers in the towns of Selenginsk and Kamensk and the village of Kabansk (pic. 4.3.3). Among the major industrial polluters are Selenginsk Pulp and Paper Mill (SPPM) and Timlyuysky cement plant (TCP) [1].

Pic. 4.3.3 Nizhneselenginsk industrial hub (Google)



Pic. 4.3.4 The technogenic impact of mining on the environment of Baikal basin [3]

During last year, emissions of SPPM amounted to 30.6 thousand tons. The share of solids was 23%, while liquid and gas emissions together accounted for about 77%. Carbon oxides were the main «ingredients» of the gaseous emissions of SPPM, constituting about 92% of the total amount of gaseous substances. The harmful sulfur compounds accounted for 4.9%, including 1.5% of sulfur dioxide. Nitrogen oxides accounted for 0.6% only [1].

In the village of Kamensk there are several enterprises, including Timlyuysky cement plant, a plant producing asbestos and cement, a brunch of electricity distributing company «Baikal electricity networks», and motor carrier enterprises. The greatest input to particulate matter emissions into the atmosphere comes from Timlyuysky cement plant. Out of the total emissions of the plant estimated to be 9287.1 tons, particulate matter accounted for 77.7% (i.e., 7189 tons). Overall, the main pollutants were benzopyrene (4.5 MPC), carbon disulfide and formaldehyde (2.0 MPC), particulate matter (1.3 MPC).

For cement production, limestone mined in Tarakanovskiy field, near the village of Kamensk, and loam from Timlyuyskiy field are used. The impact of the mining operations on the air quality has not been evaluated. The quarry dumps accumulated exposed rocks of a total volume of 190 thousand cubic meters. The mining operations covered 925 hectares, out of which 12 hectares only have been recultivated (pic. 4.3.4). The issue of safe disposal of mining waste has not been resolved.

Ulan-Ude industrial hub is the largest in terms of population and occupying territory. In the city, there are 67 industrial and 36 motor carrier companies, and 162 heating stations (including 112 industrial and 50 small heating stations). There are an estimated 6043 sources of harmful emissions into the atmosphere, of which 1784 (61%) sources are equipped with emission filters and/or emission containment equipment [1].

The main contribution to total emissions comes from the city's Central Heating Plants (41.9%), Aviation Plant (12.2%), and motor vehicles. Central Heating Plants emit annually more than 54 tons of harmful substances, including over 30 tons of soot. According to Buryat Center of Hydrometeorology, exceedances of established thresholds were observed for particulate matter, phenol, formaldehyde (2 MPC), nitrogen dioxide (1.5 MPC), and benzopyrene (12 MPC). Emissions into the air from stationary pollution sources amounted to 47.36 thousand tons, while emissions from vehicles were an estimated 40.88 thousand tons (46.3% of the total emissions in the city). The emissions from stationary sources were mainly accounted for by particulate matter (23.56 thousand tons), sulfur dioxide (12.62 thousand tons), and carbon monoxide (7.30 thousand tons). The priority pollutants were benzopyrene (6.8 MPC), formaldehyde (2.3 MPC), phenol (2.0 MPC) and nitrogen dioxide (1.5 MPC). Compared with the previous year, pollution levels by benzopyrene, formaldehyde and sulfur dioxide have decreased. However, the emissions of other pollutants remained unchanged [1].

Ulan-Ude city is surrounded by numerous organized and unorganized landfills, dumps and quarries of mining enterprises, specializing in production, transportation and processing of nonmetallic minerals used as building materials. Another growing concern is public health protection from possibly harmful impact of noise, vibration and electromagnetic fields.

Gusinoozersk industrial hub covers the area around Lake Gusinoe in the central part of Selenginskiy district of the Republic of Buryatia. Gusinoozersk city is the center of both the industrial hub and the district (pic. 4.3.5). The main industries are coal mining and electric and thermal power generation. Environmental situation in the area remains grave. The largest enterprises, which account for most of the pollution, are Gusinoozersk coal mine, Holboldzhinskiy coal opencast, and Gusinoozersk electric and thermal power plant.

Pic. 4.3.5 Gusinoozersk industrial hub (Google)

In Gusinozersk mine's waste heaps, a total of 72 thousand m^3 of solid waste is accumulated. The mine's lease area is 350 ha, of which 100 ha have been recultivated. In Holboldzhinsk opencast mine, which is the largest enterprise of its type in the Republic, 220 million m^3 of waste rock are accumulated in dumps. The total area affected by mining is 900 ha, of which 45 ha have been reclaimed and 620 ha are occupied by dumps (pic. 4.3.6).

Pic. 4.3.6 Gusinozersk mine's waste heaps (Google)

Within the industrial hub, Lake Gusinoe is the only source of drinking and industrial water supply to the city and nearby communities. One of the main sources of pollution is Gusinoozersk power plant, which uses the lake as a natural cooling facility. During winter, a polynya of more than 2 km^2 in diameter forms in the lake. In the zone subjected to the thermal influence, the water temperature exceeds background levels by 13-14 °C, which is 1.5 - 2 times higher than the normal temperature. Thermal waters contribute to algal bloom and ecosystem changes in the lake. Every day the lake receives 15-16 thousand m^3 of inadequately treated water from the city and the power plant's treatment facilities; 2 thousand m^3 of water from industrial settling tanks; and 2 million m^3 of thermal water after cooling the turbines.

Emissions into the air from stationary pollution sources amounted to 29.01 thousand tons, while vehicle emissions were 2.49 thousand tons. The emissions from stationary sources were accounted for mainly by particulate matter (10.37 thousand tons) and sulfur dioxide (13.48 thousand tons). In recent years, air pollution by particulate matter, sulfur dioxide, carbon monoxide tends to decrease, while there is a slight increase in nitrogen dioxide levels [1].

Kyahta industrial hub stretches along the border with Mongolia. Three settlements – Kyahta, Naushki and Horonhoy – are part of the hub. The biggest polluter in the area is Kyahta fluorspar mine located near Horonhoy, a station along the railway connecting Ulan-Ude and Ulan-Bator [1]. The main target product of the mine is fluorite concentrate. Annual capacity of the mine is 165 thousand tons per year. The mine has a tail dumping area of 60 hectares, of which 46 hectares are used. The volume of accumulated waste in the dump is 1900 thousand m^3. The tailings are composed of fluorite (12.8%), silica (55-60%), calcium (1.5%) and clay (7-10%).

The town of Kyahta is among the most contaminated locations in Buryatia (pic. 4.3.7). Sources of surface water pollution are inadequately treated sewage of a cantonment and spinning-knitting factory, discharges of untreated municipal wastewater, as well as disorganized storage of slag and coal by heating stations, poor municipal solid waste management within the Kyahtinka river basin.

Pic. 4.3.7 The towns of Kyahta (Russia) and Altanbulag (Mongolia) (Google)

Emissions into the air of the city from stationary sources totaled 4.75 thousand tons, while emissions from vehicles amounted to 1.67 thousand tons. The emissions from stationary sources were accounted for by mainly particulate matter (2.38 thousand tons), carbon oxide (1.53 thousand tons) and sulfur dioxide (0.67 thousand tons). The levels of other regulated pollutants did not exceed the MPCs [1].

Zakamensk industrial hub covers the central part of Zakamensky district along the banks of the Dzhida River. The hub has formed due to exploration and mining of mineral resources in the area. The largest enterprise in the hub was Dzhida tungsten-molybdenum plant that conducted open cast mining of Inkurskiy and Holtosonskiy complex ore deposits. The plant operated for over sixty years and ceased operations in 1996. The closure of the plant was not done according to sanitary and environmental guidelines, i.e. remediation of affected land was not conducted, discharges of contaminated mine water into surface water bodies were not managed, environment protection measures designed for the plant were not implemented (pic. 4.3.8). All these led to a situation when with the plant closure the negative impact of its waste on the environment and the population has not decreased, but increased significantly [7].

Pic. 4.3.8 Zakamensk industrial hub

For many years, the situation at the former plant remained environmentally disadvantaged. Environmental protection measures for the affected area were planned in the federal program «Ecology and Natural Resources of Russia in 2002-2010» but have remained unfulfilled. Only in 2011, the first stage of work on reclamation of 600 hectares of land occupied by man-made sand was carried out. The work was done by «Acropol Group» Ltd. through its subsidiary JSC «Zakamensk» - the owner of these man-made deposits. The work included relocation of 3.2 million tons of sand from the Modonkul river valley into a former hydraulic dump of the beneficiation department of the plant (pic. 4.3.9). The work was funded from the federal budget, and 500 million rubles were allocated.

Pic. 4.3.9 Relocation of sand from the Modonkul river valley into a former hydraulic dump.

To provide jobs and develop infrastructure, mining industry has been encouraged in the area. Currently, mining and processing of limestone, volcanic ash, clay, sand and gravel are conducted. Small-scale industries producing concrete, bricks, and lime are operating. Electricity is provided by Bayangolskaya thermal power plant, for which open cast mining of the brown coal deposit «Sangino» has been going on. «Sangino» has accumulated 194 thousand m^3 of tails and host rocks. The area of affected land is 1135 ha, of which 70 ha is occupied by tail dumps.

In general, the environmental situation within Zakamensk industrial hub is grave and may adversely affect public health and the environment.

South Baikal industrial hub covers the south-western coast of the lake Baikal along the Trans-Siberian railway. The major transportation hubs and industrial sites are located there; those are the towns of Baykalsk and Sludyanka, and several smaller settlements and railway stations [1].

Baikalsk Pulp and Paper Mill (BPPM) was the biggest polluter in the area until recently. It ceased operations in December 2013. During its active years, airborne emissions of BPPM spread up to 160 km north-east along the coast of Lake Baikal, entering the territory of the Baikalsk Nature Reserve, and up to 40 - 50 km or more to the west, reaching Slyudyanka and Kultuk. The main sources of emissions are small heating stations using solid fuel. Pollutant trapping removal efficiency on some of the enterprises is less than 50%, and emissions from food industry and transport are released into the atmosphere without any treatment.

The town of Sludyanka is located on the southwestern shore of Lake Baikal (pic. 4.3.10). A major railway station, many small heating stations and individual houses with their wood-burning stoves are the stationary sources of air pollution in the town. Mobile sources of pollution are motor vehicles. Maximum one-time concentrations of particulate matter, nitrogen oxides and soot exceeded the MPCs by 1.8-2, 2.5-4.0, and 3.5-5.0 times, respectively.

Pic. 4.3.10 The town of Sludyanka and the settlement of Kultuk (Google)

East Siberian Railway contributes significantly to the environmental pollution along its route between the towns of Sludyanka and Vidrino. Concentrations of petrochemicals, methanol, formaldehyde, total organic chlorine at monitoring stations exceeded MPCs by 2-4 times. From the railroad tracks contaminants are washed off into Lake Baikal by atmospheric precipitation and surface runoff.

Within a controlled zone in the vicinity of the town of Baikalsk, the area of polluted snow cover remains largely unchanged. During winter of 2012-2013, the area was around 270 km^2 (it was 350 km^2 during winter of 2011-2012).

In 2013, contamination of atmospheric precipitation reduced for the stations of Baikalsk, Khamar-Daban and Khuzhir by 25%, 33% and 11% (for the sum of monitored substances), respectively, compared with 2012.

The results of snow cover pollution monitoring in 2013 showed the reduced precipitation of suspended matter onto the lake and coastal areas of its southern part [1]. However, there were increased inputs of chromium, lead, zinc, nickel, copper, and iron near the town of Slyudyanka, the village of Kultuk and along the stretch between the village of Kabansk and the town of Baikalsk.

In 2013, the stationary sources of pollution within the Southern Baikal and Northern Baikal industrial hubs emitted 10.2 thousand tons of pollutants into the atmosphere (10 thousand tons in 2012), discharged 21.7 million m^3 of wastewater (40.2 million m^3 in 2012), generated 829.4 thousand tons of solid waste (974.1 thousand tons in 2012).

Within the **Petrovsk-Zabaikalskiy industrial hub,** the major air and water polluters are the town of Petrovsk-Zabaikalskiy, Tugnuiskiy coal mine (pic. 4.3.11) and a railway complex [1]. A metallurgical plant located in Petrovsk-Zabaikalskiy emits almost 90% of the total emissions in the district – dust, sulfur dioxide, carbon monoxide, nitrogen oxide and hydrocarbons. Among hydrocarbons, benzopyrene emissions significantly exceeded the MPC – by 10 times.

Pic. 4.3.11 Tugnuiskiy coal mine (Google)

Agriculture too contributes to environmental pollution. Stationary livestock farms and summer farms, usually located near water bodies, are of special concern. Water discharges from irrigation systems and run off from fields with an excess of fertilizers negatively impact the environment. Many municipalities still do not have wastewater treatment facilities, the available treatment facilities either do not work or work with a very low treatment efficiency.

The largest sources of environmental pollution within the **Mongolia** are sewage treatment plants of the big cities - Ulaanbaatar, Darkhan (pic. 4.3.2 and pic. 4.3.12) and Erdenet (pic. 4.3.13), mining and ore processing enterprises (pic. 4.3.4), and light industry enterprises (particularly skin and wool processing facilities) [2,8].

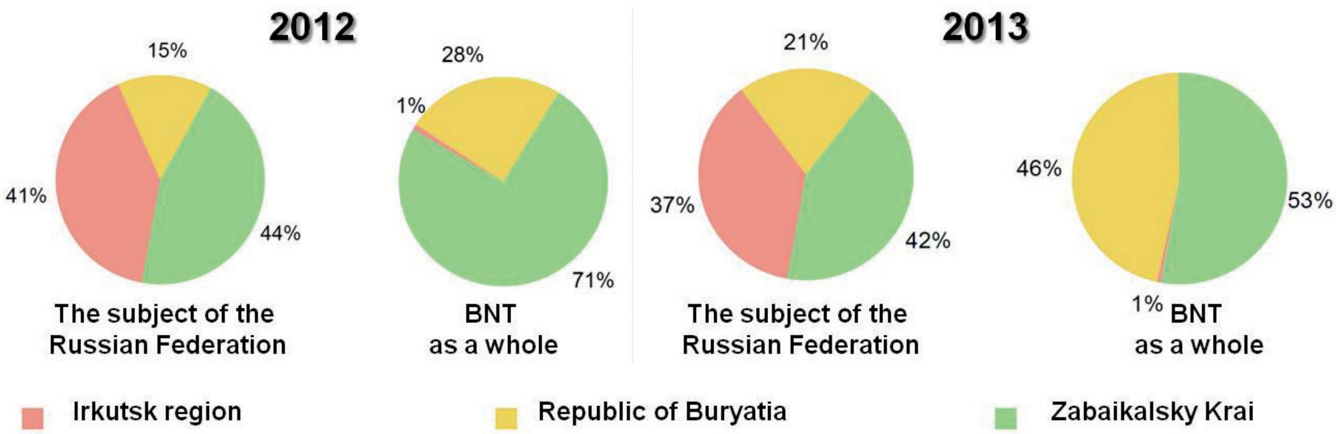
Pic. 4.3.12 Darkhan city (Google)

Pic. 4.3.13 Erdenet city (Google)

Within the frameworks of the project «Integrated natural resource management in the Baikal Basin transboundary system», a survey of pollution hotspots within the Selenga River basin was carried out by the non-governmental organization «Mongolian water forum – Water discussion» [9].

Waste generation and disposal. The volume of waste generated within the BNT increased by 31.9% in 2013 compared with the previous year (110.0 million tons in 2013, 83.5 million tons in 2012). This was associated with an increase in volumes of overburden rock in the Republic of Buryatia (pic. 4.3.14) [1,11].

In general, 59.1 million tons of waste were generated in the Republic of Buryatia in 2013, which was two times more than in the previous year (Table. 4.3.1) [12].



Pic. 4.3.14. The ratios of waste volumes in 2012-2013.

Table 4.3.1 Waste generation within the Republic of Buryatia by type of economic activity in 2010 - 2013 (million tons).

Type of economic activity	2010	2011	2012	2013	% contribution by the economic activity (2012)	% contribution by the economic activity (2013)
Total, including:	16.73	26.20	29.01	59.06	100.0	100.0
Mining	14.62	24.61	26.95	56.21	92.9	95.17
Processing industries	0.44	0.31	0.99	1.69	3.44	2.87
Production and distribution of electric energy, gas and water	0.77	0.67	0.62	0.72	2.13	1.22

The increase in waste volumes in 2010-2013 was directly related to the extraction of coal, e.g. in Mukhorshibirsky district (JSC "Razrez Tugnuisky") 17.96 million tons of waste were generated in 2013 (0.006 million tons in 2012), while in Selenginsky district (JSC "Coal Company "Bain-Zurhe") 24.3 million tons of waste were generated in 2013 (7.0 million tons in 2012).

The bulk of the generated waste is waste of the hazard class 5. A total of 0.49 million tons of waste were disposed of at waste disposal sites (sanctioned landfills), while 2.06 million tons of waste were disposed of within the industrial facilities, where the waste was generated. Within the Republic of Buryatia there were 304 waste disposal sites, including 7 landfills for municipal solid waste, 294 sanctioned dump sites, 1 landfill for municipal solid and liquid waste, 1 dump site for forest waste and 1 reinforced concrete reservoir for temporary storage of industrial waste. As of January 1, 2014, in the Republic of Buryatia there were 147 illegal dump sites over a total area of 69 hectares. In 2013, 1191 illegal dumps were identified, and 1282 illegal sites were cleaned up.

4.4 DANGEROUS NATURAL PHENOMENA AND PROCESSES

Earthquakes. Lake Baikal basin belongs to the seismically active Mongolian-Baikal seismic belt. The area is characterized by «very frequent» earthquakes of magnitude 2-3, «moderately rare» earthquakes of magnitude 6-7 and «rare» earthquakes of magnitude 9-10 [10]. Based on seismic zoning, the basin area is part of the Baikal rift zone and Transbaikal zone (pic. 4.4.1). The former is characterized by the maximum seismic activity of magnitude 9-10, while the latter by moderate seismic activity and «transits» from Baikal and northern Mongolia of magnitude up to 8. In addition, statistics show that even moderate earthquakes activate exogenous processes, and are often accompanied by landslides, rockslides, glacier movements and lead to the formation of mudflows, avalanches, etc.

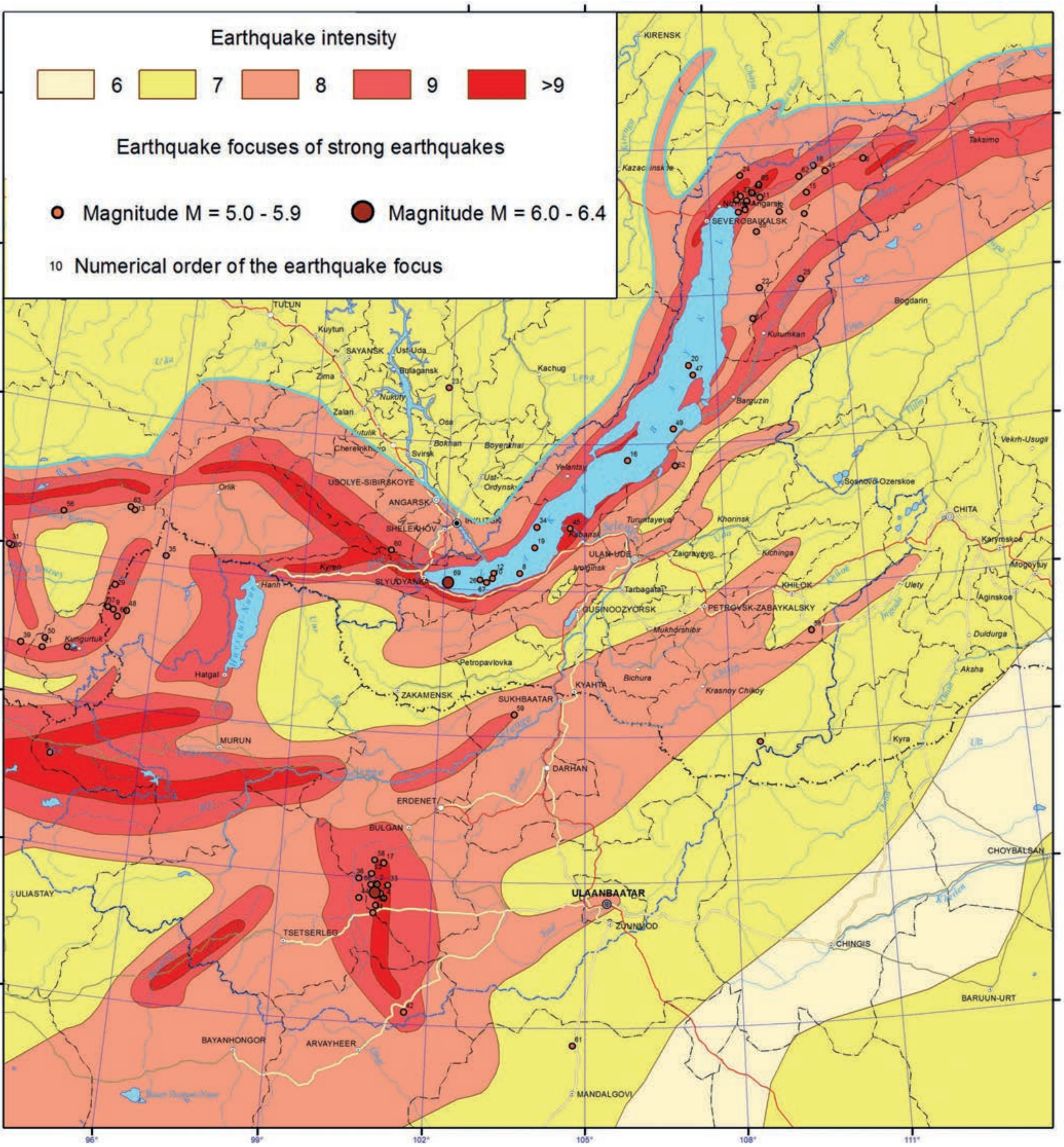
Most of the earthquake epicenters are located in Lake Baikal and the Selenga River delta. Catastrophic consequences of earthquakes of magnitude 9-10 that took place in the area are well documented in archives and chronicles. Tremors of magnitude 6-7 were recorded in southern Buryatia as a result of two strong earthquakes of magnitude 11 and 12 that took place in Mongolia on July 7th and 23rd in 1905, respectively. They were felt even in the village f Kabansk. In a village of Kultuk, 500 km away from the epicenter, two railroad tunnels were damaged due to displacement of rock masses. A number of other earthquake can be mentioned: 1) the ridge Dzhidinskiy in Northern Mongolia (06.02.1957), magnitude 9; 2) Mogot on the river Orkhon in Northern Mongolia (01.05.1967), magnitude 10; 3) Northern Mongolia, near Zakamensk (17.01.1984), magnitude 7-8; 4) Orongoy, Buryatia (02.10.1980), magnitude 7; 5) the interfluve of the rivers Selenga and Zheltura (05.13.1989), magnitude 7.

Tsagan earthquake (01.12.1862) is particularly noteworthy. Due to the earthquake, a portion of steppe between Harauz channel and the Enkhaluk river - a tectonic block with a surface area of 260 km^2 - dropped to a depth of 7-8 m. 203 km^2 of the land was inundated by the lake, forming Proval Bay. The earthquake was of magnitude 10. Tremors of magnitude 8 were felt at distances of 170-180 km from the epicenter. The earthquake was felt on the area of 2 million km^2, large rock slides were recoded within 400 km ^{2} around the epicenter.

The intensity of earthquakes with epicenters in Lake Baikal and Mongolia can reach magnitude 6-7 and even 8, while the frequency of such earthquakes is 0.028-0.049. Earthquakes with epicenters in Mongolia and within the zone of Dzhida-Vitim fault pose greater threat to settlements in Zakamenskiy, Dzhidinskiy and Kyahtinskiy districts of the Republic of Buryatia. Earthquakes with epicenters in Lake Baikal endanger population of Kabanskiy, Pribaikalskiy, Ivolginskiy, Tarbagatayskiy and Zaigraevskiy districts and Ulan-Ude city.

More than 40 earthquakes of magnitude 6 or more took place in Mongolia during the last two decades. Most of the earthquakes occur in the areas of the mountain ranges Altai, Khangai, Khovsgol and Bulnai. There were 4 earthquakes of magnitude above 8 during the 20th century – in Zavkhan aimag (1905), Arkhangai aimag, in the Mongolian Altai mountains (1931) and Gobi-Altai (1957).

Floods. Archival, literary and historical documents provide evidence of frequent catastrophic floods within

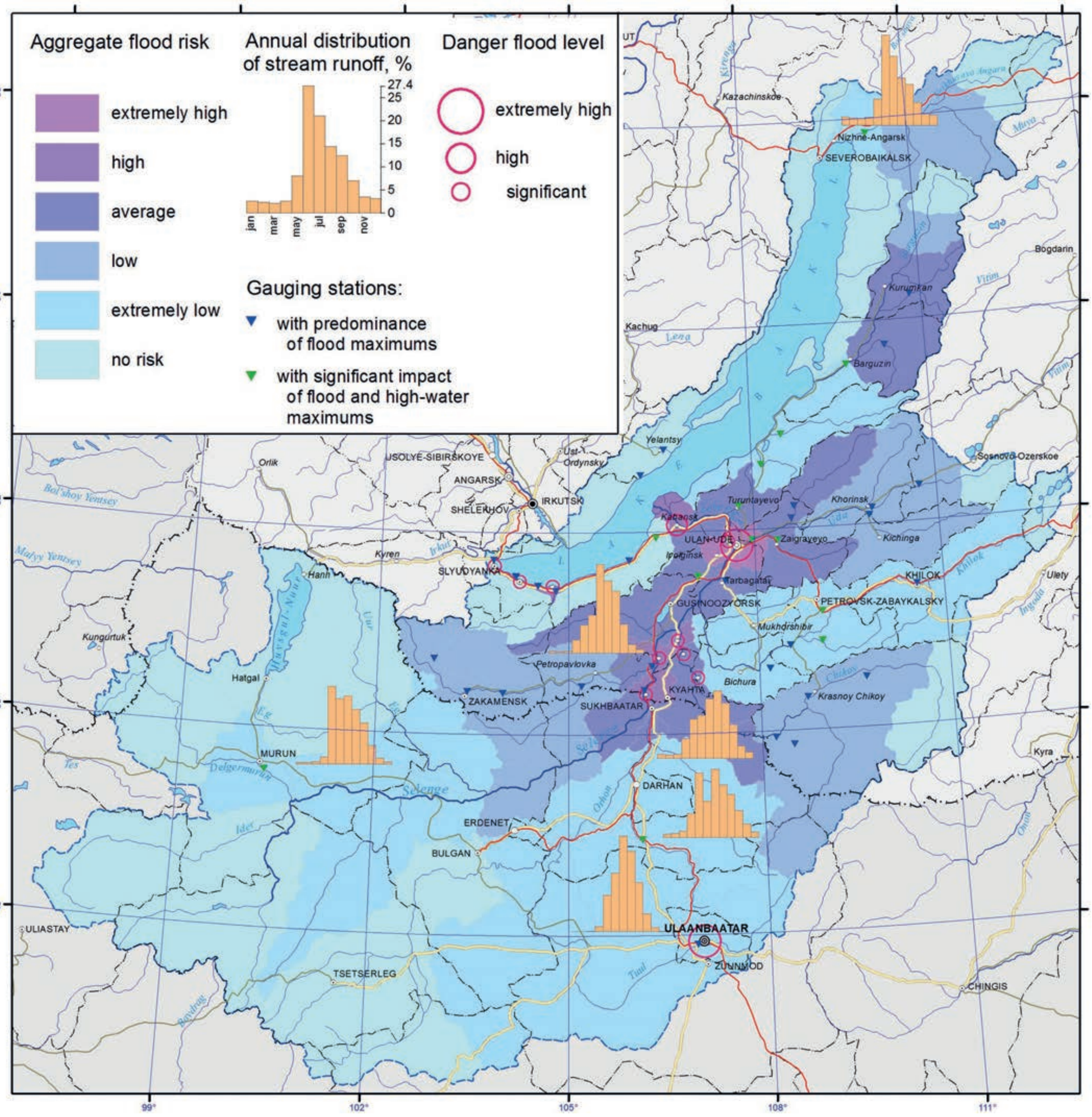


Pic. 4.4.1 Seismic risk zoning of Baikal basin [3]

the basin [10]. According to available statistical data on water levels in the Selenga river during 1936-2012, a number of major floods (above 400 cm) took place on the following dates: 06.11.1936; 08.05.1940; 08.05.1971; and 29.07.1973. Besides, a series of smaller floods (above 300 cm) took place in 1938, 1942 and 1990s. The driving factors of floods are frequent cyclones during the second half of summer bringing heavy rainfall, as well as large masses of snow accumulated in mountains during the preceding winter, and the local landscape characterized by mountains and hollows (pic. 4.4.2).

Within the basin, 61–90% of floods are flash floods caused by rainfalls or snow meltwater, while only 10% are riverine floods. The Uda river is an exception with 31% of floods being riverine due to water input from the mountainous rivers Kurba and Ona flowing into it.

Flash floods can cause serious damage as, in some areas, the water level may rise by more than 400 cm. The basin's mountainous relief and well branched river networks facilitate rapid collection and rise of water in rivers. During the largest flooding event in 70 years on the Dzhida river (1971), water level rose by 4.57 m/day (Khamnei monitoring station) and 2.79 m/day (Dzhida monitoring



Pic. 4.4.2 Floods in Baikal basin [3]

station). During a flood on the Chikoy river (1973), water level rose by 1.88 m/day (Povorot monitoring station) and 1.19 m/day (Cheremhovo monitoring station). Similarly, water level rose by 1.1 m/day during a flood on the Uda river (1991). The decline is slower, averaging 0.3-0.5 m/day. Rapid rise of water levels in mountainous tributaries (the rivers Khamnei, Kurba, Ona, etc.) is also associated with their location in permafrost zones, where soil infiltration is significantly reduced.

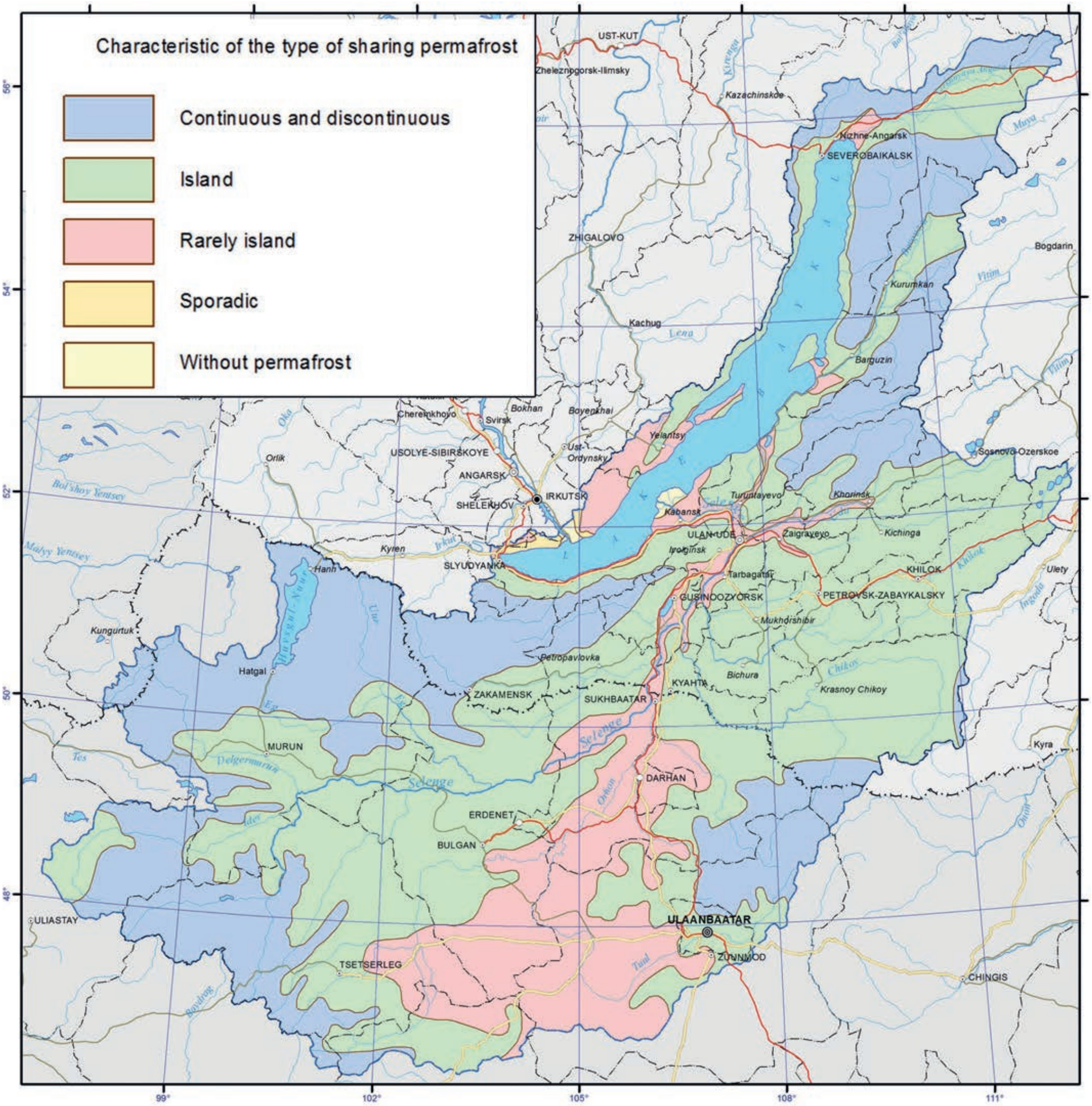
Duration of floods typically ranges between 10-15 days or more on the rivers Dzhida, Chikoy and Khilok, and 20-25 days on the Selenga river, but may reach 38 days (Ulan-Ude, 1936).

Forest fires. Typically arid conditions during spring-summer period and prevalence of pine, which has higher flammability than other trees, create fire-prone environments. Majority of forest fires have human causes [10].

Over the last decade, 431-1224 fire incidents were registered each year. The fires affected 6617 to 100 000 ha and caused huge losses. Besides, the negative consequences of forest fires include smoke emissions and associated human health risks, altered water balance and disturbed natural habitats of wildlife. The forest fires occurring near settlements pose the greatest threat. According to statistical data, up to 140 fires break out every year around the city of Ulan-Ude, putting at risk its inhabitants (pic. 4.4.3).

Pic. 4.4.3 Forest fires in the suburbs of Ulan-Ude city.

Till now the situation remains quite grave. For example, 1533 fires over the total area of 89630 ha were registered in 2011, which was 731 incidents more than in 2010. The area affected by fires in 2011 also increased by 53 708.99 hectares compared with 2010. Significant numbers of fire break-outs were reported in the following districts: Pribaikalskiy – 148 fires over 16 408.54 ha; Zakamenskiy – 68 fires over 11 671.4 ha; Kizhinginskiy – 101 fires over 7356.75 ha; Zaigraevskiy – 208 fires over 4750.35 ha; Tarbagataiskiy – 131 fires over 7175.20 ha; Khorinskiy – 120 fires over 7557.82 ha; Ulan-Ude city – 134 fires over 406.78 ha (MES RB). According to experts, the main reasons of fire break-outs were 1) burning initiated for agricultural purposes but left uncontrolled or gone out



Pic. 4.4.4 Permafrost zoning of Baikal basin [3]

of control (52.8% of all fires); 2) other human causes – arson, accidents, etc. (45.7%); and 3) natural causes - dry thunderstorms, spontaneous ignition (0.8%).

Mudflows. Tectonic activity of the Baikal rift, deep faults that cause fracture and fragmentation of rocks, and weathering processes lead to accumulation of debris on mountain slopes, that gradually drifts down the slopes [10].

During prolonged rainfall (0.1-0.2 mm/min), short-term heavy showers (1.5-2.0 mm/min), and in the presence of permafrost (pic. 4.4.4), the rainwater flows down mountain slopes carrying along surface soil and debris. The mixture enters mountain rivers further gaining speed and mass. Mudflows incorporate and carry along large amounts of mud, rock debris, water, plant material, etc. The rivers and temporary river beds in the mountain ridges Hangarulskiy, Dzhidinskiy, Hamar-Daban and Ulan-Burgasy are prone to mudflow formation. Numerous mudflows were recorded for upper and middle reaches of the Dzhida river and the mountainous rivers Modonkul, Khamney, Zun-Naryn, Tsakirka, Ulyatuy, Borgoy and others.

In the Southern Baikal region (the slopes of Hamar-Daban ridge), mudflows of varied intensities were recorded in 1863, 1889, 1903, 1910, 1915, 1921, 1927, 1932, 1934, 1938, 1952, 1960, 1962, 1965 and 1971. Mudflows were observed for small rivers in the Selenga midlands, for example the rivers Kuytunka and Tarbagatay in 1914, 1950 and 1961. Strong mudflows that caused significant damage took place along the rivers Borgoy (in 1965) and Gryaznukha (in 1968). In addition, there is evidence of mudflows in different parts of the basin in 1960-1962.

Thus, the small rivers of the basin – Kuytunka, Tarbagatayka, Sukhara, Savva and Kyahtinka – are prone to mudflow formation. Mountain slopes formed by loose sand and sandy loams and areas with gully erosion in Tarbagatajsky, Mukhorshibir, Bichursk and Kyakhtinsky districts are especially vulnerable with respect to mudflow formation. The probability of a mudflow formation in the areas is equal to 0.08-0.2.

Erosion-accumulative processes. With the development of gully and river erosion, the erosion products are washed off into rivers, form sediments and contribute to silting and shallowing of small and medium-size rivers, that, in turn, contributes to the development of channel deformations [10]. Natural conditions within the basin, contribute to the high predisposition to the development of erosion processes (gully erosion and deflation). At the same time, intensive land use has led to the widespread erosion of hollows and slopes. Eolian processes are the processes of relief formation due to wind. During strong winds, dust storms take place that facilitate redeposition/redistribution of soil and changes in the microrelief. The processes actively proceed in areas with loose sand and disturbed soil and vegetation layer. The processes are widespread on the northern slopes of the mountain ridges Zaganskiy, Hudunskiy and Tsagaan-Daban, as well as in the interfluve area of the rivers Selenga and Chikoy. In some parts of the areas, zones of exposed moving sand are observed. The average index of deflation is equal to 0.01-0.5 (pic. 4.4.5).

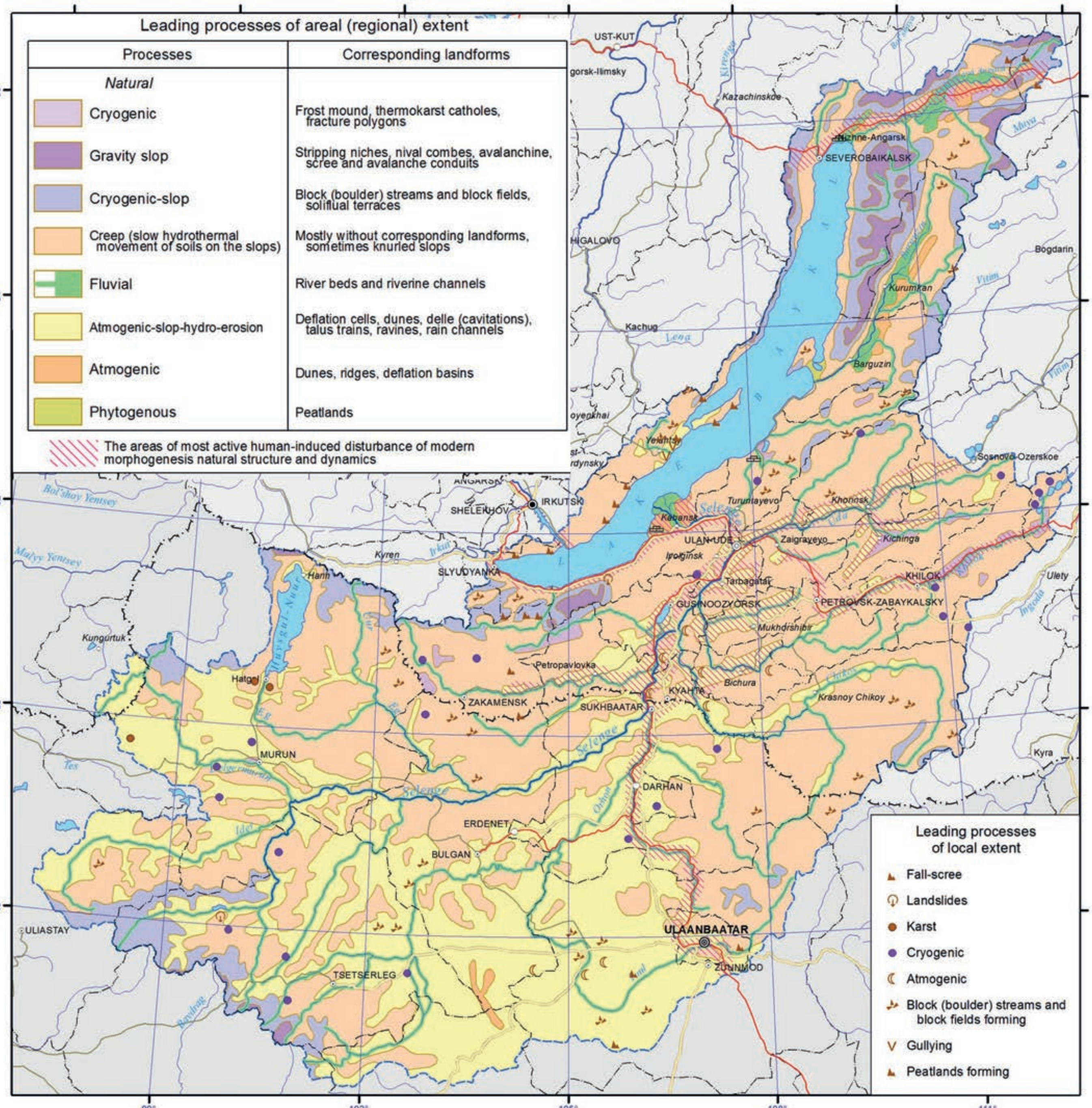
Erosion processes are ubiquitous in the basin and are observed in valleys of the rivers Selenga, Uda, Dzhida, Khilok and Chicoy. Active development of the processes is noticed in the steppe areas of the ridges Tsagaan-Daban, Malhanskiy, Zaganskiy and in the areas cleared of the forest. The density of gully erosion networks reaches 12 km/km^2 in some areas. Currently, there are 1.2 thousand gullies in the basin that are longer than 400 m. The total length of all the gullies is equal to 1.9 thousand km. The total area of erosion-affected land is in the range of 1-13/100 km/km^2, on average it is 5/100 km/km^2, and the density of gully networks is 0,03-0,19 km/km^2 (0.08 km/km^2). In areas with thick layers of loess deposits, gullies reach a length of 5-7 km and a depth of 40 m. Borgoy, Gusinoozersk, Tugnui and Uda valleys are affected by erosion to a lesser extent (0.3-1 km/km^2). On the slopes of the ridges Malhanskiy, Zaganskiy, Kudunskiy, and Kurbinskiy, linear erosion occurs in the areas cleared of the forest. The growth rate of gullies and ravines reach 0.5-26 m/year.

Within the basin, a high incidence of **anthrax** cases was recorded. As a result of an outbreak of anthrax in Kyakhtinskiy district (1999), 14 people fell ill and one died. Based on data from government agencies, there were 161 anthrax outbreak zones in Buryatia, among the areas at risk are Kabanskiy, Selenginskiyi, Zaigraevsky and Kyakhtinskiy districts. Diseases such as brucellosis, tuberculosis, leptospirosis, rabies, and foot and mouth disease also pose risks [10].

In **Mongolia**, the frequency of natural disasters has increased during the last decades. The increased frequency is often linked with and explained by climate change. The following natural disasters occur frequently: earthquakes (pic. 4.4.1), blizzards, heavy snowfalls, dust storms, “zuds” (harsh winters), flush floods (pic. 4.4.2), mud flows (pic. 4.4.5), wildfires, droughts, and desertification processes [2,9].

In 2008, natural disasters resulted in 82 human casualties, loss of 414918 heads of livestock, and economic damage of 3.5 billion tugrik. In 2009, there were 47 human casualties, 446402 heads of livestock lost, and 12.4 billion tugrik of economic damage sustained. In 2010 (the year of zud), the country sustained huge damages due to an unusually harsh winter resulting in loss of 9.7 million heads of livestock, 52.7 billion tugrik of damages and 8 human casualties. In 2011, there were 11 human casualties, 1100 heads of livestock lost and 2.8 billion tugrik of economic damage sustained.The following natural disasters took place in 2012: storms (13 events), heavy rainfall (2 events), extremely hot weather (2 events) and extremely cold weather (9 events). The conditions all together accounted for 1 human casualty and 6555 heads of livestock lost. Besides, roofs of 36 houses broke, 17 gers crashed and 58 electricity poles fell down.

Dzud is a Mongolian term for a severe winter in which large numbers of livestock die from starvation, cold or lack of water. There are various kinds of zuds, one of which is a white zud - an extremely snowy winter when livestock are unable to graze due to the tick snow cover. Another type of zud is a black zud, which is a cold snowless winter often preceded by draught conditions during summer. During a black zud, livestock dies primarily due to the lack of water, as well as starvation and cold. The most recent zud



Pic. 4.4.5 Modern exogenous processes of morphogenesis in Baikal basin [3]

Table 4.4.1 Damages caused by natural disasters during2010-2012

Year	Number of hazardous events	Number of people died	Number of livestock died	Economic damage (million tugrik)
2010	57	8	9 700 000	52 739.6
2011	70	13	1 100	2 807.2
2012	140	19	8 444	17 132.4

happened during winter of 2009-2010. 175 soums is 18 aimags were affected, 9.7 million heads of livestock died and the total economic damage sustained was estimated at 526.8 billion tugrik.

Droughts. With the prevailing arid and semi-arid conditions, Mongolia is a drought-prone country [2]. Most of the country's territory regularly experiences droughts. Drought takes place once in 10 years in the country's forest steppe and steppe zone, whereas in the desert zone the frequency is once in 2 years.

BIBLIOGRAPHY

1. State report "On the state of Lake Baikal and measures for its conservation in 2013" - Irkutsk. Siberian branch of "Rosgeolfond", 2014. - pp. 462. http://www.mnr.gov.ru/regulatory/list.php?part=1258 (in Russian)
2. State of the Environment in Mongolia, 2011-2012 (www.tsag-agaar.gov.mn/index.php/observation/environment)
3. Ecological atlas of the Lake Baikal basin – Irkutsk: Institute of Geography SB RAS. 2014. http://bic.iwlearn.org/ru/atlas/atlas
4. База данных Всемирной организации здравоохранения http://www.who.int/collaboratingcentres/database/ru/
5. Timoshkin O.A., Malnik V.V., Sakirko M.V., Boedeker K. Ecological crisis on Lake Baikal: Scientists make a diagnosis// Nauka is pervyh ruk. № 5 (59), 2014
6. (http://estandard.mn/filebase/files/4943-2011.pdf)
7. Khamnaeva G.G., Kulikov A.I., Tsydypov B.Z. On the current state of the environment in the town of Zakamensk and adjacent areas // Bulletin of BSAA - 2013. - №3. - p. 79-85.
8. Water Quality of the Kharaa River Basin, Mongolia: Pollution threats and hotspots assessment report, 2013
9. MEGD, «Strengthening Integrated Water Resource Management in Mongolia» project, «Integrated Water Management Assessment Report, Volume I», http://www.tuulgol.mn/dmdocuments/reports/national_report_volume1_english.pdf
10. Borisova T.A. Natural and anthropogenic risks within the Lake Baikal basin. Novosibirsk: "Geo", 2013. - 126 p.
11. State report "On the state of the environment and its proptection in the Republic of Buryataia in 2012". http://minpriroda-rb.ru/upload/iblock/9cb/frmoytmrq2013.pdf (in Russian)
12. State report "On the state of the environment and its proptection in the Republic of Buryataia in 2013". http://minpriroda-rb.ru/upload/iblock/26b/gocdoclad_2013.pdf (in Russian)

STATE REGULATION OF NATURE MANAGEMENT. ENVIRONMENTAL MOVEMENT

As far as transboundary cooperation in the field of environmental protection is concerned, the Russian Federation and Mongolia abide by international and state conventions and agreements. Both states signed Convention on Biological Diversity. Mongolia ratified the Convention in 1993 [1], while Russia ratified it in 1995 [2]. Mongolia is also a party to the Cartagena Protocol on Biosafety. Both countries have developed their national biodiversity strategies and roadmaps for biodiversity conservation [3].

In 1996, Lake Baikal was granted the status of a World Heritage site. The cultural landscape of the Orkhon river valley acquired the status in 2000. In accordance with the Convention concerning the protection of World Cultural and Natural Heritage, the states ascertained that these sites belong to the entire humanity, and all the counties must collaborate for their protection (paragraph 1, Article 6 of the Convention).

Cooperation on the issues of ecological safety and environmental protection began with the signing of the Agreement on the rational use and protection of the Selenga river basin in 1974. In 1988, both countries signed the Agreement on cooperation in water resource management on transboundary territories. In 1994, an agreement on cooperation in the field of environmental protection was signed by the governments of the Russian Federation and Mongolia. In 1995, the two countries signed the bilateral Agreement on the use and protection of transboundary waters, which replaced the two previous documents and regulating the following aspects [4, 5]:

- environmentally safe use of water resources, prevention of pollution and water level decline;
- hydrochemical, hydrobiological investigations and river channel research;
- joint flood control activities - research, assessment and planning;
- joint water monitoring and pollution prevention;
- maintaining conditions necessary for natural migration of fish and other aquatic fauna;
- development of the conceptual grounds for the management of water resources in river basins;
- development of common standards and procedures for pollution monitoring;
- information exchange on the planned measures in water resource management;
- joint financing of transboundary activities and attraction of international investment;
- prevention/mitigation of the negative impact on transboundary water basins on national territories.

Both countries have set up a joint working group on transboundary management of Lake Baikal basin under the leadership of the heads of state water resources departments. In 2006, the members of the working group met to discuss in detail joint activities for management of river basins. The Selenga river basin was proposed as the territory for a pilot project.

In 2008, an extended list of polluting substances was compiled, discharges of the substances were to be controlled by both states (heavy metals, oil products and mercury). In addition to that, an agreement was signed dealing with the bilateral assessment of transboundary areas of the Selenga river, its tributaries and health risks in Russia and Mongolia. Both countries undertake hydrological and hydrochemical monitoring, however their national data protocols are different.

In 2011, at a meeting held within framework of the Agreement on the protection and use of transboundary water channels both sides signed the final Protocol on bilateral cooperation. The joint working group discussed the issues of regular information exchange, cooperation on the Agreement implementation and adjustment of monitoring methods between the two countries as well as the list of regulated contaminating substances and water quality standards.

In 2013, meetings of the joint Russian-Mongolian working group (August 1-2, Irkutsk city) and the joint Russian-Mongolian commission (October 28th, Moscow city) were held within the frameworks of the bilateral Agreement. Progress in fulfilling the commitments made by parties, water protection and management measures for transboundary water bodies were discussed. Special attention was given to the prospects of developing a water management complex in the Selenga River basin. Joint initiatives of Mongolia and Russia have been mainly focused on the management of water resources of the Selenga River and the improvement of its water quality. Future management and cooperation should be based on the ecosystem model, uniting land and water components within the whole basin of Lake Baikal and henceforth aiming at the priority issues [3].

5.1 LEGAL REGULATION IN THE SPHERE OF ENVIRONMENTAL PROTECTION

The institutions involved in *environmental regulation* in Russia and Mongolia are the Ministry of Natural Resources and Ecology of the Russian Federation and the Ministry of Nature, Environment and Tourism of Mongolia. In 2002, the Government of Russian Federation set up a federal agency for protection of Lake Baikal environment (since 2012 renamed as the Territorial department for water resources of the Yenisei basin administration) in charge of coordinating cooperation with Mongolia on the issues of transboundary water resources [5].

In Russia, the Ministry of Natural Resources and Ecology is the federal body of executive power responsible for developing policies and regulations pertaining to the issues of environmental protection and monitoring. The Federal Agency for Supervision in the Sphere of Nature Management (Rosprirodnadzor) is the federal body of executive power exercising state supervision of Lake Baikal protection. Monitoring activities are also conducted by the Federal Agency for Hydrometeorology and Environment Monitoring (Roshydromet). The Federal Agency for Water Resources (Rosvodresursy) coordinates the use and protection of water resources and conducts water quality monitoring [3].

In 2007, the State Duma established the Interdepartmental Committee for Lake Baikal Protection which included representatives from the Russian Ministry of Natural Resources and Ecology, Rosprirodnadzor, representatives of Irkutsk region, the Republic of Buryatia, Zabaikalsky Krai, six federal ministries (for agriculture, economic development, emergency situations, industry and trade, energy and foreign affairs) and the Siberian Branch of the Russian Academy of Sciences. The mission of the Committee is the development and coordination of state policies for Lake Baikal protection. The Committee is also responsible for the implementation of legal documents in the field of environmental protection and rational management of natural resources within Lake Baikal Natural Territory, ecosystem monitoring and fulfilling the obligations of protecting the lake as a UNESCO world heritage site. During 2009-2012, the Committee held five sessions [3].

In 2013, two sessions of the newly composed Interdepartmental Committee were held (the new composition of the committee was announced by the order of the Ministry of Natural Resources and Ecology №148 dated April 18, 2013) (pic. 5.5.1) [4].

Pic. 5.1.1 A meeting of the Interdepartmental Committee for Lake Baikal Protection with the participation of the Minister of Natural Reesources and Ecology Donskoy S.E. (July 29, 2013, Ulan-Ude).

In 2013, as a result of the committee's work, the following activities were excluded from the List of activities prohibited within the Central Economic Zone of the Lake Baikal Natural Territory:

- bottling the lake's water;
- processing of wild plants, and vegetables, fruits and berries from individual households and farming enterprises;
- production of plant-based medicinal preparations.

Major legal documents of Russia.

Law on Lake Baikal Protection (1999, amendments were made in 2004, 2006, 2008 and 2011). This law is the only federal law, regulating the issues of water protection and use of natural resources in a particular region. The law includes 4 major sections:

- major provisions defining Lake Baikal Natural Territory, including the Central Ecological Zone, the Buffer Zone covering the lake basin area within the Russian Federation, and the Zone of Atmospheric Impact;
- protection regime of Lake Baikal Natural Territory, prohibiting or restricting certain types of economic activities, identifying the ways of protecting endemic animals and plants, managing the land and forest resources, and organizing tourism and recreation (pic. 5.1.2);
- thresholds of maximum permissible impact on the unique ecological system of the lake and Lake Baikal Natural Territory;
- state regulation in the area of Lake Baikal protection, making provisions for the development of integrated approaches to the use and protection of natural resources of Lake Baikal Natural Territory, the environmental certification of economic activities, the prohibition or conversion of the most dangerous activities, and conducting the state environmental supervision and monitoring.

The law provides the basis and coordination structure for the protection of Lake Baikal. The implementation of the law is based on and regulated by the adopted by-laws [3].

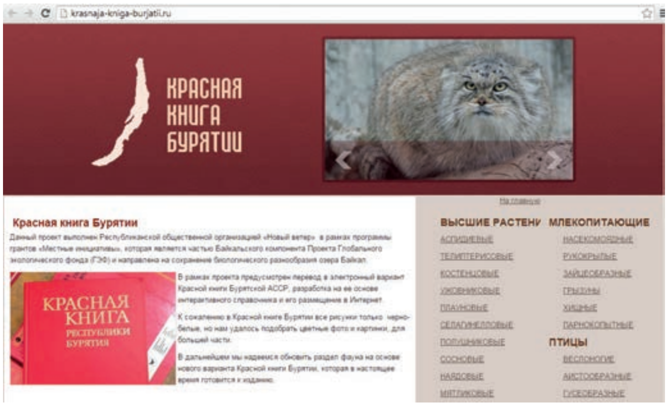
Рис. 5.1.2 A banner with a description of the prohibited activities within the water protection zone

The Government of the Russian Federation passed a number of resolutions: Decision № 643 of 2001 on the legal regulation of nature management; Decision № 1641-P, 2006 on the demarcation of ecological zone boundaries within LBNT; Decision № 234 of 2001 on the regulation of Lake Baikal water level by Irkutsk hydro-electric power station. The Decision of the Government of the Russian Federation № 67 of 2002 established the guidelines for catching endemic aquatic species and gathering endemic species of aquatic plants.

Environmental regulation arising out of the government decisions restricts the scope and character of natural resource use, imposing high requirements towards the industrial processes and water treatment facilities, towards the development and implementation of the respective measures, requiring additional material and financial resources [5].

Law on environmental protection (2002) defines the legal basis for state policies in the field of environmental protection on the basis of the balanced environmental and social-economic development. The law identifies key notions, mechanisms, instruments and priorities for protection of the environment, including surface and ground waters, forests, vegetation, and biodiversity. One of the provisions of the law stipulates that the Russian environmental legislation is based on the Constitution of the Russian Federation and comprises a set of federal laws and strategies as well as regional laws.

Law on the animal world (2004) regulates the relations in the area of animal world protection, including preservation and restoration of the natural habitats with the purpose of maintaining biological diversity, sustainable use of all components of the ecosystems. The animal world is the state property in the Russian Federation. Considered federal property are the rare and disappearing species recorded in the Red Book of the Russian Federation as well as the species inhabiting specially protected natural territories of the federal level (pic. 5.1.3).



Pic. 5.1.3 The website “Red book of the Republic of Buryatia”

Water code (2006) regulates protection of coastal territories and land around water bodies. Modern water resource management should be based on the use of a basin-wide approach. Lake Baikal is part of the Angara-Baikal water basin (pic. 5.1.4). The code stipulates the sphere and degree of responsibility of government agencies in water resource management.


Pic. 5.1.4 A meeting of the Yenisei river basin council (April 3, 2014; Ulan-Ude city).

Forest code (2007) regulates protection of forests, conservation of their biological diversity, use of forest resources taking into account their global ecological significance, forest reproduction, improvement their quality and productivity, preservation of forest’s environment-forming, water-protecting, sanitary and recuperative functions. The use, protection and restoration of forests are carried out based on the idea of forest as an ecological system or a natural resource. The code makes provisions for establishment of a legal regime for the forests located within specially protected territories and water-protection zones.

Law on fishing and protection of aquatic bio-resources (2004) regulates the establishment of water quality standards for water bodies important for fishing and sets the requirements for water bodies. The law also facilitates the protection of water bodies with the purpose of conserving valuable species of fish and other aquatic bio-resources. For this purpose, the Law allows for the establishment of specially protected territories with respect to fish species. The implementation of the Law is impeded by the absence of special legal norms for the establishment of such territories.

Law on specially protected natural territories (1995, with 2008 amendments) introduces permanent federal control over specially protected natural territories, identifies categories of specially protected natural territories, and delineates the competencies of federal and regional authorities. The law sets up the legal frameworks for the establishment and management of specially protected natural territories with the purpose of protecting biological diversity.

In 1999, **the Government of Mongolia** approved National Water Program and, in 2000, set up the National Water Committee, which is in charge of the implementation, regulation and control of the program, and coordination and control over implementation of water-related policies.

National Water Committee upholds the implementation of water-related policies for the rational use of water resources, their restoration, conservation, pollution prevention and the provision of consumers with the sufficient amount of drinking water. National Water Committee plays the role of an interdepartmental coordination center for the respective ministries and fragmented sector of water resource management. National Water Committee administers the National Program for protection of water sources developed by the Ministry of Environment and Green Development.

From 2012, National Water Committee is subordinate to the administration of the prime minister. Ministry of Environment and Green Development is responsible for the coordination of all the ministries dealing with water resources, such as the Ministry of civil engineering, Ministry of industry and agriculture, and Agency for special control, which establishes environmental and water quality standards and identifies law violations [3].

Legislation basis of Mongolia [5].

Law on water (2004, replaced by the new Law on Water in 2012) regulates the relationships arising out of the regular use, protection and restoration of water resources and water-catchment areas. In accordance with Article

19, councils for river basins or water-catchment areas are established as a way to involve the local population in water resource management with the purpose of protection, sustainable use and restoration of water resources.

Law on specially protected territories (1994) puts into place the system of protected territories at the national and local levels and sets up administrative norms for the national specially protected territories. The law regulates the use and acquisition of land for the protection and conservation of valuable resources having biological, landscape and scientific value.

Law on environmental protection (1995 г.) aims at the protection, sustainable development and restoration of natural resources. It identifies the right over natural resources stating that «land, its natural resources, forests, water, animals, plants and other natural resources are protected by the state and are considered property of the state unless they constitute the property of Mongolian citizens».

Law on forests (2007**)** regulates protection, possession and reproduction of forests. Any activities are prohibited within the protected forests «with the exception of construction of the required infrastructure, forest restoration, purification and use of non-woody resources».

Law on raw materials (1997) regulates the exploration and mining activities in Mongolia. Article 30 of the law identifies the area of responsibility of proprietors in the field of environment protection, mining licenses, including the requirement for conducting environmental impact assessment and designing environmental management plan. Such responsibility includes specific measures for mitigating detrimental impact on the natural environment.

Law on the prohibition of rock mining in the upper reaches of rivers, protection zones of water objects and forests (2009). This law restricts mining in the watershed area and revokes licenses from the enterprises hitherto functioning on the territories.

There are eight other laws related to the water resource management, including the Law on sanitation and hygiene, the Law on industrial and domestic wastes, and the Law on urban water supply and sewage systems. On the whole, the body of laws incorporates more than 40 rules and standards related to water [3].

5.2 ENVIRONMENTAL PROGRAMS, PLANS AND THEIR IMPLEMENTATION

In 2012, for the first time after the suspension of financing of the federal target program «Ecology and natural resources of Russia (2002-2010)», including the sub-Program «Protection of Lake Baikal and Lake Baikal Natural Territory», the Federal target program «Protection of Lake Baikal and socio-economic development of Lake Baikal Natural Territory in 2012-2014» was approved by the resolution of the Russian Government № 847 on August 21, 2012 [4].

The Program states that the objective of protecting the lake, a UNESCO world heritage site, with the achievement of high economic standards as part of the sustainable development strategy is in agreement with the priority tasks of socio-economic development of the Russian Federation. The problems existing within Lake Baikal Natural Territory require an integrated solution. Such a solution would be achieved through the use of program-target method, based on the interrelationship of tasks and objectives, the complex character and unified approaches to the problem resolution.

The Program includes a set of measures for conducting environmental assessment, developing and implementing the mechanisms of state support to environmental damage mitigation activities, and for developing a system of specially protected natural territories of the federal level.

Conservation of the unique ecosystem of Lake Baikal is a state mission, therefore funding for the Program is to be provided from the federal budget and the budgets of the Russian Federation subjects.

The objective of the Program is the protection of Lake Baikal and Lake Baikal Natural Territory from the negative impact of anthropogenic, technogenic and natural factors.

The total amount of the Program funding for 2012-2020 is 58 158.5 million rubles in the prices of the respective years, including:

- funding from the federal budget – 83.2 % (48 381.1 million rubles, including expenditures for capital assets – 33 513 million rubles; scientific research – 464.1 million rubles; other needs – 14 404 million rubles);
- funding from consolidated budgets of the subjects of the Russian Federation – 14.4 % (8 374.9 million rubles);
- funding from non-budget sources – 2.4 % (1 402.5 million rubles).

The financing will be allocated to the three regions – Irkutsk region, Republic of Buryatia and Zabaikalsky Krai. This can help to resolve up to 80% of all the environmental problems within Lake Baikal Natural Territory.

The state commissioner-coordinator of the Program is Ministry of Natural Resources and Ecology of the Russian Federation. The state commissioners of the Program are Ministry of Regional Development, Federal Subsurface Management Agency, Federal Agency for Water Resources, Federal Agency for Fishing, Federal Agency for Supervision in the Sphere of Nature Management, Federal Agency for Hydrometeorology and Environmental Monitoring.

To achieve the outlined goal, the following tasks are to be realized:

- reduction of contaminant discharges into water bodies within Lake Baikal Natural Territory;
- reduction of waste volumes and waste-derived pollution within the territory, particularly through remediation of the lands exposed to high and extremely high pollution;
- efficient utilization of the recreational potential of specially protected natural territories;
- conservation and restoration of biological resources within the territory;

- development of the state environmental monitoring within the territory;
- development of a shore reinforcement system for Lake Baikal and other water bodies within the territory.

The Program will be implemented in two stages during 2012-2020. During the stage I (2012-2015), the highest priority tasks will be implemented. As a result of the stage I implementation, approaches for the implementation of environmental protection measures will be designed. During the stage II (2016-2020) it is planned to complete the priority projects as well as widen the scope of environmental activities within Lake Baikal Natural Territory.

To provide the legal basis for the Program implementation, the Ministry of natural resources issued the following orders in 2012:

1) № 296 issued on September 27, 2012 - «On the format of an agreement on granting subsidies to the subjects of the Russian Federation from the federal budget for co-funding environmental activities, as stipulated by the federal target program "Protection of Lake Baikal and socio-economic development of Lake Baikal Natural Territory during 2012-2020". The order defined the agreement format, including the procedures and conditions of granting subsidies, rights and duties of the parties;
2) № 403 issued on November 28, 2012 – «On the approval of Regulations on the management of the federal target program «Protection of Lake Baikal and socio-economic development of Lake Baikal Natural Territory during 2012-2020» approved by the resolution of the Government of the Russian Federation № 847 issued on August 21, 2012».

The Regulations define:

- modalities of the Program management and cooperation of state commissioners;
- modalities of planning activities and budget for the Program implementation;
- mechanisms for correcting/revising the planned activities and provision of resources for the activities during the course of the Program implementation;
- procedures for ensuring public access to (openness of) the information on target indicators and parameters, results of the Program implementation monitoring, the Program activities and conditions on which executing agencies take part in them, as well as on tenders/competitions held and their criteria.

With the purpose of enhancing the efficiency of the Program implementation, on December 26, 2013 the Government of the Russian Federation adopted the Resolution №1295 «On the introduction of changes into the federal target program «Protection of Lake Baikal and socio-economic development of Lake Baikal Natural Territory during 2012-2020». The changes touched upon the program budget [4].

The program was designed to achieve such targets as up to 50% reduction of pollutant discharges into Lake Baikal and remediation of up to 80% of the polluted lands within Lake Baikal Natural Territory. Besides, it is planned to implement measures aimed at reducing the current negative impact and improving the system of environmental monitoring of Lake Baikal Natural Territory [3].

Apart from that, the Program includes a set of measures for conservation of biodiversity, minimization of natural hazards characteristic to the region, and development of ecotourism. The Program makes provisions for a set of priority measures to be funded from the federal budget, including the measures aimed at developing the specially protected natural territories and implementing nature protection measures at the site of the former Dzhidinsky plant in the Republic of Buryatia, Baikalsk Pulp and Paper Mill and other sites.

In 2013, 1 182.2 million rubles were allocated for the Program implementation (including 992.9 million rubles from the federal budget, 49.3 million rubles from the consolidated budget of federation subjects, and 140 million rubles from non-budget sources). The actual expenditures for the Program implementation amounted to 104%. The expenditures covered by the federal budget were 98 %, and expenditures covered by other, non-budget, sources were 144 % (140 million rubles were planned to be spent, but 201.36 million rubles were actually spent). At the cost of non-budget means, 473.6 thousand tons of waste of Dzhidinsky tungsten-molybdenum plant were processed [4].

In 2013, Lake Baikal protection activities received additional funding, besides the federal target program, of 205.70 million rubles (156.58 million rubles in 2012) from the federal budget.

The institutions of executive power of the subjects of the Russian Federation located within Lake Baikal Natural Territory provided 62.582 million rubles in 2012 and 235.08 million rubles in 2013 for the following regional activities:

- Target program «Environmental safety in the Republic of Buryatia during the period till 2017» – the funding provided was 23.823 million rubles in 2012 and 33.264 million rubles in 2013;
- Long-term target program «Protection of the environment in Irkutsk region in 2011-2015» - 36.639 million rubles were allocated in 2012 and 206.623 million rubles in 2013.

In **Zabaikalsky Krai**, major building renewals were underway in the town of Khilok in 2012-2013. The works were funded from the federal budget, while 2.12 million rubles in 2012 and 1.463 million rubles in 2013 were allocated from the regional budget in co-funding.

The Republic of Buryatia allocated 112.3 million rubles from its budget for funding environmental activities, 56.1% of that was co-funding for the federal target program «Protection of Lake Baikal and socio-economic development of Lake Baikal Natural Territory during 2012-2020» [4].

The UNDP-GEF project «Integrated natural resource management of Lake Baikal transboundary ecosystem» is being realized in Russia and Mongolia since 2011. Based on the several decade-long bilateral cooperation between Russia and Mongolia over transboundary water resources and the economic rise of mining and tourism sectors, the support from GEF is catalyzing the development and implementation of the Strategic Action Plan for management and conservation of the transboundary ecosystem of Lake Baikal basin.

The project supports the efforts of the governments and civil society of both countries to include environment protection measures into their policies and practices with the purpose of protecting and rational use of the unique transboundary ecosystem of the Lake Baikal basin.

The main aim of the project is to facilitate integrated management of natural resources of Lake Khuvsgul and Lake Baikal for achieving ecosystem resilience and sustaining water quality within the wider context of sustainable development. Since 2012, 65 tenders were organized within the project frameworks, i.e. 65 contracts were signed for implementation of a range of activities in Russia and Mongolia.

5.3 THE SYSTEM OF STATE ENVIRONMENTAL SUPERVISION

In 2011, according to the Federal law № 242-FL of July 18, 2011 «On the introduction of changes to the separate legislation acts of the Russian Federation on the issues of exercising state control (supervision) and municipal control» changes were introduced to article 65 «State environmental supervision» of the Federal law №7-FL of January 10, 2002 «On environmental protection» [6].

According to the new edition, the objective of environmental supervision is the organization and conducting of checks, adopting measures stipulated by the legislation for prevention and (or) annihilation of consequences of violations, and systematic observations of compliance with the compulsory requirements.

State ecological supervision includes:

- state supervision of geological research, rational use and protection of mineral resources;
- state supervision in the area of land use;
- state supervision in the area of waste management;
- state supervision in the area of atmospheric air;
- state supervision in the area of use and protection of water objects;
- state ecological supervision on the continental shelf of the Russian Federation;
- state environmental supervision in the domestic sees and territorial waters;
- state environmental supervision in the exclusive ecological zone of the Russian Federation;
- state environmental supervision in Lake Baikal protection;
- federal state forest supervision;
- federal state supervision in the area of protection, reproduction and use of animal world resources and their habitats;
- federal state supervision in the area of fishing and protection of aquatic bio-resources;
- federal state hunting supervision;
- state supervision in the area of protection and use of specially protected natural territories.

According to Article 19 «State ecological supervision in the area of Lake Baikal protection» of the Federal law № 94-FL of May 1, 1999 «On protection of Lake Baikal», state environmental supervision is performed by the federal bodies of executive power and the bodies of executive power of the Republic of Buryatia, Zabaikalsky Krai and Irkutsk Oblast, based on the legislation of the Russian Federation and the legislation of the respective federation subjects [4, 6].

In 2013, the number of enterprises under state environmental supervision slightly reduced. There were 551 enterprises (623 in 2012) within Lake Baikal Natural Territory, including 171 (195 in 2012) within the central ecological zone, 101 (112 in 2012) within the zone of atmospheric impact, and 279 (316 n 2012) within the buffer zone. Within Lake Baikal basin there were 511 enterprises. In total, within Lake Baikal Natural Territory there were 2847 units under environmental supervision, among them 1459 in the Republic of Buryatia, 767 in Irkutsk region and 621 in Zabaikalsky Krai.

In 2012-2013, the federal environmental supervision included 727 inspections (416 in 2012) within Lake Baikal Natural Territory with the purpose of enforcing environmental legislation, including:

- state supervision of geological research, rational use and protection of mineral resources – 116 inspections (62 in 2012);
- state supervision of land use – 124 inspections (71 in 2012);
- state supervision in the area of waste management – 184 inspections (109 in 2012);
- state supervision in the area of atmospheric air – 132 inspections (74 in 2012);
- state supervision in the area of use and protection of water bodies – 126 inspections (68 in 2012);
- federal state supervision of forestry within specially protected natural territories – 23 inspections (11 in 2012);
- state supervision in the area of use and protection of specially protected natural territories – 19 inspections (21 in 2012).

As a result of the inspections, 619 violations were identified in 2013, which was 61% more than was recorded in 2012 (385 violations). In 496 violation cases, precepts and fines were issued amounting to 12002.8 thousand rubles (6931 thousand rubles in 2012). 6576.6 thousand rubles of fines were paid (4132 thousand rubles in 2012). 237 individuals were called to administrative responsibility (186 individuals in 2012).

In 2013, 639 inspections were conducted within the frameworks of regional environmental supervision, the number was 20% less than that in 2012 (794 inspections). The number of identified violations was 599, which was 48% less than in 2012 (1144 violations). In 401 violation cases, legal percepts and fines were issued amounting to 10214 thousand rubles (9 075.4 thousand rubles in 2012), 5 183 thousand rubles of which (5 083.4 thousand rubles in 2012) were paid. 485 individuals (765 individuals in 2012) were called to administrative responsibility.

In 2012-2013, state control over domestic water transport was performed by East-Siberian branch of the state river supervision service of Rostransnadzor. During the navigation period of 2012-2013, inspections of 169 vessels (161 vessels in 2012) on Lake Baikal were conducted and

642 violations (430 in 2012) of safety standards were identified. 95 percepts (68 in 2012) ordering rectification of the violations were issued, 27 vessels were banned from operating until the violations are eliminated; 14 legal entities and 20 officials (108 in 2012) were fined for a total of 1 054800 rubles (175 200 rubles in 2012).

5.4 STATE ENVIRONMENTAL EXPERTISE

The system of state environmental expertise (SEE) is regulated by the Federal Law № 174-FL of November 23, 1995 «On environmental expertise». The objects of state environmental expertise of the federal level, including project documentation for construction within specially protected natural territories, are listed in Article 11, while the objects of state environmental expertise of the regional level are listed in Article 12.

Within Lake Baikal Natural Territory, the branches of Federal Agency for Supervision in the Sphere of Nature Management («Rosprirodnadzor») in Irkutsk Oblast, the Republic of Buryatia and Zabaikalsky Krai jointly with the bodies of executive power are implementing the state policies in the field of environmental expertise [4, 6].

The central unit of Federal Agency for Supervision in the Sphere of Nature Management conducted state environmental expertise of the entities located within BNT based on the following documents:

- documentation substantiating the total permissible catch of aquatic bio-resources in Lake Baikal and its tributaries Barguzin, Selenga, Upper and Angara in 2013 (including the environment impact assessment). The expertise was ordered by Rosrybolovstvo and FSA VNIRO (2012).
- remediation of the closed facility of mercury cell electrolysis in the town of Usolye-Sibirskoe (project documentation). The commissioner was Ministry of Natural Resources and Ecology of Irkutsk region (2013)
- documentation substantiating the total permissible catch of aquatic bio-resources in Lake Baikal and its tributaries Barguzin, Selenga, Upper and Angara in 2014. The expertise was ordered by Rosrybolovstvo (2013).

Irkutsk Oblast. In 2012, the branch of Federal Agency for Supervision in the Sphere of Nature Management («Rosprirodnadzor») in Irkutsk Oblast conducted state environmental expertise of 2 entities located within Lake Baikal Natural Territory:

- documentation substantiating the total permissible catch of aquatic bio-resources in fresh-water bodies of Irkutsk Oblast in 2013;
- project documentation for «Reconstruction of ferry boat harbor facilities in the village of Sakhyurta, Olkhon Island in Olkhonsky district of Irkutsk Oblast».

The state environmental expertise approved both the above projects. A negative assessment was given to the project documentation on «Modifications to the design of solid waste landline in the village of Markovo», based on the state environmental expertise conducted in 2011.

In 2013, state environmental expertise was conducted for one entity:

- documentation substantiating the maximum permissible catch of aquatic bio-resources in fresh-water bodies of Irkutsk region in 2014-2018. Approval was issued.

In 2012, Ministry of Natural Resources and Ecology of Irkutsk region conducted the environmental expertise of 2 entities within Lake Baikal Natural Territory, including:

- documentation substantiating the limit of procurement of wild hoofed animals, bear and fur-bearing animals during 2012-2013;
- documents of complex environmental investigation of the parts of state natural sanctuary «Okunaisky» (Swan lakes) substantiating granting of the legal status of a specially protected natural territory to the sanctuary. State environmental expertise resulted in positive assessments of the above proposals.

In 2013, regional level state environmental expertise was conducted for the following:

- documentation substantiating the limits (quotas) for procurement of animal resources within Irkutsk region during the hunting season from August 1, 2013 to August 1, 2014;
- documentation substantiating the introduction of changes into the limits (quotas) for procurement of animal resources within Irkutsk region in the period till August 1, 2014, approved by the order of the Governor of Irkutsk region №264-GO of July 31, 2013;
- documentation on complex environmental examination of the territories substantiating granting of the legal status of a specially protected natural territory to “Ulsetskaya Grove” (Batorova Grove) in Alarsky district of Irkutsk region;
- documentation substantiating the creation of an area of traditional environmental management in Kachugsky district of Irkutsk region. All the above proposals received positive reviews and were approved.

Republic of Buryatia. In 2012, the branch of Federal Agency for Supervision in the Sphere of Nature Management («Rosprirodnadzor») in the Republic of Buryatia organized and conducted state environmental expertise of 4 entities, 2 of which were located within a specially protected natural territory of the federal level («Tunkinsky national park»):

- design documentation for «Construction of an inter-municipal landline for municipal solid waste in the village of Toltoy, Tunkinsky district».
- documentation substantiating the amount of total permissible catch of aquatic bio-resources in water bodies of the Republic of Buryatia in 2012;
- documentation substantiating the quotas for hunting within «Tunkinsky national park» during the hunting season of 2012-2013;
- design documentation for «Constriction of a landline for municipal solid waste in Severobaikalsk city of the Republic of Buryatia». All the proposals received positive assessments.

In 2013, the branch of Federal Agency for Supervision in the Sphere of Nature Management («Rosprirodnadzor») in the Republic of Buryatia conducted the state environmental expertise of 3 entities within Lake Baikal Natural Territory:

- documentation substantiating the amounts of total permissible catch of aquatic bio-resources in water bodies of the Republic of Buryatia in 2014;
- documentation substantiating the limits and quotas for hunting within the area of the national park «Tunkinsky», where sport and amateur hunting is allowed, during the hunting season of 2013-2014;
- design documentation for «Fire fighting and chemical station of 2nd type in Zabaikalsky national park». All the above proposals received positive reviews.

Ministry of Environment of the Republic of Buryatia conducted the state environmental expertise of 3 regional level entities:

- design documentation for «Renovation of housing quarters of the camp «Rovesnik» in the village of Maksimikha»;
- documentation substantiating the limits and quotas for hunting within the Republic of Buryatia during the hunting season of 2013-2014;
- design documentation for «Reconstruction of the road connecting the main road Shergino – Oymur – Zarechie and the village of Noviy Enkhaluk in Kabansk district of the Republic of Buryatia». The projects received positive assessments.

Zabaikalsky Krai. In 2012-2013, the branch of Federal Agency for Supervision in the Sphere of Nature Management ("Rosprirodnadzor") in Zabaikalsky Krai did not receive applications for state environmental expertise.

Environmental monitoring. In 2012-2013, environmental monitoring was carried out by the departments of Rosgydromet, Rosprirodnadzor, Rosvodresursy, Rosnedra, Rosreyestr as well as the competent authorities of the three federation subjects – the Republic of Buryatia, Irkutsk Oblast and Zabaikalksy Krai. In addition to that, the data of Rospotrebnadzor, Rostransnadzor, Rosstat, Rostehnadzor, Ministry of Emergency Situations were used for conducting the monitoring [4,6].

In 2013, the resolution of the Government of Russian Federation № 681 of August 9, 2013 introduced the Regulations regarding the state environmental monitoring and the data obtained through environmental monitoring. The Regulations establish procedures for meeting the requirements of the Articles 63.1 and 63.2 of the Federal Law №7-FL of January 10, 2002 «On environmental protection» (in its 2011 revision, № 331-FL dated November 21, 2011).

Creation and maintenance of observation networks and information resources within subsystems of the unified monitoring system is the responsibility of the Federal Agency for Hydrometeorology and Environmental Monitoring, with the help of the federal institutions of executive power authorized to conduct environmental monitoring and the regional institutions of executive power in accordance with their mandate defined by legislation of the Russian Federation.

According to the Regulations, «State fund is the federal information system ensuring collection, processing and analysis of data», and it includes:

а) data contained in the databases of the subsystems of the unified monitoring system;

б) data obtained through industrial monitoring and state environmental supervision;

в) data of the state register of entities having negative impact on the environment.

Annex of the Regulations regarding the state environmental monitoring and the data obtained through environmental monitoring contains the List of the types of information to be included into the state fund of environmental monitoring data.

A type of information included in the list is the data obtained through state environmental monitoring of the unique ecosystem of Lake Baikal as one of the 15 subsystems of the unified system of state environmental monitoring.

In 2013, the resolution of the Government of the Russian Federation №477 approved the Regulations regarding state monitoring of the environment. The Regulations define the procedures for conducting the state environmental monitoring as well the procedures for establishing a state system of environmental observation.

The Regulations state that atmospheric air, soils, surface waters, ozone layer, ionosphere and circumterrestrial space are the objects of state environmental monitoring. The state environmental monitoring is organized and conducted by the Federal Agency for Hydrometeorology and Environmental Monitoring, with the help of the federal and regional institutions of executive power in accordance with their mandate.

In 2012-2013, the special monitoring of Lake Baikal water with respect to hydrochemical and hydrophysicochemical parameters was conducted by «Vostsibregionvodkhoz» of Rosvodresursi. The monitoring was carried out using the measurement complex «Akvatoria-Baikal» installed on the research steam-boat «Istok» (pic. 5.4.1).

Pic. 5.4.1 The onboard measurement complex «Akvatoria-Baikal»

The conducted comparative analysis of 2012-2013 data and the data acquired in the previous years showed that Lake Baikal is generally clean and that the lake's water, even in the southern part of the lake, has not experienced the impact leading to irreversible changes. Based on the results of the monitoring, «Analytical report on the results of observations on the state of water bodies within the zone of «Vostsiberregionvodkhoz» activities in 2012» and «Analytical report on the results of observations on the state of water bodies within the zone of «Vostsiberregionvodkhoz» activities in 2013» were compiled. The results of the monitoring were published on the official website of «Vostsiberregionvodkhoz» (www.vodhoz38.com).

The monitoring results obtained using the measurement complex «Akvatoria-Baikal 2» for 15 most informative sites for Lake Baikal protection (1 – Baikal pulp-and-paper mill, 2 – Slyudyanka, Kultuk, 3- the Selenga delta, 4 – Chivyrkuyski bay, 5 – Yarki islands, Nizheangarsk, 6 – Severobaikalsk, 7 – Zama, 8 – Maloe More, 9 – Mukhor and Olkhon Gate Bay, 10 – Anga, 11 – Buguldeika, 12 – Peschanaya, 13 – Goloustnue, 14 – Listvyanka and Port Baikal, 15 – Irkutsk water reservoir) during 2003-2007 are presented on the official website of the Ministry of Natural Resources of the Russian Federation – «Protection of Lake Baikal» (www.geol.irk.ru/baikal).

Space observations of Baikal natural territory in 2012 were continued by «Rosgeolfond» using the equipment capable of receiving information directly from the space apparatus intended for environmental purposes. Since 2002, the results of space observations have been published on the official website of the Ministry of Natural Resources – «Protection of Lake Baikal» (www.geol.irk.ru/baikal) in the section on Space monitoring of Lake Baikal Natural Territory. In 2013, 11 984 information products (11 659 in 2012) were prepared based on the monitoring of Lake Baikal Natural Territory, including 6172 products (6152 in 2012) for loading in GIS.

Since 2013, a new information product – Lake Baikal surface water temperature [7]. Data for the information product come from the satellites TERRA and AQUA and are processed using the software package IMAPP (International MODIS/AIRS Processing Package).

An important result of space monitoring is the continued formation of temporary data sets for studying the dynamics of natural conditions and solving scientific and applied tasks.

5.5 ENVIRONMENTAL EDUCATION

Environmental education and information dissemination raise public awareness and facilitate public participation in tackling the issues of biodiversity conservation, natural resource management and sustainable development of Baikal region and depend entirely on the educational level of the society in general [3].

Environmental education and awareness-raising campaigns are aimed at solving the following tasks:

- modification of study programs to include/enhance environmental education and publication of textbooks incorporating environmental education aspects;
- organization of extracurricular activities, summer schools and conferences;
- environmental awareness raising through mass media and publication of specialized journals;
- information dissemination and educational activities (for example, festive events during the World Environment Day, World Day of Water Resource Protection, International Birds Day and Day of Baikal);
- training of teachers specializing in environment-related issues at the regional and municipal levels.

There are two UNESCO chairs in Baikal region (University Twinnings). The chair of water resources was set up according the agreement between the UN (UNESCO) and Irkutsk State University signed on March 30, 2001. This is the only chair for water resources in Russia. Savoy University of France acted as the foreign counterpart. Apart from the departments of Irkutsk State University, the chair cooperates with Buryat State University, Institute of Earth Crust SB RAS, Vinogradov Institute of Geochemistry SB RAS and Baikal Institute of Nature Management SB RAS (the head of the chair is Prof. Smirnov A.I.)

The research activities of the chair have the following directions:

- study of the qualitative and quantitative composition of natural waters within the research area;
- development of the theoretical and methodological basis for integrated management and rational use of water resources, research into the interconnectedness and interaction of the surface and underground layers of the hydrosphere;
- expansion of the geopolitical analysis of water resources, a field of expertise of Savoy University;
- creation of an open access database of water resources within the research area.

The international project «Water resource network» is considered one of the main ways of implementing the priority tasks. «Water resource network» has been established by Irkutsk State University and Savoy University with UNESCO support and now, besides the universities, includes Mongolian National University, several water resource departments in the Mediterranean region, Institute of Geochemistry SB RAS, Institute of Geography SB RAS, and Buryat State University. In 2009, an agreement on cooperation was signed by UNESCO and «Water resource network» within the frameworks of UNITWIN/UNESCO program.

In 2013, talks were held in Chambery city (France) regarding further development and expansion (both spatially and functionally) of «Water resource network». Furthermore, in August of 2013, Summer School was conducted at Biology station of Irkutsk State University in the village of Bolshie Koty, near Lake Baikal. During the event, meetings and talks took place over the future of the Network. A fundamental two-volume book «Baikalology» was prepared and published, which was among four best books in the field of natural sciences, technology and medicine at the All-Russian contest «Best books of 2012».

The UNESCO chair for environmental ethics at the East-Siberian State University for Technology and Management («VSGUTU») in Ulan-Ude (Republic of Buryatia) was set up in April 2006 by the decision of UNESCO General Conference (the chair head is Prof. Saktoev V.E., the University President).

By now, the chair has delivered the following research output:

- conceptual basis for the international UN-supported project «Baikal model territory of sustainable development»;
- conceptual basis for socio-economic development strategy for the Republic of Buryatia;
- Baikal declaration of environmental ethics;
- concept of «moral» economy aimed at conservation of Lake Baikal Natural Territory;
- conceptual basis for sustainable tourism development in Baikal region.

The research results are embedded into the educational process along the following directions:

- a masters' program in the field of sustainable development and environmental ethics was developed based on the expertise of the chair personnel and personality-oriented teaching approach;
- the lecture course «Philosophy of sustainable development and science ethics in the information age» was developed to be taught to young scientists, Ph.D. and Master students of the East-Siberian State University for Technology and Management;
- the club "Millennium" continued its fruitful work with grade 1-9 secondary school students.

Irkutsk Oblast. Baikal Museum of the Siberian Branch of the Russian Academy of Sciences located in the village of Listvyanka receives about 90 thousand visitors per year. The number includes school and university students, teachers, representatives of Russian and foreign companies, governments, and state organizations, and forum/conference participants (pic. 5.5.1).

Pic. 5.5.1 An excursion at the Baikal Museum

Research and educational activities of the Museum rely on 8 expositions and include the following regular events: Oblast-wide ecological summer school on Baikal studies, Day of Knowledge, «Baikal connoisseurs» competition, and an international competition in Baikal studies. In 2012, the Museum hosted 6 thematic expositions.

Environmental education center of the Museum is equipped with a computer room and the «microscope-computer» system consisting of 21 computers connected into one network, which makes possible interactive classes in ecology and Baikal studies for school and university students as well as makes the Museum resources available to the wide audience.

In 2013, Baikal museum and the association «Baikal-EcoNetwork» published a workbook «Outline maps of Lake Baikal for grade 5-6 students» as a supplementary teaching resource for teaching Baikal studies.

Environmental education in the schools of Irkutsk Oblast is realized through the introduction of such disciplines as «Ecology» and «Baikal studies» into curriculum, as well as through organization of integrated classes and extracurricular activities. Additional environmental classes are given as part of the non-mandatory and elective courses, work of children's environmental associations, hosting of large-scale ecological development-oriented events and the involvement of school children in the activities of ecological summer camps.

In 2013, more than 23 thousand students in Irkutsk region were enrolled in elective and special courses in ecology, Baikal studies and natural sciences. In municipal institutions of general education, 448 circles of ecological/biological sciences engaging about 7 500 students were functioning. In municipal institutions of additional education of Irkutsk region, 1 055 associations devoted to environmental/natural sciences and engaging about 14 500 teenagers were functioning. In Irkutsk region, 7 institutions of additional education devoted to environmental/natural sciences and engaging more than 10 thousand children were functioning.

In 2012, based on the intermediate results of a regional experiment on adapting educational resources to teaching Baikal studies, a new edition of the manual "Baikalology" (Live world of Lake Baikal. Man and Lake Baikal. 6 (7) grade) was published.

The most important activities included:

- a region-wide children's environmental festival "Baikal kaleidoscope" (March 28-29, 2012);
- a region-wide convent of school forestry associations (June 22-26, 2012);
- the first international competition among school students in Baikal studies (June 5-8, 2012). Twenty four teams from the educational institutions of Irkutsk Oblast, the Republic of Buryatia, Zabaikalsky Krai and Mongolia took part in the competition. The competition was hosted by Baikal Museum of the Irkutsk Scientific Center SB RAS. Results of the competition were announced during the work of the «Baikal-Huvsgul» creative workshop;
- the second international competition in Baikal studies «Let's save Baikal» (June 5-8, 2013) took place in Baikal Museum of the Irkutsk Scientific Center SB RAS. More than 100 school children from Irkutsk

Oblast, Zabaikalsky Krai and the Republic of Buryatia participated in the competition. For the first time school children from Korea and China took part in the competition [4, 6] (рис. 5.5.2).

Pic. 5.5.2. The winners of the 2nd International contest among schoolchildren in Baikal studies “Let’s save Baikal”.

Republic of Buryatia. Ministry of Natural Resources of the Republic of Buryatia came up with «Strategy for the Development of Continuous Environmental Education and Formation of Ecological Culture on the Territory of the Republic of Buryatia in 2012-2016» (approved by the resolution of the Government of the Republic of Buryatia № 682 of December 21, 2011). The Strategy is implemented by the public environmental council chaired by the Deputy Head of the Government.

International ecological and educational center «Istomino» of Baikal Institute of Nature Management, located in the Selenga river delta (Republic of Buryatia, village of Istomino), is one of the biggest in Siberia (pic. 5.5.3).

Pic. 5.5.3 The international ecological and educational center «Istomino»

Its major activities include:
- scientific and material/technical support to the fundamental research into Lake Baikal ecosystem and the Selenga river delta as the indicator of anthropogenic impact and natural changes in Lake Baikal basin;
- hosting scientific expeditions;
- hosting scientific meetings, conferences and workshops on the issues of sustainable development of Baikal region (pic. 5.5.4);
- organization of specialized practical courses for science students and summer schools for gifted children in environmental studies, chemistry, physics and mathematics;
- development of ecotourism; demonstration of organic farming and production of organic food with the use of renewable energy sources.

Pic. 5.5.4 Participants of the International conference «Deltas: genesis, dynamics, modeling and sustainable development»

Activities:
- July 26 - August 10, 2012 – International dendroecological expedition in Western Zabaikalie (Republic of Buryatia) with the participation of researchers of the Siberian Federal University (Krasnoyarsk city) and the University of Arizona (USA) (pic. 5.5.5);

Pic. 5.5.5 A participant of the International dendroecological expedition

- July 27 – August 1, 2012 – International workshop with the participation of scientists from Mongolia (12 people) within the frameworks of the project «Study of the spatial-temporal trends in the interaction between landscape and natural-economic complexes in the northern Central Asia under conditions of the contemporary desertification processes»;
- April 18 – April 20, 2013 – Meeting of the heads of the municipal districts of Pribaikalie and the administration of specially protected natural territories within the frameworks of the Federal target program «Protection of Lake Baikal and socio-

economic development of the natural territory in 2012-2020» under the support of the Ministry of Natural Resources of the Republic of Buryatia (pic. 5.5.6);

Pic. 5.5.6 Participants of the Meeting of the heads of the municipal districts of Pribaikalie and the administration of specially protected natural territories

- June 26 – June 30, 2013 – VII school-seminar of young scientists «The issues of sustainable development in Russian regions»;
- June 25 – August 08, 2013 – international expedition within frameworks of the project «Trans-Eurasian Flight Leman-Baikal» with the participation of scholars from France and Switzerland (pic. 5.5.7, pic. 5.5.8);

Pic. 5.5.7 Participants of the international expedition within frameworks of the project «Trans-Eurasian Flight Leman-Baikal»

Pic. 5.5.8 An ultralight trike in the sky

- July 30 – August 2, 2013 – Workshop «Environmental issues within Lake Baikal basin and the role of «green economy» in their resolution» with the participation of specialists from Mongolia, including officials from the Ministry of Ecology, Green Development and Tourism, and Agency for civil supervision of police, and the Republic of Buryatia was represented by officials from Forest Agency and Burprirodnadzor.

The educational work of «Ecological and biological center of the Ministry of education and science of the Republic of Buryatia» was realized in 2012-2013 through the activities devoted to raising environmental awareness and reviving environment protection traditions of the people of the Republic – «Preserve forest for the future generations» campaign, ethno-ecological festival «Sagalgan», «Meet birds with love» campaign, «Ecological month» and «Young naturalist» ecological camp.

The traditional exhibition of children's works «Live, the Earth» provides an opportunity to more than 500 gifted students from the Republic to display their works on the annual basis. The conference «Earth – our home» was meant to reveal and provide assistance to the talented and gifted children in their further career paths.

In 2012, as part of the established tradition, students participated in the following activities:
- an all-Russian scientific ecological-biological contest in the sphere of children's additional education;
- the international all-Russian children's ecological forum «Green planet»;
- the competition in memory of Vernadsky V.I.;
- the all-Russian forestry competition «Young Growth»;
- an all-Russian contest of water-related projects among senior school students;
- the all-Russian contest «My smaller homeland: nature, culture and ethnos»;
- an all-Russian contest of interdisciplinary projects and programs in environmental and local lore studies.

Orienteering Federation of the Republic of Buryatia (Chairman E.Y. Osipov, www.fso.sdep.ru) conducts significant educational work among the younger generation. In 2012-2013, the Federation held mass events in Ulan-Ude city, town of Gusinoozersk, in the village of Sagan-Nur and on Lake Schuschiye, attended by more than 600 schoolchildren (pic. 5.5.9).

Fig. 5.5.9 All-Russia competitions in orienteering – «Russian azimuth»

Within the frameworks of celebrating «Year of forests» students organized «Preserve forests from fires» campaign. On May 12, the Day of National Forest Planting, the students of the Center together with the representatives of the Federal Forest Agency (Rosleskhoz), bodies of the executive and legislative power of the Republic of Buryatia planted about 960 pine trees in Izhir, not far from Todokhta village of Zaigraevsky district. In addition to that, within the framework of the international year of forests the roundtable «Promotion of school forest associations in the Republic of Buryatia» was organized by the city forestry association and secondary school № 49.

On September 27-29, 2013, the 9th interregional competition in Baikal studies was held in Ulan-Ude city. 20 teams from 11 districts of the Republic of Buryatia took part in the competition. The competition had 4 categories – «Baikal flora», «Baikal fauna», «Limnology» and «Environmental monitoring» (pic. 5.5.10). The finalists represented the Republic at the 1st All-Russian Youth Conference of the Russian Geographic Society held in Kaluzhskaya Oblast on November 2-6, 2013.

Pic. 5.5.10 Participants of the 9th interregional competition in Baikal studies

On September 27-28, 2013, the 5th Baikal educational forum of the environmental movement leaders devoted to the Year of Environmental Protection and the Year of Tourism was held in Ulan-Ude city by the school «ECOS» with the support from the Ministry of Natural Resources of the Republic of Buryatia. The forum participants were 8-11 grade students, school teachers and teachers of institutions of additional education of Ulan-Ude city. The following activities were conducted within the framework of the forum: an intellectual Internet-marathon, a photo vernissage «My Baikal», «Antiwaste» campaign (pic. 5.5.11), and «Environmental footprint on Earth» campaign.

Pic. 5.5.11 Participants of the «Antiwaste» campaign

Since 2004, the journal «World of Baikal» has been published under the aegis of the Ministry of Natural Resources and Baikal Institute of Nature Management SB RAS. Till the end of 2013, 40 issues of the journal have been published [8] (pic. 5.5.12).

Pic. 5.5.12 Issues of the journal «World of Baikal»

Zabaikalsky Krai. In accordance with the regional action plan for implementation of the Strategy for developing the system of environmental education and formation of ecological culture in Zabaikalsly Krai in the period till 2020 approved by the Resolution of the Government of Zabaikalsky Krai № 673-r on October 20, 2009, the funding for activities related to environmental education and formation of «ecological» culture is allocated from municipal budgets. Diverse regional level environmental campaigns, competitions, meetings and expeditions were organized in 2012 – 2013.

As a way to fulfill the order of the Ministry of Education, Science and Youth Policies of Zabaikalsky Krai № 509a of June 21, 2012, the Center for education quality assessment introduced indicators of environmental education. These indicators will be considered while determining the efficiency ratings of municipal formations.

The laboratory of environmental education of Zabaikalsky State University in collaboration with pedagogues, education specialists and scientists of Zabaikalsky Krai and other regions of Russia provide scientific support to the system of environmental education, including the development of diverse teaching materials in electronic format, teaching manuals in accordance with the new state standard. The following materials were published: the workbook «My native Zabaikalie: I learn to ask questions» (authors – E.A. Igumnova, I.V. Barakhoeva), a practical manual for organizing independent work of students – «Regional ecology» (authors – E.A. Igumnova, O.V. Korsun), the manuals «Ecological excursions to the nature of Zabaikalie» (author – O.V. Korsun), and the popular science book «Basin of the Amur River in Zabaikalie» (edited by N.V. Pomazkova).

Annually, on April 22, educational and environmental institutions set up the environmental campaign «To protect nature means to love Homeland». In 2012, 140 organizations participated in the campaign.

The website «Nature of Zabaikalie» («Zabaikalie is splendid») has been maintained as an innovative information-sharing and educational Internet-resource in Russian and English languages [9].

The Krai-level ecological newspaper «Preserve the natural environment» is published with the circulation of 999 papers.

The chair for ecology and environmental education of Zabaikalsky State University, established jointly by the Chernyshevsky Zabaikalsky State Pedagogical University and the local institute of the Russian Academy of Sciences, is functioning in the region.

A team of secondary school students from Novaya Kuka village representing the club «Young Excursion Guide» took part in the 1st International Competition in Baikal studies (2012). The team of Zabaikalsky Krai was awarded the first prize for the project «Lake Kotokel – Gaff disease – Lake Baikal – Lake Kenon».

On April 18-19, 2013, the 3rd regional competition in Baikal studies «Baikal is in my heart» was held. 83 school students from 16 districts of Zabaikalsky Krai and students of the Ecology and Biology Center of Ulan-Ude city, the Republic of Buryatia took part in the competition

On May 23, 2013, a waste collection campaign was conducted in the Ivano-Arakhleisky natural landscape sanctuary. The campaign was timed to commemorate the international day of biodiversity. Students and teachers of secondary school № 33 of Chita city, staff of «Ecologiya» Ltd. and the sanctuary took part in the campaign.

In **Mongolia,** several trainings in environmental protection, environmental awareness raising and dissemination of information were organized during 2012-2014 [10]. The Institute of Teachers' Professional Development and Mongolian Education Alliance organized the training course «Sustainable development – Eco school on November 18-19, 2013. The activity was funded by Swiss Development Agency. 20 teachers learned the methods of incorporating environmental studies into various academic subjects. In addition, «Participating community - Eco school» training course to prepare teachers for module training was held on January 27-28, 2014, and it also focused on reflecting the idea of «sustainable development» in each lesson.

The Institute of Teachers' Professional Development organized «Professional training for the chemistry teachers who are in their first year of teaching» during February 4-13, 2014 and «Professional training for the biology teachers who are in their fifth or sixth year of teaching» on May 2-9, 2014. The 115 teachers who participated in the above trainings have also participated in an outdoor training course organized by the freshwater resource agency of the Ministry of Environment and Green development (MEGD) and have listened to lectures and have seen documentary films and museum expositions devoted to environmental pollution and proper utilization of water resources. As a result of these training courses the teachers were introduced to the concepts of sustainable development and environmental education, learned instruction techniques adjusted to children's age, and learned new teaching approaches overall. The institute conducted 21 training sessions attended by 1270 teachers during 2013-2014.

In December 2012, UN general assembly announced 2013 as a «Year of Global Water Partnership». Within the framework of the year celebrations, the Ministry of Environment and Green Development focused its attention on water supply services, distribution of water, increasing water demand and usage, and organized awareness raising and advertising campaigns in order to expand international and inter-sectorial partnership and enhance comprehensive cooperation for addressing water management challenges. Moreover, the meeting «Water policy-integrated action» was held on January 29, 2013 in Ulaanbaatar city with the purpose of facilitating information exchange, enhancing transboundary cooperation over water management issues, defining national and international legal frameworks and consistency with the Millennium Development Goals. Totally, 95 representatives from government and non-governmental institutions participated.

The seminar «The multi-stake-holder council for improving social involvement in addressing environmental challenges and promoting cooperation by collective decision-making» was held on March 29, 2013 with the objectives of intensifying the work of the multilateral council, promoting the rational and responsible use of natural resources, promoting the overall idea if environmental protection. More than 100 people participated in this seminar and exchanged their opinions.

The environmental law package adopted during the spring session of State Great Khural in 2012 created the legal framework for implementing Integrated Water Resource Management. 29 river basin authorities were established all over the country. Therefore, the training on «Legal framework for implementing Integrated Water Resource Management in river basins» was organized on April 25, 2013 in Darkhan-Uul aimag. The purpose of the training was to deliver information on specific provisions of the laws and to enhance legal awareness of the local decision makers, water users, and law enforcement agencies. Totally, there were 72 participants, who were mainly officials of the Environment and Tourism Agencies of Orkhon, Selenge, Tuv, and Bulgan aimags and officials of the basin councils for the rivers Eruu and Selenga in Selenge aimag.

The seminar «Environmental and economic assessment of natural resource and ecosystem services to support the development of an ecosystem based adaptation strategy» was held on October 4, 2012 and was attended by 64 participants from various organizations, including national consultant teams, project implementation units, science institutions, NGOs, universities and project implementation aimags. The purpose of the seminar was consultations over the draft methodology of economic evaluation of climate change-related multilateral arrangements, improving the capacity of national consultant team who will carry out the economic assessment through collecting knowledge and information on best practices in economical assessment model development.

The seminar «Reformation of rules and regulations following the adoption of a package of environmental laws» was organized on November 28-29, 2012, and was attended by about 100 people. The purpose of the seminar was the discussion of the required changes in laws and regulations for harmonizing the whole body of legislation and implementation of the adopted law package.

5.6 ENVIRONMENTAL NON-GOVERNMENTAL ORGANIZATIONS

The rights and duties of non-governmental and other non-profit organizations in the field of environmentalism are legally defined in Article 12 of the Federal law «On environmental protection» (№ 7-FL of January 10, 2002).

Baikal region has more than 100 registered environmental non-government organizations (NGOs). Environmentally-oriented NGOs of Baikal region are among the most active ones in Russia [4,6,8-10].

Irkutsk region. In 2012, Irkutsk-based «Baikal Ecological Wave», a regional non-government organization, organized and held scientific «Baikal expedition», which relied on the involvement of other non-governmental organizations, the local population, academic and educational institutions, to assess the current state of bays of Lake Baikal and to identify indicators of their current state. The members of the project discovered high concentrations of phosphates (up to 0.25 mg/dm^3), large-scale proliferation of *Spirogyra* and blue-green algae (*Anabaena lemmermanni*). In Chivykuysky Bay, they identified excessive proliferation of Elodea, which at some places had the biomass concentration of 26 kg/m^2. The amount of liquid wastes discharged by tourists in the village of Monakhovo was estimated at 160 tons over a season.

The NGO conducted:

- the conference «The role of civil society in sustainable development of local communities» and webinars on the topic in the villages of Bolshoe Goloustnoe, Maloe Goloustnoe and the town of Baikalsk with the support from the municipal administrations;
- 8th International conference «Rivers of Siberia and the Far East» (together with WWF), the results of which were published in form of the conference proceedings (pic. 5.6.1).

Pic. 5.6.1 A conference session

In 2013, «Baikal expedition» was continued and resulted in the following outputs:

- the assessment of species distribution on Olkhon island was carried out for *Astragalus* and *Craniospermum* listed in the Red Books of endangered species of the Russian Federation and Irkutsk region;
- the state of the relict grove of *Populus suaveolens* in the delta of the Goloustnaya river was examined;
- the calendar «Save the plants of Olkhon sandy coast» and the postcard «Relict poplar grove» were published.

The inter-regional non-governmental organization «Greater Baikal Path» (with the support of the group of companies En+) in 2013 conducted:

- winter project (March 20-29), in which volunteers from Moscow, Murmansk and Kemerovo cities participated. The project participants removed snow off a 500-meter stretch of the path in the village of Tankhoi in Baikalsk Nature Reserve (pic. 5.6.2), and made a board on book-crossing for the visiting center;
- on May 25-26, a team of 12 volunteers participated in the reconstruction and clearing of a spring located at the 26th km of Baikalsk highway. The campaign was supported by the group of companies En+. The volunteers constructed a bowl for collecting water, cleared the water path, and reconstructed the steps leading to the spring;
- four summer projects were realized, all dealing with the construction of the tourist paths «The path to clean Baikal», «The path to the waterfall land», «Deep into Khamar-Daban-1» (pic. 5.6.3) and «Fairytale land-1» within the Baikalo-Lensky reserve.

Pic. 5.6.2 A stretch of a path for the people with reduced mobility

Pic. 5.6.3 A volunteer camp in Baikalsk Nature Reserve

On March 28-29, 2012, the non-profit partnership organization «Let's conserve Baikal together» held the regional children's environmental festival «Baikal kaleidoscope». The participants of the festival were school children of Irkutsky (2 teams), Slyudyansky, Usolsky, Cheremkhovsky (2 teams), Shelekhovsky, Olkhonsky, Taishetsky, Ust-Kutsky and Angarsky districts of Irkutsk region and the team of Irkutsk Palace of Art. In 2012, the number of participants rose to 96 people, thanks to the financial support of the group of companies En+.

On March 27-28, 2013, the same organization again conducted the regional children's environmental festival «Baikal kaleidoscope», in which 14 teams from 8 districts of Irkutsk region took part. The festival took place in Baikalsk city.

In 2012, the Center of Additional Education for Children of Irkutsk region conducted the convent of school forestry associations (June 22-26). The 11th convent of school forestry associations of Irkutsk region was held at the Irkutsk sports and recreation complex. The co-organizers of the convent were the Forest Management Agency of Irkutsk region and the Forest Protection Agency of Irkutsk Region. The general sponsor was «Yilim-Group». There were 45 teams from the region's state autonomous institutions, municipal educational institutions as well as teams from Krasnoyarsk city, Altai region, Zabaikalsky Krai and the Republic of Buryatia.

The Center co-organized the 12th regional convent of school forestry associations held (pic. 5.6.4) on July 1-5, 2013. 46 teams took part on the meeting - 39 teams from Irkutsk region, 7 teams from Altaisky, Zabaikalsky, Krasnoyarsky, Omsky, and Novosibirsky regions and the Republics of Buryatia and Sakha-Yakutia. Awards were distributed in the categories «Best school forestry association», «Young zoologist», «Young botanist», «Forest pathfinders», and the category of best means of visual agitation «Lets save forest alive».

Pic. 5.6.4 Participants of the 12th regional convent of school forestry associations

Irkutsk cinema fund organized the 11th Baikal international festival of documentary and popular-science movies Man and Nature». 116 movies from 28 countries were screened. Apart from the Russian movie-makers who presented 54 movies at the festival, film directors from Austria, Germany, Israel, Spain, Russia, the USA and Japan brought their films.

The official opening of the 1st Water Forum of the participants of the project «Pure waters of Pribaikalie – public water-protection movement» took place on November 30, 2012. The administration of Rosprirodnadzor in Irkutsk region was one of the partners of the water-protection project, launched by the regional branch of the All-Russian Society for Nature Protection. This project was implemented with the support of the Ministry of Natural Resources and the Ministry of Education of Irkutsk region and was recognized as one of the best among socially significant projects. The participants of the «Pure waters of Pribaikalie» included more than 60 environmental associations working at educational institutions of 22 administrative units of the region. During the stay in summer camps and while taking part in expeditions, school children had an opportunity to acquire skills of research work and water body passportization. The 1st Water Forum was attended by young environmentalists from Ust-Kut, Bratsk, Irkutsk, Cheremkhovo, Sayansk, Ust-Orda Buryat autonomous okrug, Slyudyanka, Kyutunsky, Usolsky and other districts of the Irkutsk region.

In 2013, the 12th Baikal international festival of documentary and popular-science movies «Man and Nature» was conducted. Movies were screened during the period from April 1 to October 30, 2013. The documentary «The great Siberian rivers Lena» directed by Pavel Fattakhutdinov received «The best documentary» award, while the popular science film «Thin Ice» by David Sington and Simon Lamba (Great Britain, New Zealand) received «The best popular science movie» award.

Republic of Buryatia. The regional non-governmental organization «Gran» is executing a joint UNDP and Coca-Cola project «Every drop matters» (2010 – 2013). The project is intended to preserve water resources, ensure access to pure drinking water, develop ecotourism, and strengthen the sense of environmental responsibility in local people. During the four-year project period, the organizations – grant winners implemented 40 subprojects in Ulan-Ude city and districts of the Republic of Buryatia and Irkutsk region (pic. 5.6.5). Within the framework of the project, «Gran» has published a book for junior and middle school children – «Baikal chest». The book was recommended by Ministry of Education and Science of the Republic of Buryatia to be used as a supplementary school-book.

Pic. 5.6.5 The environmental campaign "Bon-aqua for Baikal"

In 2013, «Gran» implemented the project «Why does nerpa cry?». Within the framework of the project, an exposition was created featuring nerpa and composed of the colorful dioramas «Nerpa rookery» with stuffed nerpas from the museum funds and «Winter lair» with a stuffed calf; various children's activities were organized, including master-classes (sculpturing of nerpa figurines, painting of souvenir magnets in form of nerpa, etc.), games, contests and screening of a movie on nerpa.

The non-commercial partnership «Greater Baikal Path - Buryatia» organized the following activities in 2012:

- launched cooperation with colleges and universities of the Republic, based on the obtained positive experience of educational activities in orphanages;
- an ascent to Munku Sardyk Peak. Pollution of White Irkut River was detected, this is because many drivers and mountain climbers use the ice covered channel of the river as a road while ascending, up to the point of confluence of the rivers Muguvek and White Irkut;
- construction of the infrastructure on the Sleeping Lion Mountain (Tarbagataisky district) was continued, and it was second year since the works commenced;
- an expedition to Shumak (natural park of the regional significance) was organized.

In 2013, the partnership «Greater Baikal Path – Buryatia» performed works on improving the existing paths (Maksimikha – Ust-Barguzin; Khoito-Gol - Shumal; Arshan – Verkhnyaya Berezovka). Illegal cutting was taking place near the tourist camp Maksimikha. During the three-week period, participants of the work camp cleared the path off cutting waste and placed markings on trees. A model path was built on a stretch between the localities Arshan and Verkhnyaya Beresovka. Within the framework of the ecotourism forum «Baikal+20», a master-class for guests was held at the path. The path is equipped with the modern infrastructure elements - entrance ensembles, signs, viewpoints, and information stands. A stretch of the Moscow highway between the villages Tankhoi and Pereemnaya was explored. Many elements of the old infrastructure have remained intact and the path could be used for building a bicycle road.

The team of the project «Let's conserve Lake Baikal» opened its 10th anniversary camp season of the International Baikal Shore Volunteer Service. From July 18 to August 15, 2012 the camp was visited by 47 people. Intensive work of cleaning the shore was done - piles of garbage were excavated and sorted, 43 m^3 of glass, 28.3 m^3 of plastic, 14.6 m^3 of tin and 68.6 m^3 of mixed garbage were collected and shifted for proper disposal (pic. 5.6.6).

Pic. 5.6.6 Garbage collection

In 2012, the Lake Baikal Conservation Foundation organized:

- the ecological camp «Khakusy»;
- the first charity marathon «Preserve Lake Baikal together with the whole world», devoted to the Day of Baikal, was organized on August 17 in cooperation with the Ministry of Natural Resources of the Republic of Buryatia. The raised funds (1 million rubles) would be spent during the next summer season on cleaning and providing necessary facilities at the places of public recreation on the shores of Lake Baikal (in particular, in the towns of Gremyachinsk and Goryachinsk in Pribakalsky district) (pic. 5.7.7).

Pic. 5.7.7 Participants of the first charity marathon «Preserve Lake Baikal together with the whole world»

In 2013, the Fund initiated the research expedition «TransEurasian flight Leman – Baikal». The expedition's objectives were to develop new methods and devices for air and water sounding, enhance knowledge on the impact of forest fires on carbon cycle, develop proposals on complex environmental protection measures for the area covered by the expedition and attract public attention to the environmental issues common to Europe and Asia.

Besides, the Fund supported implementation of the following projects:

- a winter expedition of the Student's Science Society of the Geography Department of Moscow State University was organized in the Republic of Buryatia;

Pic. 5.6.8 Participants of the expedition at the museum of the town of Kyakhta

Pic. 5.6.9 A session of the summer ecological school at the conference hall of the International Ecological and Educational Center "Istomino"

- an exposition devoted to the expedition «The submersibles MIR in Lake Baikal» was installed in the National Museum of the Republic of Buryatia;
- a joint expedition with the Far East Expedition Center of the Russian Geographical Society with the objective of studying the population dynamics of Baikal nerpa;
- the environmental campaign «Clean Ice of Lake Baikal» in Barguzinsky district of the Republic of Buryatia;
- the international forum on ecology and tourism «Ecotourism in Lake Baikal region»;
- in 2013, the Buryat Branch of the Russian Geographical Society took part in the following activities;
- the expedition «In the footsteps of Przhevalsky» (in the honor of the 150th anniversary of the first expedition) (pic. 5.6.8);
- summer schools in geography and environmental sciences on the basis of the international ecological and educational center «Istomino» (pic. 5.6.9).

Mongolian Environmental Civil Council (MECC) was established in 2008 at the First National Conference of Non-Governmental Organizations. MECC with 700 NGOs being its members and branches in 21 aimags can be called an umbrella organization. Supreme authority of MECC is the national council of environmental NGOs that convenes once in two years. At the convention, the board of directors and supervisory boards of MECC are selected and policy documents for the next two years are discussed.

MECC's main functions are the provision of information and services to non-governmental organizations engaged in environmental activities and coordination of cooperation between the government and other organizations [12].

Besides MECC, there are other NGOs, such as «Greenpeace Mongolia», «Gal-Undesten association», «Golomt TSEKH», «United Movement of Mongolian Rivers and Lakes», «MUEM», «Nogoon Has», «Restoration management», «United TMT movement», «The future without nuclear radiation», that are active in the field of environmental protection. At the web site of the Environmental Information Center, there is a list of Mongolian environmental NGOs with description of their work and directors' names.

In addition, within the framework of the project «Integrated Natural Resource Management in the Baikal Basin Transboundary Ecosystem», in 2014 the NGO «Mongolian Water Forum – Ushelts» initiated the establishement of a network of the environmental NGOs that work within the Lake Baikal and Selenga river basins. The list of organizations united into the network is available in the «Friends» section of the «Baikal Information Center» web portal.

BIBLIOGRAPHY

1. Convention on Biological Diversity www.cbd.int/countries/default.shtml_country=mn
2. Convention on Biological Diversity www.cbd.int/countries/default.shtml country=ru
3. Transboundary diagnostic analysis of the Lake Baikal basin http//Baikal. Iwlearn.org
4. State report "On the state of Lake Baikal and measures for its protection in 2013" – Irkutsk. Siberian Branch of "Rosgeolfond", 2014. – 462 pp.: http://www.mnr.gov.ru/regulatory/list.php?part=1258
5. Mikheeva A.S., Tulokhonov A.K., Ptitsyn A.B., Tsybekmitova G.T. / Institutional mechanisms of regulating nature management within transboundary territories/ In the book "Environmental cooperation in the transboundary regions: Russia – China – Mongolia". Chita, Poisk Publishing. 2012. - Part 2. - p. 52-60.
6. State report "On the state of Lake Baikal and measures for its protection in 2012" – Irkutsk. Siberian Branch of "Rosgeolfond", 2013. – 436 pp.: http://www.mnr.gov.ru/regulatory/list.php?part=1258
7. ФГУНПП «Росгеолфонд», http://geol.irk.ru/baikal/
8. Журнал «Мир Байкала», www.mirbaikala.ru
9. Природа Забайкальского края, http://www.nature.chita.ru)
10. A website of the "Green Earth – Green Future" NGO, "Ecological education: Environment – friendly children", http://veg.mn/page/50
11. White book of Baikal basin, http://bic.iwlearn.org/ru/druzya/belaya-kniga-basseina-ozera-baikal-obschestvennye-organizacii
12. Environmental Information Center, Environmental organizations, human resources information center, Database of NGOs, http://www.eic.mn/orgstaff/nongovernment.php

SUMMARY

Lake Baikal is the largest (23 thousand km^3) freshwater lake on the planet, with the volume equal to the total runoff of all Russian rivers for a seven-year period and the total runoff of all Eurasian rivers for a three-year period. In 2013, the state of Lake Baikal ecosystem did not undergo any significant changes, and the quality of its waters has remained stable for decades and far exceeds the requirements for drinking water.

In 2013, during the lake filling period the water level indicators were within the mean annual values due to controlled discharge. The water levels did not exceed the levels defined by the Resolution of the Government of the Russian Federation № 234 of March 26, 2001 "On the maximum water levels of Lake Baikal during the implementation of economic and other activities".

In 2013, there was a 7% reduction in the total runoff of the five largest rivers within the Lake Baikal basin. The runoff of the rivers Barguzin and Turka decreased by 10%, and that of the rivers Upper Angara and Tyya decreased by 45% and 18%, respectively. On the other hand, the runoff of the Selenga river increased by 9%. In recent years, the fluctuations in the runoff have not exceeded the average long-term fluctuations.

The average annual air temperature in 2013 was close to the average long-term values, despite significant temperature anomalies observed in some months. Only in the southern part of Irkutsk region the average annual air temperature was higher by 1-1.5 °C.

In Mongolia, climate change became more noticeable, manifested in the form of more frequent droughts and zuds (severe winters), progressing desertification and water scarcity.

The 46% decrease in wastewater discharge by Baikalsk Pulp and Paper Mill in 2013, as compared with 2012, due to closure of the main production facilities, helped to improve the water quality of Lake Baikal at the control site 100 meters away from the underwater discharge point.

Compared with 2012, the input of contaminants into the lake by the 5 most studied rivers (Selenga, Barguzin, Turka, Upper Angara, and Tyyl) increased in 2013. The input of suspended solids, dissolved minerals and petrochemicals increased by 24%, 12%, and 31%, respectively. At the same time, the input of volatile phenols, surfactants and copper reduced significantly – by 55%, 80% and 31%, respectively. The input of easily oxidizable and oxidation-resistant substances, phenolics and asphaltenes remained almost at the same level.

Exceedances of the maximum permissible concentrations were recorded for 13 out of 17 hydrochemical indicators measured in 2012-2013. In general, hydrological and climatic conditions were the main factors affecting the quality of surface waters within Lake Baikal basin in 2013. The exceptions were the rivers Modonkul (Zakamensky district of the Republic of Buryatia) and Kyakhtinka (Kyakhtinsky district of the Republic of Buryatia) due to intensive anthropogenic impact.

The Selenga River remained the major supplier of controlled substances into the lake. In 2013, the river brought 87.6% of suspended solids, and 78.0% each of dissolved minerals, oxidation-resistant and easily oxidizable organic substances. The major anthropogenic impact on the river water composition in the Russian territory comes from the industrial hubs of the cities Nizhneselenginsky, Ulan-Ude, Kyakhtinsky and Petrovsk-Zabaykalsky, in Mongolia – the enterprise's of Ulaanbaatar, Erdenet, Darkhan, as well as numerous gold mining cooperatives.

In 2012-2013, no significant changes were observed in the subsurface hydrosphere of Lake Baikal basin.

The amounts of air emissions in 2013 remained similar to those in the previous years. In both Mongolia and Russia, the main sources of air pollution were enterprises of the energy sector and vehicles. Another significant source of pollution was Selenginsk Pulp and Paper Mill located in close proximity to the lake.

The intensification of research on hydrocarbon systems of Lake Baikal involving submersibles «Mir» has helped to clarify the spatial distribution of hydrocarbon-oxidizing microorganisms and their ability to process petroleum hydrocarbons entering the lake from natural oil seepages, as well as to explore the distribution and mechanisms of formation of gas hydrate deposits at the bottom of Lake Baikal. This international expedition was the result of cooperation of the international community for conservation of the unique lake.

The intensity of dangerous endogenous geological processes in 2013 was low, and compared with 2008, when the ten-year maximum total seismic energy was recorded, the geological activity was 500 times less in 2013.

The existing network of the sites monitoring dangerous endogenous and exogenous geological processes is insufficient. The results of performed observations provide only fragmentary data on the regime of hazardous processes in separate areas. To implement reliable monitoring and forecasting of hazardous endogenous and exogenous geological processes, the number of monitoring stations must be increased by an order of magnitude throughout the basin.

In Mongolia, due to a combination of rising temperatures, reduced atmospheric precipitation, growing livestock population and other factors, the processes of degradation of steppe and forest ecosystems have intensified and the areas affected by desertification have expanded. One of the factors of degradation of pasture lands in Mongolia is the increased number of goats, associated with the growth in production of high-quality wool (cashmere), which is in demand around the world.

The bulk of the forest resources of the basin are located within its Russian part (about 90%) and, based on the assessment of the current situation, timber harvest is expected to increase. This is facilitated by the following factors: growing demand for and prices of forest products, including larch timber, in the foreign markets, and increasing illegal logging.

The forested land area in Mongolia is insignificant. Deforestation is an ongoing problem that has several reasons: legal and illegal logging, forest fires, and insect infestation. These problems are typical for the Russian part of the basin too, but to a lesser extent. However, in both Mongolian and Russian parts of the basin, preserving forests and reforestation are the tasks that require urgent action.

The extent of mining operations within Lake Baikal basin decreased in 2013, when compared with 2012. This was due the environmental restrictions over the use of natural resources within Baikal Natural Territory (the Law «On Protection of Lake Baikal»). At the same time in 2012-2013, coal production increased at the coal deposits of Buryatia and Zabaikalsky Krai, far from the Central Ecological Zone of BNT.

In Mongolia, along with a general increase in extraction of mineral resources, the share of illegal mining, especially mining of gold, increased significantly. Illegal gold mining is common in Tuv soum of Zamaar aimag, Bulgan soum of Burenhangay aimag and Tsenkher soum of Arkhangai aimag (Selenga river basin).

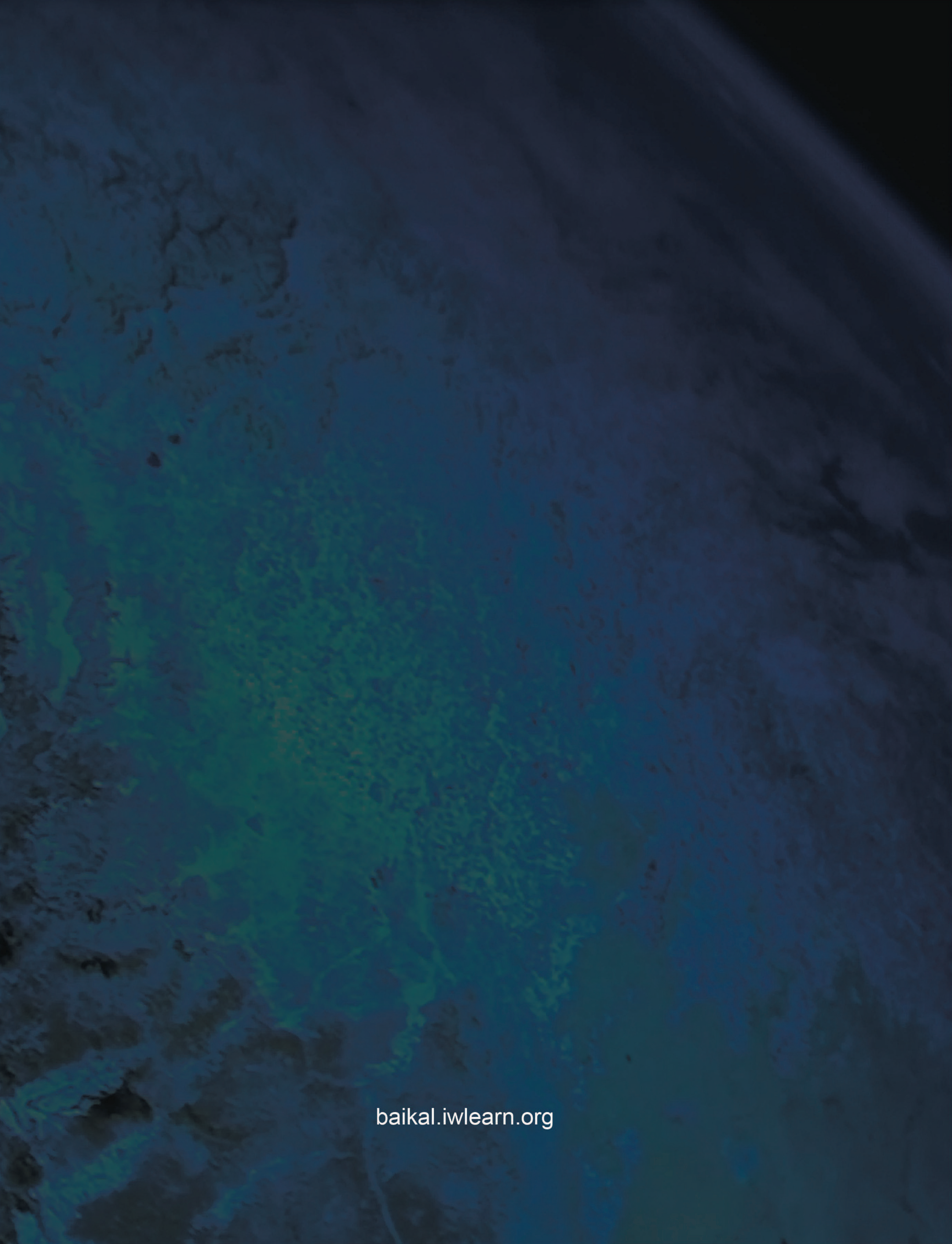
The total population of the Russian part of Lake Baikal basin is 1058.5 thousand people (according to the Russian Census of 2010). Most of the population is concentrated within the Republic of Buryatia. Increased birthrate and reduced mortality resulted in a population growth in 2012-2013. While the total population of Mongolia is 2930.3 thousand people, 65.4% of it lives within the lake basin. The total population growth in 2013 was 2.2%. More than 43% of the entire population lives in Ulaanbaatar city.

Planned development of a tourist and recreational complex in the basin can provide significant commercial, fiscal and social effects, as well as to compensate for the economic losses of the Irkutsk region and the Republic of Buryatia due to environmental restrictions of economic activity. At the same time, the complex would increase the anthropogenic pressure on the coastal ecosystem of Lake Baikal. The government of the Republic of Buryatia, Irkutsk Region and Zabaikalsky Krai need to utilize the successful experience of Mongolia in state regulation of tourism sector.

Despite a certain economic growth and improved standard of living in both Russia and Mongolia, the challenges of sustainable development in the region can only be addressed taking into account mutual interests. Among them is the responsibility for damage caused to transboundary natural resources. The Selenga River belongs to such natural resources, being the main tributary of Lake Baikal - a World Natural Heritage Site.

Russian scientists have developed economic instruments for replenishing international environmental foundations established for protection of the natural environment within a transboundary basin (exemplified by the Selenga River basin). The creation of the Baikal Environmental Fund will ensure the accumulation of resource payments and provide target funding for conservation and restoration of natural objects and biodiversity, implementation of innovations related to environmentally sustainable development in the region.

Thus, the population of Russia and Mongolia living within the basin of Lake Baikal is facing the challenges of sustainable socio-economic development under conditions of the harsh climate, thermal and electric power shortages, high transport costs, low level of economic innovation, high dependence on natural resources and, more importantly, the contradiction between economic development of the region and the need to protect the environment.



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