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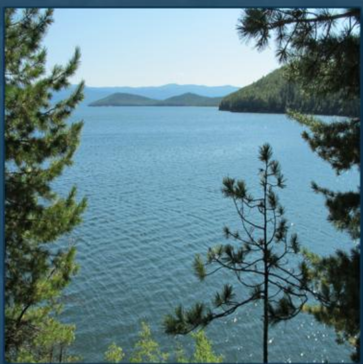
LAKE BAIKAL BASIN TRANSBOUNDARY DIAGNOSTIC ANALYSIS



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LAKE BAIKAL BASIN

TRANSBOUNDARY DIAGNOSTIC ANALYSIS

April 2013

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Abbreviations and Acronyms

Asl	Above sea level
BEZ	Buffer ecological zone of Lake Baikal (term from Russian Federal Law № 94-FZ “Lake Baikal protection”)
BNT	Baikal natural territory
CBD	Convention on biological diversity
BOD	Biological oxygen demand
CCA	Causal chain analysis
CET	Central ecological zone of Lake Baikal (term from Russian Federal Law № 94-FZ “Lake Baikal protection”)
CITES	Convention on International Trade in Endangered Species of Fauna and Flora
DO	Dissolved oxygen
EcoQOs	Ecosystem quality objectives
ESIA	Environmental and social impact assessment
FSHEM	Federal Service on Hydrometereology and Environmental Monitoring (Russian Federation)
GA	Governance analysis
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
GRP	Gross regional product
HPP	Hydroelectric power plant
IHP	International Hydrological Programme of UNESCO
IPCC	Intergovernmental Panel on Climate Change
IWBM	Integrated water basin management
IWRM	Integrated water resource management
MA	Management area
MAB	Man and Biosphere Programme of UNESCO
MNT	Mongolian tögrög (currency)
MPC	Maximum permissible concentration
N	Nitrogen
P	Phosphorus
PA	Protected area
POP	Persistent organic pollutant
SAG	Scientific advisory group
SAP	Strategic Action Programme
SFD	Siberian Federal District
SFU	Sheep forage unit
SPA	Strictly protected area
SRB	Selenga River Basin
SRPP	Gusinoozersk State Regional Power Plant
TDA	Transboundary Diagnostic Analysis
TPA	Transboundary Protected Area
TPP	Thermal Power Plant
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNOPS	United Nations Office for Project Services
WWF	World Wide Fund for Nature
WWTP	Wastewater treatment plant

Glossary of Terms

Agenda 21 United Nations Conference on Environment and Development (Earth Summit) agreement on action to be taken to protect the environment. It proposes integrating environmental protection and economic development.

Aimag First-level administrative subdivision of Mongolia (comparable to provinces). Each aimag is divided into several districts.

Biological invasion The introduction of an organism into a new environment or geographical region, followed by rapid multiplication and expansion of its range.

Biological Oxygen Demand (BOD) Amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. Used as an indication of the organic quality of water.

Bog Area with a waterlogged, spongy, acidic substrate.

Buffer Environment Zone (BEZ) The Buffer Environment Zone of Lake Baikal is the physical catchment area of the lake within Russia. Also see Central Ecological Zone and Zone of Atmospheric Impact (term from Russian Federal Law N^{o} 94-FZ “Lake Baikal Protection”).

Convention on Biological Diversity The principal objectives of the Convention on Biological Diversity, which entered into force in 1993, are the conservation and sustainable use of biological diversity, and the fair and equitable sharing of benefits arising from its utilisation. The Convention recognises that the key to maintaining biological diversity depends upon using it in a sustainable manner.

Catchment area The drainage area of a land surface that contributes flow to a single water body, such as a river, lake or an ocean.

Central Ecological Zone (CET) The central ecological zone of Lake Baikal includes the lake itself, and the natural parks and reserves that are located around the lake. Also see Buffer Environment Zone, and Zone of Atmospheric Impact (term from Russian Federal Law N^{o} 94-FZ “Lake Baikal Protection”).

Convention A convention is a set of agreed, stipulated or generally accepted standards, norms, or criteria.

Dublin-Rio Principles Key principles for IWRM presented at the World Summit in Rio de Janeiro in 1992:

1. Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
3. Women play a central part in the provision, management and safeguarding of water.
4. Water is a public good and has a social and economic value in all its competing uses.
5. Integrated water resources management is based on the equitable and efficient management and sustainable use of water.

Dzud Mongolian term for an extremely harsh winter, during which livestock is unable to find sufficient food and large numbers of animals die from starvation. Successive dzuds took place in Mongolia between 2000-2002, and 2009-2010.

Ecoregion Global Ecoregion is a concept that was developed by WWF and global experts to rank habitats according to their importance for biodiversity conservation. There are 200 Ecoregions in the world. See: wwf.panda.org/about_our_earth/ecoregions/about

Ecosystem The dynamic complex of plant, animal and micro-organism communities and their non-living environment, which interact with each other and with their environment as a

	functional unit.
Ecosystem approach	Strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way, while recognizing that humans, with their cultural diversity, are an integral component of ecosystems.
Ecotone	Transitional zone between two or more ecological communities.
Eutrophication	Excessive enrichment of waters with nutrients, typically in the form of nitrates and phosphates, often from human sources such as agriculture, sewage, and urban runoff, which may lead to adverse biological effects, including toxic algal growth and anoxia.
Ger District	Unplanned settlement in the suburbs of a city, where inhabitants predominantly live in traditional Ger (also known as yurt) housings. Inhabitants of Ger districts often do not have access to basic infrastructure including central heating, water and sanitary facilities.
Greenhouse gas	Gas that absorbs and emits radiation within the thermal infrared range in the atmosphere. The primary greenhouse gases in the Earth's atmosphere are water-vapor, carbon dioxide, methane, nitrous oxide, and ozone.
Habitat	The specific place and physical environment within an ecosystem that surrounds (and is influenced by, and utilized by) a particular species of animal, plant, or micro-organism.
Hydrologic flow	The characteristic behaviour and the total quantity of water involved in a drainage basin, determined by measuring such quantities as rainfall, surface and subsurface storage and flow, and evapotranspiration.
Invasive species	Animals, plants or other organisms introduced by man into places out of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species.
IWRM	Integrated Water Resources Management (IWRM) is a process that promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment.
Keystone species	Species with a disproportionately large effect on its environment relative to its abundance. Keystone species play a critical role in maintaining the structure of an ecological community, affecting many other organisms in an ecosystem.
Nonpoint source pollution	Nonpoint source pollution refers to pollution from diffuse sources. Nonpoint source water pollution can affect a water body from sources such as runoff from agricultural areas draining into a river, or atmospheric pollution.
Point-source pollution	A point source of pollution refers to a single, identifiable source of air, water or thermal pollution.
Precautionary Principle	If an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus that the action or policy is harmful, the burden of proof that it is not harmful falls on those taking an act. The precautionary principle implies that there is a social responsibility to protect the public and the environment from exposure to harm, when there is a plausible risk.
Rangeland	Vast natural landscapes, including steppes and tundras, which can be used to graze livestock.
Sedimentation	Increased concentration of suspended sediments, and to the increased accumulation (temporary or permanent) of sediments on the bottom of rivers, lakes, and other aquatic systems. The origin of the increased sediment transport into an area may be erosion on land, or activities in the water.
Silage	Fermented, high-moisture content fodder for cattle and sheep.
Steppe	Landscapes that are characterised by grassland plains that are mostly without trees.
Waterlogged	Soil that is saturated by groundwater, sufficient to prevent or hinder agriculture.
Taiga	Landscapes that are characterised by coniferous forests, which consist mostly of pines, spruces and larches.
Tundra	Landscapes that are characterised by extremely cold climates, low biotic diversity, simple vegetation structures, and absence of trees.
Urbanisation	The physical growth of urban areas as a result of rural migration and/or suburban concentration into cities.
Zone of Atmospheric Impact (ZAI)	The Zone of Atmospheric Impact of Lake Baikal is the area immediately outside the physical catchment area to the west and north-west of the lake.

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Executive Summary

This document presents the results of extensive expert analyses relating to the present and expected future status of Lake Baikal and its catchment basin, which is shared by the Russian Federation and Mongolia. The analyses specifically focus on issues that may induce environmental impacts beyond national boundaries, or issues that are common to both countries.

Collectively, this represents a Transboundary Analysis (TDA). The TDA is intended as a decision support tool for issues to be addressed within the context of immediate and long-term sustainable management of the ecosystems in the Baikal Basin. The TDA forms the basis for the development of a comprehensive Strategic Action Programme (SAP) for addressing priority environmental issues.

Lake Baikal and its Catchment Basin

Lake Baikal is a global hotspot of biodiversity. The lake harbours an extraordinary variety of flora and fauna that comprises over 2,550 species, including hundreds of species that occur nowhere else in the world. The Baikal Basin includes Lake Khovsgol, which is Mongolia’s largest lake and contains almost 75% of the country’s surface freshwater.

The Baikal Basin exists at the junction between biogeographically distinct regions: Central Asian, Eastern Asian, and European-Siberian. These regions consist of combinations of mountains and valleys, taiga, tundra, steppe and deserts with high scenic beauty and significant natural values. Consequently, the Baikal Basin harbours extremely diverse communities of plants and animals.

Given the national, regional, and global significance of the biodiversity in the Baikal Basin, as well as the ecosystem services provided by its aquatic and terrestrial systems, transboundary and international cooperation for the protection and sustainable management of the basin is of vital importance.

Need for Action

The biodiversity and the health of the aquatic and terrestrial ecosystems in Lake Baikal and its catchment basin are increasingly under pressure from the impacts of a growing human population and its demands on natural resources.

In recognition of the value of the natural resources for the people inhabiting the Baikal Basin, the Governments of Mongolia and Russia signed several transboundary agreements. In 1995, the bilateral “Protection and Use of Transboundary Waters” was signed, replacing earlier agreements from 1974 and 1988.

Various initiatives towards protection of biodiversity and sustainable management of natural resources have taken place in both Mongolia and Russia. This includes a GEF-financed Biodiversity Project that was implemented in Russia from 1996-2003, which resulted in the development of a Lake Baikal Biodiversity Conservation Strategy, providing a political and institutional context for expanding Protected Areas and developing watershed plans.

In spite of agreements and cooperation between the two countries, limited progress has been made towards achieving sustainable transboundary management of the basin. To address the need for improved transboundary planning, cooperation and action, a new project was initiated on Integrated Natural Resource

Management in the Baikal Basin Transboundary Ecosystem, which started its implementation phase in November 2011.

The project has the objective to spearhead integrated natural resource management of the Lake Baikal ensuring ecosystem resilience, and reduced water quality threats in the context of sustainable economic development. The project is supported by UNDP and the Governments of Mongolia and Russia, executed by UNOPS, and financed by the GEF with co-financing from the Foundation for the Protection of Lake Baikal, the Coca-Cola Every Drop Matters program, and UNESCO.

In accordance with GEF best practices for international waters projects, a preliminary transboundary diagnostic analysis (TDA) was undertaken between 2008-2009. The present document represents an update of the preliminary TDA, which will function as a basis for further strategic action planning.

TDA Updating Process

To coordinate and implement the updating process, a Scientific Advisory Group (SAG) was established, comprising expert teams from Mongolia and Russia. To ensure continuity, the SAG included several of the experts who also participated in the drafting of the preliminary TDA. During the period August 2012 – March 2013 the members of the SAG collected and analysed data and information relevant to a range of topics, including pollution hotspots, biological invasions, and climate change. With support from UNESCO, additional data was collected and analysed relevant to the sustainable use of groundwater resources in the Baikal Basin. The new data is either integrated in this document, or presented as Technical Annexes. Additional technical reports will be annexed to this document as they become available during further updating processes.

Boundaries of the TDA

The geographical area of this TDA focuses on the physical water catchment basin of Lake Baikal[1], which covers an area of c.a. 540,000 km^2 in south-eastern Siberia and northern Mongolia. Based on the Russian Law on Lake Baikal, the Russian part of the Baikal Basin comprises three environmental impact zones:

1. The Central Ecological Zone: Lake Baikal and natural parks and reserves that are located around the lake.
2. The Buffer Environment Zone: Physical catchment area within Russia.
3. The Zone of Atmospheric Impact: Area immediately outside the physical catchment area to the west and north-west of the lake.

In terms of thematic scope, this TDA covers the Baikal Basin Transboundary Ecosystem, which is defined as the dynamic complex of plant, animal, human, and micro-organism communities as well as their non-living aquatic and terrestrial environments, acting as a functional unit within the spatial boundaries determined by the physical water catchment area of Lake Baikal, including Lake Baikal itself and parts of Mongolia as well as parts of the Russian Federation.

Overview of the Findings of the TDA

The main problem areas and specific problems identified for the Baikal Basin are listed in Box A, in order of prioritisation. For each of the specific problems, the TDA describes the present situation, root causes, underlying and immediate causes, as well as the sectoral activities that are associated with the causes. The TDA furthermore describes challenges for future management and offers recommendations that could be integrated into the SAP process.

The problem areas were prioritised on the basis of their geographical scope and expected severity. The **degradation of aquatic and terrestrial habitats** through deforestation and sedimentation, overgrazing, intensification of landuse, and unsustainable landuse methods in agriculture was identified as one of the key problems for ecosystems in the Baikal Basin.

Hydrological regime changes were also identified as a main transboundary problem. This problem particularly counts for water level decrease resulting from withdrawal of water for domestic, agricultural or industrial purposes, deforestation, and the impacts of climate change. Hydrological regime changes resulting from water level increase caused by dams and hydroelectric power plants was identified as a local problem,

[1] The physical water catchment basin of Lake Baikal is denoted elsewhere in this TDA as “Baikal Basin” or “Lake Baikal catchment basin”, following the definition as outlined in section 1.6.

especially in Russia was identified as a problem that specifically affects the aquatic and nearshore ecosystems of Lake Baikal.

The **decline of the quality of surface and groundwater resources** resulting from point source and nonpoint source pollution is a significant concern in both Mongolia and Russia. As polluted water can be transported over long distances, it affects downstream areas and is a significant transboundary issue. Once pollutants reach Lake Baikal, they could possibly accumulate for centuries, since water stays in the lake for an estimated 300 years. Five specific problems were identified that affect the quality of water resources in the Baikal Basin:

- **Chemical contamination**: Mainly concerns pollution caused by heavy metals, hydrocarbons, persistent organic pollutants (POPs) and pesticides. Key pollution sources are the mining industry as well as other industries and domestic waste.
- **Increased suspended solids and sedimentation**: Caused by combined effects of deforestation, unsustainable landuse practises, mining activities, and inadequate treatment of wastewater.
- **Microbial pathogenic contamination**: Resulting from insufficiently treated wastewater, use of bio-control agents such as bacteria, fungi and viruses, inappropriate discharge of medical waste, and inadequate disposal of infected animal carcasses.
- **Organic pollution and eutrophication**: Insufficiently treated wastewater contaminated with faecal matter, detergents and oil hydrocarbons (including fuels and lubricants) forms a point source of organic pollution. Non-point sources include atmospheric deposition, and runoff from areas treated with fertilisers, herbicides and insecticides.
- **Thermal contamination**: Results from use of water as a coolant for power or industrial plants. Thermal contamination is a point-source problem that can have significant impacts on local flora and fauna.

Concerns around the **sustainability of fisheries and wildlife exploitation** in the Baikal Basin are the loss of aquatic and terrestrial biodiversity, as well as loss of potential stocks for human consumption. Overfishing is a major concern in Lake Baikal, particularly on species that are listed as endangered in the Red Books of Mongolia and Russia (e.g. Baikal sturgeon, lenok, taimen). Hunting is to a large extent regulated in the Baikal Basin, and licences are required for the majority of species that are preferred by hunters. However, unregulated hunting and poaching poses problems for wildlife in the basin. The problem is particularly pressing for populations of wildlife whose habitats are declining as a result of deforestation, unsustainable landuse practises, pollution, and the impacts of climate change.

The extent of **biological invasions** in the Baikal Basin thus far seems to be limited to 13 fish species and 1 plant species in aquatic systems, as well as 3 plant species in terrestrial systems. However, degraded and polluted habitats are more receptive to biological invasions than pristine habitats, due to a loss of local species diversity and resilience to change. Therefore, due to the levels of habitat degradation and pollution in the Mongolian and Russian territories of the Baikal Basin, the risk of future invasions is high and a level of precaution should be in place.

Climate change was identified as a cross-cutting theme, which directly or indirectly affects all other problem areas in the transboundary basin. Natural disasters were also identified as a cross-cutting theme. Although **natural disasters** are not caused by human activities, environmental degradation can aggravate their impacts. Conversely, sustainable environmental management can mitigate some of the impacts of natural disasters.

Box A. Main concerns and specific problems identified for the Baikal Basin Transboundary Ecosystem

MAIN PROBLEM AREA	SPECIFIC PROBLEM
1. Degradation of Aquatic and Terrestrial Habitats	• Deforestation • Degradation of agricultural, pasture, and range lands • Ecosystem changes
2. Hydrological Regime Changes	• Water level decrease in the catchment basin • Water level increase in the catchment basin
3. Decline of Water Quality	• Chemical contamination • Increased suspended solids and sedimentation • Microbial pathogenic contamination • Organic pollution and eutrophication • Thermal contamination

4. Unsustainable Fisheries and Wildlife Exploitation	• Over-exploitation of aquatic biota • Over-exploitation of terrestrial wildlife
5. Biological Invasions	• Alien species invading aquatic habitats • Alien species invading terrestrial habitats
CROSS-CUTTING AREAS	
6. Impacts of Global Climate Change	• Fluctuations in freshwater flow • Increased extreme weather events
7. Natural Disasters	• Earthquakes • Mudslides • Droughts and floods

Governance and Natural Resource Management

Besides identifying problem areas and causes, the TDA identifies the socio-economic, legal, administrative, and political contexts or constraints relevant for the integrated management of the transboundary water basin.

There are a number of common challenges related to the existing governance structures related to all problem areas in the TDA. In general, there are shortcomings in the available legislative frameworks, with inadequate or incoherent laws and regulations. A lack of implementation or enforcement is also a common problem. Legislative weaknesses are accentuated by inadequate institutional frameworks, and issues of technical capacity and financial mechanisms.

The principles and opportunities for good governance in sustainable natural resource management are presented in the TDA, as well as an overview of the present and potential role of civil society. Civil society movements are steadily emerging in the region, and increasingly able to influence general public opinion as well as governance, in spite of obstacles or state-imposed constraints. The TDA also discusses the important role of environmental education activities and public awareness campaigns in empowering people about issues relevant to the protection of biodiversity, management of natural resources and sustainable development opportunities.


Photo by Urabazaev

Introduction

1.1 LAKE BAIKAL AND ITS CATCHMENT BASIN

Lake Baikal, situated in south-east Siberia, is one of the world's most unique lakes. It is a global hotspot of aquatic biodiversity, harbouring an extraordinary variety of flora and fauna, including hundreds of endemic species of amphipods, flatworms, and fish, as well as the only species of freshwater seal on earth. At present, over 2,550 species are known from Lake Baikal, including 1,550 species of fauna and 1,000 plant species (Timoshkin 2001) and numbers continue to increase as new species are being discovered (e.g. Kaygorodova 2012; 2013).

Similar to Lake Tanganyika in East Africa, Lake Baikal lies in a geological rift zone that continues to extend as a result of the divergence of continental plates. With an estimated age of between 25-30 million years, and a maximum depth of 1,637 m, Lake Baikal is the world's oldest and the deepest lake. The lake contains approximately 20% of the globally available surface freshwater. Lake Baikal is also famous for its water clarity, which can reach up to 40 m.

In 2008, the Russian Government declared Lake Baikal to be one of the Seven Wonders of Russia. In 1996, Lake Baikal was added to the UNESCO list of World Heritage Sites (UNESCO 1996[2]), due to it's value as a natural phenomena, representing outstanding examples of ongoing ecological and biological processes in evolution and development of freshwater ecosystems, and as a significant habitat for the conservation of biodiversity. Furthermore, the Baikal region includes numerous historical, archaeological and cultural monuments, several of which are traditionally considered sacred.

A total of 336 rivers flow into Lake Baikal with only one outlet, the Angara River. As a result, the residence time of water in the lake is over 300 years. The largest tributary of Lake Baikal is the Selenga River, which starts in Mongolia and contributes over 60% of annual inflow to the lake. In 1996, the delta of the Selenga River was included on the list of Ramsar Wetlands of International Importance because of its significant role as a habitat for flora and fauna, as well as its role in functioning as a water filter against pollution flowing into the lake.

The water catchment of Lake Baikal is shared by the Russian Federation (Russia) and Mongolia[3]. The Baikal Basin includes Lake Khovsgol, which is Mongolia's largest lake and contains almost 75% of the country's surface freshwater. The basin includes numerous mountains, extensive boreal forests, tundra, and steppes

[2] The criteria of the World Heritage Convention on the basis of which Lake Baikal was selected are as follows:
vii. To contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.
viii. To be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.
iv. To be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.
v. To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation. http://whc.unesco.org/en/criteria

[3] For a definition of the Baikal Basin, see section 1.4.

with high scenic beauty and significant natural values. Due to the climatic and geologic differences in the region, a great variety of plants and animal species is found.

Given the national, regional, and global significance of the biodiversity in the Baikal Basin, as well as the ecosystem services provided by its aquatic and terrestrial systems, transboundary and international cooperation for the protection and sustainable management of the basin is of vital importance.

1.2 NEED FOR ACTION

The biodiversity and the health of the aquatic and terrestrial ecosystems in Lake Baikal and its catchment basin are increasingly threatened as a result of the impacts of a growing human population and its demands on natural resources.

There is mounting evidence that global climate change is resulting in an increase of the air temperatures in the region, and this is expected to result in the alteration of food-web structures and functioning of aquatic as well as terrestrial ecosystems (Shimaraev et al. 2002; Moore et al. 2009). An increase in extreme weather effects such as droughts and floods is expected to result in damage to ecosystems, as well as to infrastructure and agricultural sectors, leading to economic losses.

Pollution from point and non-point sources causes significant threats to the health of ecosystems as well as humans in the Baikal Basin. Unsustainable practices used in the mining industry has lead to a growing amount of detrimental environmental impacts. Approximately 40% of the total forested area in the Baikal basin has been reduced over the past 10 years as a result from tree felling and forest fires. Invasive species are increasingly threatening biodiversity as well as productivity of rangelands, pastures and agricultural areas.

As a consequence of the continued degradation of aquatic and terrestrial habitats in the Baikal Basin, ecosystem services such as buffering and filtration of pollution and control of erosion, as well as sustainability of water levels and micro-climates are increasingly at risk. As such, there is a clear need for joint, transboundary support and action to ensure the protection of biodiversity and health of aquatic and terrestrial ecosystems so that they can continue to provide critical services for future generations.

In recognition of the value of the natural resources for the people inhabiting the Baikal Basin, the Governments of Mongolia and Russia signed several transboundary agreements. In 1995, the bilateral “Protection and Use of Transboundary Waters” was signed, replacing earlier agreements from 1974 and 1988. Both countries regularly share information, exchange visits, and have a scheme of cooperation in place, in case of emergencies.

Various relevant projects and initiatives towards protection of biodiversity and sustainable management of natural resources have taken place in both Mongolia and Russia. This includes a GEF-financed Biodiversity Project that was implemented in Russia from 1996-2003, which resulted in the development of a Lake Baikal Biodiversity Conservation Strategy, providing a political and institutional context for expanding Protected Areas and developing watershed plans.

In spite of the agreements and cooperation between the two countries, and actions at the national level, limited progress has been made towards achieving sustainable transboundary management of the basin. To address the need for improved transboundary planning, cooperation and action, a new project was initiated on Integrated Natural Resource Management in the Baikal Basin Transboundary Ecosystem (UNDP-GEF 2011), which started its 4-year implementation phase in November 2011. The project is supported by UNDP and the Governments of Mongolia and Russa, executed by UNOPS, and financed by the GEF with co-financing from the Foundation for the Protection of Lake Baikal, the Coca-Cola Every Drop Matters program, and UNESCO.

The project has the objective to spearhead integrated natural resource management of the Lake Baikal basin including Lake Khovsgol, ensuring ecosystem resilience, and reduced water quality threats in the context of sustainable economic development. The project has three primary components:

- Elaborating a strategic policy and planning framework.
- Strengthening institutional capacity for IWRM.
- Demonstrating water quality and biodiversity mainstreaming practice, including groundwater monitoring and protection.

In accordance with GEF best practices for international waters projects, a preliminary transboundary diagnostic analysis (TDA) was undertaken between 2008-2009. The present document represents an update of the preliminary TDA, which will function as a basis for further strategic action planning.

1.3 PURPOSE OF THE TDA

The main purpose of the Transboundary Diagnostic Analysis (TDA) is to ensure that interventions for sustainable development of shared water bodies are based on facts and informed decision making. The TDA is a non-negotiated technical document that provides the factual basis for the formulation of a Strategic Action Programme (SAP). The objective of the TDA is to provide a scientific and technical analysis on the status and impacts of the environment. The TDA aims to:

- Identify, quantify, and set priorities for environmental issues which are transboundary in nature.
- Identify the immediate and root causes of these priority environmental issues.
- Identify specific practices, sources, locations, and sectors of human activity associated with these priority environmental issues and from which environmental degradation arises or threatens to arise.

The TDA is an element of an adaptive management strategy that enables the identification of transboundary issues and their causes. It is intended as an ongoing process, which needs to be updated with periodic reports as new information about the status of the transboundary basin emerges.

1.4 TDA-SAP PROCESS AND PRINCIPLES

The development of a TDA as well as a Strategic Action Programme (SAP) is recommended by the GEF as a best practice for international waters projects[4]. The process of formulating a TDA requires detailed analyses of environmental issues, which are subsequently prioritized according to their current or expected severity and impact. Furthermore, the impacts of the environmental issues are assessed, possible causes identified and, as far as possible, quantified or qualitatively justified.

The priority transboundary environmental issues are subject to the process of a causal chain analysis (CCA) to determine their root causes, immediate and intermediate causes as well as sectoral activities associated with the root causes. The main purpose of a CCA is to identify the most important root causes of each of this priority problems in order to target them by appropriate policy measures and interventions for remediation or mitigation. Furthermore, the CCA is an important basis for the design of the practical actions that will be included in the SAP.

Components of a Causal Chain Analysis include:

- **Priority transboundary environmental problems or issues**: Environmental issues as identified from the studies and evaluations conducted during the TDA process, which are prioritised before the CCA.
- **Immediate causes**: Physical, biological or chemical variables that have a direct impact on a priority environmental issue.
- **Root causes**: Key factors, trends, processes or institutions that: (a) influence a situation, issue, or decision; and (b) propel the system forward, and determine the outcome of a scenario.

Institutional mapping and stakeholder analyses should be an integral component of the TDA. Another important aspect of the TDA is a governance analysis, which identifies all the socio-economic, legal, administrative, and political contexts or constraints relevant for the integrated management of the transboundary water basin.

The preparation of a TDA can take place in a number of ways depending on the specific local situation, but it should always involve both national as well as regional joint-fact finding initiatives.

The development of a SAP starts with a review of the priority transboundary issues, and their immediate and root causes that have been identified in the TDA. The SAP has two main objectives: Firstly to identify policy options and associated governance mechanisms in addressing priority transboundary issues, and secondly to formulate appropriate mechanisms to implement priority interventions. The SAP is a negotiated policy document that is endorsed at the highest levels of all relevant sectors.

[4] For background information see: http://manuals.iwlearn.net/tda-sap-methodology

The SAP should establish clear priorities for action relating to reforms in policy, legal, institution or investments. Furthermore, the SAP should enable the achievement of agreed regional objectives through specific national actions. The priority transboundary issues that have been identified in the TDA are used for the formulation of ecosystem quality objectives (EcoQOs), indicators for monitoring and evaluation, as well as targets to define strategic program actions for mitigating the environmental problems. Specific, quantifiable and time-constrained targets are then set for achieving the EcoQOs. Subsequently, specific interventions are developed to realise the EcoQOs within the time frame designated.

1.5 METHODS USED FOR UPDATING THE TDA

As part of the preparation phase for the UNDP-supported, GEF-funded Project on Integrated Natural Resource Management in the Baikal Transboundary Ecosystem, a preliminary TDA “Joint Actions to Reduce PTS and Nutrients Pollution in Lake Baikal through integrated basin management” was prepared in 2008 and finalised in 2009. Because the preliminary document omitted key steps that are recommended according to GEF best practices for international waters projects, a process was initiated to update the TDA.

The TDA updating process addressed the following issues:

- Ensure that all key stakeholders have a shared understanding of the GEF TDA-SAP process.
- Formulate a definition of the Baikal Basin, including boundaries and conditions for the focus of the TDA.
- Revise the list of transboundary challenges for the protection of biodiversity and sustainable management of natural resources in the Baikal Basin.
- Prioritise the identified transboundary challenges for future strategic interventions.
- Prepare a strategy to obtain missing data and information relevant to the completion of the TDA.
- Elaborate a causal chain analysis (CCA) to ensure that root causes of the transboundary challenges are well-understood, as well as their immediate and intermediate causes and the sectoral activities associated with the root causes.
- Complete an analysis of stakeholders relevant to the sustainable management of the Baikal Basin.

To coordinate and implement the updating process, a Scientific Advisory Group (SAG) was established, comprising expert teams from Mongolia and Russia (Annex I). To ensure continuity, the SAG included several of the experts who also participated in the drafting of the preliminary TDA. The SAG was supervised by the Project Manager and an international consultant with expertise on the GEF TDA-SAP process. A two-day regional workshop[5] was organised in September 2012 during which a short training course was provided on the TDA-SAP process, transboundary challenges were revised and prioritised, and a causal chain analysis was implemented (4.1.1 and Annex X).

The preparation phase for the Project on Integrated Natural Resource Management in the Baikal Transboundary Ecosystem and the preliminary TDA both included analysis of stakeholders relevant to the transboundary management of the Baikal Basin. During the process to update the TDA, an additional stakeholder analysis was conducted as part of the CCA. The combined results of these analyses are presented in this TDA.

During the period August 2012 – March 2013 the members of the SAG collected and analysed additional data and information relevant to a range of topics, including pollution hotspots, biological invasions, and climate change. With support from UNESCO, additional data was collected and analysed relevant to the sustainable use of groundwater resources in the Baikal Basin. The new data is either integrated in this document, or presented as Technical Annexes to the TDA. Additional technical reports will be annexed to this document as they become available during further updating processes.

1.6 BOUNDARIES AND CONDITIONS OF THE TDA

The geographical area of this TDA focuses on the physical water catchment basin of Lake Baikal[6], which covers an area of c.a. 540,000 km^2 (Kozhov, 1963) in south-eastern Siberia and northern Mongolia (Figure 1.6.1).

[5] For a report of the meeting, see: Marijnissen, S. (2012) Regional workshop on updating the Lake Baikal Basin Transboundary Diagnostic Analysis, Ulan-Ude 18-19 September 2012. UNDP-GEF Project on Integrated Natural Resource Management in the Baikal Transboundary Ecosystem report, 37 pp. including Annexes.

[6] The physical water catchment basin of Lake Baikal is denoted elsewhere in this TDA as “Baikal Basin” or “Lake Baikal catchment basin”, following the definition as outlined in this section.

The Russian part of the Baikal Basin comprises three environmental impact zones:

4. The Central Ecological Zone: Lake Baikal and natural parks and reserves, which are located around the lake.
5. The Buffer Environment Zone: Physical catchment area within Russia.
6. The Zone of Atmospheric Impact: Area immediately outside the physical catchment area to the west and north-west of the lake.

The Baikal Basin exists at the junction between biogeographically distinct regions: Central Asian, Eastern Asian, and European-Siberian. These regions consist of combinations of taiga, tundra, steppe and deserts. Consequently, the Baikal Basin harbours extremely diverse communities of plants and animals (Kozhova and Izmesteva, 1998).

Figure 1.6.1: Map of Lake Baikal and its transboundary water catchment basin that is shared by Mongolia and the Russian Federation.

In terms of thematic scope, this TDA covers the Baikal Basin Transboundary Ecosystem[7], which is defined as the dynamic complex of plant, animal, human, and micro-organism communities as well as their non-living aquatic and terrestrial environments, acting as a functional unit within the spatial boundaries determined by the physical water catchment area of Lake Baikal, including Lake Baikal itself and parts of Mongolia as well as parts of the Russian Federation.

The TDA promotes a holistic approach by addressing and integrating issues related to water-based as well as land-based sources and activities that can affect the health of the aquatic and terrestrial components of the Baikal Basin Transboundary Ecosystem. The main thematic areas of this TDA are therefore:

1. Degradation of aquatic and terrestrial habitats.
2. Changes of hydrological regimes.
3. Decline of water and soil quality.
4. Unsustainable fisheries and wildlife exploitation.
5. Biological invasions.
6. Climate change impacts (cross-cutting theme).
7. Natural disasters (cross-cutting theme).

By identifying specific practices, sources, locations, and sectors of human activity associated with these areas, the TDA offers opportunities to develop integrated, cross-sectoral interventions for the protection of biodiversity and ecologically sustainable management of the natural resources in the Baikal Basin.

[7] According to the Convention on Biological Diversity, an ecosystem can be defined as “A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit” (CBD, Article 2) www.cbd.int/convention/articles/?a=cbd-02


Photo by Anna Rynkova


Photo by Sergey Kudelya

Description of the Lake Baikal Basin

2.1 PHYSICAL CHARACTERISTICS

2.1.1 GEOGRAPHIC AND GEOMORPHOLOGICAL FEATURES

Lake Baikal is the oldest, deepest, and most voluminous of the world's great rift lakes (Table 2.1.1). The Lake Baikal basin is shared by two countries: Mongolia and Russia (Figure 1.6.1). The lake is situated at 455.5 m asl between 51°28'−55°47' North and 103°43'−109°58' East. Mongolia occupies 55.4% of the catchment area, whereas Russia occupies 44.6% (Buryatia 31.8%, Zabaikalsky Krai 10.2%, Irkutsk Oblast 2.2%, Republic of Tyva 0.4%)(E.J.Garmaev, 2010).

The Baikal Basin is situated in a tectonically active rift zone of over 2,000 km long. Lake Baikal itself is estimated to have originated between 25-30 million years ago (Mats et al. 2000; Horiuchi et al. 2003) through the divergence of the Eurasian Plate and Siberian platform to the west, and the Amur Plate to the east.

Bathymetric maps of the lake revealed that the lake is made up of three sub-basins (INTAS 2002). The central basin has a maximum depth of 1,637 m (1,186.5 m below sea level), which makes Lake Baikal the deepest lake in the world. The northern basin has a maximum depth of 904 m, the southern basin has a maximum depth of 1461 m, and the mean depth is 744.4 m. With an estimated volume of 23,615.39 km^3, Lake Baikal contains approximately 20% of the world's available surface freshwater.

Table 2.1.1: **Characteristics of Lake Baikal compared to the African Rift Lakes**

	Lake Baikal	Lake Tanganyika	Lake Malawi	Lake Victoria
Estimated age (million years)	25-30	9-12	4.5-8.6	0.25-0.75
Maximum depth (m)	1,642	1,470	706	80
Mean depth (m)	744.4	570	264	40
Surface area (km^2)	3,1722	32,600	29,500	68,870
Volume (km^3)	23,615.39	18,880	7 775	2 760
Length of the lake (km)	636	670	569	412
Length of the shoreline[8] (km)	2,000	1,900	1,500	3,460
Catchment drainage area (km^2)	542,672.2	223,000	100,500	193,000

Lake Baikal contains 22 islands. The largest island is Ol'khon (Figure 2.1.1.a), which has an area of 730 km^2, making it one of the largest lacustrine islands in the world. Other significant islands are Boruchansky and Izhilkhey. Main island groups in the lake are Bolshoi Ushkaniy[9], Chayachiy, Listvianichny and Yarki.

[8] The total length of the shoreline varies with the fluctuation of the lake water level.
[9] Ushkaniy island is one of the important breeding grounds for the endemic freshwater seals of Lake Baikal.

Figure 2.1.1.a: Shaman Rock on Olk'hon Island near Khuzir, considered a sacred place by the Buryat people, and one of the most iconic touristic images from Lake Baikal. Photo: Andrzej Barabasz

The Baikal Basin also includes Lake Khovsgol, which is situated 1,645 m asl in the northwest of Mongolia at the foot of the Sayan mountain. With a maximum depth of 262 m, a surface area of 2760 km^2, and a volume of 380.7 km^3 (Tserensodnom Zh., 2000), Lake Khovsgol is the largest lake by water volume and second largest by water surface area.

Figure 2.1.1.b: Lake Hovsgol, photo by Janchivdorj L.

As a result of its location in a tectonically active rift zone, the Baikal Basin is characterised by dramatic mountain ranges (Figure 2.1.1.c). The western shoreline of Lake Baikal is rimmed by the Primorsky and Baikalsky ranges, with a maximum height of 2,678 m. The Barguzinsky mountain range, with maximum height of 2,840 m is found in the east, whereas the south-east and the south of the lake are rimmed by the Khamar-Daban range.

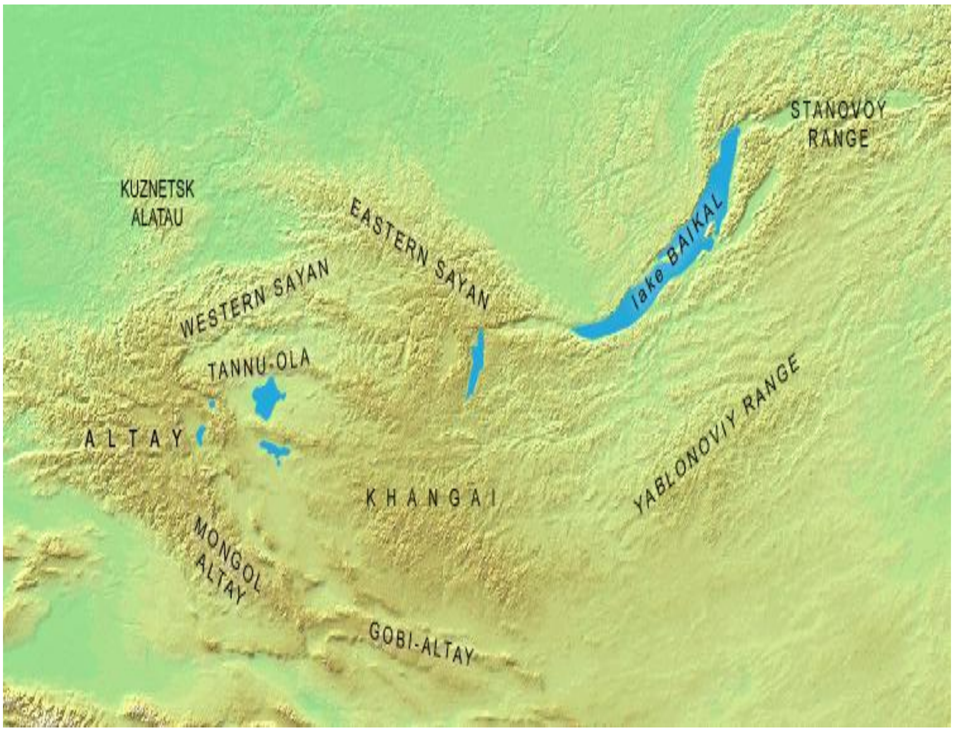


Figure 2.1.1.c: Map of the main mountain ranges in the Baikal Basin. Source: Wikipedia.com

The Baikal Basin furthermore includes the Yablonoviy mountain range, which runs north-east from Mongolia into Russia, with a peak of 2,500 m. The Altay-Sayan mountain range is situated between north-western Mongolia and southern Siberia, with a general elevation of 2,000-2,700 m. The highest peak in this mountain range is the Mönkh Saridag, which has a height of 3,492 m. The overall highest mountain in the Baikal Basin is the Otgontenger in the Khangai mountain range in Mongolia, which has a peak of 3,905 m.

The continued extension of the rift is associated with high seismic activity, and as a result, earthquakes are common in the region (Radziminovitch 2006). Annually, more than 2,000 earthquake tremors are registered by seismic stations in the Russian part of the Baikal Basin. In 1959, an earthquake with a magnitude of 9 on the Richter scale caused displacements of 12-20 m at the bottom of Lake Baikal. The occurrence of earthquakes in the region is being monitored closely. In 2001, monitoring data indicated that during a period of 40 years over 110,000 earthquakes had taken place in the Baikal Rift System (Déverchère et al. 2001).

Another result of the fact that Lake Baikal is situated in an active rift system, is the occurrence of so-called "cold seeps", where methane and/or other fluids actively escape from the lake floor, forming mud volcanoes (Granin and Granina 2002).

2.1.2 SURFACE WATER HYDROLOGY

Lake Baikal has only one outlet, the Angara River, which exits the lake in the west near Irkutsk. The Angara River is 1,779 kilometers long and forms the headwater tributary of the Yenisei River, which flows into the Arctic Ocean. Lake Baikal is predominantly fed by run-off from 336 rivers and streams. The largest contributions come from the Selenga, Upper Angara, Barguzin, and Ruka Rivers. On average, 57.77 km^3 of river water is contributed annually to Lake Baikal, adding up to 82.4% of the lake's total water balance. Precipitation contributes 13.2% to the lake's annual water balance, whereas groundwater sources contribute 4.4%.

Table 2.1.2.a Average annual water balance of Lake Baikal (MNRE 2012).

Inflow	**km^3 /year**	**Outflow**	**km^3 /year**
Surface waters	57.77	Angara River	60.89
Precipitation	9.26	Evaporation	9.26
Groundwater	3.12		
Total	**70.15**	**Total**	**70.15**

The Selenga River (also called Selenge River in Mongolia) is the largest tributary to the Lake Baikal. The river has a length of 1,024 km, of which 615 km in Mongolia and 409 km in Russia. The Selenga River ends in a large delta of 680 km² on the eastern shores of the lake in Republic of Buryatia. The basin covers seven provinces in Mongolia (Zavkhan, Khubsgul, Bulgan, Arkhangai, Uvurkhangai, Selenga, and Tuv), including the capital Ulan Bator and two provinces in Russia (Republic of Buryatia and Zabaikalsky Krai).

The catchment of the Selenga River occupies 447,060 km^2 (E.J.Garmaev, 2010), of which 299,690 km^2 (67%) is located in Mongolia (Figure 2.1.2.a) and 147,370 (33%) in Russia (Janchivdorj L. Reason of the drying of the Eg River and ecological degradation of Lake Hovsgol. Geoecological issues in Mongolia, # 8, Ulaanbaatar 2009). The Selenga River contributes on average 29,2 km^3 water to Lake Baikal annually (E.J. Garmaev, 2010), adding up to half the lake's total riverine inflow. In addition, the Selenga River deposits over 3,5 million tons of sediment per year.

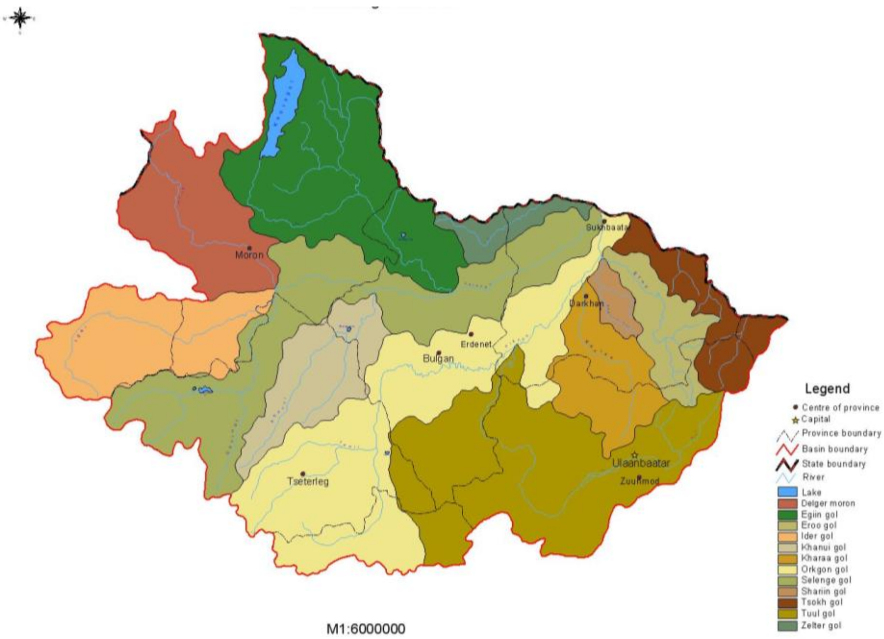


Figure 2.1.2.a: The Selenga River catchment basin in Mongolia.

The Selenga River is mainly fed by thawing water and precipitation, and starts at the confluence of the Ider and Delgermurun Rivers in Tömörbulag, Mongolia (Figure 2.1.2.b). The Ider River originates southeast of the highest peak of the Khangai Mountain range in central Mongolia (4,301 m asl), whereas the Delgermurun River originates in the Ulaan Taiga mountain range (2,616 m asl) close to the border of Russia.

The main tributaries of the Selenga River are the Orkhon, Tuul, and Eg River in Mongolia (Table 2.2.2.b), and the Djida, Uda, Chikoy and Khilok Rivers in Russia. The Djida, Uda and Khilok Rivers flow through dry steppe areas and only contribute very low volumes of water (0.0005- 0.002 m^3/sec). The Orkhon River is the largest tributary to the Selenga River. Its source is the sacred Suvraga Khairkhan mountain in the eastern Khangai Mountain range, from where it flows northwards for 922 km before joining the Selenga River. The Orkhon is the longest river in Mongolia, and it has a catchment area of 132,725 km^2.

Table 2.1.2.b Characteristics of the Selenga River and its tributaries in Mongolia (Janchivdorj L. Reason of the drying of the Eg River and ecological degradation of Lake Hovsgol. Geoecological issues in Mongolia, # 8, Ulaanbaatar 2009).

River	Catchment area (km^2)	length (km)
Selenge	25,441	534
Ider	24,094	440
Chuluut	19,999	280
Delger	23,000	391

Hanui	14,890	338
Eg	42,200	453
Orkhon	132,725	922
Zelterin	5,477	
Tsukh	11,864	
Total:	299,690	

The catchment basin of the Selenga River is predominantly mountainous, and the basin is characterized by substantial differences in elevation. The Selenga basin includes Lake Khovsgol, which contains 75,1% of Mongolia's available surface freshwater resources. Lake Khovsgol has 96 tributaries and only one outflow, the Eg River, which joins the Selenga River. During flash floods, sediment inflow can create a natural dam in the mouth of the Eg River. As a result, the water flow from the Eg River is sometimes blocked.

The volume of the Selenga River shows significant variation on an annual basis, and the difference between low-flow and high water level can be as much as six meters. Large floods of the Selenga River occur on average once in every ten years.

Figure 2.1.2.b: The origin of the Selenga River at the confluence Delger River and Ider River.

For most of the rivers in the Lake Baikal Basin, 80-90% of the annual run-off occurs during the summer, with flow peaks from July to August. The majority of the rivers in the basin freezes during winter months from around November to April. In Mongolia, rivers flow approximately 6 months, as a result of limited precipitation and freezing during the winter. The uneven distribution of annual run-off, as well as the freezing and shallow depths during the winter hampers economic utilization of the majority of the inflowing rivers in the Lake Baikal Basin.

2.1.3 GROUNDWATER HYDROLOGY

Groundwater forms a significant component of the overall hydrological cycle[10], and aquifers are important hydrological units in watersheds and river basins. It plays an important environmental and socio-economic role as a reservoir, and as a linkage between water systems. In nature, groundwater is a key element of many geological and hydrochemical processes, and it plays a role as a geotechnical factor that conditions soil and rock behaviour. Groundwater forms a valuable component of ecological systems that sustain spring discharge and river basin flow, as well as lakes and wetlands.

Groundwater resources play an important role in supporting Russian and Mongolian households and economic development. The majority of the urban and rural populations in the Baikal basin depend on

[10] For additional details and information relevant to this section, see UNESCO (2013) Groundwater resource assessment as a contribution to the TDA, including surface water-groundwater interactions and groundwater dependent ecosystem in the Baikal Basin, Preliminary Report, 20 January 2013, 72 pp. and Annex X.

groundwater for domestic purposes. Groundwater resources are also important for supporting mining, industrial and agricultural activities.

In Mongolia, 80% of the water supplies for domestic, industrial agricultural purposes are derived from groundwater resources. The main cities are fully dependent on groundwater. In Russia, groundwater is used mostly for domestic purposes and drinking water supplies. Mining industries also use groundwater, whereas other industrial enterprises mainly use surface water.

The groundwater system in the Lake Baikal Basin is characterised by both deep and shallow circulation. Deep groundwater flow occurs through tectonic activity that creates vertical passes and cleavages in the rock environment. Tectonic structures allow rainwater to penetrate into great depths and form active geothermal systems. The Baikal Basin also includes deep aquifer systems, which contain non-renewable fossil water. Shallow groundwater circulation occurs through topsoil and permeable river sediments that are widely developed in the Baikal basin. This type of groundwater is most sensitive and vulnerable to the human impacts and pollution. The main source of groundwater recharge is influx from mountains and precipitations. Discharge of river water into shallow aquifers also occurs in many parts of the Baikal Basin.

Groundwater is naturally discharged via springs and natural watercourses (rivers, streams, lakes), or by man-made facilities (wells, galleries). The discharge rates of groundwater depend on the type of rocks and their permeability. For instance, karst formations in the Baikal Basin can discharge groundwater in wet seasons up to 200 l/sec. However, the yields of karst springs can fluctuate substantially. Discharge from sandstones is lower (tens of l/sec.) but is more stable. Discharge from granite and other hard rocks varies mostly between 0.5−3 l/sec. However, yield of wells located in tectonically disturbed and highly fissured hard rocks may reach several tens of l/sec.

In the Mongolian part of the Selenge River Basin, two groundwater units have been identified according to geological conditions and tectonic structure: i) Northern Mongolia, and ii) Mongolia –Transbaikal unit. Both are affected by the deep tectonic faults of Tamir and Bayangol. A variety of unconsolidated deposits and hard rock formations contain significant resources of groundwater.

Shallow aquifers in alluvial deposits composed by porous sands and gravels are often hydrologically connected to surface streams or rivers. Highly productive shallow aquifers with abundant groundwater resources exist in the fluvial deposits of Selenge, Tuul and Orkhon, as well as other rivers. They are used as a main source of drinking water supplies for major cities in Mongolia including Ulaanbaatar, which is the largest consumer of groundwater resources in Mongolia, as well as in Erdenet, Darkhan, Murun, Sukhbatar, Tsetserleg, and Zuunkharaa cities.

Groundwater is also stored in continuous permafrost deposits. In the high plateaus of the Khovsgol, Khangai and Khentii mountains in Mongolia, the permafrost deposits are particularly widely developed, and can reach a thickness of 200-500 m. Continuous and non-continuous permafrost islands with a thickness ranging from 15-25 or 50-100 m are spread accross the Khangai mountain zone and small river valleys. In the major part of the Russian territory of the Baikal Basin mostly fragmented permafrost occurs. However, continuous frozen grounds can be found in the southern and northeast flanks of intermountain basins (East Sayan Mountains, Barguzin, and Severomuyski). Groundwater in permafrost deposits can be either in frozen or liquid form, and is mostly used as water supply for small rural settlements and for pasture livestock.

Three areas with significant groundwater resources have been identified in the Russian part of the Lake Baikal basin: i) the eastern part of the Lena-Kirenga Basin; ii) the Baikal Rift zone, and iii) Trans-Baikalia. In each of these areas there are different hydrogeological conditions, depending on their geological and tectonic features. The groundwater basins in the Baikal Rift zone contain significant groundwater resources in aquifers in intermountain deep, asymmetric depressions filled by unconsolidated sediments. Basins composed by Pre-Cambrian crystalline rocks can be found between 3,000-5,000 m below ground. The main groundwater resources in Russian part of Baikal Basin are found in artesian basins in inter-mountainous areas, and in shallow aquifers in fluvial deposits in the valleys of large rivers. The shallow aquifers in Selenge River fluvial deposits provide groundwater for Ulan-Ude city, which is home to about half of the population of the Republic of Buryatia, and consumes most of the groundwater resources that are presently being extracted.

2.1.4 CLIMATIC CONDITIONS

The Baikal Basin is situated near the centre of the Asian continent, and as such characterized by a pronounced continental climate with very cold winters (dominated by anticyclones centred over Siberia), cool to hot summers, large annual and diurnal ranges in temperature, and generally scanty precipitation. The difference between the mean temperatures of January and July can reach 44°C, and temperature variations of as much as 30°C can occur in a single day.

Lake Baikal itself functions as a large thermo-stabilizator, due to the fact that water masses accumulate much heat and are warmed during the summer to depths of 200-250 m. The average annual temperature of the lake's surface water is +4°C. In the summer, near-shore water temperature can reach +17°C, and up to +23°C in shallow bays. Winter temperatures are significantly warmer and summer temperatures are cooler around the coast of Lake Baikal than in the rest of the Siberian territory. For instance, there is typically a 10ºC difference in temperature between locations close to Lake Baikal and Irkutsk, which is located 70 km west of the lake.

Lake Baikal freezes every year, for a period of almost five months (Figure 2.1.4.a). The lake is gradually covered with ice from the north to the south, starting in late October when shallow bays freeze, until the entire lake is frozen in the middle of winter (around the first two weeks of January). In the winter, the ice is about 1 m thick. When the temperatures decline, ice compresses at night and subsequently tears into separate fields following thermal patterns. As the temperatures increase, the ice expands, pressure emerges on cracks, and hummocks are formed. Around April 25-30 the ice typically starts to break open near the Bolshoi Kadilny Cape, as a result of increasing air temperatures and deep warm waters being brought to the surface by lake currents. The northern part of the lake is normally the last to be cleared of ice, around the first two weeks of June.

Figure 2.1.4.a: Lake Baikal during the winter, when the lake is frozen over. The ice can reach a thickness of about 1 meter. Photo: Daniil.

Lake Baikal is well-known for being one of the roughest lakes in the world, with waves that can reach over 6 m. Maximum wind speeds are recorded in April, May and November, whereas minimum wind speeds occur in February and July. The diversity of prevailing wind patterns in Lake Baikal is reflected in the fact that over 30 local names exist for different types of wind. For instance, the *Gornaya* is a western and north-western mountainous wind that picks up suddenly and very quickly becomes very strong. The most powerful wind is the *Sarma*, which is a variety of the *Gornaya* and reaches speeds of up to 40 m/sec.

The air temperature above Lake Baikal is influenced by the temperature of the underlying water surface and follows its isotherms curves. Throughout the year the average air temperature over the surface of Lake Baikal in the open waters changes from -21°C in winter to +15°C in summer, and from -25°C to +17°C in the coastal areas. The water temperature of the coast is influenced by the shallow delta areas of the Selenga, Barguzin, and Upper Angara Rivers, which reach +22°C during the summer.

Precipitation as rain, snow, or air condensation forms the second most important contribution to the water balance of Lake Baikal after river runoff. On average, 9.26 km^3 of precipitation (294 mm) contributes 13.2% to the annual water balance of the lake.

Precipitation patterns in the catchment basin of Lake Baikal are highly unevenly distributed. The following five areas can be distinguished in the Baikal Basin based on their average annual precipitation patterns:

- South-Western near-Baikal (from the Angara River to the Pokoyniki River): 475 mm.
- Northern-Baikal (north from the Pokoyniki and Turka Rivers): 700 mm.
- Khamar-Dabansky: 1,145 mm
- Chikoy taiga: 555 mm.
- Selenginskaya Dauria (SRB without Chikoy taiga): 420 mm.

Ol'khon Island in Lake Baikal, and the nearby Tazheransky steppes between Lake Baikal in the east and the Primorsky mountain range in the west receive the overall lowest amount of precipitation, with an annual average of 164 mm.

Precipitation in the Mongolian part of the Baikal Basin increases with elevation and latitude. Precipitation patterns are highly variable in amount and timing, and fluctuate considerably from year to year. Maximum rainfall occurs during the summer months, and varies from 300-500 mm in the mountains to 50-100 mm in arid zones. The Orkhon-Selenga Basin receives about 250-300 mm of precipitation annually. At the same time a high evaporating capacity is characteristic of all regions of Mongolia. In some regions, and in some years, the evaporation exceeds the precipitation. In the highland regions the volume of precipitation and amounts to 500 mm/year, in the forest-steppe evaporation amounts to 550-700 mm, evaporation from the water surface - 550-700 mm, in the steppe – 650-750 mm, and in the desert areas it amounts to 800-1000 mm (MARCC 2009).

Data collected for over 70 years in Mongolia revealed that precipitation follows a pattern of wet and dry cycles that reaches a maximum every 13-16 years (Figure 2.1.4.b). Wet cycle years occurred between 1970-1990, resulting in an increase of floods. A dryer cycle was observed from 1998-2008, with less precipitation and as a result a significant decrease in the number of floods.

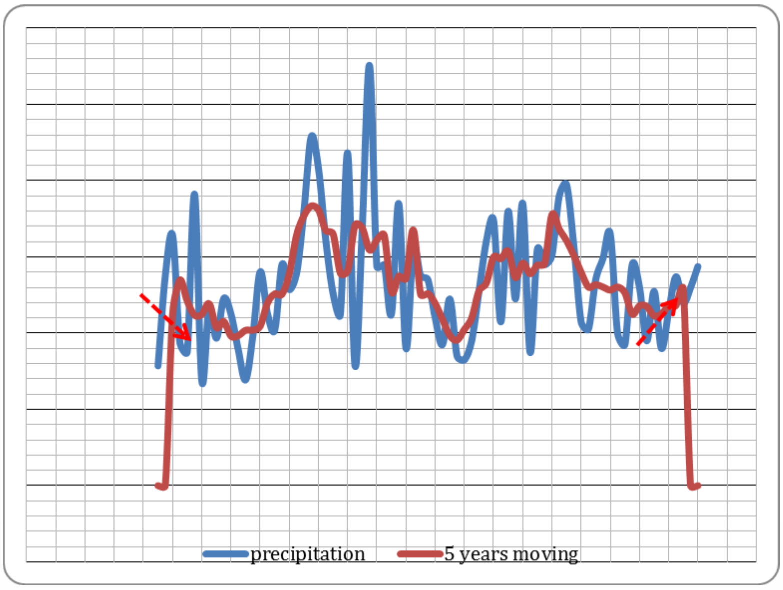


Figure 2.1.4.b: Precipitation patterns in the Selenga River Basin (Ulaanbaataar).

There is mounting evidence that global climate change is increasingly impacting the Baikal Basin. Environmental warming in Siberia has surpassed estimates of temperature increases elsewhere (Serreze et al. 2000, Shimaraev et al. 2002). The average air temperature in Mongolia has increased with 1.56ºC over the past 60 years (Ma et al. 2003). The surface water temperatures of Lake Baikal have increased with 1.21ºC since 1946 (Hampton et al. 2008). These changes are expected to have longer-term effects on both terrestrial and aquatic ecosystems and their services in the Baikal Basin (see Chapter 4.7).

2.2 BIODIVERSITY AND NATURAL RESOURCES

2.2.1 TERRESTRIAL HABITATS AND BIODIVERSITY

In total, the Baikal Basin encompasses ¾ of the ecosystem diversity of the Palaearctic part of the Asian continent (Figure 2.2.1.a). This diversity is the combined result of: i) the location of the basin at the junction of three biogeographically distinct regions, namely the Central Asian, Eastern Asian, and European-Siberian region; ii) climatic variation across latitudes and longitudes; iii) the existence of multiple mountain ranges with large differences in altitude. Main ecosystem types in the basin include mountain tundra's[11], taigas[12], steppes[13], as well as river delta's. Main ecosystem types can be further sub-divided according to climatic variables (Figure 2.2.1, Table 2.2.1.a).

In general, landscapes at high altitudes of over 1,800 m asl are dominated by mountain tundra. Alpine forests, and Siberian cedar forests in the lower regions of these high altitudes. Mid-elevation landscapes between 1,200-1,800 m asl are characterised by coniferous forests and cedar groves. Low-mountain landscapes between 600-1,200 m asl are dominated mostly by conifers, cedar and larch, pines, and mixed taiga habitats. The low plains are characterised by forest, steppe and march landscapes.

The landscapes in the Baikal Basin also include three areas that have been assigned as important Global Ecoregions[14] for the conservation of biodiversity: the Siberia Taiga (Russian part of the basin), Altai-Sayan (shared by Mongolia, Russia, China and Kazakhstan) and the Daurian Steppe Ecoregion (shared by Mongolia, Russia, and China).

Table 2.2.1.a Terrestrial ecosystems in the Selenga River Basin (Gunin et al. 2012),

Groups of ecosystem types	Ecosystem types	Area in Mongolia (%)	Area in Russia (%)
Automorphic and polyhydromorphic natural	Nival-golets[15]	3.63	0.9
	Mountain-tundra-grassland	5.46	1.32
	Sub-golets	3.55	5.53
	North-taiga	9.20	11.81
	Mid-taiga	12.95	22.04
	South-taiga	13.50	16.63
	Forest-steppe	30.69	5.64
	Moderate dry steppe	0.69	1.69

[11] Tundra landscapes are characterised by extremely cold climates, low biotic diversity, simple vegetation structures, and absence of trees.
[12] Taiga landscapes are characterised by coniferous forests, which consist mostly of pines, spruces and larches.
[13] Steppe landscapes are characterised by grassland plains that are mostly without trees.
[14] Global Ecoregion is a concept that was developed by WWF and global experts to rank habitats according to their importance for biodiversity conservation. See: wwf.panda.org/about_our_earth/ecoregions/about
[15] Golets are bold rocks in the landscape. The nival zone is characterised by vegetation that lives on rocks and gravel, with a few scattered areas of continuous meadow.

	Dry steppe	7.46	5.73
Hydromorphic natural	High-mountain and forest	7.79	8.42
	Forest-steppe and steppe	1.17	15.19
Anthropogenic	Arable and abandoned	2.50	3.12
	Urbanized	1.39	1.98
Total area		**100**	**100**

As a result of the diversity in ecosystems and habitats, the Baikal Basin harbours a wide diversity of flora and fauna species (Table 2.2.1.b), including numerous rare and endangered species (Table 2.2.1.c). In total, 129 species of animals, and 121 species of plants in the Baikal Basin are listed as protected in the Red Books of Russia and Mongolia (of which 51 animal and 75 plant species in Mongolia).

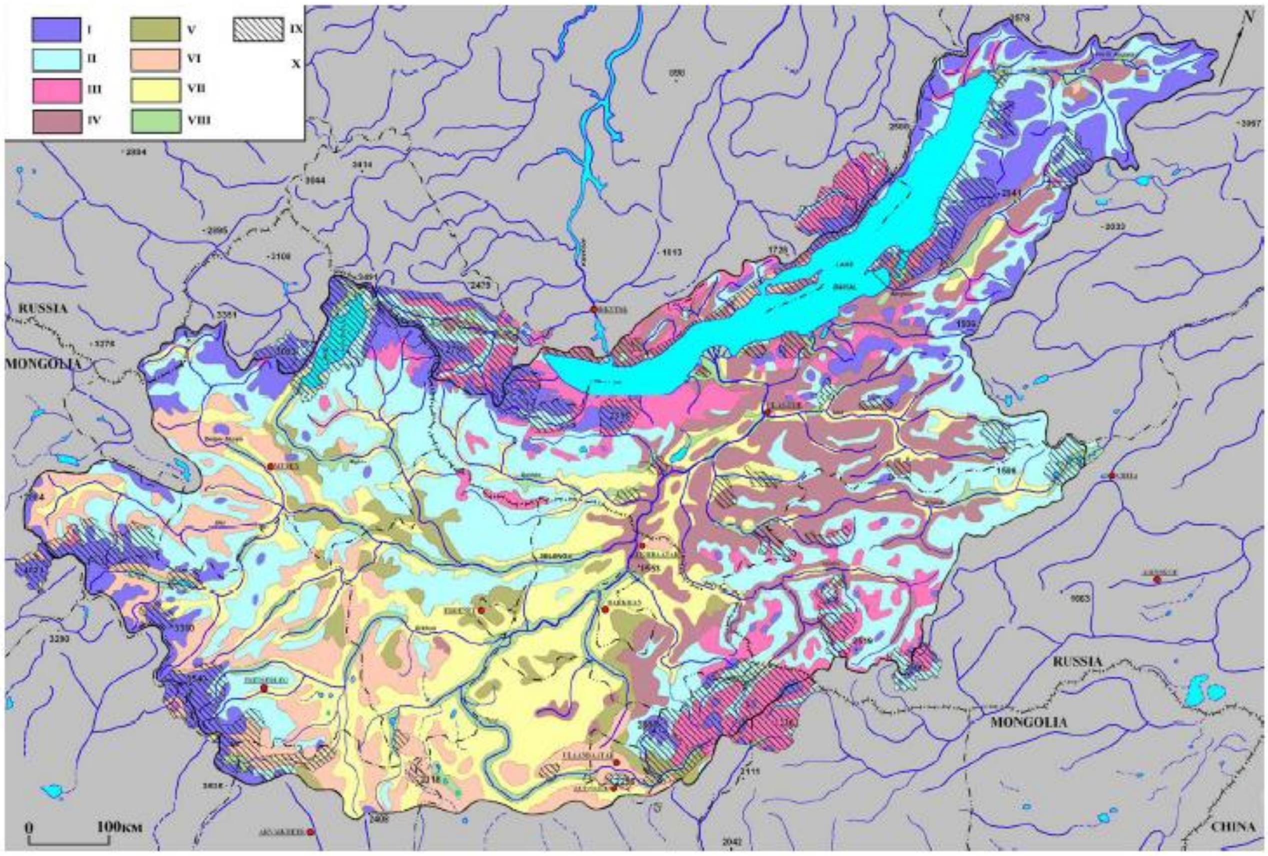


Figure 2.2.1.a: Ecosystem groups in the Baikal Basin. I high mountains wilderness and glades; II mountains forests with larch (*Larix sibirica*, *Larix dahurica gmelinii*); III mountains forests with cembra pine (*Pinus sibirica*) and fir (*Abies sibirica*); IV forest with pine (*Pinus silvestris*); V forest-steppe; VI middle high mountains steppe; VII plain or valley steppe; VIII rivers glades; IX special natural protected areas. (Kalikhman 2011).

The highest levels of biodiversity are found in the forested areas in the Baikal Basin. In general, Mongolia has a relatively low forest cover and most of its forests are located in the northern parts of the country on the transition zone between the Great Siberian boreal forest and the Central Asian steppe deserts. A large part of Mongolia's forests is located within the Baikal Basin and form transboundary ecosystems that are shared with Russia.

Table 2.2.1.b Numbers of species of terrestrial flora and fauna in the Mongolian and Russian parts of the Baikal Basin.

	Mongolia	Russia	Total Baikal Basin
Mammals	70	108	178
Birds	415	400	815
Reptiles and amphibians	12	20	32
Insects (Coleopterous beetles)			3,500
Vascular plants	2,010[16]	2,000[17]	4,010
Muscoids		380	-
Lichens		450	-

As the southernmost extension of the east Siberian taiga, the forests consist mainly of Siberian Larch (*Larix sibirica*) and Siberian Pine (*Pinus sibirica*), as well as plenty mosses and lichens. Ungulates typical of Eurasian forests are found here, including Musk Deer (*Moschus moschiferus*), Elk (*Alces alces*), Roe Deer (*Capreolus pugargus*), and Reindeer (*Rangifer tarandus*). Forest predators include the grey wolf (*Canis lupus*), brown bear (*Ursus arctos*), wolverine (*Gulo gulo*), and Eurasiona lynx (*Felis lynx*). Typical birds of these forests include great grey owl (*Strix nebulosa*), boreal owl (*Aegolius funereus*), black-billed capercaillie (*Tetrao parvirostris*) and pine grosbeak (*Pinicola enucleator*). At lower altitudes, a high degree of biodiversity occurs in areas where the taiga forest meets the steppes. Here mixed conifer and broadleaf forests intermingle with lush grasslands, and the fauna includes species characteristic of both taiga and steppe (Batsukh 2004).

The Altai-Sayan Ecoregion between north-western Mongolia and southern Siberia (Figure 2.2.1.b) is one of the most diverse terrestrial landscapes in the Baikal Basin. It includes a mosaic of coniferous forests, tundra, taiga, forests, semi-desert, intermontane steppes, alpine meadows, rivers, flood plains, and salty marches, and harbours a diversity of wildlife (Onon et al 2004). The conservation of the Altai-Sayan Ecoregion and its biodiversity is of global significance, and offers opportunities to protect ecosystems that are still relatively intact.

Figure 2.2.1.b: The picturesque beauty of the Sayan Mountain range in the north of Lake Khovsgol.

The Altai-Sayan fauna includes a number of rare and endangered wildlife species such as snow leopard (*Uncia uncia*), wild sheep or argal (*Ovis ammon*), Siberian ibex (*Capra sibirica*), Mongolian saiga (*Saiga tatarica mongolica*), musk deer (*Moschus moschiferus*), Pallas' cat or manul (*Felis manul*), black tailed gazelle (*Gazelle subgutturosa*), wild boar (Sus scrofa nigipes), stone martin (*Martes foina*), marbled polecat

[16] This includes 95 families and 476 genera of vascular plants. In total, 37 species of plants are endemic.
[17] This includes 100 families and 600 genera of vascular plants. In total, 180 species of plants are endemic.

(*Vormela peregusna*), Altai-Sayan subspecies of the reindeer (*Rangifer tarandus*), and elk or European red deer (*Cervus elaphus*).

The Altai-Sayan furthermore harbours a number of rare and endangered birds, including the snowcock or Altain ular (*Tetraogallus altaicus)*, cenereous vulture (*Aegypius monachus*), golden eagle (*Aquila chrysaetos)*, lammergeyer (*Gypaetus barbatus*) , spoonbills (*Platalea Leucorodia*), Dalmatian pelican (*Pelecanus crispus*), great white egrets (*Egretta alba*), whooper swans (*Cygnus cygnus*), great blackheaded gulls (*Larus ichthyatus*), black Storks (*Ciconia nigra*) and swan goose (*Anser cygnoides*).

Other important species that are found in the Baikal Basin and are listed as rare and endangered include the bighorn (*Ovis nivicola*), Siberian moose (*Alces alces pfizenmayeri*), Przewalski horse (*Equus przewalskii*), zeren (*Procapra gutturosa*), Daurian hedgehog (*Erinaceus dauricus*), red dog (*Cuon alpinus*), East Siberian brown bear (*Ursus arctos*), river otter (*Lutra lutra*), Mongolian beaver (*Castor fiber*), Mongolian marmot (*Marmota sibirica*), and the Pallas' coluber (*Elaphe dione*)

Rare and endangered birds in the Baikal Basin include the red-throated diver (*Gavia stellata*), swan goose (*Cygnopsis cygnoides*), Gray goose (*Anser anser*), lesser white-fronted goose (*A. erythropus*), the taiga subspecies of the bean goose (*A. fabalis*), the bar-headed goose (*Eulabeia indica*), Baikal teal duck (Anas *formosa*), common crane (*Grus grus*), white-naped crane (*G. vipio*), white crane (*G. Leucogeranus*), demoiselle crane (*Anthropoidos virgo*), common bastard (*Otis tarda*), greater spotted eagle (*Aguila clanga*), fish hawk (*Pandion haliaetus*), saker falcon (*Falco cherrug*), relic gull (*Larus relictus*), black tern (*Chilodonis niger*), whiskered tern (*Ch. hybridus*), little tern (*Sterna albifrons*), Caspian tern (*Hydroprogne caspia*), and the common eagle-owl (*Bubo bubo*).

Table 2.2.1.c Numbers of rare and endangered species in northern Mongolia and Buryatia, Russia. (Gunin et al. 2012).

Type	Buryatia, Russia	Mongolia
Mammals	25	10
Birds	70	21
Reptiles	4	0
Amphibians	3	2
Fish	5	3
Insects	22	14
Molluscs	0	1
Fauna (total)*	**129**	**51**
Vascular plants	115	55
Bryophytes	0	2
Algae	0	4
Lichens	6	9
Mushrooms	0	5
Flora (total)*	**212**	**75**

*Note that some of the species listed in the Red Book of Buryatia are absent in the Red Book of Mongolia, and vice versa

2.2.2 WETLAND HABITATS AND BIODIVERSITY

The Baikal Basin encompasses numerous delta areas as well as marshlands and swamps, including in the upper reaches of the Selenga, Orkhon, and Tuul Rivers. Wetland functions are extremely important because they provide a multitude of ecosystem services:

- Accumulate and maintain fresh water supplies.
- Regulate surface groundwater runoff.
- Maintain groundwater levels.
- Purify water and act as a filter against pollutants and suspended substances.
- Produce and emit oxygen to the atmosphere.
- Act as a stock and reserve of atmospheric carbon.
- Stabilize microclimate conditions, especially precipitation and temperature.
- Slow down erosion and stabilize coastlines.
- Present high levels of primary ecosystem production.
- Support high levels of floral and faunal biodiversity.

- Serve as a habitat for many species of plants and animals, including rare and economically important species.

Wetlands in the Baikal Basin provide habitats for threatened migratory bird species such as the relict gull (*Ichthyaetus relictus*), swan goose (*Anser cygnoides*), and white-naped crane (*Grus vipio*).

The main wetland area in the basin is formed by the 680 km² delta of the Selenga River. The Selenga Delta is included on the list of Ramsar Wetlands of International Importance, plays a significant role as a habitat for flora and fauna, as well as its role in functioning as a water filter against pollution flowing into the lake. The delta serves as a habitat for over 170 seasonally migrating bird species, and a nesting site for over 110 bird species. Furthermore, 31 rare and endangered animal species are found in the delta, which are listed in the Red Data Book of Buryatia (2005).

The water of the Selenga delta is inhabited by 27 fish species, including pike, nerfling, dace, bream, roach, Siberian spiny loach, river perch, eelpout, Baikal omul, and white Baikal grayling. The Amur carp, bream, Amur catfish and Amur sleeper are also found in the Selenga River Delta. They have been introduced to river systems in the region and they are not native to the Baikal Basin.

The benthic microfauna in the delta is numerically dominated by oligochaetes, chironomids, and amphipods. Dominant insects in the delta are dayflies, stone flies, dragonflies, caddis flies, beetles, bugs, ticks, and biting midges. Gastropoda are also found in the delta, including two species of swan mussel.

Over 700 species of plants are found in the delta, including algae, 520 species of moss, and 190 species of vascular plants. This includes 44 rare and endangered plant species, listed in the Red Data Books of Buryatia (2002) and the Russian Federation (1988). The main macroalgae in the benthic area of the delta are *Oedogonium* sp. ster. And *Cladophora fracta*. A recent study on benthic habitats and ecosystem health in the Selenga River Delta done in the framework of this TDA found 22 species of algae, including 8 species that are new to science and remain to be described (Annex III).

2.2.3 RIVERINE HABITATS AND BIODIVERSITY

The Baikal Basin includes hundreds of rivers and streams, which are characterized by predominantly pebble riverbeds, sometimes alternated with pebble-sandy or slimy-sandy substrates. Floral and faunal diversity of riverine habitats is generally low, and has not been intensively studied.

The riverine flora in the Russian part of the Lake Baikal Basin encompasses a total of 140 species, including 77 semi-aquatic species and 63 aquatic plant species. The most diverse families are the Poaceae (12 species), Potamogetonaceae (11 species), Polygonaceae (9 species), Asteraceae (8 species), Cyperaceae (6 species), and Ranunculaceae (5 species).

Riverine plankton communities typically include three main groups (in order of dominance): bacterial plankton, phytoplankton and heterotrophic flagellates. Total plankton biomass in Mongolian rivers was estimated to be between 182 and 591 mg C/l.

In the SRB, 219 species of zooplankton have been found, including 63 species of Cladocera, 16 species of Calanoida, 23 species of Cyclopoida and 117 species of Rotatoria. The majority of these zooplankton species are also found in other water bodies in the Baikal Basin. Seventy six species of macro-zoobenthos have been described from lakes within the Selenga and Tuul River Basins in Mongolia.

The species diversity of fish depends on the size and hydrological features of the river. Shallow, rapid rivers up to 10 km long are generally populated by grayling, minnow, spotted sculpin and Siberian loach. Small rivers up to 50-80 km long, include grayling, minnow, spotted sculpin, Siberian loach, lenok, taimen, burbot, and dace. Rivers over 80 km long typically harbour over 15 species, predominantly made up of Cyprinids.

2.2.4 AQUATIC HABITATS AND BIODIVERSITY IN LAKE BAIKAL

Lake Baikal is famous for its outstanding diversity of aquatic species of flora and fauna. At present, over 2,550 species are known from Lake Baikal, including 1,550 species of fauna and 1,000 plant species (Timoshkin 2001) and numbers continue to increase as new species are being discovered (e.g. Kaygorodova 2012; 2013). In comparison, the world's second oldest (estimated 9-12 My), second deepest (max. depth 1.47 km) Lake Tanganyika harbours over 1,500 species.

The levels of endemicity in Lake Baikal are extraordinary. In total, 40% of plants and 85% of animal species are found nowhere else on earth. The origin of the diversity of species in Lake Baikal has been the subject of many studies. With the development of increasingly improved molecular techniques, the phylogenetic and evolutionary processes that shaped the diversity in ancient lakes including Baikal as well as Tanganyika and Malawi are now beginning to emerge (e.g. Martens 1997, Sherbakov 1999, Kontula et al. 2000, Kornfield and Smith 2000).

It is generally accepted among evolutionary biologists that the outstanding diversity and endemicity in ancient lakes is the combined result of their longevity, water clarity, and diversity of aquatic habitats. Lake Baikal has exceptionally clear water, which can reach Secchi depths of 20-40 m (Hampton et al., 2008), although some shallow areas near river deltas have Secchi depths as low as 1−2 m (Kozhova and Izmest'eva, 1998). In contrast to Lake Tanganyika, where oxygen only reaches the upper 200-150 m as a result of temperature-induced stratification, the water in Lake Baikal is oxygenated throughout the water column (Kozhova and Silow, 1998), allowing fauna in the lake to inhabit substrates at over 1000 m depth.

Table 2.2.4.a Summary of diversity and endemicity in the main taxonomic groups found in Lake Baikal.

Taxon	Family/Genus	Endemic Species/Subspecies	% Endemism
Mammalia	Pennipedia	1	100
Osteichthyes	Cottidae	33	97
Osteichthyes	Coregonidae	2	100
Amphipoda	Gammaridae	> 259	> 99
Copepoda	Canthocamptidae	35	81
Gastropoda	Baikaliidae	37	100
Tricladida	Dendrocoelidae	40	100
Bacillariophyta	Cyclotella	3	75

The substrate in Lake Baikal alternates between rocks, pebbles, sand and mud, providing a variety of habitats. The lake also harbours unique underwater reefs of living sponges that filter bacteria and algae from the water, and provide a habitat for a diversity of fish, crustaceans, molluscs, and other invertebrates. Hydrothermal vents are found at a depth of about 400 meters and provide a habitat for sponges, bacterial mats, snails, transparent shrimp, and fish.

With the exception of the partially closed shallow bays in some of the eastern shores of Lake Baikal, higher plants are essentially absent from the open littoral region. Exceptions are *Elodea Canadensis*, which was introduced into the lake in the 1950s, as well as the cosmopolitan plants *Myriophyllum* and *Potamogeton* spp., which can be locally common in sheltered areas along the shore.

Benthic algae occur throughout the littoral zone, especially in rocky habitats. The upper 20 cm of the littoral are dominated by *Ultothrix*, *Tetmspora*, and *Draparnaldioides* species. Benthic macroalgae including *Cladophora* and *Draparnaldioides* species, together with green cushions of *Aegagrophila* extend to over 30 m depth. With the exception of *Ulothrix*, all these genera include endemic species.

Lake Baikal contains over 400 taxa of diatoms (*Badllariophyta*), of which over 50% is endemic (Flower 1993, Pomazkina and Votyakova 1993, Shcherbakova et al 1998). The most common planktonic diatoms in the lake are dominated by the endemic *Aulacosdra baicalensis* and *Cyclotella minuta*. Diatoms are ubiquitous siliceous microalgae that are often used as important indicators of water quality. Because their siliceous remains (frustules) are typically well preserved in sediments, and can provide a record of past changes in environmental conditions as well as past species diversity (e.g Mackay et al. 2006).

The littoral areas between 15-20 m are characterised by the highest levels of zoobenthic productivity. Dominant groups in rocky habitats are amphipods, molluscs, caddis flies and chironomids. Zoobenthos biomass in these habitats can reach 20-50 g/m^2.

Sandy littoral habitats harbour lower levels of biomass, with a maximum of 20 g/m^2 in the deeper areas between 15-20 m, and approximately 1-3 g/m^2 in shallow near-shore areas. Oligochaetes and amphipods constitute the bulk of zoobenthic biomass in these habitats. The Selenga shoal is one of the most productive shallow sandy habitats of Lake Baikal, which is related to the large amounts of organic matter that are deposited by the Selenga River.

Littoral habitats often harbour larvae of insects, mainly belonging to the Pkcoptera, Trichopetera and the Chironomidae. Plecoptera and Trichopetera do not live below 20 m, whereas Chironomidae can be found at great depths. In total, 135 species and larval forms of chironomids are found in Lake Baikal (Representatives of the Sergentia genus have formed a diverse subgroup of endemic chironomid species (Proviz 2000). Endemic Trichoptera are famous for their mass abundance after the ice breaks, usually in June. Freshly emerged species of *Baicalina*, and to a lesser extent of *Apatania*, can form 10 cm thick living caddis fly carpets near the lake shore.

Thus far, 180 species of molluscs have been described in Lake Baikal and adjacent water bodies, of which 117 are endemic (Kozhov 1936, Starobogatov and Sitnikova 1990, Sitnikova 2006). The majority of mollusc species diversity in Lake Baikal is found within the Gastropoda. In total, 15 species of gastropods has been found in deep water (>200 m depth), mainly in the genus *Benedictia*. Littoral gastropods are numerous, often dominated by endemic taxa within the families Acroloxidae and Planorbidae. Overall gastropod diversity is highest in the littoral zone between 5-20 m (Sitnikova 2006).

The crustacean fauna of Lake Baikal encompasses high levels of species diversity and endemicity, particularly among ostracods, copepods and amphipods. The ostracods are very diverse, and includes approximately 200 species with over 90 per cent endemicity (Martens et al 2008). Planktonic copepods are not very diverse, but they can occur in great numbers. The endemic copepod *Epischura baikalensis*[18] (Sars 1900) constitutes 80-90% of the total zooplankton biomass throughout most of the year, and it is a key species in the food webs of the lake (Penkova 1997). Benthic cope-pods (Harpacticoidea and Cyclopoidea) are diverse, and also largely endemic. More than 120 species are known, and new species continue to be described (Boxshall et al., 1993)

Sponges are mainly found in the shallower littoral zones, as they harbour zoochlorellae that require light. The best known sponges from Lake Baikal are the endemic *Lubomirskia baicalensis,* which can form vivid green branches rising up 70 cm from rocky substrates, and species of *Baicalospongia,* which form large crusts over stones.

Annelid worms are also well represented in Baikal with over 200 species, of which about 75 per cent are endemic. One of the most unusual species is the endemic tube-dwelling polychaete *Manayunkia baicalensis*. Oligochaetes achieve high densities of up to 20,000 individuals m^2 (Kozhova and Izmesteva, 1998) on silty bottoms with plenty of food. They extend to the deepest depths of the lake, but in the oligotrophic abyssal zones their population densities are low.

Free-living Platyhelminthes (flat worms) or turbellarians include over 80 species. Endemic species flocks have been described in the *Letithoepithdiata*, *Tridadida*, and *Proktithophora* (Timoshkin 1994). The flatworms express a variety of shapes and colours. One of the most remarkable flatworms is *Baikaloplana valida*, which occurs in deep water and can reach a length of 30 cm.

The Baikal amphipods are well-known among evolutionary biologists for their remarkable morphological diversity (Figure 2.2.4.a). *Macrohectopus branickii* (DYB.) is adapted to the open-water pelagic zone, and it is the dominant invertebrate zooplanktivore in the lake. Its average biomass in the upper 50 meters reaches 6-24 g/m^2 during its peak population density between August-September. Several deep-water species of amphipods exist, including *Hyakllopsis* spp. that occur in deep-water sediments. In shallower waters, armoured gammarid amphipods are common. The largest of these is the carnivorous *Acanthogammarus maximus* (up to 70 mm in length). Some of the amphipod species occupy very specialized niches. For example, *Spinocanthus* spp. is adapted to graze on the surface of sponges. In the upper littoral zone smaller gammarid species can be found. This includes less specialized species, such as *Gamdinoides fasdatus*,

[18] *Epischura baikalensis* is listed as vulnerable on the IUCN Red List of Threatened Species (Reid 1997).

which has colonized rivers and lakes around Baikal. Amphipods can be very abundant in the upper littoral zone, were densities of up to 30,000 individuals per m^2 have been found (Kozhov 1963).

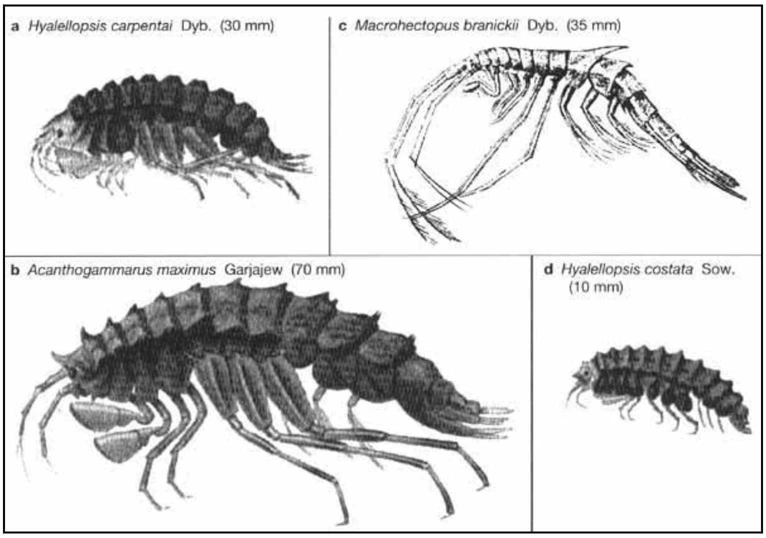


Figure 2.2.4.a: Examples of morphological diversity in Lake Baikal's endemic amphiphod fauna (a) *Hyalellopsis carpenteri* Dyb. (30 mm), (b) *Acanthogammarus maximus* Garjajew (70 mm), (c) *Macrohectopus branickii* Dyb. (35 mm), (d) *Hyalellopsis costata* Sow. (10 mm). Figures in parentheses are maximum lengths. After Kozhova and Izmesteva (1998)

Other major groups include the Nematoda, Protozoa, and Rotifera and these are all species-rich (Kozhova and Izmesteva, 1998). The classification and taxonomy of these groups largely remains to be done, and opinions differ on their reported degrees of endemism.

One of the most famous species from Lake Baikal is the endemic freshwater seal *Pusa sibirica* (Figure 2.2.4.b). The Baikal seal, or nerpa, together with the Saimaa ringed seal (*Pusa hispida saimensis*) and the Ladoga seal (*Pusa hispida ladogensis*) are the only exclusively freshwater pinniped species in the world (Reeves et al. 2002). Similar to the Caspian Seal, the Baikal seal is related to the Arctic ringed seal. Female Baikal seals reach sexual maturity around 3-6 years of age, whereas males reach it around 4-7 years. The Ushkanyi Islands are among the most important breeding grounds of the seal. The Baikal seal is classified as requiring special attention and enhanced protection measures. A population estimate conducted in 2000 indicated that approximately 55,000-65,000 seals remain in Lake Baikal (Schofield 2001).

Figure 2.2.4.b: Endemic Lake Baikal seal (*Pusa sibirica*). Photo: Per Harald Olsen.

The fish fauna of Lake Baikal encompasses 56 species in 15 families (Table 2.2.4.b). The majority is endemic, however six species have been introduced to the lake, and some of the shallow-water species are cosmopolitan (e.g. the perch *Perca fluviatilis*, and roach *Rutilus rutilus*).

Table 2.2.4.b Species diversity of the Lake Baikal ichthyofauna.

Family	Species and subspecies	% of total number of species	Number of endemic (sub)species
Cyprinidae	7	9	-
Percidae	1	1	-
Cobitidae	2	2	-
Esocidae	1	1	-
Gadidae	1	1	-
Thymallidae	1	2	2
Coregonidae	1	3	1
Salmonidae	3	3	-
Acipenseridae	1	1	1
Cottidae	4	7	5
Comephoridae	1	2	2
Abyssocottidae	6	20	20
Siluridae	1	1	-
Total	**30**	**53**	**31**

Rare and endangered species include the Baikal sturgeon (*Acipenser baerii baikalensis*), Baikal white grayling (*Thymallus arcticus brevipinnis),* taimen (*Hucho taimen)*, lenok, (*Abyssocottus elochini* Taliev), and the dwaf sculpin (*Procottus gurwici* Taliev). The Frolikh char (*Salvelinus alpinus erythrinus*), has not been registered in Lake Baikal for over 40 years, and is probably extinct.

The Baikal sturgeon is the most ancient and the largest fish in the lake, and one of the most endangered species. The sturgeon occurs mainly in habitats at a depth of 20-50 m in river deltas and bays in Lake Baikal. In autumn, when strong winds pick up, the sturgeon descends to 150 m depth. Males become mature at the age of 15-16 years, when they reach approximately 1 m length and 6-7 kg. Females mature at the age of 18-20 years with a body length of 100-120 cm and a weight of 12-14 kg. Spawning occurs every one or two years. A typical spawning flock consists of males of 15-28 years and females of 20-37 years. The fecundity of the sturgeon depends on its size: the larger the female, the higher level her fecundity. Reproduction mainly takes place in the Selenga, Upper Angara, Barguzin Rivers. The sturgeon enters the rivers in great numbers in late May-early June. Spawning takes place at 10-15ºC. Adult Baikal sturgeon mostly feeds on benthic organisms including amphipods, juvenile fish, larvae of chironomids and other insects.

One of the most famous endemic fish species from the lake is the Baikal omul (*Coregonus autumnalis migratorius)*. At present, there are three groups of omul known that each have different ecological and morphological adaptations: a pelagic group (Selenginskaya), a coastal group (North-Baikalian and Barguzinskaya), and near-bottom deepwater group (Posolskaya, Chivyrkuiskaya and other populations reproducing in small rivers). The pelagic omul spawns in the Selenga River, where it goes upstream at a distance of 1600 km. Adult pelagic omul feed on zooplankton, *Macrohectopus*, pelagic sculpins, and their larvae. It overwinters at a depth of 200-300 m. The coastal omul spawns in the Upper Angara (640 km), the Kichera (150 km), and the Barguzin (400 km). Adult coastal omul feed on zooplankton (23%), *Macrohectopus* of medium size (34%), pelagic sculpins (26%), and other organisms (17%). The near-bottom deepwater omul occurs up to 350 m depth. It spawns in small tributaries with a spawning distance from 3-5 km (the Bezymyanka River and the Maly Chivyrkui River) to 20-30 km (the Bolshoy Chivyrkui River and the Bolshaya Rechka). The prevailing food of the near-bottom dwelling omul is *Macrohectopus* of medium size (52%), fish (25%), benthic gammarids (12 %), and zooplankton (10%).

Two species of grayling inhabit lake Baikal: the white grayling (*Thymallus arcticus brevipinnis)* and the black grayling (*Thymallus arcticus baicalensis)*. The black grayling inhabits rivers entering Lake Baikal, as well as coast and bays. The black grayling is found mainly in the southern and northern parts of the lake, in habitats with a stony-pebble bottom. In summer, the grayling occurs at a depth of 10-20 m. In autumn, it migrates to the shores to overwinter, where the fish aggregate at depths of 3-12 m. Spawning migrations are observed in late March and spawning starts when the water temperature is between 4-8.5ºC. The black grayling spawns in streams with stony and pebble habitats and swift currents. Maturity is reached at a body length of 25-30 cm and weight of 250-400 g. The white grayling inhabits coastal zones of Lake Baikal up to the depth of 50 m, where it mainly feeds upon benthic organisms. It spawns in Lake Baikal, and can reach a weight of 3.0-3.5 kg.

Figure 2.2.4.c: Russian postal stamps from 1966 with the endemic grayling (*Thymallus arcticus*) and the Baikal omul (*Coregonus autumnalis migratorius*).

The cottoid fish, or sculpins, consist of 33 species (Sideleva 2001). They are typically small (< 20 cm), and the majority occurs in benthic habitats. Some species have adapted to shallow waters (e.g. *Cottocomephorus* and *Procotus* spp.) while others have adapted to deep water (e.g. *Abyssocottus* spp.). Two species occur in open water, *Comephorous dybowskii* and *C. baicalensis*. Both have evolved large pectoral fins and translucent bodies with reduced ossification as adaptations to their pelagic habitat. Cottoid fish are consumed by seals and other fish, and they are key components of the food webs in Lake Baikal.

2.2.5 PROTECTED AREAS

The Baikal Basin encompasses multiple protected areas, which include Nature Reserves, National Parks, Management Areas, and National Heritage Monuments (Table 2.2.5). The level of effective biodiversity protection of these areas depends partly on their protected area status. Nature Reserves, or Zapovedniks in Russian, are Strictly Protected Areas, whereas Management Areas or Zakazniks in Russian have the least protected status. The level of protection also depends on the remoteness from human settlements, ability to control visitor numbers, the adequacy of zoning, and presence of buffer zones against human impacts.

In both Mongolian and Russian cultures nature plays an important role, and traditional ways of life are built on a strong respect for the environment. Many natural objects are traditionally considered sacred. The Baikal Basin encompasses numerous natural monuments with a special cultural value. This includes mountains, rocks, caves, volcanic craters, islands, individual trees, etc. As a result, indigenous people treat these sites with special care, thus protecting associated landforms and waterscapes over centuries.

Several of the tributaries to the Selenga River derive from the slopes of mountains that are traditionally considered as sacred by the Mongolian people. The upper courses of the Rivers Murun, Ider, Orkhon, and Tuul are sacred places. In 2004, the Mongolian Government officially recognized Bogd Uul as a sacred area, followed by Burkhan Khaldun in 2004 and Suvraga Khairkhan in 2007. Lakes Khovsgol, Terkhiin Tsagaan, and the Otgon-Tenger Mountain peak also play important roles in traditional cultures.

Lake Baikal itself has traditionally been treated with a high degree of sacredness, and until fairly recently it was considered taboo to settle on the shores of the "Sacred Sea". The Buryat people in Russia have numerous legends about spirits and sacred sites along Lake Baikal. In the Republic of Buryatia, 111 aquatic monuments exist, including 3 glaciers, 61 springs, 33 lakes and 12 waterfalls. Among the most sacred places for the Buryats are Ol'khon Island and its Shaman Rock (Figure 2.1.1.a). The strong emotional attachment of the Buryat people to Lake Baikal also gave rise to the first Russian environmental movement in the mid-1960's, which continues today.

The total protected area coverage constitutes 17% of the entire Baikal Basin (61% of which is protected by Mongolia and 39% is protected by Russia). In Mongolia, 5,7 million ha of the Baikal Basin enjoys a protected status (Figure 2.2.5.a), which adds up to 18.9% of the total protected area in the country. The largest part of the protected areas is located in the upper mountainous areas of the SRB, including Lake Khovsgol and Khangai Nuruu National Parks.

Bogd Khan Uul is the oldest nature reserve in Mongolia. It is located to the south of Ulan Bator, in the southernmost forest steppe zone and the Khentii Mountain area. Nature conservation in this area dates back to the twelfth and thirteenth century when the Toorl Khan of Mongolian Ancient Khereid Aimag claimed the Bogd Khan as a holy mountain. The reserve was officially protected in 1778. The area was traditionally used by nomads, and continues to be inhabited. In 1994, a total of 70 families (346 people) lived in the reserve who are mostly nomads that are engaged in traditional livestock raising (UNESCO 2007).

The Mongolia Government has committed to expand the network of protected areas in the Baikal Basin, and included Zed, Khantai, and Buteeliin Nuruu in 2011 as strictly protected areas (SPA). Furthermore, the Ulan Taiga was recently upgraded from a special protected area to a SPA. There are currently 5 strictly protected areas in the SRB in Mongolia, 10 National Parks, 4 reserves, and 4 natural and historic heritage monument areas (Table 2.2.5).

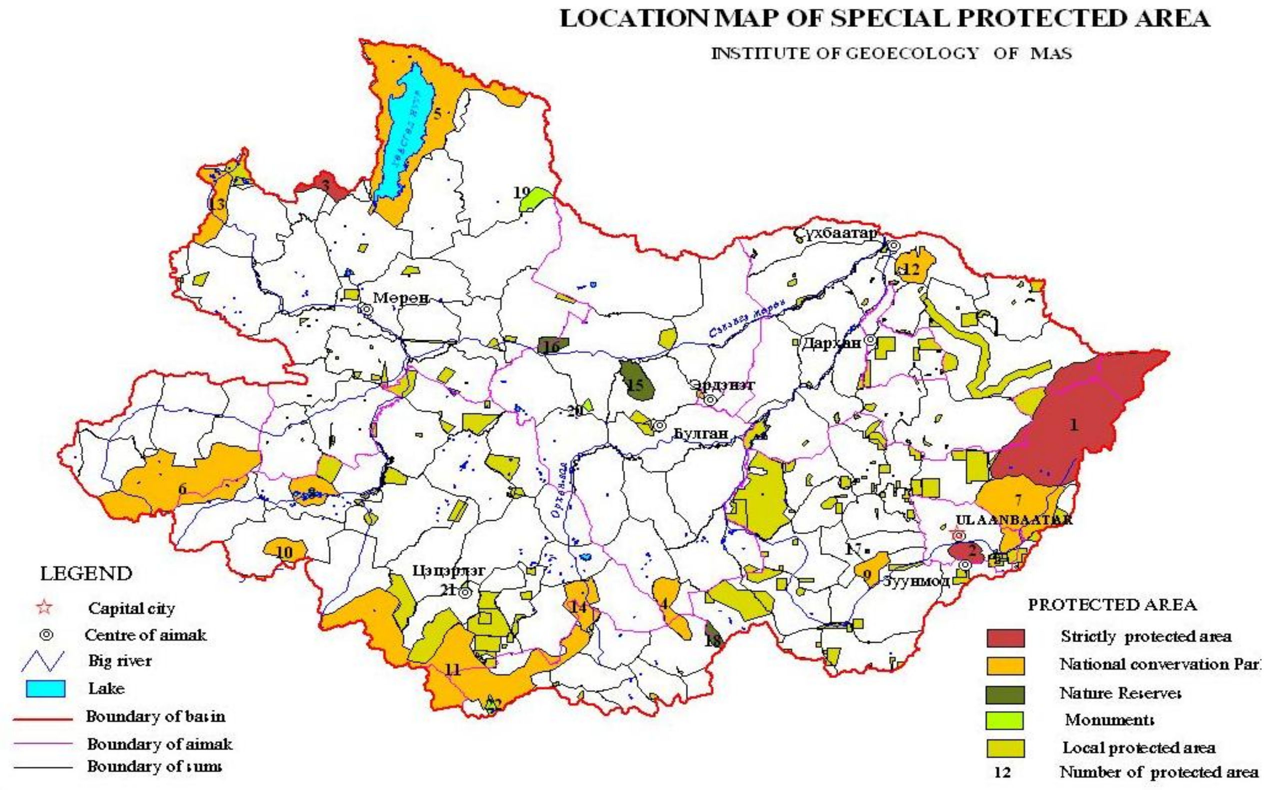


Figure 2.2.5.a: Protected areas in the Mongolian part of the Baikal Basin.

In the Russian part of the Baikal Basin, a total of 7 protected areas exist along the shoreline of the lake: Pribaikalskiy National Park (NP), Zabaikalsky NP, Frolikhinsky NR, Kabanskiy NR, Pribaikalskiy NR, Stepnodvoretskiy NR, and Verkgeneangarsky NR. In Irkutsk Oblast, 1.12 million ha within the Baikal Basin is protected, constituting an almost uninterrupted belt along the western shoreline. Other protected areas are situated within the catchment in the Republic of Buryatia (Figure 2.2.5.b).

Zabaikalsky NP is situated on the eastern shores of Lake Baikal, adjacent to the southern border of Barguzinsky NR. The park includes the Ushkany island archipelago, which is a key habitat for the endemic Baikal seals. Zabaikalsky NP is one of the best protected areas in the Russian part of the basin. The park is relatively remote, it only has two entry points that are well controlled, and its zoning is in agreement with the previous use of the area. Several very small seasonal settlements exist within the protected area, which were traditionally used as summertime camps for local fishermen. Their continued use was allowed after the establishment of the park in 1969 so there was no conflict of stakeholders' interests.

Pribaikalsky National Park is a narrow area that stretches 600 km along the western coast of lake Baikal in the Irkutsk Oblast. The park has numerous entries from both the water and the land, which makes it difficult to exert control over the number of annual visitors. Another problem is that the zoning of the park did not meet its initial use. Areas that have been used as recreational sites for many decades were turned into conservation zones after the park was established in 1986. On the other hand, over 40 settlements remained, and agricultural lands within the park were not converted into protected areas. These factors limit the usefulness of Pribaikalsky National Park for the protection of biodiversity.

Tunkinsky NP Is situated in the southern part of Lake Baikal, and includes part of the Khamar-Daban and Eastern Sayan mountain ranges. The boundaries of Tunkinsky National Park partly overlap those of Pribaikalsky National Park, resulting in the confusing situation where one area is under two different administrations. As a result, it is difficult for Tunkinsky National Park to implement its environmental protection regime.

In total, 3.6 million ha is protected within the Republic of Buryatia, including three reserves in the Selenga River Delta and its adjacent territory. The Kabanskyi reserve includes 12,100 ha within the Selenga Delta itself, mostly comprised of wetlands.

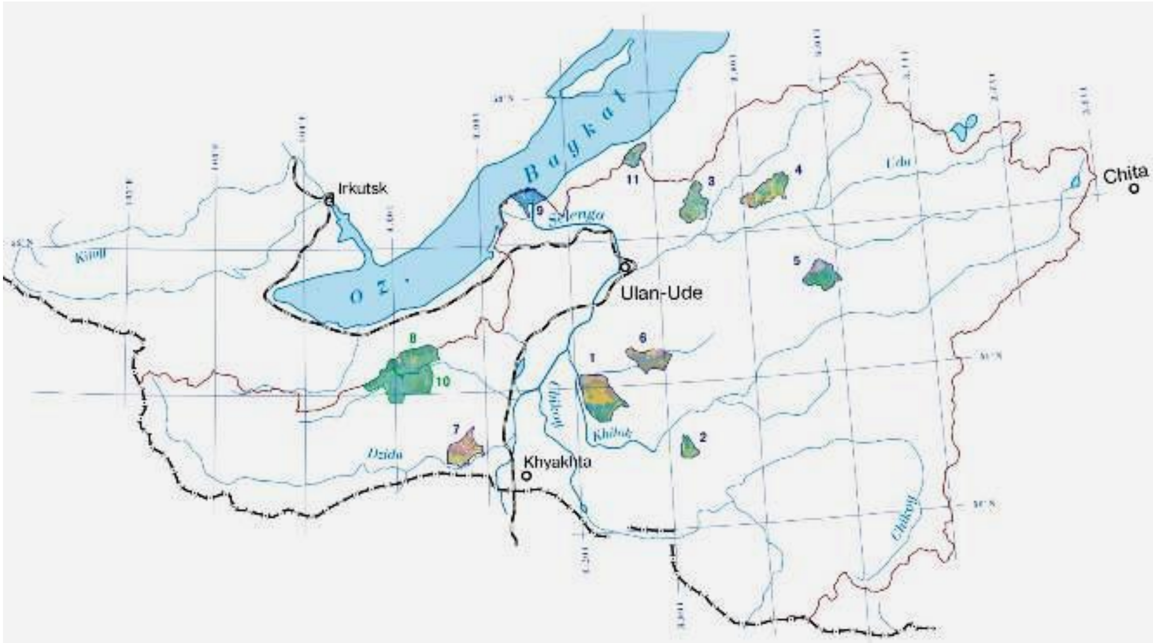


Figure 2.2.5.b: Protected areas in the Republic of Buryatia (from Gunin et al 2012).

Table 2.2.5: Location of protected areas in the Baikal Basin and the year of their establishment (protected areas that have been re-established/re-classified are denoted in brackets). Special international designations are denoted in bold.

	Name	Administrative Unit	Area (ha)	Year
Russian Federation	Baikalo-Lensiky Nature Reserve SPA	Irkutsk Oblast, Olkhonsky, Kachugsky	659,919	1986
	Barguzinsky Nature Reserve SPA **Biosphere Reserve** (1986)	Rep. Buryatia Severobaikalsky	374,423	1916
	Baikalsky Nature Reserve SPA **Biosphere Reserve** (1986)	Rep. Buryatia Kabansky, Selenginsky, Djidinsky	165,724	1969
	Pribaikalsky NP	Irkutsk Oblast Olkhomsky, Irkutsky, Sludyansky	418,000	1986
	Dzherginsky Nature Reserve	Rep. Buryatia Kurumkansky	238,100	1992
	Sokhondinsky Nature Reserve **Biosphere Reserve**	Chita Province Krasnochikoisky, Kyrinsky, Uletovsky	211,000	1973
	Zabaikalsky NP	Rep. Buryatia Barguzinsky	245,000	1986
	Tunkinsky NP	Rep. Buryatia Tunkinsky	1,183,662	1951
	Frolikhinsky NR	Rep. Buryatia Severobaikalsky	68,000	1976
	Kabanskiy NR **Wetland of International Importance, Ramsar Convention** (1994)	Rep. Buryatia Kabanskiy	12,100	1967
	Stepnodvoretsky NR	Rep. Buryatia Kabanskiy	15,000	1975
	Verkgeneangarsky NR	Rep. Buryatia Kabanskiy	24,500	1979
	Enkhelutsky NR	Rep. Buryatia Kabanskiy	12,300	1995
	Total		**3,627,728**	

Mongolia	Khan Khentii SPA	Tuv, Khentii, Selenge aimag	1,227,736	1992 (1995, 2012)
	Boghd Khan Uul SPA **Biosphere Reserve** (1996)	Tuv aimag, Ulaanbaatar	41,651	1778 (1957, 1974, 1995)
	Khoridol Saridag SPA	Khovsgol aimag	188,634	1997
	Zed, Khantai, Buteeliin Nuruu SPA	Bulgan aimag	611,300	2011
	Ulaan Taiga SPA	Khovsgol aimag	108,237.6	2003 (2011)
	Lake Khovsgol NP	Khovsgol aimag	1180,270	1992 (1995, 2011)
	Khugnu-Tarna NP	Bulgan, Uvurkhangai, Arkhangai aimag	83,612.3	1997 (2003)
	Tarvagatai Nuruu NP	Arkhangai, Zavkhan aimag	525,440	2000
	Lake Terhiyn Tsagaan NP **Wetland of International Importance, Ramsar Convention** (1998)	Arkhangai aimag	77,267	1965 (1995)
	Gorkhi-Terelj NP	Tuv aimag	293,168	1993
	Khangain Nuruu NP	Arkhangai, Uvurkhangai, Bayankhongor aimag	888,455	1996
	Noyon Khangai NP	Arkhangai aimag	59,088	1998
	Khustai Nuruu NP	Tuv aimag	50,620	1993 (1998)
	Tujiin Nars NP	Selenge aimag	70,019.5	2002
	Khanjargalant NP	Bulgan aimag	62,968	2003
	Orkhonii Khundii NP **UNESCO World Heritage Site** (2000)	Uvurkhangai Arkhangai aimag	92,956.7	2006
	Batkhaan Mountain NR	Tuv aimag	21,850	1957 (1995)
	Namnan Mountain NR	Bulgan aimag	29,721.8	2003
	Bulgan Mountain NHM	Arkhangai aimag	1,840	1965 (1995)
	Huisiin Naiman Lake NHM	Uvurkhangai aimag	11,500	1992 (1995)
	Dayan Deerkhi cave NHM	Khovsgol aimag	31,303.4	2006
	Uran Togoo-Tulga Mountain NHM	Bulgan aimag	5,800	1965 (1995)
	Total		**5663,438.8**	

SPA Strictly Protected Area; NP National Park; NR Nature Reserve; NHM National Heritage Monument

Three sites in the Baikal Basin are included in the Ramsar[19] list of wetlands of international importance. The Mongolian territory of the Baikal Basin encompasses 2 Ramsar sites, namely Lake Terhiyn Tsagaan (1998) and Lake Ogii (1998). Laka Tsagaan has a protected status as a National Park (Table 2.2.5), whereas Lake Ogii currently does not have an officially protected status. The Russian territory of the Baikal Basin encompasses the the Selenga River Delta Ramsar site, which is located in Kabanskiy Nature Reserve (1994).

Furthermore, four areas in the Baikal Basin were declared as important Biosphere Reserves under the Man & Biosphere Programme[20] (Table 2.2.5), which is an intergovernmental scientific programme supported by UNESCO that aims to set a scientific basis for the improvement of the relationships between people and their environment globally. The MAB programme supports research and capacity building that targets the ecological, social and economic dimensions of biodiversity loss.

Lake Baikal itself was listed as a UNESCO World Heritage Site[21] in 1996 for its unique flora and fauna and its importance as an outstanding example of a freshwater ecosystem (see section 1.1.1), the lake itself does not receive a specially protected status and there are no protected aquatic habitats within the lake itself.

In 2000, the 121,967 ha Orkhon River Valley Cultural Landscape in Mongolia was also listed as a World Heritage Site, out of which 92,956.7 ha has a protected status as a National Park. The Orkhon Valley includes numerous archaeological remains dating back to the 6th century. The site also includes Kharkhorum, the 13th and 14th century capital of Genghis Khan’s vast Empire. The site reflects the symbiotic links between nomadic, pastoral societies and their administrative and religious centres, and show the importance of the Orkhon valley in the history of Central Asia. The grassland is still grazed by Mongolian nomadic pastoralists.

[19] http://ramsar.wetlands.org
[20] http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/man-and-biosphere-programme
[21] http://whc.unesco.org/en/list/754

In total, the combined area of sites with some protected status in the Baikal Basin adds up to 9,291,166 hectares (Table 2.5.5). Although the National Parks and Nature Reserves were designed to cover a diversity of ecosystems and wildlife, including rare and endangered species (also see section 2.2.1). The majority of the water catchment of Lake Baikal has no protected status.

The lack of protected status is particularly pressing for the surface and groundwater ecosystems, as well as riparian habitats and deltas of important rivers and streams in the Baikal Basin. The Selenga River Delta is the only significant wetland with a partly protected status, whereas other wetland areas that fulfil key roles as freshwater filters and habitats for migratory birds and other important flora and fauna remain unprotected. Moreover, there are practically no protected areas in the central part of the Selenga Basin, which is an important where most of Mongolia's largest settlements as well as its main rivers and streams are located.

To address part of this problem, a strategy was developed to extend the network of important areas for biodiversity conservation. In total, 15 areas within the Mongolian part of the SRB have been designated for future protection. This strategy is being planned and implemented step by step. Areas designated for future protection within the SRB include: Nogoon nuur, Gun yamaat, Khonin nuga (spa), Badryn nuruu (NR), Khalkhan Bulnain nuruu (NR), Shariin adag, shar khyaruuni belcher (NR), Bust nuur (NR), and Bokhloi chagtai mountain (NR).

The establishment of Transboundary Protected Areas (TPAs) between Mongolia and Russia would be beneficial to ensure conservation of important ecosystems and wildlife that are shared between the two countries. Several areas would be eligible for the establishment of a TPA:

In the east of the Baikal Basin a Khentey-Chikoyskoye Highland TPA could be established. In the Chita Oblast on the Russian side this could include the existing Sokhondinsky SPA, Burklsky and Atzinnsky management areas, as well as the planned Chikoysky NP. In Mongolia, the Khan Khentiy and Bogd Khan Uul SPA's and the Terelzh and Khustain Nuruu NPs could be linked. Furthermore, SPA's outside the Baikal Basin could be connected to establish even wider wildlife corridors, including Onon Balzh NP and Nagal khaan NR. Connecting these areas would contribute to the protection of important mountain taiga, steppe, and forest-steppe ecosystems, as well as wildlife such as the Chikoy sable.

2.2.6 LAND USE PATTERNS

The Baikal Basin has traditionally been inhabited by nomads and hunters that had very low impact on the land. Livestock keeping, including sheep, horses, cows, camels and goats, remains an important part of the economy today, especially in Mongolia (also see 3.2.2). The two other main land use categories in the area are agriculture and forestry. In the Mongolian part of the Baikal Basin, agriculture is presently the most important form of landuse, whereas in the Russian part of the basin the land is mostly used for forestry (Table 2.2.6.a).

Agriculture in Buryatia is mostly concentrated in the southern and central regions. As a result of the cold and dry climate in the region, and the generally low fertility of the soil due to its extreme exposure to wind and water erosion, the agricultural production potential is 2-2.5 times lower than in western Russia. Agricultural lands in Buryatia cover 3,149.4 thousand hectares (5.5 % of the total farmland of the Siberian Federal District).

Table 2.2.6.a: General land use patterns in the Lake Baikal Basin area in Russia and the Selenga River Basin in Mongolia. Numbers are provided in percentage of the total area.

Land type	**Baikal nature territory (central zone, buffer zone and zone of atmosphere impact), Russia, %**	**Selenga River basin, Mongolia, %**
Forest	62.6	28,2
Agriculture	15	50,5
Protected areas	10	18,9
Water bodies	9.4	1,5
Towns & settlements	1	0,6
Industry & infrastructure	2	0,3
Total	100	**100**

Since the mid-1990's a shift in landuse patterns has taken place in Mongolia, with an increase in urbanisation and mining activities as well as an increase in protected areas. At the same time, a decrease is observed in the available amount of arable land, water bodies, and forest cover (Table 2.2.6.b). Shifts in landuse patterns have also been observed in the Russian part of the Baikal Basin. Since 2000, there has been a reduction of agricultural use in nearshore areas and an increase in recreational use (Solodyankina 2012).

The SRB is most intensively used for agriculture. Over 50% of the river basin is used for agricultural purposes in Mongolia. In Russia, extensive parts of the river's riparian land is also used for agriculture, including the Selenga River Delta (Figure 2.2.6). The basin includes 80% of the total cropland in Mongolia, due to its favourable natural conditions for the cultivation of crops (Mun et al. 2008). Grain represents the main cultivated crop in the Mongolian part of the Selenga Basin.

One of the challenges is that crop cultivation requires significant water resources, and appropriate management. Crop cultivation began in the 1960's in Mongolia, and soared under the socialistic economy. However, after 1990 the expanse of cultivated land dropped dramatically due to the breakdown of the centrally planned management system. People in rural areas returned to their traditional nomadic husbandry systems and abandoned large part of crop land. In combination with expansion of livestock breeding and unsustainable land management practices this resulted in massive soil erosion problems, which further degraded the land (Mun et al. 2008).

Irrigation plays an important role in the landuse in the SRB. Existing irrigation systems are presently mainly concentrated in the northern and central parts of the basin. In 2007, almost 4,000 hectares for the production of cereals, fodder, potatoes, vegetables and fruits were irrigated by sprinkler systems (Mun et al. 208).

Table 2.2.6.b: Land use change in Mongolia during the period 1975-2005 (in thousands of hectares). Data adopted from P.Myagmartseren (2011)

Year / **Land use types**	**1975**	**1990**	**2005**	**Change between 1975-2005**
Forest land	15,171.5	14,403.1	14,748.1	-423.4
Arable land	748.5	1281.6	697	-51.5
Pasture	120,990.4	119,304.6	111,229.7	-9,760.7
Fallow, abandoned agricultural land	196.9	84.4	478.4	+281.5
Protected areas	132.5	5,282.7	20,864.8	+20,732.3
Water bodies	1,619.2	1,630.5	667.8	-951.4
Towns & settlements	464.6	501.0	466	+1.4
Mining area	46.8	58.9	97	+50.2
Road	61.1	203.8	278.2	+217.1
Utility	-	4.5	50.1	+50.1
Military	2,543.3	2593.2	218.1	-2,325.2

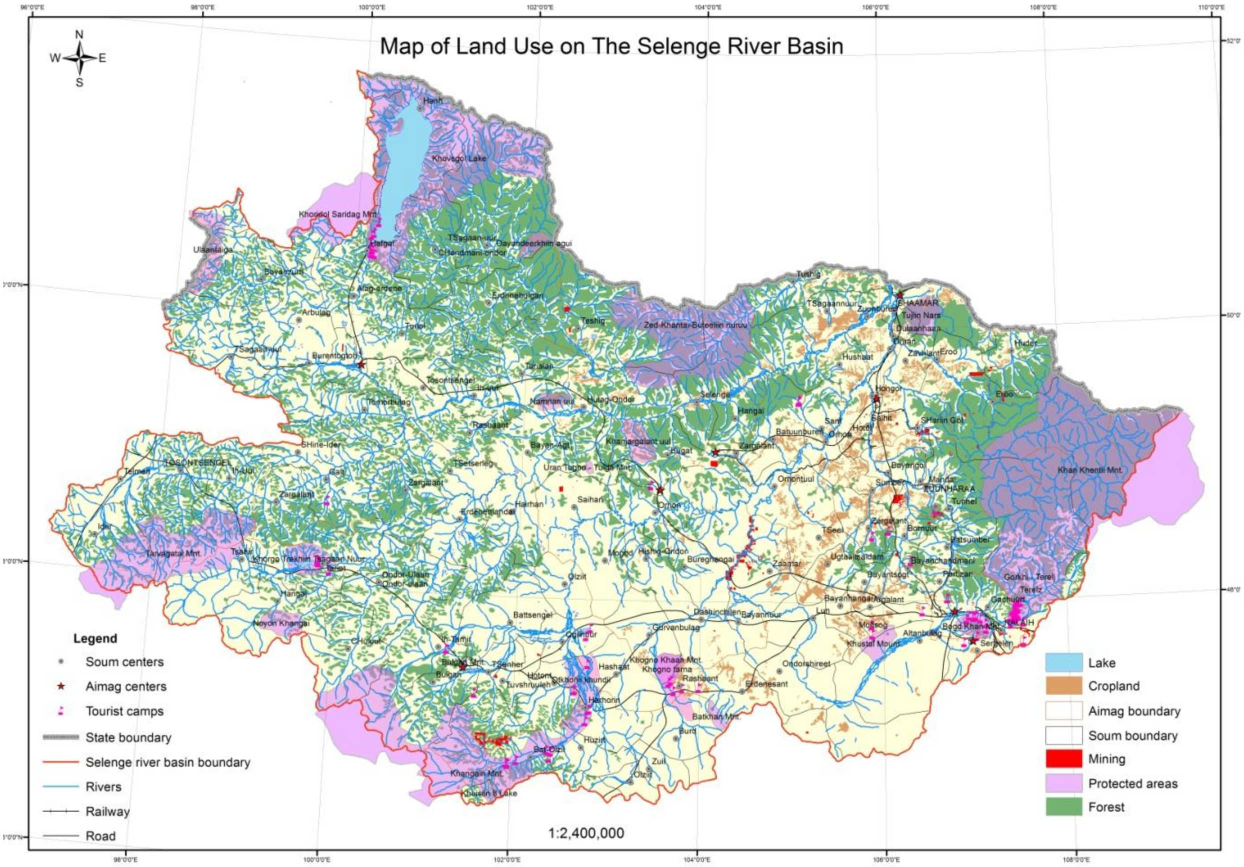


Figure 2.2.6.a: Land use in the Baikal Basin in Mongolia (Mongolian land cadastre, georeferenced basin map).

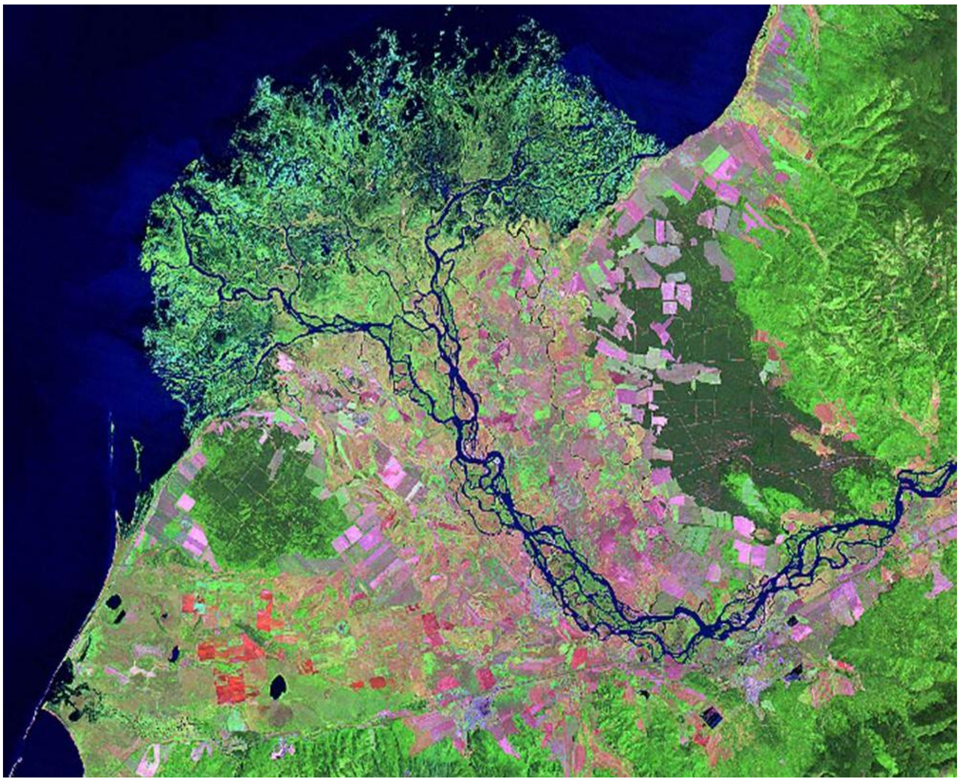


Figure 2.2.6.b: Land use in the Selenga River Delta. Areas highlighted in pink and red denote agriculture and human infrastructure. Image from NASA U.S. Geological Survey, August 2003,USGS/EROS/NASA Landsat Project Science Office.

Photo by Urabazaev

Photo by Michail Chumak

Social and Economic Background

3.1 DEMOGRAPHY AND URBANISATION

The Baikal Basin is inhabited by a diversity of ethnicities. In Mongolia, 94.9% of the population is made up by Mongols (mostly Khalkha, as well as Oirats, Buryats, and others), 5% are Turkic (mostly Kazakh, as well as Tuvan, Khoton, Chantuu, and Tsaatan), and 0.1% are other ethnicities, including Chinese and Russian (2000). In the Republic of Buryatia, Russians presently make up 66.1% of the population, Buryats 30%, Ukrainians 0.6%, Tatars 0.7%, Soyots 0.4%, and Tungus 0.3%. Other groups inhabiting the Basin in Russia are Tuvins, Belarusians, Mongols, Kyrgyzs, Georgians and Uzbeks as well as Chinese and Germans.

During the past 15 years, the total fertility rate in Mongolia declined by approximately 58%, falling from 4.6 children per woman in 1989, to 2.2 children per woman in 2000, to 2.3 children per woman in 2007. Over the period 1989-2005, the death rate declined from 8.3 to 6.2 per 1000 population. As a result of rapid development and healthcare improvements, the average life expectancy at birth has increased significantly over the period 2005-2011. Average life expectancy in the Selenga River Basin (SRB) is presently 68.4 years, which is slightly higher than in the rest of Mongolia (68 years).

The average population density in Mongolia is 1.8 persons per km^2, however it is 4.4 person per km^2 in the SRB. In 2011, a total of 2.1 million people inhabited the SRB (Table 3.1.a), representing 73.6% of the country's population. Due to the location of the capital Ulaanbaatar in the Selenga Basin, it is Mongolia's most important political, economic and cultural centre.

Table 3.1.a: Total human population inhabiting the Selenga River Basin in Mongolia, over the period 1990-2011 (in thousands of persons).

Year / Aimag	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011
Arkhangai	89.2	103.0	97.5	93.8	93.3	92.8	92.5	92.5	84.6	84.3
Bulgan	56.7	63.3	62.6	59.9	60.3	60.5	61.4	62.3	53.7	54.1
Zavkhan	93.5	105.8	87.2	80.1	80.6	81.1	79.8	79.3	65.4	64.2
Uvurkhangai	100.3	112.9	113.0	113.8	114.9	115.7	116.6	117.5	101.4	101.2
Selenge	91.2	102.9	100.9	99.8	100.1	100.5	101.6	103.5	97.9	99.2
Tuv	105.8	110.9	98.0	87.4	86.4	85.9	86.8	88.5	85.4	85.7
Khovsgol	106.6	120.1	119.8	121.7	122.1	122.4	123.0	124.1	114.9	115.9
Darkhan-Uul	82.2	89.4	84.8	87.7	87.5	87.6	88.2	90.0	94.9	96.0
Orkhon	50.0	64.6	76.0	79.0	79.4	80.1	81.9	83.1	90.9	91.5

Ulaanbaatar	555.2	616.9	786.5	965.3	994.3	1031.2	1071.7	1112.3	1244.4	1287.1
Total	1330.7	1489.8	1626.3	1788.5	1818.9	1857.8	1903.5	1953.1	2033.5	2079.2
Growth Rate (%)	**-**	**11.96**	**9.16**	**9.97**	**1.70**	**2.14**	**2.46**	**2.61**	**4.12**	**2.25**

Source: Mongolian Statistical yearbooks 1999, 2003, 2006, 2009, 2011

Migration rates within Mongolia are high and the population densities are changing fast throughout the country. Population numbers are decreasing in aimags such Arkhangai, Selenge, Ovorkhangai, Tov, and Khovsgol, while they are increasing in Ulaanbaatar, Darkhan Uul, and Orkhon (Figure 3.1.a).

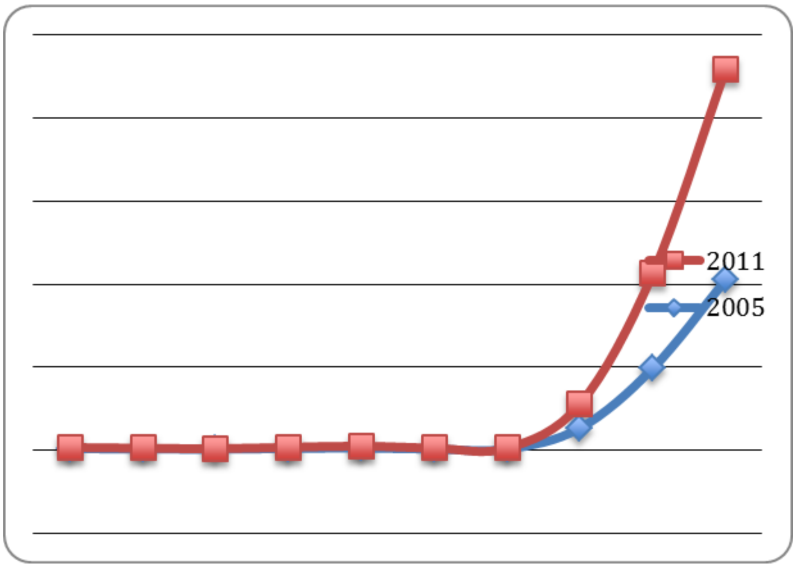


Figure 3.1.a: Population densities per Aimag in the Selenga River Basin in Mongolia.

Ulaanbaatar has the highest population growth rates in the country. Between 1969-1989, the growth rates in the capital were relatively low and increased from 267.4 to 548.4 thousand persons. After the country's changes in social-economic policies in the 1990's the growth rates in the capital went up from 616.9 thousand in 1995 to 1,2 million persons in 2011 (Figure 3.1.b). The annual population growth in Ulaanbaatar is 3.6%, and the city is expected to reach a population of 1.8 million by 2030.

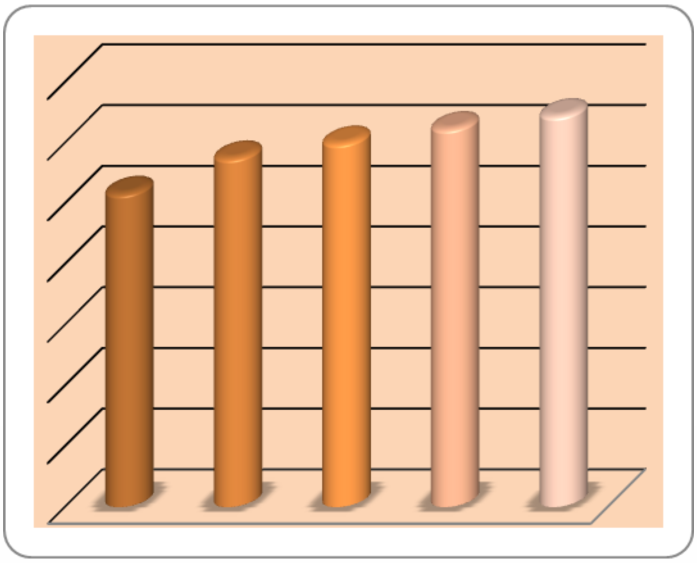


Figure 3.1.b: Human population growth rates in Ulaanbaatar between 2007 and 2011.

As a result of this rapid urbanisation, more than half the area of Ulaanbaatar today consists of unplanned settlements called Ger districts, which house more than half of the city's residents and nearly 25 percent of Mongolia's total population (Figure 3.1.c). Many of the inhabitants of the Ger districts lack access to basic infrastructure, including central heating, water and sanitary services. As a result, they rely on charcoal and firewood for heating and cooking. Fuel costs can be as high as 40% of a family monthly income. Typical inhabitants of Ger district on average consume around 10 litres of water per person per day (UNDP.UNICEF. Access to water and sanitation services in Mongolia, 2010), which is purchased from water stations that are often located at a distance of over 1 km.

Figure 3.1.c: Ger district near Ulaanbaatar. Photo by Mark Leong/National Geographic

In Buryatia, population densities achieved a peak in 1989, and then decreased with 5.4% during 1990-2010 (Figure 3.1.d). The rate of decline appears to have slowed down in recent years, and was 0.12% over the period 2002-2010. In 2005, the total fertility rate was 14.8 per 1000 people, and increased to 17 births per 1000 inhabitants in 2010, which is the highest birth rate in Buryatia since1990.

Life expectancy rates at birth are 62 years for men, and 74 years for women. Mortality rates dropped from 14.5 per 1000 people in 2005 to 12.7 in 2010. This is among the lowest mortality rates in the Siberian Federal District. The natural population growth is currently almost equal to the migratory exodus rates in Buryatia. Since 2010, the relative percentage of the rural population in Buryatia started to decline (Figure 3.1.e), due to its migration to Ulan-Ude.

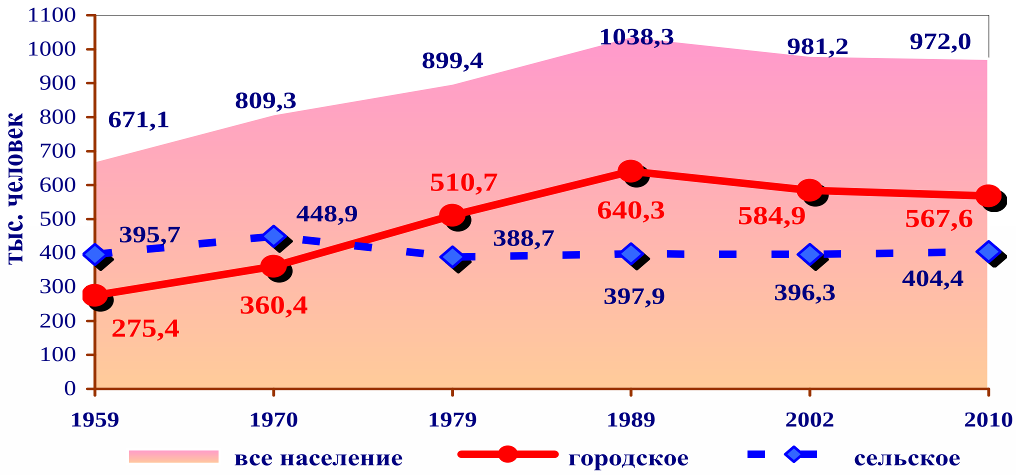


Figure 3.1.d: Total human population inhabiting the Republic of Buryatia over the period 1959-2010 (in thousands of persons). Area highlighted in pink denotes the overall population; red line denotes the urban population, blue dotted line denotes the rural population. Source: Russian population census 2010.

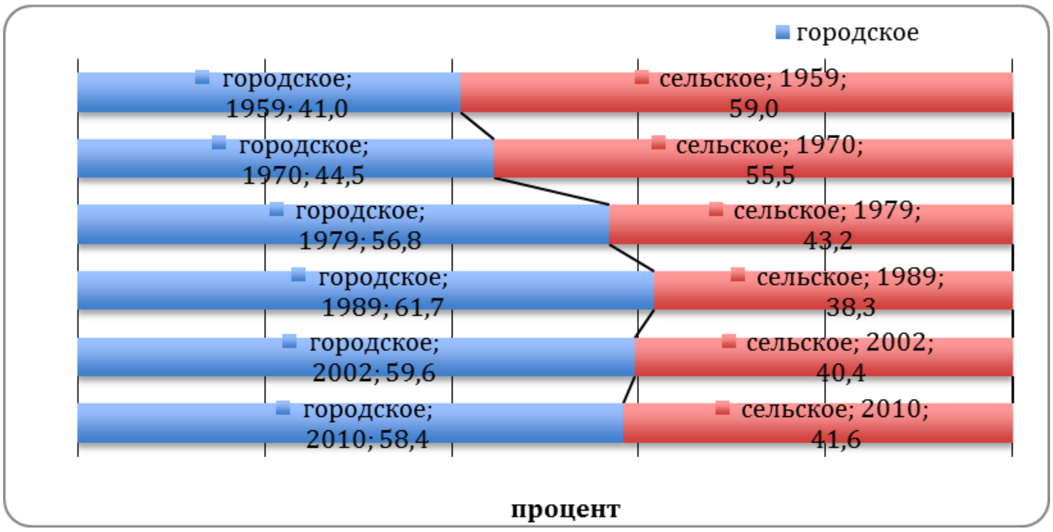


Figure 3.1.e: Ratio of urban versus rural population in the Republic of Buryatia over the period 1959-2010 (in percentage). Source: Russian population census 2010

The average population density in Buryatia is 3 persons per km^2, although densities can reach to over 1,000 people per km^2 in the 8 main cities in the area (Table 3.1.b). Almost 84% of the population of the Republic of Buryatia lives in the SRB, with 41.6% of the total population living in rural areas and 58.4% in urban areas.

Over 33% of the total population lives in the local capital Ulan-Ude. Although the amount of people inhabiting Ulan-Ude has increased, 6 out of the 8 cities in the area have seen a decrease of population over the past decade.

The population in the Irkutsk Oblast area of the Baikal Basin varies between districts[22]. In 2010, the Olkhonsky District had a total population of 9,416 thousand people, which were mostly located in rural areas with a density of less than 1 person per km^2. The Sludyansky district had a population of 40.5 thousand people, of which 89.6% lives in the cities Baikalsk and Slyudyansk.

Table 3.1.b: Number of inhabitants in the Baikal Basin in Russia in 2011. Source: Buryatstat 2011.

Name of city	Area (km^2)	Number of resident population (thousand people)	Number of resident population, per km^2
Ulan-Ude	377,12	405,8	1,076,1
Gusinoozersk	13,00	24,6	1,892,3
Severobaikalsk	110,54	24,9	225,3
Zakamensk	59,22	11,5	194,2
Kyakhta	25,00	20	800,0
Babushkin	13,55	4,8	354,2
Slyudyanka	38,00	18,6	489,5
Baikalsk	52,00	14,4	276,9

[22] http://irkutskstat.gks.ru

3.2 SOCIAL CHARACTERISTICS

3.2.1 EDUCATION

Literacy rates in the Baikal Basin region are relatively high. In Mongolia, 97.4% of the population over 15 years old is literate (96.9% men, and 97.9% women). Mongolia's education system has undergone major changes in the past century, and the Government made significant efforts to develop the education sector at all levels since its transition to democracy. However, there is a risk that as Mongolia is rapidly developing the disparity between rich and poor could result in marginalisation of populations that would benefit less from education (Gundenbal and Salmon 2011). Non-formal distance learning programs exist that offer possibilities for nomadic populations to develop basic skills.

The literacy rate among the 15-24 age groups in the SRB is the highest in Mongolia. Literacy rates in Ulaanbaatar are 99.5%, followed by 99.1% in Darkhan-Uul, and 98.9% in Orkhon.

In 2010, out of every 1,000 people in the Republic of Buryatia, 258 had received complete or incomplete higher education, 300 secondary vocational, 48 an initial professional and 201 a secondary education. Compared to 2002, the number of people with complete or incomplete higher education in Buryatia had increased with 41%. The number of employees with a higher professional education in Buryatia is 243 out of every 1,000. This makes the employed labour force of Buryatia the second highest educated in Russia (after the Tomsk Region, which has a total of 255 higher educated employees out of every 1,000).

3.2.2 GENDER EQUALITY

Mongolia has made significant progress in promoting gender equality, including the introduction of laws, policies and programmes to promote gender equality. Despite these commitments, obstacles to substantive gender equality remain. Although Mongolia has achieved gender parity or near parity in primary, secondary and tertiary education, this has not translated to equality in economic opportunity or political participation. Nonetheless, women have adjusted to the new business environment of small and medium enterprises more readily than men (ADB 2005).

Under the Soviet system, patriarchal traditions were rejected in several regions, and women received equal access to education and salaried employment. However, as a result of the economic disruptions caused by economic and political changes, women have experienced a relative decline in their social and economic status; this may also indicate that patriarchal traditions are reasserting themselves (ECOSOC 2006). Women continue to earn lower salaries than men, are more often unemployed, and remain responsible for most family obligations. In 2002, women ran about 30% of medium-sized businesses and 10% of large businesses in Russia. In 2009, the number of women taking managerial positions increased from 30 to 40%[23].

[23] www.state.gov/g/drl/rls/hrrpt/2010/eur/154447.htm

3.3 SOCIO-ECONOMIC DEVELOPMENT

Some of the main challenges that Mongolia and Russia each have in common for the sustainable socio-economic development of the populations in the Baikal Basin are the economic and structural isolation of the region, the harsh climate that limits productivity, high transport costs, discrepancy between the demand and supply of electricity, a low degree of economic innovation, and a high dependence on the use of natural resources. Nonetheless, the economies and the livelihoods of the people inhabiting the Mongolian part as well as in the Russian part of the Baikal Basin are steadily improving.

The introduction of the open-market economy in the early 1990's provided a wide variety of opportunities and choices for Mongolia as a nation, resulting in increasing economic growth. Mongolia is presently classified as a lower middle income country[24], but its economy is growing rapidly, which helps to boost disposable incomes and improve consumer confidence.

Between 2000-2003 the average annual growth was 4.3%, whereas during 2004-2007 the growth increased to 9.1%. In 2010 the economic growth was slightly slowed down with 6.4%, however growth had reached 17.3% by 2011. The GDP has increased significantly in the past few years. In 2011, the GDP reached 10,829.7 billion MNT in current prices, which is an annual growth of 17.5%[25]. Per capita GDP increased to US$2,562 in 2007 to US$ 5,400 in 2012[26].

The highest growth rates are generated in the SRB, which contributed 87.5% to the countries GDP in 2010. The economic growth in the basin is currently 18.3%, which is the highest in the country. Of the 9 Aimags that are located within the basin, the main contributions to the GDP are made by Ulaanbaatar and Orkhon, where the country's largest industrial and agricultural centres are located (Figure 3.3.a)

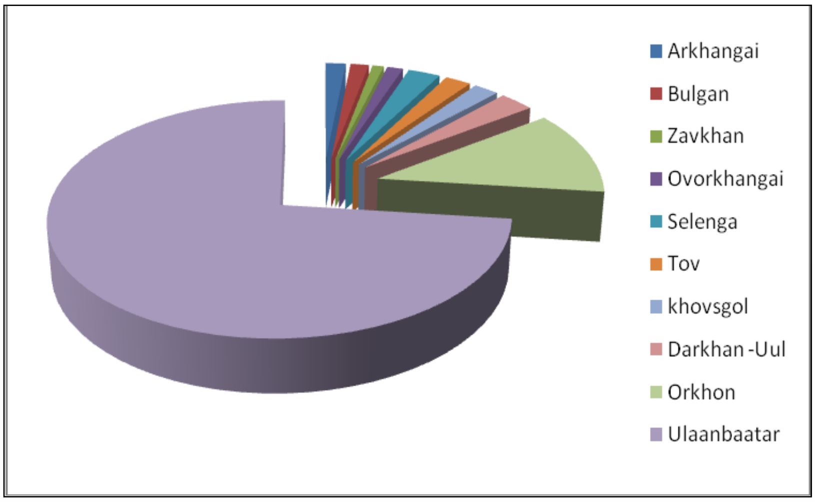


Figure 3.3.a: Average GDP in 2011 per Aimag in the Selenga River Basin.

[24] http://data.worldbank.org/country/mongolia
[25] www.worldbank.org/en/country/mongolia
[26] https://www.cia.gov/library/publications/the-world-factbook/geos/mg.html

As a result of the economic growth, there has been steady reduction in the percentage of population living under the national poverty line. In 2000, national poverty rates in Mongolia were 35.6%. Between 2003-2006, urban poverty decreased from 30.3% to 27% percent, whereas rural poverty dropped from 43.4% to 38%.

Between 2007 and 2011 the number of people engaged in the economy in the SRB in Mongolia ranged between 715,000 and 716,000 individuals. Unemployment rates in the SRB have fluctuated over that same period, with a peak in 2009 followed by a significant reduction between 2010-2011. There are marked differences in employment rates between Aimags, with the highest unemployment found in Orkhon (Figure 3.3.b). These unemployment rates are likely an underestimation, as they are calculated from administrative records of job seekers.

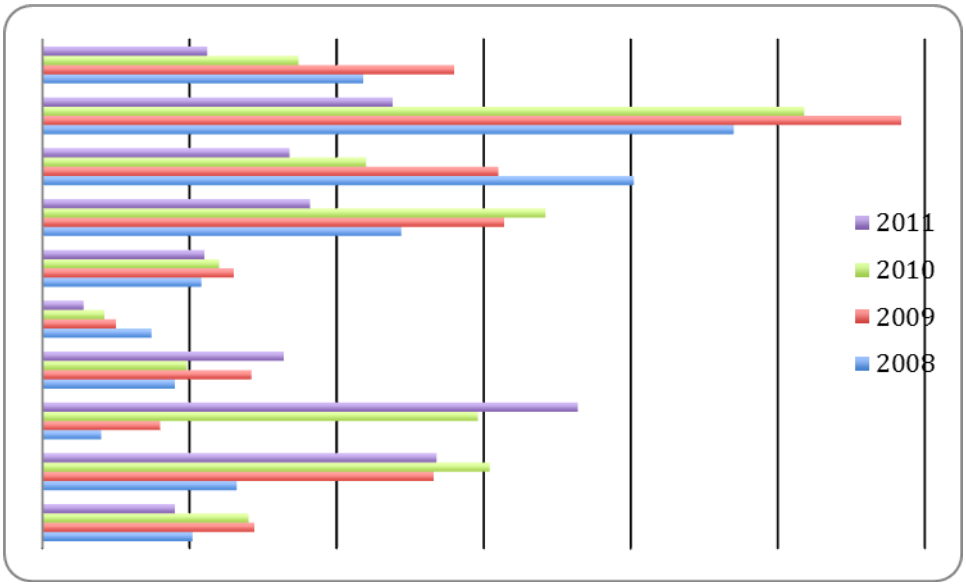


Figure 3.3.b: Unemployment rates (in percentage) per Aimag in the Selenga River Basin.

The economy of the Republic of Buryatia has been quite stable over recent years (Table 3.3). The gross regional product (GRP) in real terms from 2008 to 2011 years increased by 4 percentage points, in nominal terms-by 20.0% (Burstat 2011[27]). In 2011, the GRP of Buryatia amounted to 152.3 billion rubles (approximately US$ 4.9 billion), with the rate of growth of 104.2% over the previous year.

Although the growth rates are similar to the overall average growth rate in Russia, the GRP per capita in the Republic of Buryatia as well as in Zabaikalsky Krai and the Irkutsk area is lower than elsewhere in the country (Figure 3.3.c). Investment in fixed capital per inhabitant also lagged behind the average Russian level, although this difference seems to have become smaller in recent years.

Table 3.3: Dynamics of the gross regional product of the Republic of Buryatia over the period 2000-2011.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
In current prices, billion rubles	21,6	30,2	37,9	52,3	63,9	74,9	91,7	107,4	124,7	124,6	136,7	152,3
In % to the previous year	105	106,4	106,4	106,7	103,7	104,8	105,8	107,7	105,4	92,6	102,3	104,2

Source: Регионы России. Социально-экономические показатели. Статистический сборник, 2011, Москва

[27] See: http://burstat.gks.ru

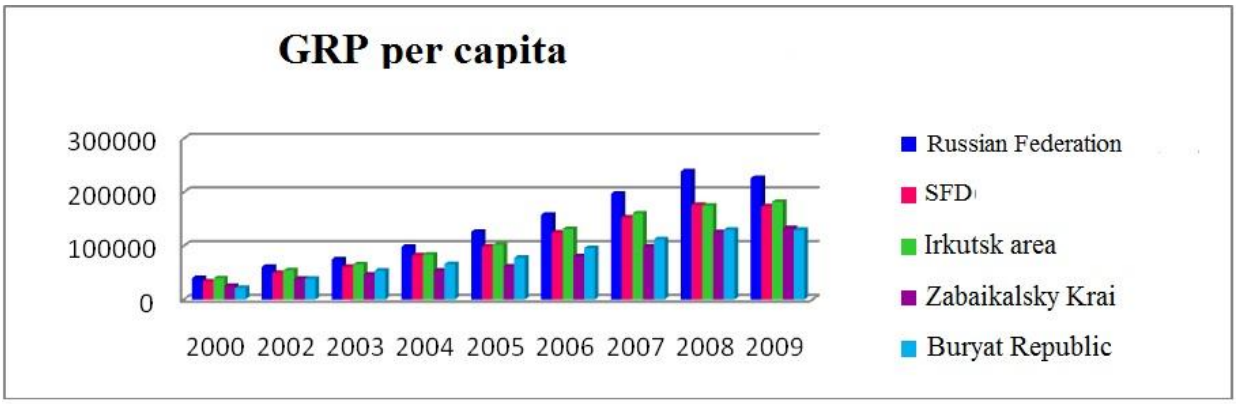


Figure 3.3.c: Dynamics of gross regional product per capita in Russia over the period 2000-2009. SFD: Siberian Federal District.

In 1995, over half of the population in Buryatia had an income that was below the subsistence level. Poverty levels have since then decreased, and dropped from 38.3% in 2004 to 29.7% in 2006. However this is still much higher than the overall poverty levels in Russia, which were 15.8% in 2006. Over the period from 1995-2010 the average income of the population of Buryatia has steadily increased. In 2011, the average GDP per capita was 14,3 thousand rubles (approximately US$ 4,628.4), which is slightly below the SFD average of 14.9 thousand rubles. This is significantly below the national GDP, which was US$ 17,000 in 2011[28].

The highest average monthly salaries are paid in the mining and quarrying industry, finance, production of transport equipment, transport and communications, and public administration. The lowest paying sectors remained agriculture, hunting and forestry, fishing, manufacture of textiles and textile products, manufacture of wood and wood products, hotels and restaurants.

Over the past years, the employment rates have fluctuated significantly, largely as a result of the economic recession crisis in 1998. A period of recovery took place between 1998-2002, and employment rates became more stable. Since 2004, an increase in employment of 0.5% has been observed annually. In 2011, a total of 441.1 thousand people (92.6% of the economically active population) were employed in the economy, and 34.9 thousand people (7.3%) were unemployed and actively searching for jobs.

The labour situation in Buryatia is influenced by several factors, including the national market, high social costs, and low competitiveness of the local economy. In addition, economic activities in the Central Ecological Zone of Lake Baikal are limited due to environmental considerations. Previously, construction was allowed up to 300 m from the lake shore. However, in 2007, the protected area was increased up to 4 times to a total of 89.1 thousand km^2. There are several consequences:

- Reduction of the area that can be exploited by the lumber industry.
- Development is limited to dedicated special zones for tourism and recreation.
- Borders of existing settlements need to be revised.
- Waste and recycling materials cannot be amassed within the protected area.

Although the maintenance of a relatively pristine environment can help to ensure the long-term provision of future ecosystem services that underlie economic activities, there are also indications that the expansion of the protected zone cause a loss of income for the Republic of Buryatia on the short term.

[28] https://www.cia.gov/library/publications/the-world-factbook/geos/rs.html

3.4 ECONOMIC SECTORS

For both Mongolia and Russia counts that the highest levels of economic growth and the largest contribution to the local economy is generated within the SRB sub-catchment of the Baikal Basin. The relative contribution per economic sector differs between the two countries.

Traditionally, the main foundation of the economy of Mongolia was pasturing livestock husbandry, and this remains an important part of the country’s economy, employment and export revenues. The sector, which includes industrial processing of livestock products and related services, employs 33% of total labour force, and constitutes approximately 19% of the annual GDP and 25% of the country’s export revenue.

The contribution of the agriculture and industry sectors to the overall national GDP varies per aimag (Figure 3.4.a). Agriculture is the dominant sector in Selenga, Tov, Arkhangai, Bulgan, Zavkhan, Ovorkhangai, and Khovsgol aimags., whereas Darkhan Uul, Orkhon, and Ulaanbaatar are industrial centres.

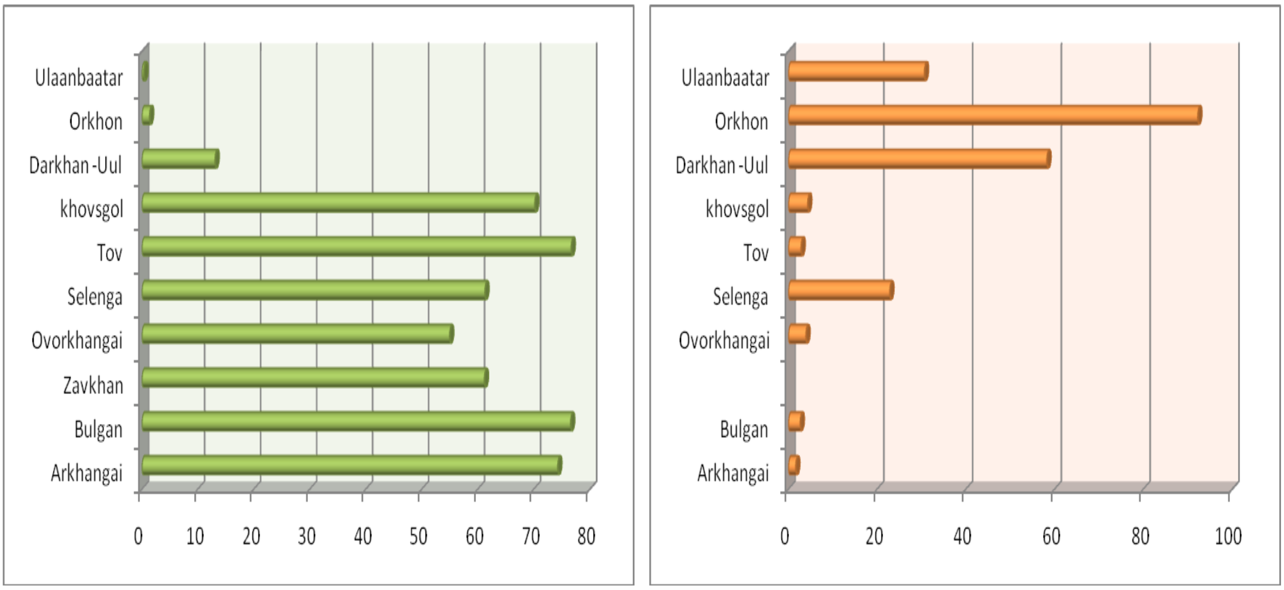


Figure 3.4.a: Relative contribution of the agriculture (left) and industry (right) sectors to the overall GDP per aimag in 2011.

The past few years the economy of Mongolia has been changing in structure. The mining sector is becoming an increasingly dominant sector and has lead the economic growth of the country (Figure 3.4.b). The agriculture sector decreased from 18.7% in 2008 to 13.1% in 2011, whereas the industry sector increased from 37% to 58.3% over that same period.

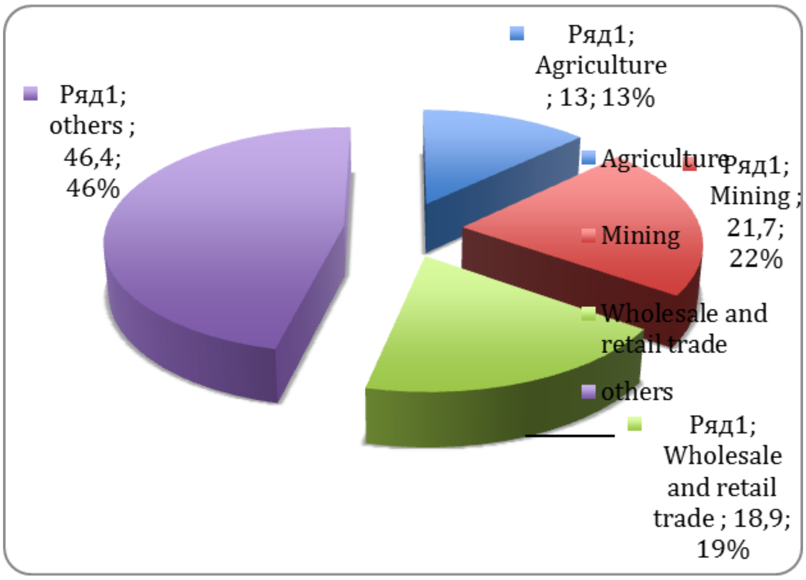


Figure 3.4.b: Relative contribution of different sectors to the overall economy of Mongolia in 2011.

In the Republic of Buryatia, there has been a slight increase in the annual GRP contribution of the industry sector compared to the agriculture sector between 2007-2011. The contribution of the transport sector reduced significantly during that same period. (Figure 3.4.c). Overall, there has been a steady decline in the proportion of people employed in industry, agriculture and construction since 1985 (Figure 3.4.d). Agriculture is traditionally an important employment sector in Buryatia, but this sector was impacted heavily by the economic crisis in the 1990's and now only represents 11.9% of the total workforce. The employment rates in trade almost doubled in the same period. The largest increase in employment took place in the public administration sector.

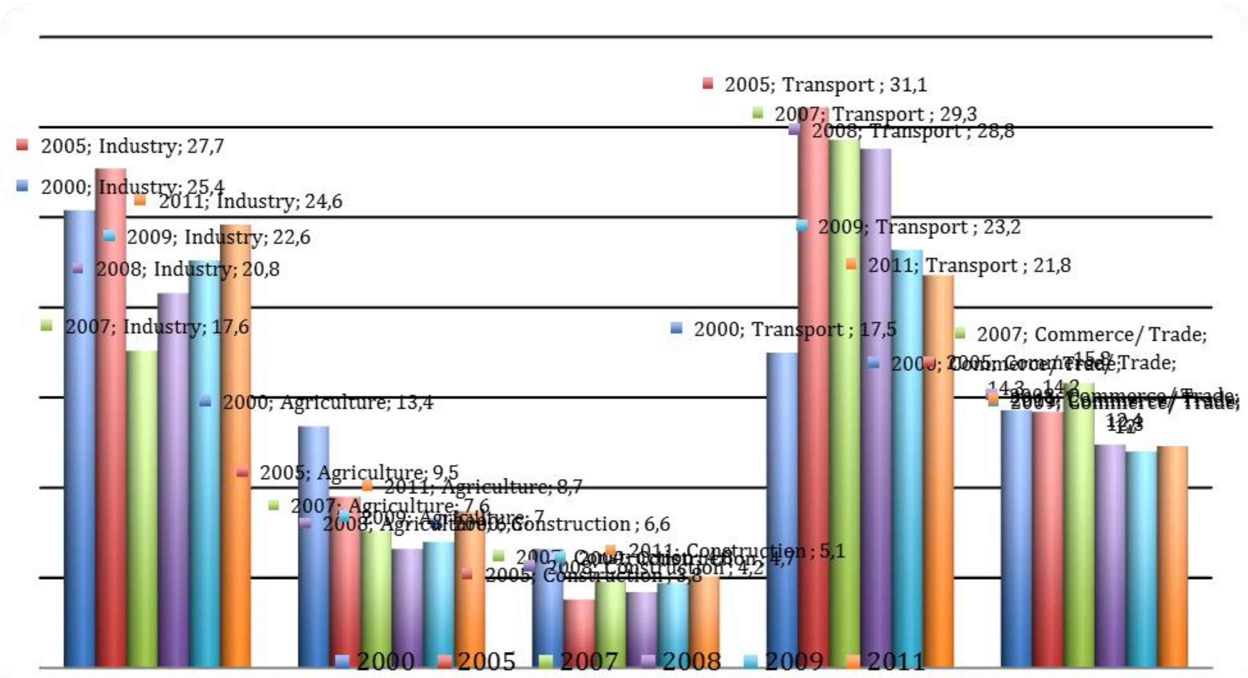


Figure 3.4.c: Contribution of major economic sectors to the Gross Regional Product of the Republic of Buryatia during 2000-2011 (in %).

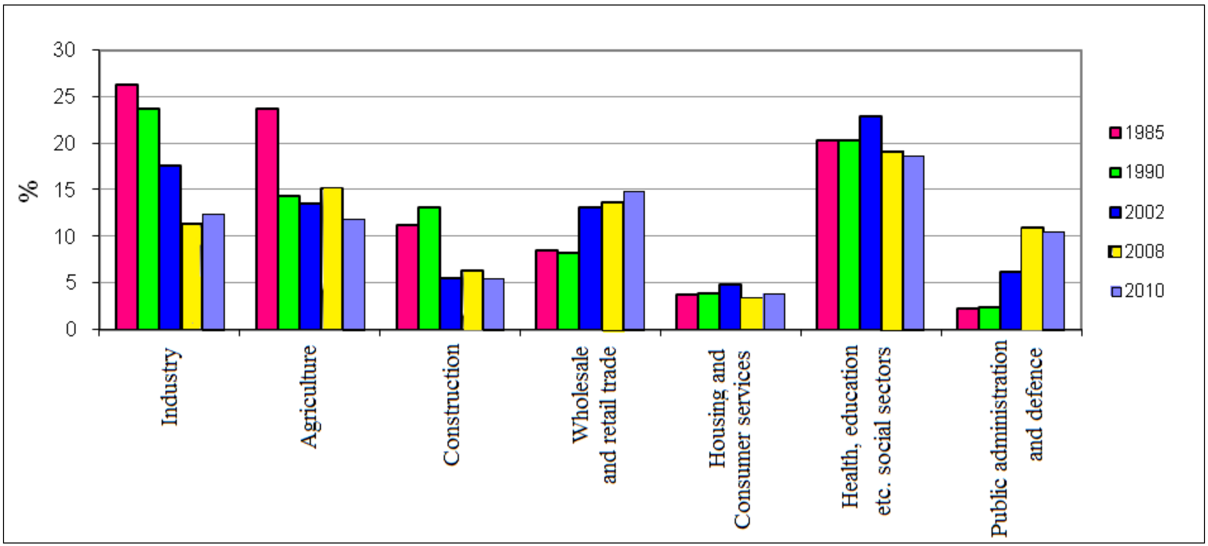


Figure 3.4.d: Employment structure per main economic activity in the Republic of Buryatia (Buryastat 2010).

Economic growth in the Republic of Buryatia is mostly generated in Ulan-Ude and the SRB. Although the SRB only occupies 31.5% of the territory of Buryatia, it accounts for about 90% of industrial and 83% of agricultural output. Other areas around Lake Baikal have less opportunities for economic growth. In the Olkhonsky District, the economy is mostly driven by subsidized agriculture, and main sources of revenue generation in the Slyudyansky area take place in the towns of Baikalsk and Slyudyanka. The Baikal PPP accounts for over 40% of the revenues of the district budget. The Irkutsk areas adjacent to Lake Baikal are characterised by overall low standards of living and high levels of hidden employment.

3.4.1 HUNTING AND FISHERIES

The contribution of hunting and fisheries to the local, regional and national economy of Mongolia is limited. Hunting is part of a traditional way of life in both Mongolia and Russia, and continues to be practiced for subsistence as well as recreational purposes.

Among the animals that are legally hunted in the Baikal Basin are bears, lynx, wolverines, wolves, wild boars, wapiti, musk deer, roe deer, reindeer, foxes, sable, kolinsky, hare, ermine, and squirrels. For the majority of these species there are hunting quota. Deer are among the most popular prey for game hunters. The Siberian stag or red deer used to be hunted intensively because of its stags. As a result of a rapid population decline, it is now banned from hunting in Mongolia. Hunting is also forbidden on musk-deer and East Siberian moose deer. Restricted trophy hunting is allowed on the East Siberian brown bear.

Hunting also takes place on several species of water fowl, as well as other birds including bustard, little bustard, grouse, partridge, and quails. Hunting with falcons also takes place in the Baikal Basin, and the birds are caught for export as well (especially to the Middle East). Other birds of prey, including buzzards, are also caught for international export, although this is now illegal. Mongolian marmots or tarvaga, used to be hunted, but the Mongolian Government banned marmot hunting in 2004 due to the rapid decline in their populations.

One of the more controversial aspects is the legal hunting of Baikal seals by indigenous people for their meat and fur, as well as for research and monitoring purposes. The Russian Government allows a fixed number of seals to be hunted every year. In 2011, a total of 1,750 seals was legally hunted. There is also excessive poaching on the seals. Over the period 1977-2001, the average number of seals that were both legally hunted and illegally poached added up to an estimated 6-7,000 individuals per year.

Traditionally, the predominantly nomadic herders of Mongolia do not consume fish as part of their staple diet, and it was not until the 1950’s that large or medium sized commercial fisheries started to be developed in parts of the region. Due to the harsh climate, low water temperature (12-15ºC during the summer) and low levels of nutrients, the fisheries productivity of lakes such as Khovsgol, Terkhiin Tsagaan and Ogii is very low. The rivers in the basin are typically shallow and frozen during 6 months of the year, and they do not provide a sufficiently productive environment for large commercial fisheries.

Nonetheless, commercial fishing occurs in the lakes in the Baikal Basin. Between mid-1950's until 1980 annual fish harvests in Mongolia would add up to 800 tonnes. Currently, about 10 small fish processing factories exist in Khovsgol aimag. Prior to 1990, fisheries in Mongolia were regulated and monitored by the central government. After the 1990's monitoring became very limited, and no data is presently available about the fishing resources and profits generated by the fisheries industry in the country.

Fisheries resources in Mongolia are currently mainly used for sport fishing. In total, 14 species are registered for commercial exploitation, including 6 in Lake Terkhiin Tsagaan, and 12 in Lake Ogii. Between 2009-2011, there were on average 8 companies with a sport fishing licence. Sport fishing is mostly done by tourists in Mongolia. During 2009-2011 the number of sport fishing tourists increased from 220 to 264 per year. A one-week licence has to be purchased, at a cost of USD 330 per person. Per licence, a maximum of 10 fish may be caught. There is a strict regulation for Taimen. Only 2 specimens may be caught per licence, and they have to be returned into the water alive.

Figure 3.4.1.a: Member of a fishing club in Mongolia holding a taimen. Source: WWF Mongolia 2011

Both commercial and sport fishing takes place in Lake Baikal and other lakes, as well as in rivers in the Russian part of the Baikal Basin. In the Republic of Buryatia, a total of 28 organizations and individual companies are engaged in the fishing industry. In 2009, the total output of fish products was 3,136 tons, and the production volume amounted to 182.5 million rubles (approximately US$ 5,9 billion).

Fisheries in Lake Baikal concentrate on the nearshore areas, up to a depth of approximately 100 meters. These areas, which total approximately 377 thousand ha (12% of the entire volume of the lake), harbour the highest densities of commercially interesting fish. The main fishing areas in Lake Baikal are the nearshore areas of the Selenga Delta (145 thousand ha), Pribaikalsky (31 thousand ha), Barguzin (84thousand ha), North Baikalsky (62 thousand ha), and Malomorskij (55 thousand ha).

The fishing industry is mainly based on Baikal omul, roach, and perch, as well as carp, ide, burbot, sazan, and pike. Exotic fish species that have invaded the Baikal Basin are also commercially fished, including the Amur sazan, the Amur sheatfish and the bream. Fisheries on whitefish and Baikal grayling has become limited. The Baikal sturgeon used to be a commercially important species, but has been overfished to the brink of extinction and is now listed as endangered in the Red Book of Russia and the IUCN Red List of Threatened Species. Taimen have also been overfished and are listed in the Red Books of both Mongolia and Russia, as well as the IUCN Red List of Threatened Species.

Figure 3.4.1.b: Smoked omul, a treasured delicacy from Lake Baikal. Photo: Wikipedia.

Due to its high demand, the omul is one of the most important commercial fisheries in Lake Baikal. The highest recorded annual landed catches occurred in 1940s and amounted to 60-80 thousand tonnes. A subsequent crash in the population led to a closing of the fishery in 1969, followed by a reopening with strict quotas in 1974 (Galazin 1978). Currently, the omul fishery accounts for roughly two-thirds of the total Lake Baikal fishery (Buyanova 2002). Fluctuations in the population and intensive fishing make sustaining the fishery one of the highest priorities for local fisheries managers.

Total fish catches in Lake Baikal declined significantly between 2003-2007, and have been gradually increasing again during the last 5 years (Figure 3.4.1.c). In 2011, the total fish catch was 2,311.8 tons. The increase in catches was mainly due to an increase in catches of omul. The total catches of omul in Lake Baikal and the major spawning rivers of this species are presented in Table 3.4.1. On average, approximately half of the amount of omul caught in rivers is artificially reproduced. To protect the stocks of omul, fishing quotas have been established for this species. However, monitoring data indicates that in 2011, no less than 25% of the omul fishing was done illegally and the quota were exceeded.

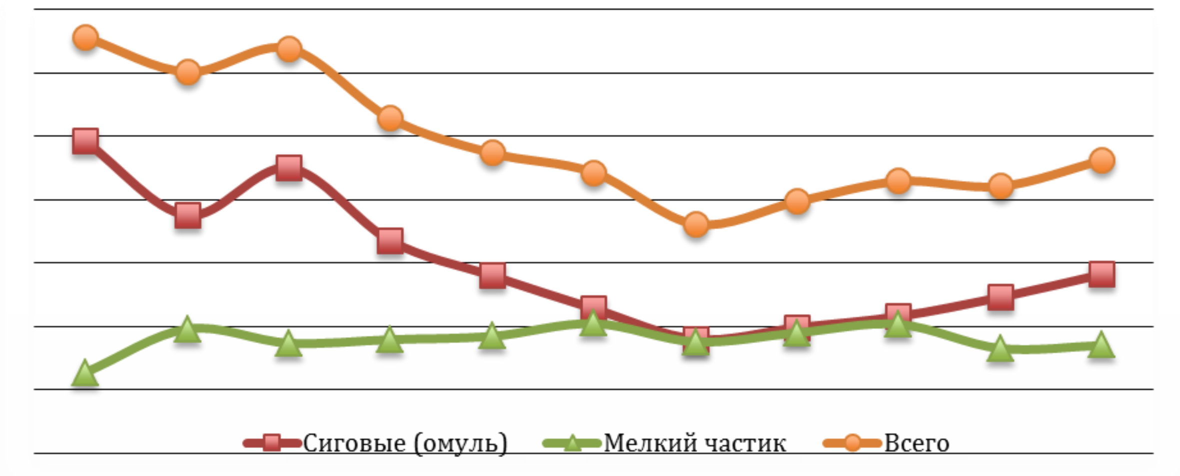


Figure 3.4.1.c: Fish catches in Lake Baikal during 2001-2011 (tons). Red squares: Omul or white fish; green triangles: other small fish; orange circles: total.

Table 3.4.1: Omul fisheries during 2010 and 2011 per area (tons).

Area	Fishing Company	2010		2011	
		Baikal	River	Baikal	River
North Baikalsky	OJSC Nizhneangarskij rybzavod	173,55	82,56	175,02	200,22
	RA MNS and ETSO	26,84	20,68	22,02	20,71
	Others	1,09	2,83	0,96	17,47
Barguzin	LLC Katun	44,00		41,44	
	FC Baikaletz	34,80		69,01	
	LLC Fish Union Baikal	134,06		113,00	
	IP-Korobenkova	55,73		58,00	
	FE Nurijew	34,88		40,00	
	JSC Vostsibrybtsentr		3,88		7,71
	FE Nurijew	15,13	0,68	26,93	1,00
Pribaikalsky	JSC Vostsibrybtscentr		10,18		15,58
	LLC Golden Fish	20,10		13,43	
	Others	1,50		8,15	
Selenga	SPC Kabansky R/P	208,01	5,65	171,66	5,36
	SPC Sukhinsky	36,00		36,72	5,00
	SPC Razhuhovsky	47,19	3,72	40,98	6,06
	OJSC Vostsibrybtscentr		51,82		79,22
	Others	4,25	7,82	16,49	13,09
Malomorsky	LLC Baikalskaya Fish	39,11		27,10	
	OJSC Malomorsky Fish Plant	44,36		34,93	
	LLC Maloe Sea	34,15		40,24	
	PA Olhon	22,20		24,98	
	Others	20,12		33,13	
Southern Lake Baikal	All	39,27		44,18	
All areas	All	3,95		2,66	
TOTAL		**1040,29**	**189,2**	**1041,03**	**371,42**

Because the stocks of commercially important fish in Lake Baikal and its adjacent rivers are declining, aquaculture is actively being promoted since the 1930’s. At present, Amur bream, Amur catfish, carp, Baikal sturgeon and omul are produced in aquaculture farms.

The main artificial fish reproduction companies are: the Bolsherechensky fish farm (launched in 1933, reconstructed capacity is 1.25 milliard roe), the Selenginsky omul and sturgeon farm (launched in 1979, the capacity is 1.5 milliard omul roe and 2.0 million Baikal sturgeon roe) and the Barguzinsky fish farm (launched in 1979, the capacity is 1.0 milliard roe). In the Irkutsk region there is the Burduguzsky fish farm (launched in 1968, the capacity is 100 million omul roe) for settling the omul in the Irkutsk water reservoir, and the Belsky fish farming department of the Irkutsk fish farm on the Belaya river (launched in 1964, the capacity is 150 million roe) for reproducing the sig fish acclimatized in the Angara cascade water reservoirs (Molotov and Shagzhiyev 1999).

In 2010, a total of 674.23 million larvae and juvenile omul were released back into their natural habitats, which is more than double of the previous year. The purpose of the artificial production of omul is to maintain stable annual catches of 3 thousand tons. The fry and the juveniles of the Baikal omul are introduced into many lakes and reservoirs of Russia, as well as Mongolia (e.g. Lake Khövsköl), China and Japan.

3.4.2 AGRICULTURE AND LIVESTOCK KEEPING

Agriculture constitutes an important part of the Mongolian economy, and the sector employs approximately 33% of the countries labour force. At present, 88.5% of the agriculture contribution to the economy is provided by livestock husbandry, including industrial processing of livestock products and related services. Although the relative contribution to the national economy has decreased over the past years due to the increasing development of the mining sector, it is expected that agriculture and livestock rearing will continue to play a fundamental role in the development of the country.

Animals raised commercially in Mongolia include goats, sheep, camels, cattle, and horses. Livestock is raised primarily for their meat, although goats are valued for their hair which is used to produce cashmere. Mongolian cashmere fibers are obtained by manual comb-out process in the spring by the nomadic herders, and the wool has unique characteristics that make it a highly sought-after commodity in the fashion industry. Mongolia is the world's second largest producer of cashmere goat's wool, with 15% of the world market (Lecraw et al. 2005).

Figure 3.4.2.a: Camels in Darkhan Uul aimag, Mongolia. Photo: UNDP-GEF Project PMU Mongolia.

Cashmere is by far the most profitable source of income available to Mongolian herders, and they can make between 50,000-70,000 tugrik per kilogram cashmere. The structure of the cashmere industry is complex and has been largely dysfunctional in the past.

Figure 3.4.2.b: Sheep and goat herds in Mongolia. Photo: Altex cashmere

A sharp decline in the global cashmere prices in 2009 encouraged herders to increase the size of their herds in order to compensate. Before successive severe winters (dzuds) between 2000-2002 decimated herds, goats accounted for almost half of the country's estimated 44 million livestock (Figure 3.4.2.c). The number of grazing animals puts a considerable strain on the limited pastureland. Goats are much more voracious eaters than other livestock, and consume the root of the grass thereby stopping it from growing altogether. As a result, the herding sector can impose substantial negative influences on pasture land through overgrazing (Lecraw et al. 2005).

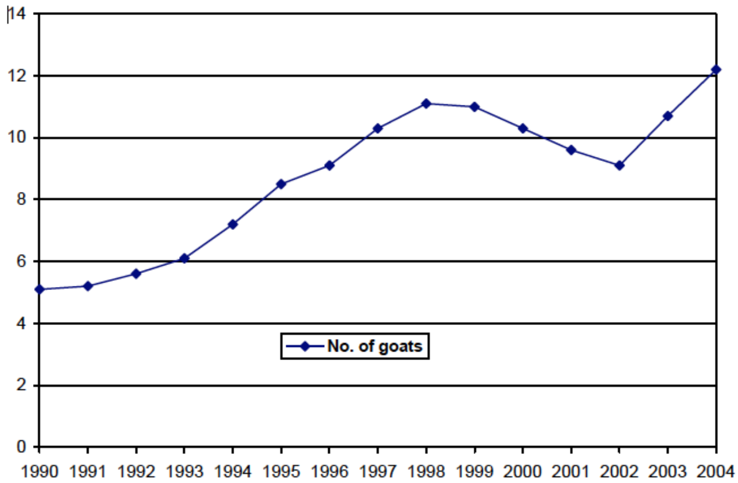


Figure 3.4.2.c: Total number of cashmere goats (mln) in Mongolia during 1990-2004. Source: Mongolia National Statistics Office.

The carrying capacity of the natural environment in Mongolia for herd animals including goats as well as sheep, camels, cattle, and horses is limited. An estimate of the total carrying capacity indicated that in equivalent sheep forage units (SFUs), Mongolia's herd size surpassed its carrying capacity already in the mid to late 1990's. The SFUs were only reduced below the carrying capacity by the dzuds in the early 2000's. By 2004, however, with the recovery of the herds, SFUs again significantly surpassed the estimated carrying capacity (Lecraw et al. 2005).

After significant losses in livestock numbers occurred during the dzuds between 2000-2002 and 2009-2010, livestock numbers have recovered and are currently increasing again (Figure 3.4.2.d), raising questions about environmental sustainability. The consequences of overgrazing can be severe. Maintenance of low culling rates and increase of livestock leads to land degradation, loss of pasture area and desertification. Ultimately, the effects of continued SFU's exceeding the carrying capacity of the environment will be a significant loss of livestock itself, as they will no longer be able to find sufficient food (Badarch and Ochirbat 2002).

As a result of the socio-economic changes and infrastructure development in the 1990's, an increasing number of herders started to move into the SRB. At present, about 25% of Mongolia's livestock is situated in the SRB, but this percentage is rapidly increasing. In 1990, the total number of livestock in the SRB was 6,600,00 and the number had increased to 12.9 million by 2011. Because it is not possible to develop productive crop land and at the same time use the land for nomadic livestock keeping, this is leading to increased conflicts between agricultural land users and traditional herders.

Natural grasslands, which are traditionally used as livestock pasture, amount to 24,700 thousand ha (82% of the SRB). As a result of poor land management, increased drought, uneven distribution of precipitation, and increased demand on water resources by multiple users, at present 52.6% of the pastureland in the SRB in Mongolia is degraded.

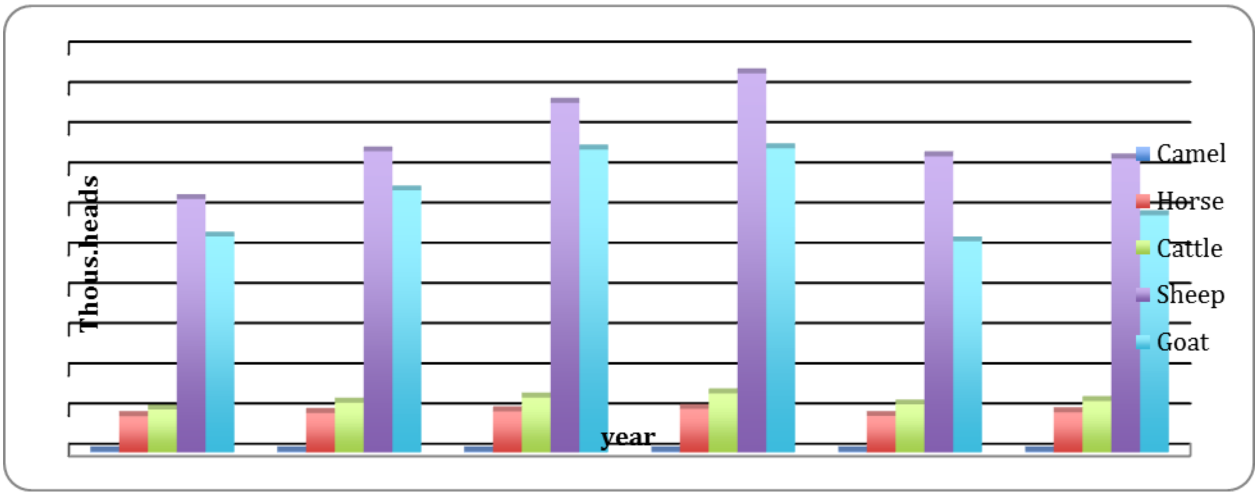


Figure 3.4.2.d: Numbers of livestock reared annually in the Selenga River Basin between 2006-2011.

Table 3.4.2.a: Livestock production in 10 aimags situated within the Selenga River Basin in Mongolia in 2011.

Aimags	camel	horse	cattle	sheep	goat	Total
Arkhangai	905	196,092	30,1950	1,327,485	852,751	267,9183
Bulgan	852	182,800	176,100	1,179,700	753,600	2,293,052
Zavkhan	4,060	65,380	51,590	601,370	479,990	1,202,390
Ovorkhangai	10,290	79,660	53,340	627,620	636,440	1,407,350
Selenga	800	61,800	143,500	612,200	447,300	126,600
Tov	155,890	139,886	120,393	951,121	684,534	205,1824
Khovsgol	1,062	114,469	249,620	1,032,012	1,015,002	2,412,165
Darkhan -Uul	717	10,195	32,470	127,614	78,825	249,821
Orkhon	182	10,713	17,767	73,090	67,447	169,199
Ulan Bator	200	20,800	54,900	101,590	85,400	262,900
Total	**174,958**	**881,795**	**1,201,630**	**6,633,802**	**5,101,289**	**12,854,484**

The high altitude, extreme fluctuation in temperature, long winters, low precipitation, and short growing season of 95-110 days per year provides limited potential for agricultural development. The main areas for agricultural development are located in the SRB, including Bulgan, Selenga and Tov aimags, which produce 99% of all agricultural products such cereal, potato and vegetables.

In spite of the harsh climate, the agricultural output in Mongolia is significant. Under the central planned economy in the 1960s, major expansion of rain-fed agriculture took place, and the production of crops soared. After privatization in the 1990s, the area of cultivated land expanse dropped dramatically due to the lack of an adequate management system. Mongolia has approximately 1,2 million ha of arable lands. In 2009, only about 200,000 ha were utilised
as cropland. The remaining 1 million ha had been abandoned. An estimated 65% of cropland area has been eroded, of which 35% are moderately and severely eroded.

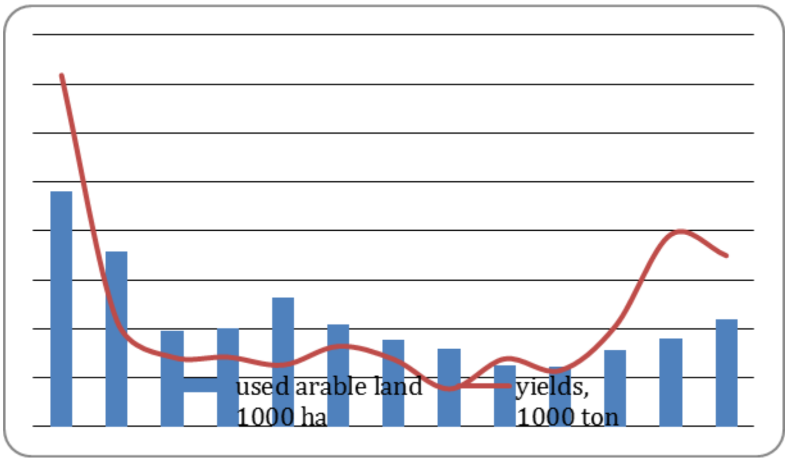


Figure 3.4.2.e Rainfed agricultural land use and total crop yields in Mongolia from 1990-2010.

Since 2007, the agricultural yields have started to improve again, as a result of improved land management schemes (Figure 3.4.2.e). Irrigation plays a key role in the growth of the agricultural sector in Mongolia. At present, 25,400 ha of agricultural land is irrigated in the SRB, and 11 dams have been built to provide reservoirs for irrigation purposes (Figure 3.4.8.b). Irrigation is mainly used for fruits and vegetables, as well as grains and potatoes.

The relative contribution of the three main agricultural crops has changed over the past 5 years. Potato production went up in 2007, but then sharply declined, whereas the number of hectares planted with cereals dramatically increased (Figure 3.4.3.f).

In general, the agricultural sector in Mongolia exhibited consistent growth in the past few years, reaching 19% of GDP in 2006 (MDG Report 2007). In 2011, the gross agricultural output was 2,053.7 billion MNT in current prices (approximately US$ 1.5 billion) which is a growth of 2.7% compared to the previous year.

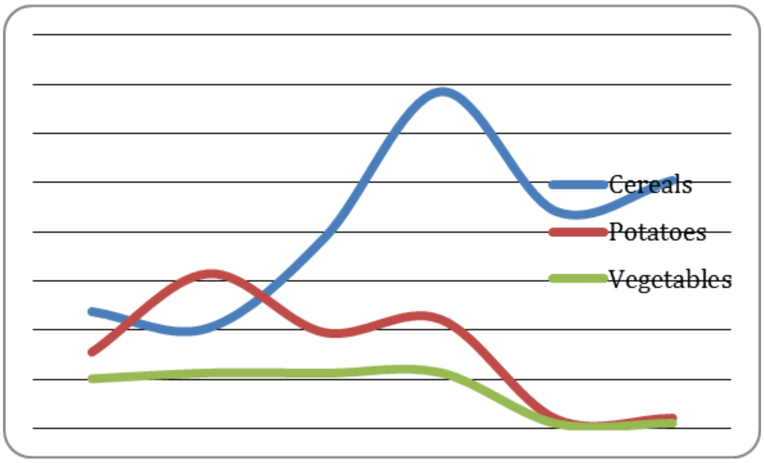


Figure 3.4.2.f: Annual amounts of hectares planted with cereals, potatoes and vegetables in Mongolia during 2006-2011.

Agriculture also plays an important role for the local economy in the Russian part of the Baikal Basin. The bulk of the agricultural production (83-85%) is concentrated in the Republic of Buryatia (Table 3.4.3.b). In 2011, the agricultural production in Buryatia amounted to 16.13 billion rubles, compared to 14.9 billion rubles in 2010 (Buryatstat 2011).

In the Irkutsk region in Russia, the agricultural production is very low and does not have a commercial character. In the Olkhonsky district agricultural production mainly consists of livestock. In the Sludyansky district, contribution of agriculture to the local economy is marginal (0.5% of the total).

Table 3.4.2.b: Output of agricultural products in the Russian part of the Baikal Basin (in million rubles)

Area / Year	Central Ecological Zone (CEZ)				Buffer Environment Zone (BEZ)				Total CEZ and BEZ	
	Irkutskaya Oblast		Republic of Buryatia		Republic of Buryatia		Zabaykalsky Krai			
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Production volume	576	640	3,021	2,343*	11,483	12,519	2,410	2,414	17,125	17,916
Share in total production at the BNT	1,5%	3,6%	18%	13%	67%	70%	12%	13%	100%	100%

*Preliminary data, obtained 16 July 2012.

Over 40% of the population of the Republic of Buryatia is rural. The coastal regions of Buryatia (Kabansky, Barguzinsky, Pribajkalsky, and Severobajkalsky) presently include a total of 20 agricultural farms, 19 peasants, 31,491 smallholdings and other individually owned farms. In addition, the Severobajkalsky district has Evenki family clans that are engaged in reindeer-herding.

Agriculture provides a significant part of the employment opportunities, and is a diversified system that generates over 8% of gross regional product and offers opportunities for further development. At present, 169 agricultural organizations, 4820 farms, and 136 thousand personal subsidiary plots exist in Buryatia.

Due to the dry and cold climate, and the low fertility of the soil, agriculture in Buryatia is generally characterised by a productivity potential that is up to 2.5 times lower then in European Russia (RB 2011). Nonetheless, there are sufficient land resources for the production of basic agricultural products. Agricultural lands in Buryatia are mainly concentrated in the southern and central regions of the Republic, and cover an area of 3,149.4 thousand ha, including 846.6 thousand ha of arable land. This adds up to 9% of the total area of Buryatia.

Most of the agricultural land in Buryatia is used for pasture (58.5%) and hayfields (12.4%). Gross agricultural outputs are dominated by livestock production (over 70%), whereas the production of crops is less than 30% (Figure 3.4.3.g). Livestock mainly consists of cattle, pigs, sheep, goats, horses, and poultry. Among the agricultural crops, the highest production is generated by livestock fodder, vegetables and potatoes (Figure 3.4.3.h). In 2011, grain harvest was 97.8 thousand tonnes (135% increase compared to 2010).

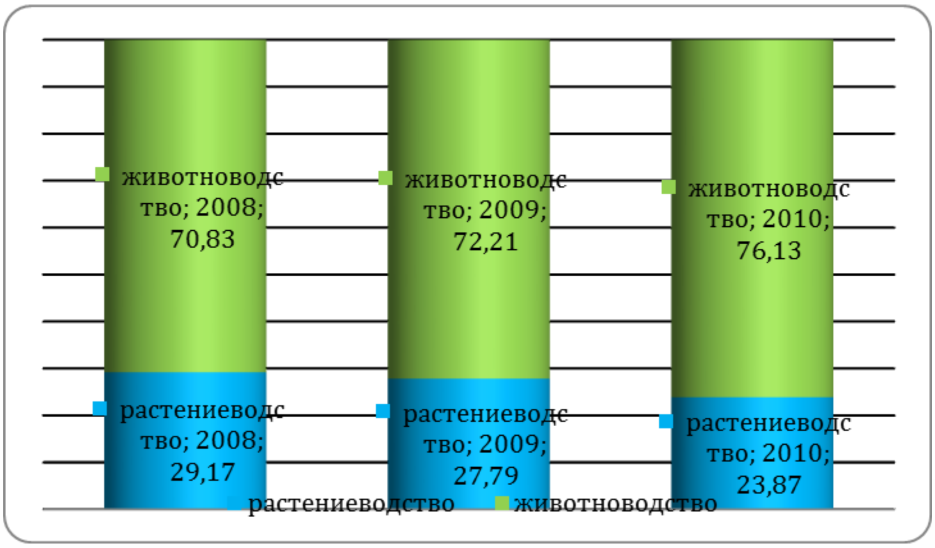


Figure 3.4.2.g: Relative contribution of crop production (blue) versus livestock production (green) in Buryatia during 2008-2010. Source: Buryatstat 2011.

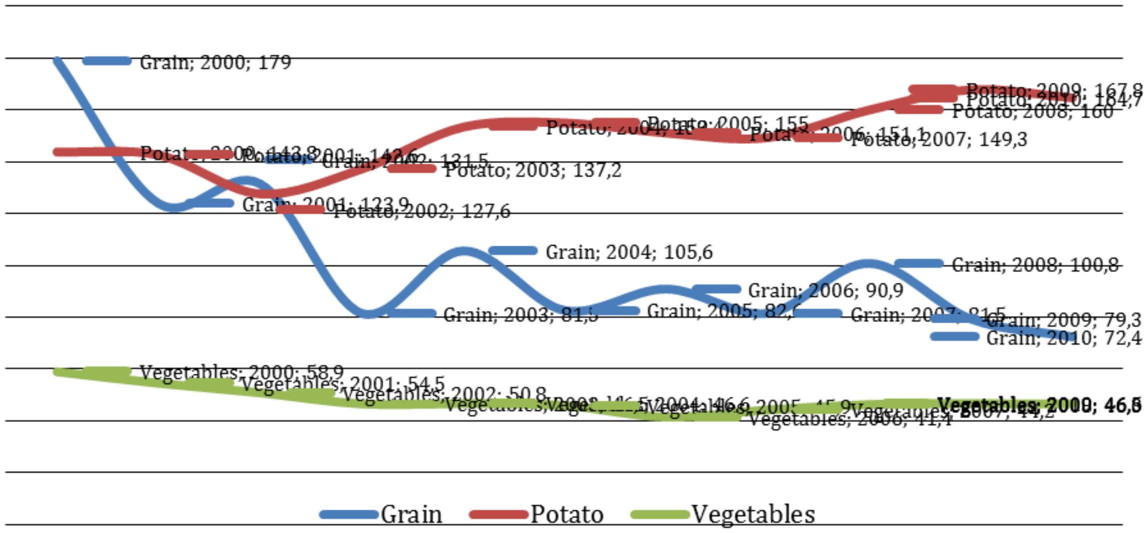


Figure 3.4.2.h: Annual amounts of hectares planted with grains, potatoes and vegetables in Buryatia during 2000-2011.

The agricultural sector was significantly impacted by the economic recession that started in the late 1990's. Between 1991 and 2009, the area of arable land decreased by 250 thousand ha (26.4%) whereas fallow land more than doubled to a total of 44.9 thousand ha. At the same time, there has been an increase in the proportion of privately owned medium-sized and large enterprises to 70.5% compared to 25% in 1996. Over the past decade the amount of livestock that is being kept in Buryatia has remained relatively stable, although the production of hogs has slightly decreased whereas the amount of sheep and goats has slightly increased (Figure 3.4.2.i). The overall productivity of livestock and poultry farms in Buryatia is relatively low. Gross milk production was 279.9 thousand tonnes in 2011 (122% increase compared to 2010). Meat production was 50.4 thousand tonnes in 2011, which is an annual increase of 100.4%.

The agricultural sector uses a significant amount of water. In 2010, the area of irrigated land in Buryatia was 118.798 thousand ha. The volume of fresh water used by the agricultural sector in 2011 was 12.9 million m^3 for production and 19.88 million m^3 for irrigation.

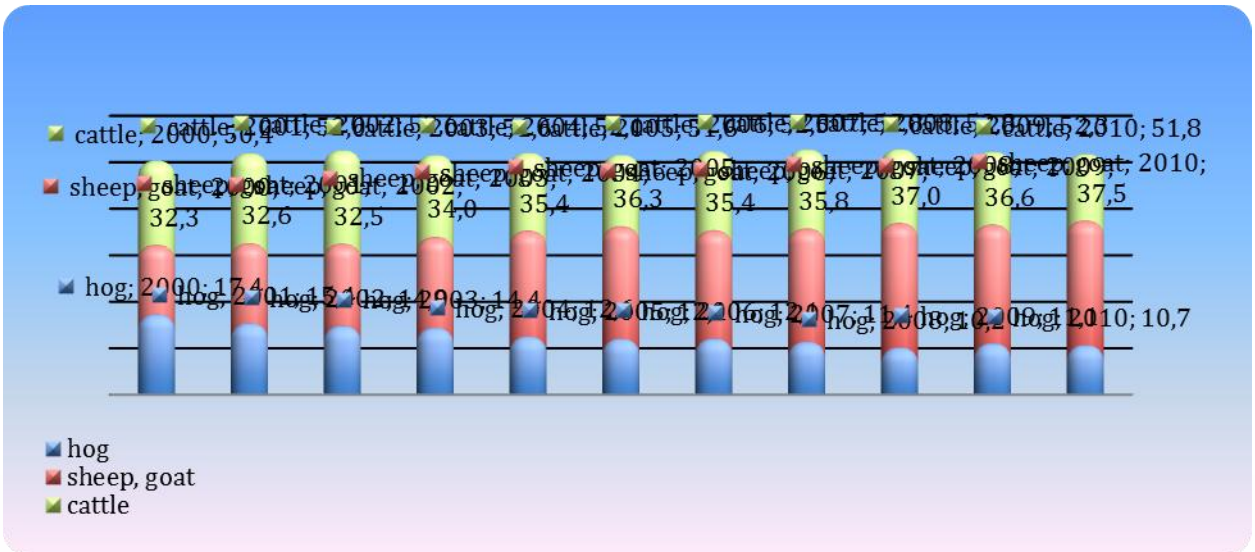


Figure 3.4.2.i: Livestock production in the Republic of Buryatia during 2000-2010 (in thousands of heads)

3.4.3 FORESTRY

Most of the forests in the Baikal Basin are located in the Russian part of the catchment. Mongolia has a relatively low forest cover, which is predominantly coniferous. In 2012, 11.9% of its territory is considered as forest fund area, of which 75.4% are covered with coniferous and larch forests, and 24.6% has sparse forest and saksaul vegetation (Figure 3.4.3.b). The forests are mainly located in the north-central parts of the country, between the Khangai and Khentii mountain ranges and the Khovsgol region, forming a transition zone between the Great Siberian boreal forest and the Central Asian steppe desert. Due to the harsh climate, Mongolian forests have a low capacity for natural regeneration and are very sensitive to forest fires, insect invasions and human use.

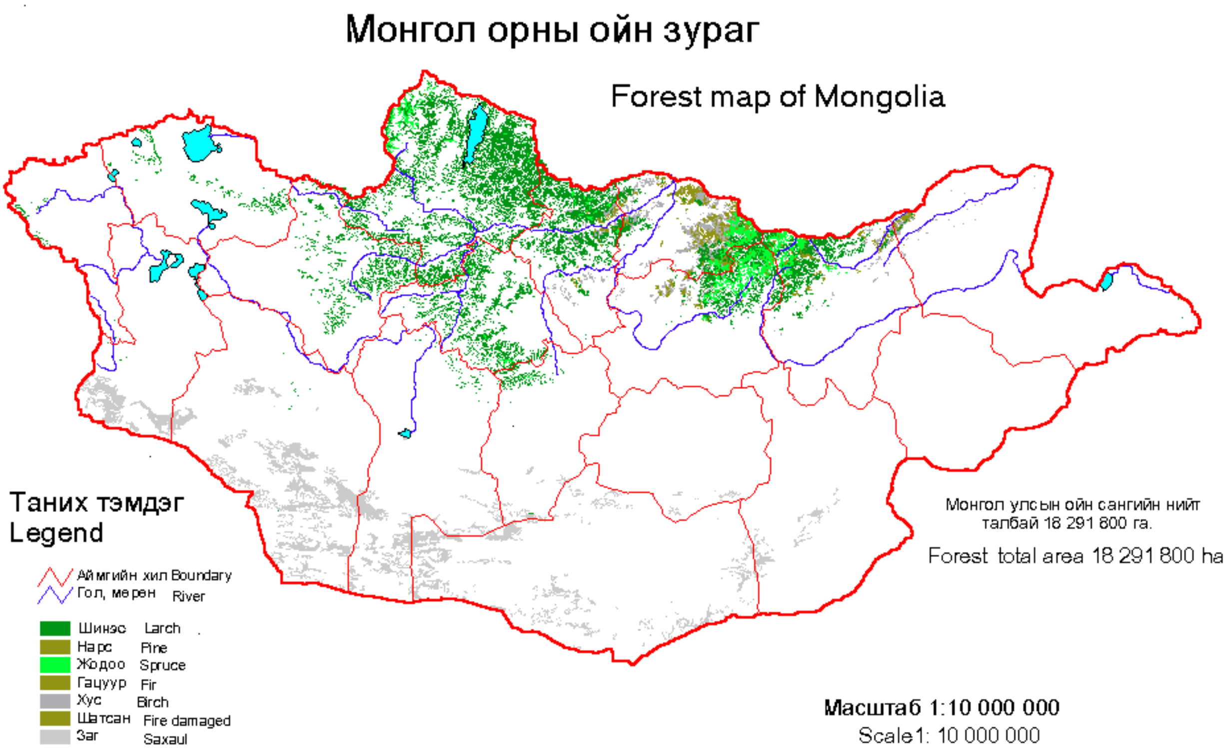


Figure 3.4.3.a: Forest map of Mongolia. Source: Batsukh 2004.

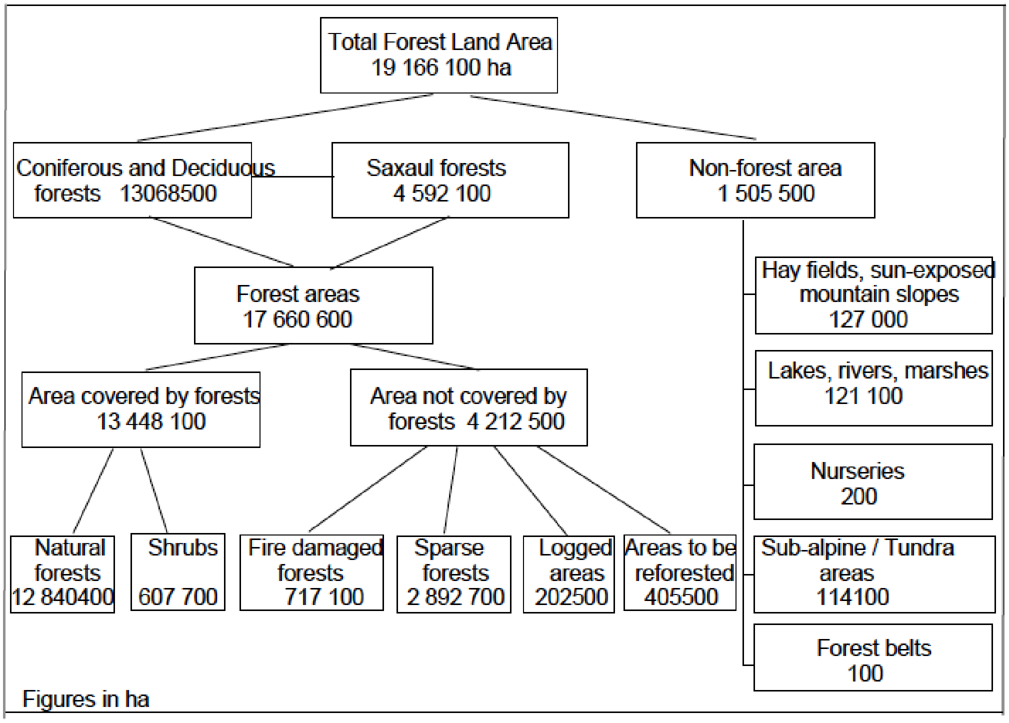


Figure 3.4.3.b: Forest structure of Mongolia. Source: Water and Forest Resource Centre 2007.

According to the Mongolian Forest Law, the forests are functionally classified as strictly protected forests (8.4 million ha), protected forests (7.9 million ha) and utilisation forests (1.2 million ha). The extent of utilization forests has been progressively reducing since 1992 by transferring areas to the category of strictly protected and protected forests. In addition, the National Forest Council was formed in 2001 to revitalize the wood industry and support the social functions of forestry.

The average contribution of the forest sector to the national economy of Mongolia in terms of profits or earnings as represented by organised timber harvests and timber processors is marginal (Crisp et al. 2004). In 2010, the contribution of the forestry sector to the GNP was 0.26%, compared to 4.1% in 1990 (Ykhanbai 2010).

The amount of industrial logging has decreased drastically in Mongolia over the past 20 years. In the mid-1980s the annual volume of logging was about 2.2 million m^3, and was reduced to 0.5 million m^3 by 2000. This drop in timber harvest level is partly the result of institutional and policy changes involving decentralisation and privatization of production enterprises. It is also the result of a reduction in the amount of timber available for harvesting, due to the fact that the Government reclassified a number of utilisation forests as protected areas. This resulted in a reduction of 5.8 million ha in 1985 to 1.19 million ha in 1996. Furthermore, clear felling of natural forests was prohibited in 1995, and selective cutting became mandatory for timber harvesting.

In spite of threefold increase in the area of protected forests between 1990 and 2006 (from 3.6% to 13.3% of the total territory of Mongolia), there has been a continued reduction in forest cover. Between 1999-2000, forest areas in Mongolia comprised between 8.2-8.5% of the total territory. In 2006, the relative amount of forests had declined to 7.7%.

Fires cause great challenges for the sustainable management of forest assets in Mongolia. Fires are the main cause of forest loss. Many of the fires are incendiary, caused by herders and collectors of antlers. About half of all the closed forest (amounting to 7.52 million ha) in the country was affected by forest fires from 1990-2000. In 2007, there were 216 forest fires in total, out of these, 156 (72.2%) were in the SRB. It is estimated that on average, forest fires result in a loss of 500,000 ha of forest cover (Ykhanbai 2010). The fires in 2007 resulted in the loss of 1,335.2 thousand hectares of forest. In total, 219 human lives were lost, a total of 1,431 homes were destroyed, and 10.8 thousand heads of livestock died. The economic loss caused by the forest fires added up to a total of 200.6 billion MNT (approximately US$ 142.9 million).

Reforestation and natural regeneration is promoted in Mongolia. Annually, 6,000-8,000 ha are reforested by state and private companies (Ykhanbai 2010). At present, about 92% of the total original forested area of 17.5 million ha is currently growing trees, while 8% is not (IFFN 2007)

The Baikal Natural Territory (BNT) in Russia has large forested areas, which are predominantly coniferous (74.2%) and include larch, pine, cedar, birch and aspen. Forest cover varies among the different administrative districts in the region. The highest levels of forest cover are in Zakamensky (86.6%), Horinsky (81.5%), Pribajkal'sky (80.8%), Zaigraevsky (74.1%), Kizhinginsky (70.2%) and of Buryatia 59.3%. The lowest level of forest cover are in Kabansky (32.1%), Kyahta (39.0%) and Mukhorshibirsky (41.8%).

In 2011, the area that was covered by forest vegetation amounted to 11,099.2 thousand ha[29] of which 44.3% is located in the Republic of Buryatia and 38.2% in the Irkutsk Oblast. The forests in Buryatia are dominated by medium-aged forest (37.9%), young growth stands (27.7%), mature and overmature (24%), and premature (10.4%).

Lumbering in Buryatia is done by over 140 companies, with an estimated total capacity of over 1,000 m^3 per year. A timber lease was passed for 92 forest areas sections in 2010, adding up to a total of 1,074 thousand ha and an annual felling volume of 1,151 thousand m^3.

In total, 442 companies, including 2 large, 21 average and 419 small business entities are active in processing forestry products (RB 2011). In 2009, the forestry sector produced 1,020 thousand m^3 of timber, 218.6 thousand m^3 of lumber, 100 thousand tonnes of cellulose, 95.3 thousand tonnes of cardboard, 5.3 thousand tonnes of paper.

[29] www.geol.irk.ru/baikal/rep_2011/content.htm

The forest sector plays a significant role in the Republic's external trade. Regional export commodity structure in wood and articles of wood constitute more than 30%. China currently accounts for over 95% of exported wood products. It is expected that China will have an annual solid wood fibre deficit of about 150 million m^3 by 2015. Lumber companies in the Baikal region are anticipating to expand their market share in China and rapidly grow their revenues and profits from exploitation of the forest resources[30].

The largest wood processing enterprises in the region are the Baikal PPP and the Selenga Pulp and Board mill. The following major investment projects were approved by the national Government in 2007[31]:

- Establishment of a forest and wood processing infrastructure in the Eravninsky area by the JSC Baikal Lesnaya Company, with a felling volume of 340 thousand m^3 (by 2013).
- Processing of wood and wooden construction objects by LPC Baykal-Nordic, with a capacity of 500 thousand m^3 (by 2015).
- Establishment of infrastructure for forestry and wood processing (chips and wood-polymer composites) in the Northwest Baikal area by Forest Invest LTD. (by 2013).
- Construction of a factory for manufacture of hardboard in the Zaigraevsky region by LLC Forest Exchange (by 2017).
- Modernization of cardboard and paperboard equipment, and creation of forestry infrastructure in the Republic of Buryatiya by JSC Selenga PCC (by 2014).

Most of the commercial felling occurs in the Irkutsk region. The amount of annually harvestable wood in the BNT is 14.99 million m^3, of which 51.1% (7.67 million m^3) is located in the Irkutsk region. In 2010, the actual amount of wood harvested through commercial felling in Irkutsk was 2.3 million m^3 and in Buryatia 4.84 million m^3. In 2011, the amount of wood that was commercially harvested in Buryatia was reduced to 0.96 million m^3

In Buryatia, the majority of the felling is done for thinning and sanitary cuttings. In 2011, 38.7 thousand ha were thinned, and 23.5 thousand ha were felled for sanitary purposes.

The forests in the vicinity of Lake Baikal are extremely sensitive to forest fires, due to the predominance of coniferous trees, and the frequent occurrence of spring-summer droughts with strong winds. In 2011 a total of 2,328 fires were reported and 114.6 thousand ha were affected.

Since 1996 reforestation has been promoted, which mainly focuses on planting pine. In 2006, 31.1 thousand ha were planted and natural regeneration was promoted in 28.9 thousand ha. In 2011, 57.1 thousand ha were reforested. Natural regeneration mainly occurs in areas that have been burnt out, in clearings and around lakes.

Figure 3.4.3.c: Coniferous forests in the Baikal Basin. Source: www.baikalforest.com

3.4.4 TOURISM

The Baikal Basin is a relatively unexplored travel destination that offers a great combination of scenic natural features, a wide variety of untouched landscapes including vast open spaces, paleontological and historical heritage areas, as well as different cultural aspects, such as the nomadic lifestyle.

[30] For instance, see: www.baikalforest.com/en/about.asp
[31] Government of the Russian Federation, Resolution No. 419 from 30.06.2007.

The Government of Mongolia has recognized tourism as a priority sector with a great potential to contribute to socio-economic development of the country. Accordingly, the mission of the Government is to develop Mongolia as an internationally competitive destination, by developing new tourist destinations, products and attractions (MRTT 2006).

In accordance with the government policy on tourism development, the number of foreign tourists has been steadily increasing with an average of 15-30% per year. Between 2000 and 2011, the total number of tourists went from 137,374 to 2.2 million, although there has been a decline in growth in the past few years as a result of the global economic crisis. In 2005, the tourism sector had generated a total of US$ 201 million and employed a total of 12,000 people (MRTT 2006).

Ecotourism, sport and adventure tourism, as well as health and wellness tourism are niche segments of the travel and tourism sector that the government and private industry are currently developing[32]. Capitalising on Mongolia's numerous natural hot and cold mineral-springs, and vast and pristine landscape dotted with mountain steppes and endless plains, these specialised travel activities and tour packages are starting to find popularity amongst foreign tourists looking for a novel experience. Main touristic destinations that are being developed within the Baikal Basin include Lake Khovsgol (Figure 3.4.4.a).

Until recently Lake Khovsgol was relatively inaccessible. However, several infrastructure improvements are planned that are expected to result in a significant increase in tourism to this region. A paved road is planned in order to connect the area with the provincial capital of Murun, where a regional airport is located. In addition, a newly opened border crossing with Russia at the northern end of the lake promises to usher in a new influx of visitors from the larger Lake Baikal region.

Figure 3.4.4.a: Lake Khovsgol, with the snow-capped Khoridol Saridag Mountains in the background. Photo: http://asia.ansp.org/hovsgol

Lake Baikal and its adjacent nature parks and reserves are important areas for touristic development, which includes 26 mineral springs of recreational value, 182 natural monuments, as well as 94 historical and cultural objects.

At present, the contribution of the tourism sector to the regional economy is limited, and does not exceed 1%. Inaccessibility is a challenge in the Lake Baikal area, as currently 70% of the coast is inaccessible from the land. Infrastructure development is required to further expand the tourism sector in this region.

[32] For example, see: www.mongoliatourism.gov.mn

The Government of Russia has therefore assigned specific economic zones in Buryatia and Irkutsk Oblast for further development of tourism and recreation, by establishing public-private partnerships, and investing in infrastructure improvements. It is anticipated that future activities will include options for ecotourism, hunting and fishing, as well as others that are linked to the regions cultural heritage[33]. The aim is also to improve the regulation of tourism in the region, and reduce pressure on the environment from unregulated, informal tourism and recreation. The overall target is to attract 0.5 million visitors to the Lake Baikal area by 2028, from which it is expected that approximately 15% will be foreign (Rosabal and Rao 2011).

The main sites for further tourism development are the “Gate of Lake Baikal” in the Irkutsk region, which includes an area of 1,590 ha near the Goloustnoe village in the Sludyansky area, and the “Baikal Harbour” in the Pribajkalsky district, which includes an area of 3,658.12 ha on the eastern shore of Lake Baikal. In addition, local clusters for tourism development were assigned in the 15 municipalities of the Republic of Buryatia, including the city of Ulan-Ude, Kyakhta, Barguzin, Severobaikalsk and Kabansky, Pribaikalsky, Tunkinsky, including North Baikal, Kurumkansky, Zaigrayevsky, Ivolga, Okinsky, Tarbagatai, Kjahtinsky, Selenginsky area. In the North of Lake Baikal, a resort for traditional Tibetan medicine is planned. Open-air ethnographic parks are planned to showcase the culture of the local people. Tourism in the region will also be linked to cross-border destinations, including the Great Tea Route, the Eastern Ring, the Trans-Siberian Express, and the Lake Baikal-Lake Khovsgol Route.

At present, there are 49 tour operators and 191 tourism agencies operating in the region. It is expected that these figures will rapidly increase. The number of tourists visiting Lake Baikal continues to grow (Table 3.4.4). Between 2006-2011, the tourist flow to Buryatia increased 3.3 times[34]. Most of the tourist visit the region for recreational purposes (Figure 3.4.4.b). In 2011, the Irkutsk region and the Republic of Buryatia were visited by 1,303 thousand officially registered tourists, including 75.4 thousand foreign tourists, mostly from Mongolia. The revenue generated by tourism in that year was an estimated 13,517.5 million rubles (approximately US$ 4,377 million).

Table 3.4.4: Indicators of development in the touristic sector in the Republic Buryatia between 2006-2011. Number of tourist arrivals in thousands of persons, and volume of paid services in million rubles.

Indicators	2006	2007	2008	2009	2010	2011
Number of tourist arrivals	162.5	229.4	302.2	361.2	471.2	530.0
Volume of paid services rendered to tourists	561.9	654.0	868.9	1,069.0	1,302,3	1,400.0

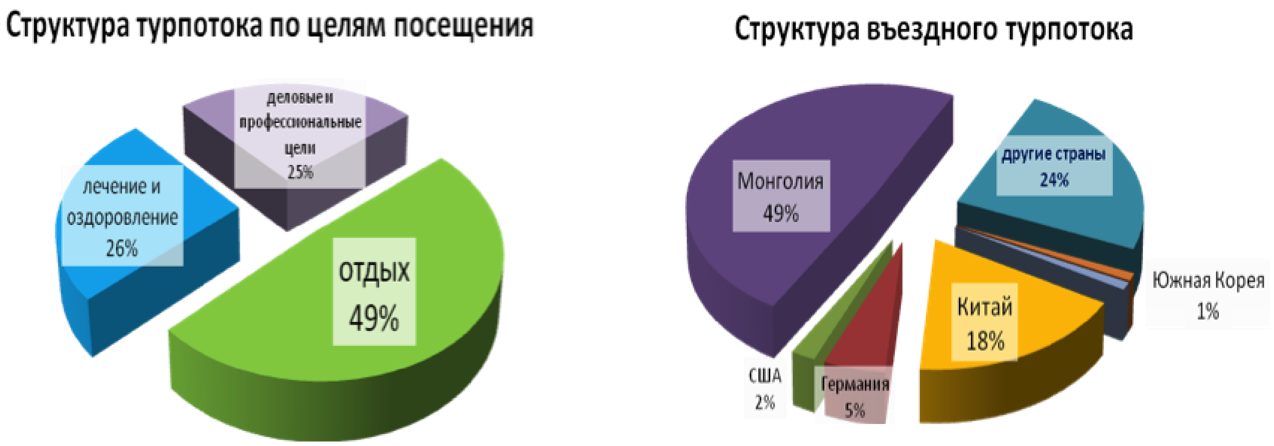


Figure 3.4.4.b: Structure of tourism in the Republic of Buryatia, based on purpose of the visit (left: blue, health and wellness; purple, business and professional objectives; green, recreational), and origin of the visitor (right: purple, Mongolia; blue, USA; yellow, China).

[33] For example, see: www.baikaltravel.ru/en/buryatia
[34] National report of the Ministry of natural resources of Russia on the Status of the Baikal Lake and Measures for its Protection, 2011. See: www.geol.irk.ru/baikal/rep_2011/content.htm

3.4.5 INDUSTRY

The industrial sector is rapidly becoming an increasingly important contributor to the economy of Mongolia, and accounted for 29.5% of the country's GDP in 2009. The main industrial activities are mining (see 3.3.6) and manufacturing. In 2007, the production of industry (at current prices) amounted to 2,602.9 million MNT, out of which, 90.2% (2,356.8 million MNT) was generated in the SRB (NSO Yearbook 2007[35]).

The manufacturing industry in Mongolia mainly centres around the processing of domestic raw materials. Products include foods (meat, beverages, dairy products, and flour), clothing made from cashmere, wool, hides, skins, and furs; and wood products such as ger frames and furniture. Brewing, distilling, and bottling of soft drinks have grown, as has the manufacture of construction materials (including cement). Early in the post-1990 conversion to a market economy, several of the clothing manufacturers were converted to making textiles and garments from imported materials for export. Among the manufactured products that have started to be produced since 2000 are rolled copper sheeting, copper wire, and zinc concentrates.

Ulaanbaatar is the centre of Mongolia's manufacturing, especially of the lighter industries. The country's main heavy industrial enterprises include those at Erdenet that concentrate copper and molybdenum ores for shipment. The Erdenet Mining Company (EMC) accounts for 13.5% of Mongolia's GDP and 7% of tax revenue (also see 3.3.6).

Figure 3.4.5.a: Mongolian-Russian Erdenet copper and molybdenium Mining Corporation in Mongolia (left); Reservoir of the waste in Mongolia (right).

Industry is the leading sector of the economy of the Republic of Buryatia. The sector contributes 24.6% to the gross regional product, and 40% to the annual consolidated budget of Buryatia. Over 18,943 enterprises, associations and their branches are active in the industrial sector in Buryatia, and over 60% are privately owned.

In 2010, the industry sector had an overall growth rate of 122.9%, and in 2011 the growth rate was 112.9%. The mining industry grew 114%, manufacturing industries 116.2%, and the production and distribution of electricity, gas and water 97.9%.

The engines of the industrial production in the region are the production of civilian and military-industrial machinery, metalworking, and production of energy (see 3.3.8). Primary processing industries including the non-ferrous metallurgy and fuel industry, food processing industry and the forestry sector, are increasingly becoming important (Figure 3.4.5.b).

[35] See: www.nso.mn

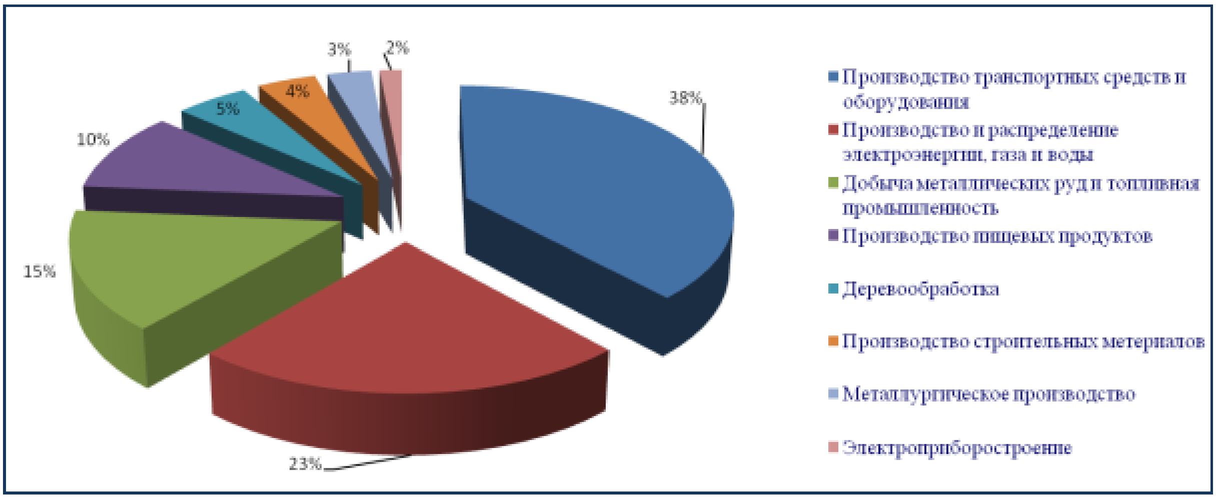


Figure 3.4.5.b: Structure of the industrial production sector in the Republic of Buryatia in 2012. Legend on the right (from top to bottom): Manufacture of the transport vehicles and equipment; Production and distribution of electricity, gas and water; Mining of metal ores and fuel industry; Manufacture of food products; Manufacture of wooden products; Production of construction materials; Metallurgical production; Production of electronic instruments.

In 2012, a draft concept of the industrial policy of the Republic of Buryatia for the period 2013-2017 and up to 2025 was developed, in order to accelerate the diversification of industrial production complex. The following areas were identified for further development:

- Mechanical engineering (instrumentation, motor construction, auto-assembly plants and agricultural machinery).
- Agriculture (vegetables and meat canning production).
- Timber-processing industrial complex (building materials, furniture).
- Complex processing (quartzite and radio-elements).

For this purpose, Buryatia is actively encouraging the development of modern industrial infrastructure, and establishment of industrial and technological parks. In the cities of Ulan-Ude, the Gusinoozersk and Severobaikalsk and Zaigraevsk district, 4 economic zones have been assigned for the further development of industrial production and technical innovation.

Production in the Sludyansky district in the Irkutsk Oblast mainly focuses on the forest and paper industry (the Baikal PPT contributes 58% of the local industry). Main activity of the Baikal PPT, which was established in the beginning of 60s last century, is production of bleached cellulose, paper and paper board. The plant is main pollutant of Lake Baikal. In February 2013 the Russian government decided to close the Baikal PPT. Further contributions to the local industrial sector are made by the East-Siberian Railway (27%), and smaller enterprises. The industrial sector in the Olkhonsky area is mainly represented by fish-processing enterprises, marble quarrying, and bread- and butter factories.

3.4.6 MINING

Mongolia's wealth of mineral resources (see 2.2.7) is extremely important for the future economic prosperity of the country, and plays an increasingly important role as a contributor to the GDP (Figure 3.4.6.a). Between 2007-2011 the number of workers in the mining and quarrying industry increased from 44,100 to 45,100, which is a far greater percentage increase than in any other sector. Mining opens opportunities for both formal and informal employment. Informal employment in the mining sector is a new phenomenon which emerged in Mongolia after transition to the market economy. Statistical data suggests that informal employment in the mining sector of Mongolia equals or exceeds formal employment in that sector (HDR 2007).

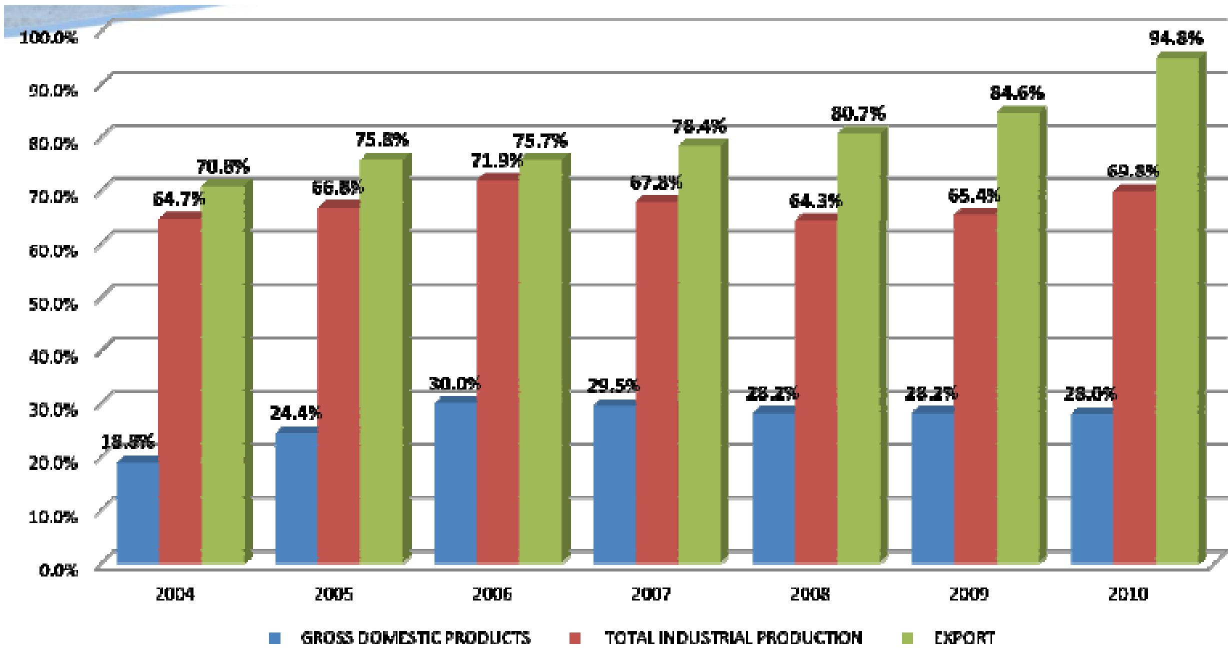


Figure 3.4.6.a: Contribution of the mining sector to the national economy of Mongolia. Source: Ministry of Mineral Resources and Energy, Mongolia.

In 1997, the Government of Mongolia passed a new Mineral Law that brought more consistent and effective mining rules for the country, subsequently attracting foreign investment in the sector. However, a law implemented in 2006 called for higher taxes and growing control of natural resources, allowing the state to own up to 34% investment in the mine, and if state participate in exploration costs up to 50%. At present, this law is no longer in force, and the Government is drafting a new law on mineral resource use.

The mining industry's historic output is largely based on copper and gold. The Mongol-Ore Company has been mining gold in the SRB since 1904. In 1975 the company also started mining copper, molybdenum and coal. In recent years, gold mining has become the most dynamic sector of Mongolian economy. Gold production has grown 30 times from 1990 to 2007. In 2007, in total 17.4 tons of gold were produced. However, gold production slowed down after 2007 when the Government passed a Law that prohibits the exploration and exploitation in forested areas, and protected water catchment areas. As a result of this Law, in total 254 mining licenses were withdrawn.

The Erdenet Mining Company (EMC) has been operational since 1978 and is a joint venture between the Mongolian (51% of the shares) and the Russian Government (49%). EMC is located in northern Mongolia, 400 km from Ulaanbaatar. EMC is the 3rd largest copper and molybdenum mine In the world. In 2008, EMC posted net profits of 115 billion MNT and provided 512 billion MNT to the state and local budget. About 8.000 people are employed in the mine. Other important mines in the Mongolian territory of the Baikal Basin include the Modot-1 and Modot-2 molybdenum mines[36] in Burentogtokh soum, Khovsgol aimag, and the Eruu Gol and Tumertei iron ore mine[37] in Selenga aimag.

The mining industry of the Republic of Buryatia focuses on the extraction of non-ferrous and precious metals, coal, construction materials, chemically pure limestone, and uranium. The total gross value of proven and estimated reserves of mineral resources in Buryatia is equal about US$ 135 billion, of which about two thirds are fuel and energy resources, precious, non-ferrous and rare metals. In the Irkutsk territory, the mining industry mainly focuses on the quarrying of marble.

There is a significant amount of deposits that have been discovered but are not yet being exploited, including quartzite in the Olkhonsky district, and syenites, lazuritov, as well as wollastonite in the Slyudyansky district. In Buryatia, there are promising deposits of nepheline ores, fluorite, phosphate, brown coal, potassium ores and iron ore that remain to be exploited.

Despite the high resource potential of the region, there are a number of features that limit the development of the mining industry:

[36] See: www.mining-mongolia.com/index.php?option=com_content&view=category&layout=blog&id=27&Itemid=34
[37] See: www.haranga.com/CompanyStrategyAndOverview.html

- Insufficient geological knowledge.
- Depth, complexity, and hardness of the substrate.
- Lack of adequate transport, energy and social infrastructure.

It is evident that the mining industry in the Baikal Basin will continue to grow in the near future. Not only because of the large mineral endowment in the area, but also because of its proximity to China, which is expected to sustain a growing demand for mineral commodities. Both the Mongolian and Russian Governments are investing in the development of infrastructure to support further exploitation of their mineral reserves. It is anticipated that besides the ongoing exploitation of main mineral resources such as coal, copper, and gold, the capacity to exploit other minerals will increasingly be developed. The main challenge will be for both countries to develop the mining sector responsibly, not only in terms of the environment and industry practices, but also economically.

3.4.7 MINERAL AND ENERGY RESOURCES

Mongolia has enormous mineral reserves (e.g. Wacaster 2011). Over 6,000 deposits of 80 different types of minerals have been discovered in the country. Northern Mongolia, particularly Tov and Selenga Aimags, had widespread gold deposits. One of the main deposits is located in the north Kentii Gold Belt[38], northwest from Ulaanbaatar in Selenga aimag. Tungsten, fluorine-fluorite and wolfram deposits exist in Tov Aimag, copper in Bulgan Aimag, Iron ore and phosphates in Khovsgol Aimag and Selenga Aimag. Furthermore, a major limestone deposit was discovered Bulgan Aimag.

In Russia, over 700 deposits have been found. This includes deposits of monetary metal, tungsten, uranium, iron ore, molybdenum, beryllium, tin, and aluminium. Reserves of fluorspar, brown coal, mineral carbon, asbestos, apatite, phosphorite, graphite, and zeolites also exist in the Baikal Basin. The Bargunzinsky District has deposits of clay and limestone. The Kabansky District contains deposits of limestone and graphite which are being prospected. In total, 228 deposits of alluvial gold were found along tributaries of the Upper Angara and Barguzin, and in valleys of the Djida, Temnik, Lower Selenga, and Chikoy Rivers. The Republic of Buryatia contains significant deposits of uranium, as well as coal, fluorite, lead, zinc, tungsten, apatite, and granulated quartz, which are found approximately within a 140-200 km zone near Lake Baikal.

The prospecting, survey, extraction, and processing of raw minerals are important for the development of the economy and social stability in the Baikal Basin region. At the same time, the extraction of minerals can have significant negative impacts on the environment. The potential environmental impacts of mining depend on the type of mineral that is extracted, the extraction method, the scale of the mining, and the proximity to ground and surface water sources.

The main non-renewable energy sources in the Baikal Basin are coal and petroleum. Important coal deposits exist in the Selenga Basin in Mongolia as well as Russia. Mongolia also has rich reserves of petroleum in the east and south-east of the country outside the Baikal Basin. Prospecting for petroleum in other parts of the country is ongoing. A petroleum refinery is planned to be built in Dakhan Uul Aimag, which is within the Selenga Basin.

The presence of oil, as well as gas in the Russian part of the Baikal Basin has been known since the 17th century. Natural release of gas and seepage of oil occurs in Lake Baikal. The two main sources of natural seepage near the Barguzinsky Bay and the Bolshaya Zelenovskaya River close to the Selenga Delta produce about 6 tons of oil annually. It is estimated that over 500 million tons of oil exist in the 7.5 km of sediment at the bottom of Lake Baikal.

Renewable energy sources exist in the Baikal Basin in the form of water, wind, sun, biofuel and biomass. Between 1956-1958 a dam of 44 m height and 2.5 km length was constructed in the Angara River for the Irkutsk hydroelectric power plant (HPP). Since then, two additional power stations were built in the Angara River near Bratsk and Ust-Ilimsk, and one more is under construction near Bogushansk. Furthermore, two hydropower stations were constructed in the Yenisei River, near the cities of Divnogorsk (Krasnoyarsk HPP) and Sayanogorsk (Sayano-Shushensky HPP), which together form the Angara-Yenisei HPP cascade. In Mongolia, two small HPP exist in the SRB, which are operated seasonaly: the Erdenebulgan HPP on the Eg River, and the Tosontsengel HPP on the Ider River. The Kharkhorin HPP on the Orkhon River was taken out of operation since 2010.

[38] See: http://mongolianresourcecorporation.com/blue_eyes

Figure 3.4.7: Seasonal HPP at Ider River (Tosontsengel)/400 kWt. Photo by Janchivdorj

Wind, solar power, biofuel and biomass renewable energy sources are presently not being exploited in the Baikal Basin, although the Mongolian Government is in the process of constructing wind and solar generation plants near Ulaanbaatar. In order to improve energy supply Mongolian government is investigating possibilities to built long term operational HPP on the Selenge river in Mongolia.

3.4.8 PETROLEUM AND GAS PRODUCTION

Reserves of petroleum and gas are known to exist within Lake Baikal itself, but so far no reserves have been found on the Mongolia side of the basin (see 3.4.7). However, a petroleum refining factory will be constructed in Darkhan Uul aimag, which is situated in the SRB.

Over 50 natural gas seepages (49-97% methane gas) have been discovered in Lake Baikal and the Selenga River Delta, with a total annual production rate between 20-35 million m^3. Exploration was done in the Ust-Selenginsky basin in 2002, but this was stopped due to the prohibition of crude oil and natural gas production in the Central Ecological Zone of Lake Baikal.

To provide the inhabitants of the Republic of Buryatia with a sufficient supply and promote further socio-economic development, investments are made to develop a network for natural gas transportation from neighbouring regions. Special emphasis is being placed on ensuring environmental safety, related to the preservation of the ecosystem of Lake Baikal[39].

3.4.9 ENERGY PRODUCTION

In Mongolia, most of the power demand is met by the thermal power plants. In 2011, the total supply of electricity in the country was 1,047 MW, of which 80% (835.5 MW) was supplied by thermal power plants, 12.8% imported from Russia and China, 8% (46 MW) supplied by diesel generators, 3% (28 MW) from hydropower generation, and 0.35% (3.7 MW) from small solar or wind powered stations (Figure 3.4.9.a). Over 300 million MNT was paid in 2011 for the import of electricity (IWM National Assessment Report 2012).

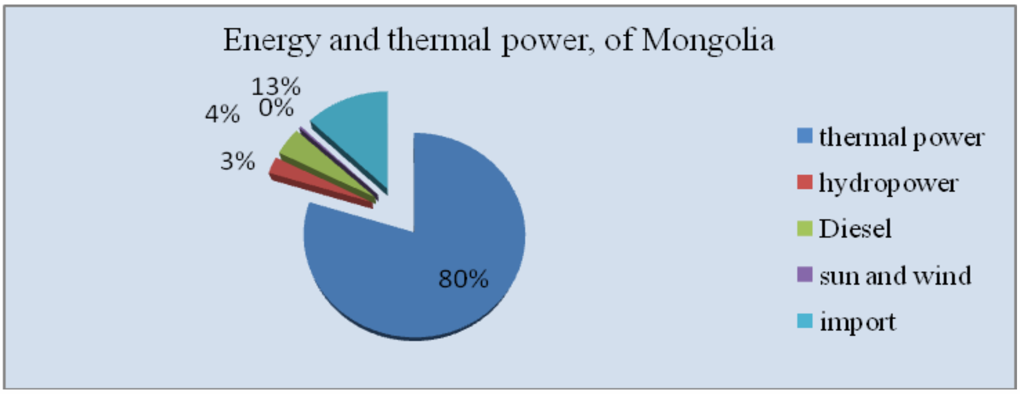


Figure 3.4.9.a: Relative contribution of energy resources in Mongolia in 2011.

[39] See: www.gazprom.com/press/news/2010/february/article76531

A grid powered by coal-fired thermal power plants (TPP) supplies the main industrial region with electricity. Five TPPs are concentrated in the SRB, with a combined power capacity of 813.5 MW. Three TPPs are located in Ulaanbaatar (560, 148 and 21.5 MW each), one in Erdenet (36 MW) and one in Darkhan (48 MW). In addition, there are plans to build an additional, 450 MW TPP in Ulaanbaatar.

The Mongolian Government established a National Programme to encourage increased used of renewable energy in 2005, and passed a Law on Renewable Energy in 2007. Hydroelectric power stations and renewable energy systems are now beginning to replace some of the small provincial diesel stations in the country. A national integrated system is being developed, with the privatization of power generation and supply, although transmission of electricity will remain in the public sector. Mongolia's first wind farm in Salkhit will be inaugurated in June 2013.

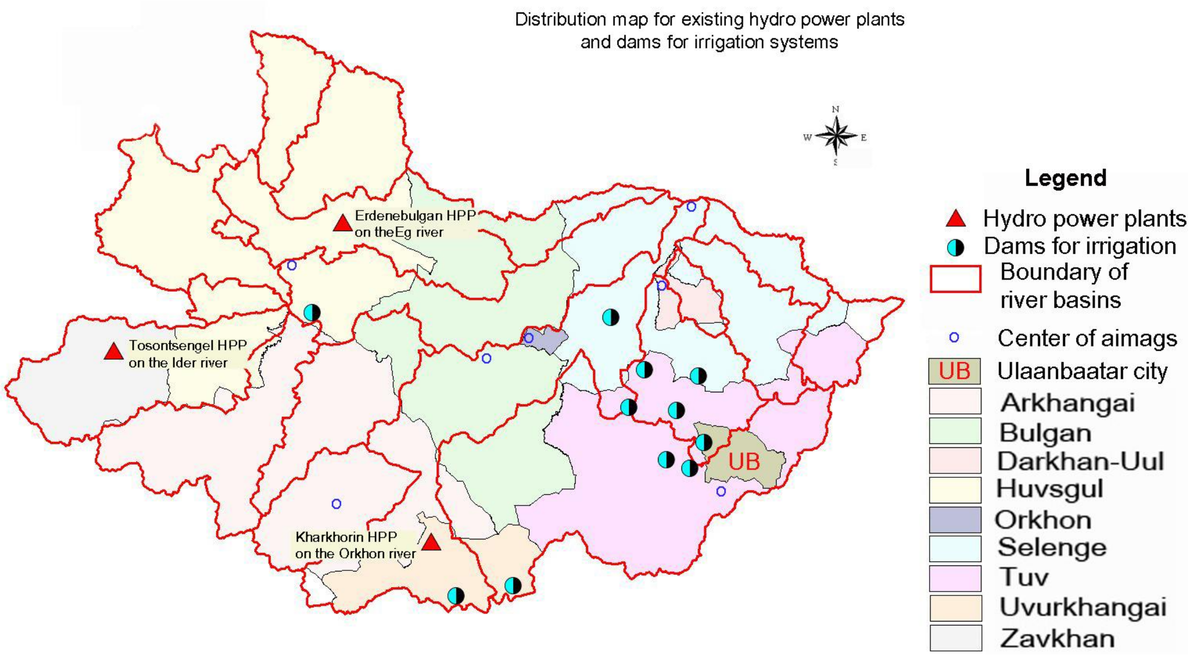


Figure 3.4.9.b: Location of existing hydropower plants and irrigation dams (see section 3.4.2) in the Baikal Basin in Mongolia. Three more plants are planned in the Eg, Orkhon and Delgermoron Rivers (see Table 3.3.8).

In total, 80% of the hydro energy resources of the country are located in the SRB, including 12 sites in the western Khangai Mountains and a site in Delgermuren. As a result of the increasing demands for electricity to support socio-economic development, the Government has planned to build additional HPPs in the SRB (Table 3.4.9). Furthermore, the World Bank has approved to support the construction of a 400 MW HPP in the Selenga River, with main financing from the Kuwait Fund. A working group of relevant ministries and agencies is currently researching possibilities for technical and economic resources for the project.

Table 3.4.9: Proposed Hydroelectric Power Plants (HPP) in the Selenga River Basin.

Name of site	River	Feasibility Study		Capacity (MW)
		Year	**Company**	
Bulgan aimag, Eg HPP	Eg	1993	Electro Watt-Electro Consult, Swiss	220
Bulgan aimag, Ulaan khunkh HPP	Orkhon	2004	Chubu Co. ltd, Japan	100
Khovsgol aimag, Chargait HPP	Delgermoron	2008	Renewable Center, Mongolia	24

A total of 750 coal-fired TPPs were built prior to 1960 near Ulan-Ude, Lake Gusinoe, and several other sites in Buryatia. An additional TPP was constructed near Ulan-Ude in 1991. HPP's have been constructed near Gusinoe in the Zababaikalsky Krai, as well as in the Angara and Yenisei Rivers near Irkutsk (see 3.4.7).

In 2012, the combined capacity of the power plants in the region was 1,303.2 MW. Nonetheless, there are parts of Buryatia that do not receive electricity and there is a chronic deficit in the supply. As a result, Buryatia remains dependent on external electricity supply (Figure 3.4.9.c). This leads to significant economic costs for the region, especially also since the prices of electricity have steeply increased over the past 10 years.

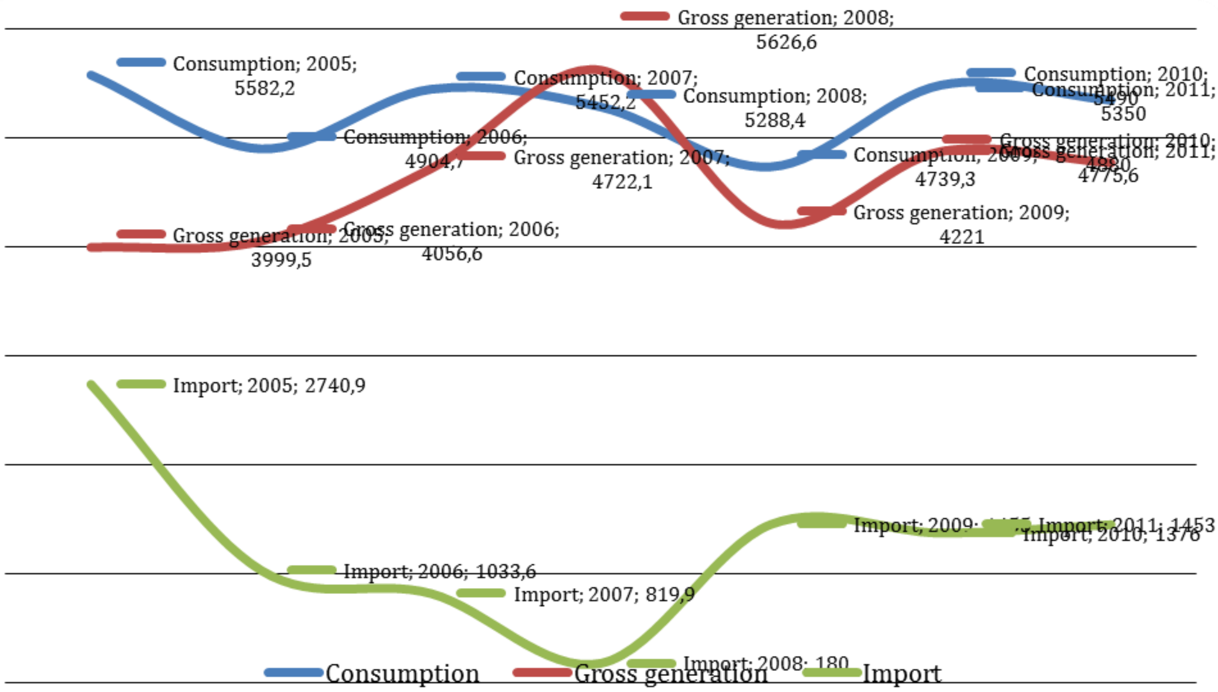


Figure 3.4.9.c: Electricity generation and consumption in the Republic of Buryatia. Between 2005-2011 (billion kWh).

As a result of the presence of the Angara-Yenisei HPP cascade, which has an annual capacity of 9,002.4 MW electricity is significantly cheaper in Irkutsk Oblast there than elsewhere in the region. This has a direct effect on the on the living standards of the local population as well as on the competitiveness of the local industry. As a result, industry in Buryatia is significantly less competitive than in the Irkutsk region. The problems of the electric power supply in the Buryatia are closely linked to the general problems of the energy development in Siberia:

- High tariffs for electric energy due to uneven distribution of generation and consumption; use of the obsolete equipment and old technologies; dominance of coal generation, and low quality of the coal.
- Lack of an effective model for the electric power industry in the region, and segmentation of the electricity industry.
- Increased projected levels of power consumption.

Due to the increased demand for electricity and the high costs of providing an adequate supply, the Government is implementing programs to meet energy-saving targets, and is encouraging the use of renewable energy sources, including solar energy and hydropower. During 2000-2008, over 80 solar installations were constructed, with a total area 3,600 m^2 of solar panels. The solar plants produce over 2 GW thermal energy per year, and contribute to the reduction of 2,800 tons of harmful emissions to the atmosphere.

The Barguzin and Jida Rivers have considerable potential for hydroelectric power generation. The total capacity of planned hydroelectric power plants in the Barguzin region is 6.4 MW, the Kurumkansky district 4.7 MW and the Dzhidinsky district 0.8 MW.

Buryatia also has significant reserves of geothermal water, which can be used to supply local heating systems. Over 20 geothermal sources have been identified in the region, with an estimated output of 50 thousand m^3 per day. Important geothermal sources include Mogojskij (up to 80°C), Garginskij (76°C), Pitatelevskij (68°C) and Gusihinskij (55-74°C).

There are plans for the construction of a uranium enrichment centre at an existing nuclear facility in Angarsk, about 95 km from Lake Baikal. The centre would enrich uranium sent from countries which do not have nuclear infrastructure, and return it to them for reuse. After enrichment of uranium, only 10 percent of the radioactive material would be returned to customers abroad, leaving 90% in the Baikal region for storage. This would make Russia the only country in the world willing to accept radioactive waste from other countries for processing, long-term storage and burial.

3.4.10 TRANSPORT

Because Mongolia has a vast territory and a relatively sparsely settled population, the transportation sector is very important for its economy. The single most important transport link is the Ulaanbaatar Railway, which exists of 1,815 km of railways, which serve the three largest industrial cities, Ulaanbaatar, Darkhan and Erdenet, and link Mongolia with Russia and China. Mongolian Railway executes 70% of the annual national freight turnover. In 2011, the volume of freight transported by the Ulaanbaatar Railway increased by 25.9% while the number of passengers had decreased by 11.6%.

Other transport options in the country are limited, and the road network is poor. Although major settlements are connected by improved roads, severe weather conditions can often make roads in rural areas impassable during the winter. In 2011, the total length of roads had increased with 1,088 km compared to 2008, adding up to a total of 7.6 thousand km (of this, 4.1 thousand km have a hard surface, the remaining 3.1 thousand km are sand roads).

In 2010, the transport network of the Republic of Buryatia consisted of 1,227 km of railway tracks, 7,277.8 km of public roads, 1,912 km of waterways, 4 airports and 13,920 km covered by local airlines. Up to 170.2 thousand passengers and around 23.0 thousand tons of cargo are transported on a daily basis.

Lake Baikal represents one of the main inland waterways of the Russian Federation, with a total length of 2,356 nautical miles in waterways. The fleet on the lake consists of a total of 300 medium-tonnage and 5,000 small ships (less than 80 gross tons), including dry cargo vessels, passenger vessels, research ships, undersized ships, ferries for passengers and freight, and self-propelled tugs. Cargo transportation in Lake Baikal declined 9% over the last decade, and passengers transport has declined by 10%. Up to 90's the Selenga, Barguzin and Upper Angara Rivers were also used as main transportation ways, but this has now largely been largely by other means of transport. It is anticipated that the role of water transport will increase again when tourism becomes more developed in the Lake Baikal region.

The Baikal region is serviced by two railway lines: Trans-Siberian Railway (TSR) and BAM. The main transit location is in the Slyudyansky district, from where Irkutsk-Ulan-Ude and Irkutsk-Mongolia are connected. The total length of the railway in the Baikal Basin in Russia is 1,432 km, of which 327 km is situated inside the Central Ecological Zone. In some places, the railway passes a few hundred meters from the edge of the lake.

In 2010, a total of 9,879 thousand tons of goods were transported by the railways. In total, 75.4% of the cargo transported by the railways is coal for the energy industry, whereas wood from the lumber industry comprises 7.3%. Transport of petroleum products is increasingly becoming important as well. Passenger turnover on the other hand, decreased from 1,623.5 million passengers in 1994 to 988 million passengers in 2010.

Major motorways (highways of federal importance) are located between Ulan-Ude-Irkutsk, Ulan-Ude-Kyahta, and Kultuk-Mondy. The Barguzin tract is the only highway along the east coast of Lake Baikal. Roads account for 96% of passenger transport in the region, compared to 3.9% for railways, and 0.1% for air transport. In 2011, a total of 57.4 million persons used roads for transportation, which is a 6.6% increase compared to the previous year.

Remote district centers and their major population centers are connected by airlines from Ulan-Ude, which also serves long-haul national flights and international airlines. Local airports exist in Barguzin, Kurumkan, Nizhneangarsk, Goryachinsk and Nizhneangarsk. So far only Ulan-Ude and Nizhneangarsk have paved runways. The number of passengers on local airlines as dropped from 569 to 44 thousand people in recent years, and as a result many local airports have been shut down and routes were eliminated.


Photo by Anna Rynkova

Assessment of Major Transboundary Challenges

4.1 INTRODUCTION

4.1.1 IDENTIFICATION AND PRIORITISATION OF PERCEIVED PROBLEMS

General and specific environmental problems were identified on the basis of their current or expected future impacts on the health of aquatic and/or terrestrial ecosystems.

For each specific problem, the current geographical scope is assessed according to four categories:

Very widespread / pervasive	Affects the ecosystem throughout the entire Lake Baikal basin
Widespread	Affects the ecosystem in many parts of the basin
Localized	Affects the ecosystem in several parts of the basin
Very localized	Affects the ecosystem only in very limited parts of the basin

Subsequently, each specific problem was rated according to their expected severity and scope (Box 4.1.1.a). The following issues were taken into account for the prioritisation process:

- Expected future risk of the problem
- Relationship with other transboundary problems
- Expected multiple benefits that might be achieved by addressing the problem
- Lack of perceived progress in addressing or solving the problem at national level
- Recognised multi-country water conflicts
- Reversibility / irreversibility of the problem

After prioritising the issues, a causal chain analysis (CCA) was conducted. CCA traces the cause-effect pathways of a problem from the environmental and socioeconomic impacts back to its root causes. The purpose of a CCA is to identify the most important causes of the priority problems, so that they can be targeted by appropriate policy measures for remediation or mitigation. Understanding the linkages between issues affecting the transboundary basin and their causes will help stakeholders and decision makers in supporting sustainable and cost-effective interventions.

The following three broad categories were included in the CCA:

Immediate causes	Direct, primary, technical causes of the problem. They are predominantly visible and tangible (e.g. increased nutrient inputs, changes in land use), and with distinct areas of impact (with the exception of causes such as atmospheric deposition or climate change).
Underlying causes	Contribute to the immediate causes. They can broadly be defined as underlying resource uses and practices, and their related social and economic causes. Governance related causes are often identified as underlying causes.
Root causes	Linked to the underlying social and economic causes and sectoral pressures. Often related to fundamental aspects of macro-economy, demography, consumption patterns, environmental values, and access to information and democratic processes.

The outcomes of the prioritisation exercise are listed in Annex II and Box 4.1.2.a.

BOX 4.1.1.a CRITERIA FOR PRIORITISATION OF PERCEIVED ENVIRONMENTAL PROBLEMS

SEVERITY: The **level of damage to the Lake Baikal transboundary basin** that can reasonably be expected within 10 years under current circumstances - given continuation of the problem.

4: Very High Likely to destroy or eliminate part of the ecosystem
3: High Likely to seriously degrade part of the ecosystem
2: Medium Likely to moderately degrade part of the ecosystem
1: Limited Likely to only slightly impair part of the ecosystem

SCOPE: Most commonly defined spatially as the **geographic scope of impact on the ecosystem** integrity that can reasonably be expected within 10 years under current circumstances given the continuation of the problem.

4: Very High Likely to be very widespread or pervasive, and affect the ecosystem throughout the basin
3: High Likely to be widespread in its scope and affect the ecosystem in many parts of the basin
2: Medium Likely to be localized in its scope and affect the ecosystem in a few parts of the basin
1: Limited Likely to be very localized in its scope and affect the ecosystem only in very limited parts of the basin

OVERALL RATING: The overall rating is derived by combining the results of the severity and the scope.

	SCOPE				
		4: Very high	**3: High**	**2: Medium**	**1: Limited**
SEVERITY	**4: Very high**	8	7	6	5
	3: High	7	6	5	4
	2: Medium	6	5	4	3
	1: Limited	5	4	3	2

4.1.2 OVERVIEW OF PERCEIVED PROBLEMS IN THE BAIKAL BASIN

The main problem areas and specific problems identified for the Baikal Basin are listed in Box 4.1.2.a, in order of prioritisation. Climate change was identified as a cross-cutting theme, which directly or indirectly affects all other problem areas in the transboundary basin. Natural disasters were also identified as a cross-cutting theme. Although natural disasters are not caused by human activities, environmental degradation can aggravate their impacts. Conversely, sustainable environmental management can mitigate some of the impacts of natural disasters.

Box 4.1.2.a. Main concerns and specific problems identified for the Baikal Basin Transboundary Ecosystem.

MAIN PROBLEM AREA	SPECIFIC PROBLEM
1. Degradation of Aquatic and Terrestrial Habitats	• Deforestation • Degradation of agricultural, pasture, and range lands • Ecosystem changes
2. Hydrological Regime Changes	• Water level decrease in the catchment basin • Water level increase in the catchment basin
3. Decline of Water Quality	• Chemical contamination • Increased suspended solids and sedimentation • Microbial pathogenic contamination • Organic pollution and eutrophication • Thermal contamination
4. Unsustainable Fisheries and Wildlife Exploitation	• Over-exploitation of aquatic biota • Over-exploitation of terrestrial wildlife
5. Biological Invasions	• Alien species invading aquatic habitats • Alien species invading terrestrial habitats
CROSS-CUTTING AREAS	
6. Impacts of Global Climate Change	• Fluctuations in freshwater flow • Increased extreme weather events
7. Natural Disasters	• Earthquakes • Mudslides • Droughts and floods


Photo by Zhamyanov

4.2 PROBLEM AREA 1: DEGRADATION OF AQUATIC AND TERRESTRIAL HABITATS

4.2.1 DESCRIPTION & TRANSBOUNDARY RELEVANCE

Habitat degradation is the process that leads to the loss of the physical, chemical and/or biological system that supports species of flora and/or fauna. It is a cross-cutting problem that can occur in a number of direct and indirect ways, which include each of the transboundary problem areas that are described in this TDA (see 4.2.2).

The degradation of natural aquatic and/or terrestrial habitats occurs when habitats are physically altered, for instance through deforestation, land conversion, unsustainable use of pasture and range lands, as well as human construction activities (see 4.2.2 and 4.2.3). Indirect habitat degradation also occurs when habitats dry out or are flooded as a result of the modification of hydrological flows (see chapter 4.2), or as a result of pollution (4.4), or biological invasions (4.5). Furthermore, the impacts of climate change (4.6) as well as natural disasters (4.7) can result in habitat degradation. The degradation of natural habitats and resulting modification of ecosystems is presently the main threat to global species diversity.

4.2.2 ECOSYSTEM CHANGES

As a result of habitat degradation, ecosystems become functionally unable to support species diversity. Healty ecosystems support sufficient species diversity and density to compensate for temporary losses. When habitat degradation within an ecosystem occurs on a sufficiently large scale and/or over a protracted period of time, this may result in loss of ecosystem resilience, and ultimately the collapse of the entire system.

The various ways in which ecosystems in the Baikal Basin are modified through indirect habitat degradation are described in the other chapters of this TDA. Direct habitat degradation and ecosystem modification through deforestation and degradation of agricultural, pasture and rangelands through unsustainable use are described in section 4.2.3 and 4.2.4 below.

Urbanisation is another main cause of direct habitat degradation and ecosystem modification (see 3.1). As a result of urbanisation, natural habitats are converted into buildings, schools, shops, etc. The growing tourism and recreation industry also results in construction of buildings, often in natural areas that have a high biodiversity value. In addition, the transport and infrastructure sectors contribute to habitat degradation and ecosystem modification through the construction of roads, ports or harbours, railroads, fuel stations, etc.

Some of the main characteristics of impacted ecosystems are (after Western, 2001):

- High extraction rates of natural resources (e.g minerals, timber, water, etc.).
- Short food chains and food web simplification.
- Habitat and landscape homogeneity.

- Increased use of herbicides, pesticides, and insecticides.
- Large importation of non-renewable energy resources.
- Large importation of nutrient supplements.
- Convergent soil characteristics.
- Modified hydrological cycles.
- Reduced biotic and physical disturbance regimes.

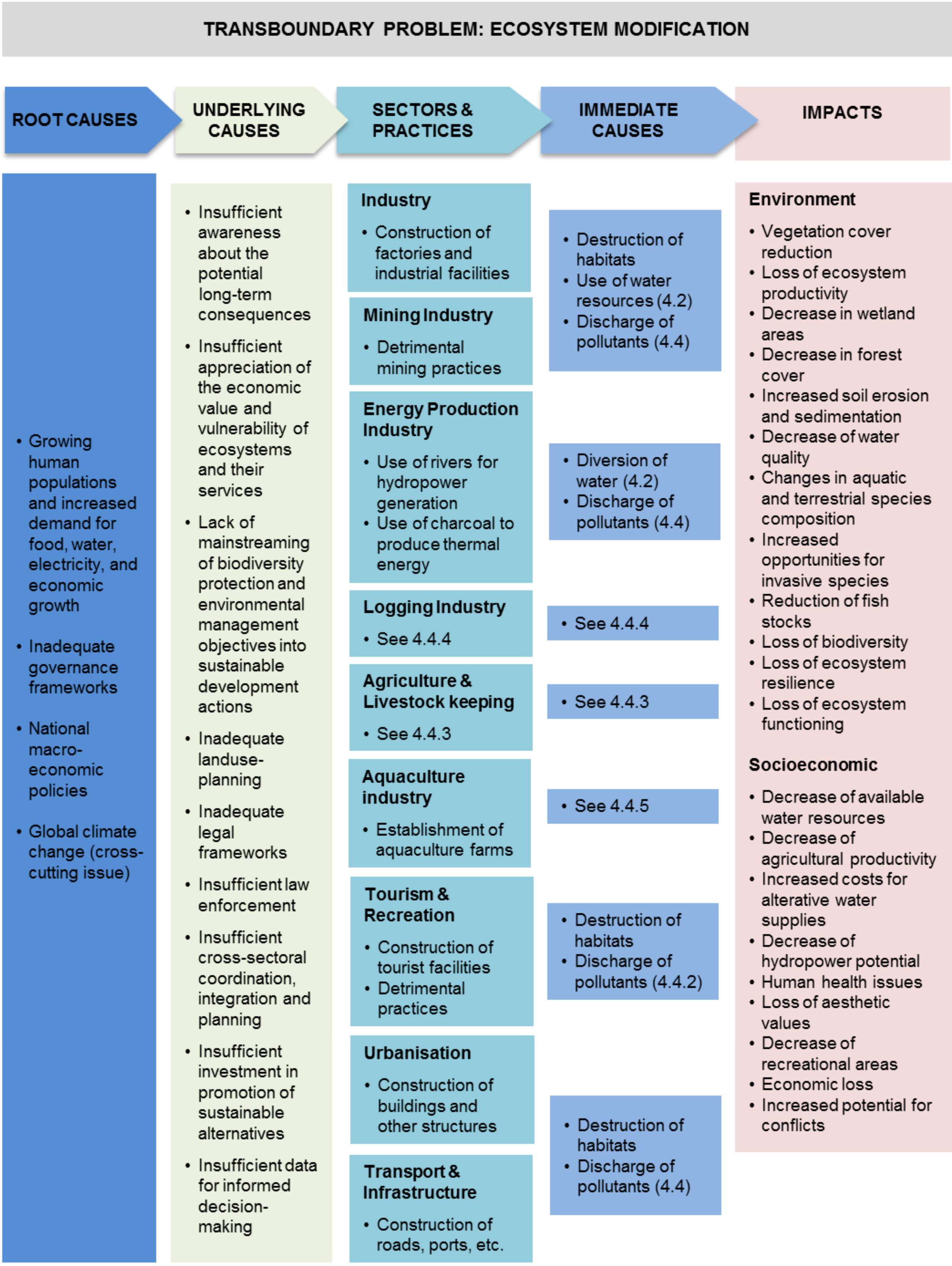


Figure 4.2.2 Causal chain analysis of ecosystem modification in the Baikal Basin.

4.2.2.1 Present and Future Impacts

Similar to other parts of the world, human-caused habitat degradation has been ongoing in the Baikal Basin for multiple decades. The results of deforestation, unsustainable landuse, and pollution are increasingly becoming visible at the national as well as the transboundary level (also see other sections of this TDA).

The consequences of severe habitat degradation and ecosystem modification not only affect biodiversity and natural ecosystem resilience, but also affects the quality of life for people. Humans depend on the proper functioning of ecosystems for their own survival. When natural ecosystems are modified, they may lose their ability to perform key life-supporting services, such as the provision of drinking water, clean air to breath, provision of habitats for plants, and animal species for consumption and medicins, etc.

The loss of habitats and modification of ecosystems in the Baikal Basin is particularly a concern for areas that are important because of their levels of biodiversity and because of the services that they provide for humans (e.g. see 2.2.6). This includes Lake Baikal (2.2.4) and other aquatic ecosystems (2.2.3), wetland habitats such as the Selenga River Delta (2.2.2), steppe and taiga rangelands (2.2.1), and key forested areas (3.4.3).

Table 4.2.2.1.a Impacts of ecosystem modification (after Western, 2001).

• Habitat and species loss. • Overharvesting of natural resources. • Genetic loss of wild and domestic species. • Truncated ecological gradients. • Reduced ecotones. • Loss of productivity. • Simplified predator–prey, herbivore–carnivore, and host–parasite networks. • Low internal regulation of ecosystems due to loss of keystone agents. • Invasive nonindigenous species, especially weeds and pests.	• Atmospheric and water pollution. • Nutrient leaching and eutrophication. • Pollution from domestic and commercial wastes. • Ecological impact of toxins and carcinogenic emissions. • Side effects of fertilizers, pesticides, insecticides, and herbicides. • Proliferation of resistant strains of organism. • New and virile infectious diseases. • High soil surface exposure and elevated evaporation. • Accelerated erosion.

4.2.2.2 Challenges for Future Management

One of the main challenges for future sustainable management is the lack of knowledge and appreciation of the environmental and socio-economic value of the services that are provided by the various aquatic and terrestrial ecosystems in the Baikal Basin. Another problem is the insufficient mainstreaming of biodiversity protection and environmental management objectives in overall development actions. For further details on future management challenges see the individual sections of this TDA.

To ensure that biodiversity-rich areas remain protected and key ecosystem services are available for future generations, it would be recommendable to initiate a joint assessment of land-degradation and biodiversity conservation hotspots. Such an assessment could be used as the basis for designing a transboundary network of protected areas that can help to maximise overall ecosystem resilience (also see 2.2.5).

4.2.3 DEFORESTATION

Forests play a vital role in conserving soil, water, wildlife, and plant and animal genetic diversity. Conservation of forest resources and rational utilization of forest products is crucial for human welfare. Forests influence, and are influenced by, development issues (such as generation of employment and income, alleviation of poverty, provision of energy for domestic and industrial use, supply of essential forest products and earning of foreign exchange), and conservation issues (such as soil and water conservation, control of desertification, protection of wildlife, agricultural productivity, maintenance of biodiversity and mitigation of greenhouse gas emissions and climatic changes).

In general, Mongolia has a low level of forest cover (on average 10%), although it is relatively higher in the Selenga River Basin (25.6%). Forest cover in the Russian territory of the Baikal Basin is significantly higher, and ranges from 39-86.6% between districts (see 3.4.3). Deforestation is an ongoing challenge in the Baikal Basin, which has multiple causes, including legal and illegal felling of trees, forest fires, and insect infestations (Table 4.2.3.1.a).

Figure 4.2.3.a Deforestation in the Tuul River valley, Mongolia. Photo: Jeroen Nooter

Mongolia's forest-based industries in the northern areas suffer from lack of capitalization, lack of experience (of privatized companies) in capital profiling and structuring, and weaknesses of financing institutions and banking system. The present estimated levels of forest harvesting are unsustainable, and some of the forest areas that are zoned for utilisation are inadequate. In 2004, between 36-80% of the total harvest from forests in Mongolia was illegal. Because the Government receives no royalties or taxes on illegal harvests, this distorts domestic prices for construction wood and fuelwood (Chrisp et al. 2004). As a result, market forces and prices are not reflected in the allocation of cutting quotas or in the calculation of fees.

A major issue relating to forest management is reforestation. Natural regeneration of desired species such as pine and larch often does not occur, due to the characteristics of the terrain and the high levels of deforestation. Under such circumstances, artificial planting or sowing with desired species is necessary to supplement the natural forest regeneration. However, the areas that have been artificially planted in the Baikal Basin are very small compared to the deforestation and the degradation of the remaining accessible forests.

Furthermore, the quality of planted forests is often low, due to a lack of compatibility between the ecological characteristics of the sites and the requirements of the species, poor quality of the planting stock (resulting from poor seeds and nursery techniques), inappropriate plantation practices, and a lack of maintenance of newly planted forests.

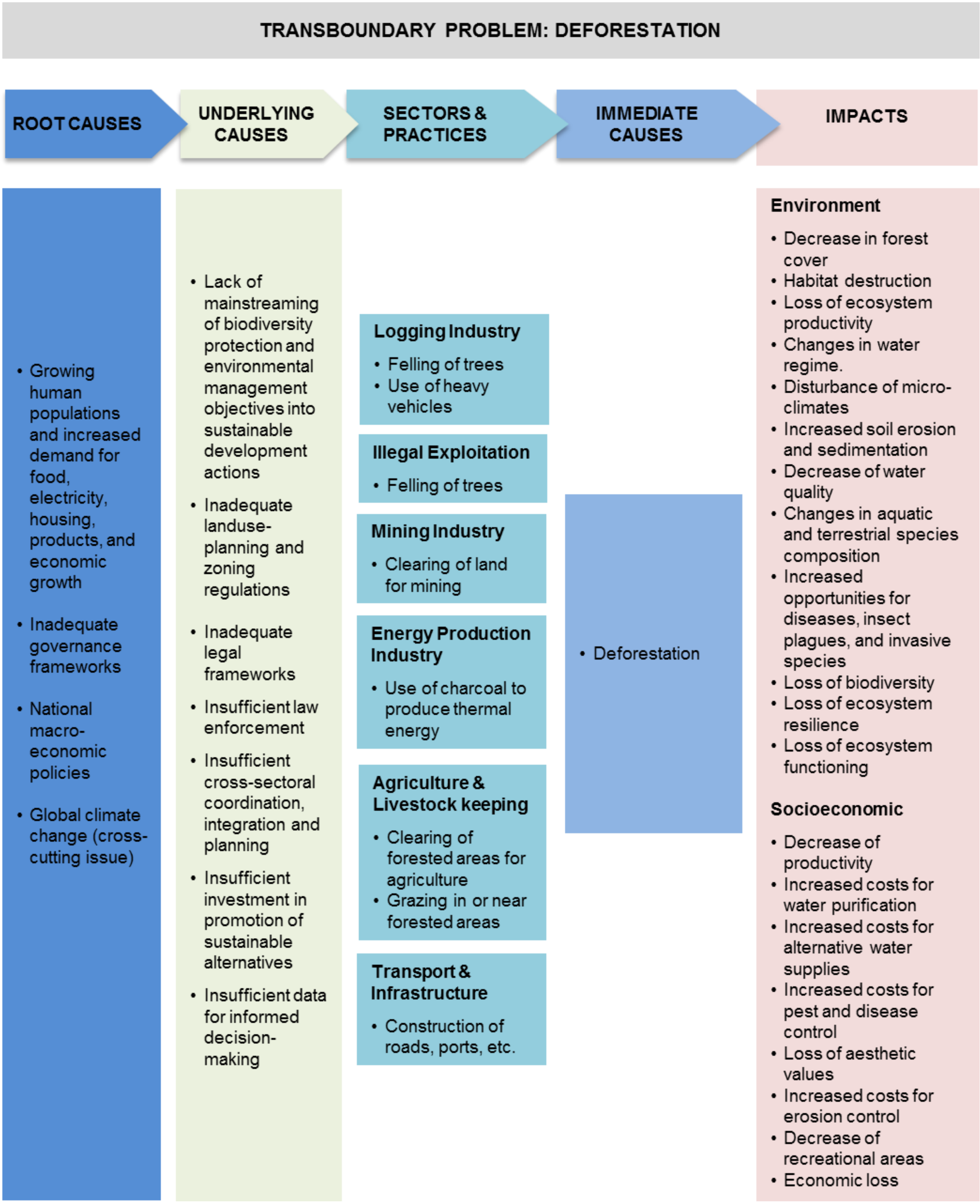


Figure 4.2.3.b Causal chain analysis of deforestation in the Baikal Basin.

4.2.3.1 Present and Future Impacts

Deforestation itself results in a reduction of vegetation cover, loss of topsoil and erosion, reduction of groundwater recharge, and loss of ecosystem productivity. The use of heavy logging tractors results in the destruction of understory growth, and contributes to erosion processes. The degradation of unique forest habitats in the Baikal Basin not only results in loss of flora and faunal diversity, but also changes in the water regime, and increased erosion (Table 4.2.3.1.a). In addition, there are substantial economic losses as a result of loss revenue for the timber industry, and costs that are associated with loss of productivity, erosion, and changes in water regime.

Forest-steppe areas in northern Mongolia and southern Buryatia in Russia have been particularly impacted by deforestation, and in the majority of cases the natural forest types were not restored. Instead, significant areas that were previously forested have been replaced by scrubs (e.g. *Betula fusca, Dasiphora fruticosa, Spiraea aquilegifolia, Amygdalus pedunculata, Armeniaca sibirica, Caragana bungei, C. spinosa, and C. microphylla*). In the Russian territory of the Baikal, 19% of the pine forests in the Pribajkalsky district, 11% in Zaigraevsky, 12% in Ivolginsky, 8% in Bichursky, and 4% in Kizhinginsky and Kabansky were felled between 1988-2007.

Leach and birch forests in the basin have been significantly affected by insect infectations, particularly by the Siberian silkworm (*Bendrolimis sibiricus*) and gypsy moth (*Lymantria dispar*). It is estimated that each year, 20% of the forests in Mongolia is affected by insect infestations. As a result of a large plague between 2000-2002, 30-50% of the natural forests in the Tchingiz-Nuru mountains, the eastern Khentai, Bogdo-Ula, and Tærælzh National Park was affected.

Natural and human-caused fires are also a major concern in the Baikal Basin, and have resulted in massive losses of forest cover (see 3.4.3). Both logging and forest fires contribute to increased erosion rates. As a result of increased droughts caused by the impacts of global climate change (4.7), the amount of forest fires in the region is also expected to increase. The fires destroy not only plant life, but also soil mantle, contributing to the development of erosion. Due to the steepness of some of the slopes in the basin, extensive gullies can be formed and extensive loss of topsoil may result (Krasnoshekov 2004). Forest fires furthermore contribute to increased emission of greenhouse gasses in the atmosphere. In 2009, of the total 1,201 fires that were reported in the Republic of Buryatia, 7 were transboundary forest fires[40].

Fuelwood constitutes between 65-80% of the total wood that is harvested in Mongolia, and is used mainly by poor rural and urban households for cooking and heating. It is predicted that if alternative sources of domestic fuel are not developed and current levels of forest depletion continue, serious fuel shortages will result (Chrisp et al. 2004).

[40] http://egov-buryatia.ru/rawood

Table 4.2.3.1.a Causes and impacts of deforestation in the Baikal Basin

Main cause	Factors of influence	Impacts
Felling*	• Logging • Skidding of felled trees using heavy vehicles. • Pollution from wood waste.	• Habitat destruction • Destruction of understory growth • Disturbance and/or removal of the organic material necessary for soil replenishment • Loss of biodiversity • Intensification of forest pests and diseases • Erosion • Degradation of water quality • Changes in water regime, reduction of the natural infiltration of rainwater and groundwater recharge, alteration of stream flows and further habitat loss • Disturbance of micro-climates
Forest fires	• Grass fires (human caused or natural) • Wild fires	• Habitat destruction, including trees, understory growth, and litter • Increased erosion • Loss of biodiversity • Degradation of water quality • Changes in water regime • Atmospheric pollution
Grazing	• Improper use of forest as grazing areas for domestic animals, including cattle, sheep, and goats	• Removal of understory growth and reduced ability for forests to rejuvenate
Insect infestation	• Absence or inadequacy of protective measures	• Destruction of larch and birch forests
Tourism and recreation	• Unregulated and improper use of forests as recreational areas • Construction and operation of recreational facilities	• Trampling of saplings and other plants • Pollution

* Felling may occur for commercial purposes, as well as to clear land for mining, agriculture, or construction.

4.2.3.2 Challenges for Future Management

Mismanagement of natural resources and ineffective measures for their maintenance and protection is a main underlying cause of the degradation of forests in the Baikal Basin. Faced with the problem of declining forests and its ecological consequences, the Mongolian Government has recently emphasized forest conservation. The objectives are to protect wildlife, conserve bio-diversity, maintain ecological balance, enhance beneficial influences of forests, and control desertification.

The following areas are recommended for action in order to address the underlying causes of deforestation, and sustainably manage forest resources in the basin (after Chrisp et al. 2004):

- Forest zoning based on environmental and economic resource and operability analyses.
- Promotion of community-based forest resource management in order to stimulate local communities to take responsibility for, and receive benefits of, forest management and harvesting operations.
- Capacity enhancement for improved forest management and regulatory enforcement.
- Establishment of national GIS-based information management systems (e.g. forest cover and forest loss, erosion rates, forest fire outbreaks, etc.) as well transboundary information management systems (e.g. data relevant to pest outbreaks).
- Introduction and promotion of market-based economic instruments to encourage efficient wood use and alternatives to wood consumption.
- Development and modernization of wood and non-wood product industry. Promotion of closed-loop and low-waste technologies.
- Development of sustainable value-adding activities and livelihood alternatives.

4.2.4 DEGRADATION OF AGRICULTURAL, PASTURE, AND RANGELANDS

The intensification of landuse and resulting degradation of agricultural lands, pastures and rangelands is an increasing concern in the Baikal Basin. Key issues associated with this problem are the conversion of natural landscapes, loss of topsoil and erosion, use of water resources for irrigation see 4.3.2), pesticides and fertilizers (4.4), opportunities for biological invasions, as well asincreased densities of grazing livestock (3.4.2).

TRANSBOUNDARY PROBLEM: DEGRADATION OF AGRICULTURAL, PASTURE, AND RANGELANDS

ROOT CAUSES

- Growing human populations and increased demand for food, and economic growth
- Inadequate governance frameworks
- National macro-economic policies
- Global climate change (cross-cutting issue)

UNDERLYING CAUSES

- Lack of mainstreaming of biodiversity protection and environmental management objectives into sustainable development actions
- Inadequate landuse-planning and zoning regulations
- Inadequate legal frameworks
- Insufficient law enforcement
- Insufficient cross-sectoral coordination, integration and planning
- Insufficient investment in promotion of sustainable alternatives
- Insufficient data for informed decision-making

SECTORS & PRACTICES

Agriculture & Livestock keeping

- Conversion of natural landscapes into agricultural lands
- Use of pesticides and fertilisers
- Overgrazing by livestock
- Changes in livestock composition
- Diversion of rivers
- Construction of wells

IMMEDIATE CAUSES

- Deforestation
- Habitat degradation
- Pollution
- Use of water resources for irrigation and livestock

IMPACTS

Environment

- Decrease in forest cover
- Habitat destruction
- Loss of ecosystem productivity
- Increased soil erosion and sedimentation
- Increase in desertification
- Decrease of water quality
- Changes in aquatic and terrestrial species composition
- Increased opportunities for invasive species
- Loss of biodiversity
- Loss of ecosystem resilience
- Loss of ecosystem functioning

Socioeconomic

- Decrease of productivity
- Increased costs for water purification
- Increased costs for alternative water supplies
- Increased costs for pest and disease control
- Loss of aesthetic values
- Increased costs for erosion control
- Loss of traditional lifestyles
- Poverty increase
- Economic loss

Figure 4.2.4.a Causal chain analysis of degradation of agricultural lands, pastures, and rangelands in the Baikal Basin.

4.2.4.1 Present and Future Impacts

Conversion of natural landscapes into agricultural land in the Baikal Basin has lead to the replacement of diverse habitats with single-species crops (monocultures), resulting in an overall loss of habitats for wildlife. Agricultural landuse also resulted in contamination and runoff of livestock wastes, pesticides, and fertilizers (4.4).

Increased erosion rates as a result of unsustainable agricultural practices and overgrazing is a major concern in the Baikal Basin. In 1973, a total of 567 thousand hectares of arable land were degraded and eroded in the Republic of Buryatia (58% of the total arable lands). By the end of the 1980s, this amount had increased to a total of 650 thousand hectares, including approximately 300 thousand hectares of pasturelands (Cybzitov and Ubugunova 1992). At present, a total of 1,028 thousand hectares of agricultural land in Buryatia is deemed susceptible to erosion (approximately 74% of total arable land). As a result of the ongoing erosion in the area, humus contents of the soil has dropped approximately 1.3-3.2 times since 1994.

As a result of a combination of increased temperatures and decreased summer precipitation (4.7), increased numbers of livestock, deforestation and erosion, the soil fertility and productivity of agricultural, pasture and rangelands in Mongolia has decreased with 20-30% over the past 40 years (Angerer et al 2008). These patterns are expected to intensify as a result of the impacts of climate change.

Densities of grazing livestock have repeatedly exceeded the carrying capacity of the environment, resulting in substantial degradation of steppe and forest-steppe ecosystems as well as increased desertification. Overgrazing also resulted in an increase of non-edible and often poinsonous plant species, including *Ephedra sinica*, *Artemisia adamsii*, *Stipa inebrians*, *Juniperus pseudosabina*, and *Potentilla acaulis*. As pasture degradation progresses, herders tend to move to more productive areas, leading to displacement of local wildlife and increased human/wildlife conflict.

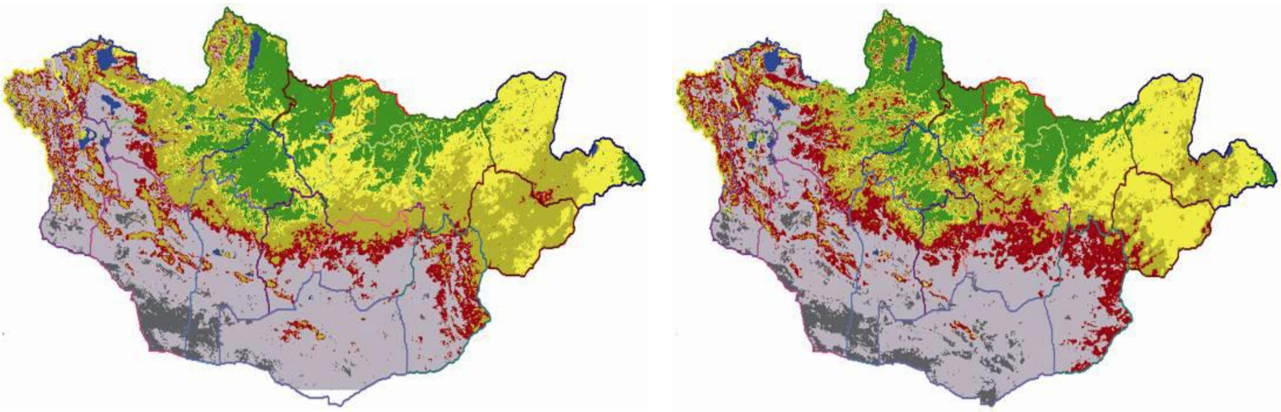


Figure 4.2.4.1.a Desertification (grey areas) in the Mongolian territory of the Baikal Basin between 1974-2004 (D.Dash, N. Mandakh, Institute of geoecology 2008).

In important socioeconomic effect of the degradation of pasture and rangelands is increased poverty among herders, movement to urban areas (particularly Ulaanbaatar) and the loss of their traditional ways of life.

The decrease in natural plant species diversity also affects the composition and densities of wildlife. Micro-mammals form important contributions to natural as well as agricultural ecosystem, because they can alter the soil and vegetation layers. Micro-mammal species composition can be altered by human activities, and as a result effect the functioning of the ecosystem. Species diversity and density of rodents have been found to increase under conditions of moderate grazing by livestock, whereas it decreases when there is overgrazing.

Mass outbreaks of Brandt voles (*Lasiopodomus brandti*) have been observed in Mongolia and parts of the Russian Lake Baikal Basin, which can cause major detrimental impacts on local vegetation (Kucheruk, 1985). Brandt voles feed on both the underground and aerial parts of plants, and as a result pastures can become very bare during an outbreak, poor subsoil can be brought to the surface by the burrowing activities of the voles, and coarse weeds can become established. Rodents can also be vectors for human diseases and livestock.

Figure 4.2.4.1.b Brant vole (*Lasiopodomus brandti*), a rodent that can have potentially destructive effects on vegetation in areas that are grazed by livestock. Photo by P.L. Bogolomov

The changes in farming practices and poorly managed transitions from croplands to fallowlands have caused detrimental shifts in plant species composition. Due to the changed composition of the soil, alkaloid species gain an advantage and rapidly replace the natural vegetation (also see 4.6.3). Among the most invasive alkaloid species are the redroot (*Cannabis sativa*) and ruderal hemp (*Cannabis ruderalis*). As a result of the rapid expansion of these plants, both fallow (non-arable) lands as well as agricultural, pasture and rangelands are affected.

As a result of a shortage of water for their livestock, herders have settled near natural water resources and wells. Due to the increased densities of livestock near these wells, the surrounding pastures are showing high levels of local degradation. Furthermore, the use of water resources for agricultural irrigation causes the decrease of natural water flow in rivers, lakes and mineral springs (also see 4.2), resulting in the degradation of aquatic and semi-aquatic habitats. In Mongolia, the area of swamp ecosystems has decreased with 5.8% in the past 35 years.

4.2.4.2 Challenges for Future Management

One of the challenges for future management is the lack of GIS-based systems that can inform improved zoning and landuse planning using parameters of current landcover and soil erosion rates, as well as information about soil composition and quality.

To reduce the high pressure on the environment by excessively large herds of grazing livestock, strict rules need to be enforced about maximum allowable units per area, based on a thorough analysis of the carrying capacity of the ecosystem. Alternative livelihood options need to be explored for livestock keepers, including value-adding activities.

Multiple solutions are available to enhance the environmental sustainability of agricultural activities. These include improved irrigation techniques with adequate drainage, recycling of crop waste and use of manure for soil fertilisation, and mixing of crops with nitrogen-fixating plants. Protection of soil against water runoff and erosion can be accomplished by the use of methods such as crop rotation, conservation tillage, mulching, establishment of conservation buffers, as well as contour plowing, and contruction of terraces and erosion barriers.

An economic assessment of the costs of environmental degradation versus the benefits of sustainable land management options would be useful to encourage Governments and private industries to invest in improved alternatives.

Photo by Zhamyanov


Photo by Sergey Kudelya

4.3. PROBLEM AREA 2: HYDROLOGICAL REGIME CHANGES

4.3.1 DESCRIPTION & TRANSBOUNDARY RELEVANCE

The ecosystem services provided by water resources such as streams, rivers, wetlands, lakes, and groundwater systems are of crucial importance for the livelihoods of the people inhabiting the Baikal Basin, as well as for the national economies of Mongolia and Russia.

Growing human populations, an increased demand for water for domestic, agricultural, and industrial use, and climate change affect hydrologic flows[41] as well as interactions between surface and groundwater. Overexploitation could cause a local decrease in groundwater levels, and alter the direction of groundwater fluxes. In case of shallow aquifers in floodplains, this could affect surface water runoff and can result in reduced water runoff, drying up of rivers, and reduction of lake water levels. Construction of dams for generation of hydroelectric power causes surface and groundwater levels upstream to increase, while water levels downstream decrease.

Changes in the flow regimes of surface and groundwater resources are both national and transboundary issues (e.g. Figure 4.2.1). An increase in surface water use upstream results in a decrease of water that is available downstream. Local decrease in groundwater resources can also have significant effects on downstream surface water. For instance, the rising population and economic growth in Ulaanbaatar is reflected in an increased demand on water supplies. The water supply for Ulaanbaatar is delivered from a shallow aquifer, which is connected to the Tuul River. A decrease in the water level of the aquifer near Ulaanbaatar will result in a decrease of the volume of the Tuul River. This theoretically leads to a decrease in both surface and groundwater runoff from Mongolia to Russia. Similar transboundary hydrological connections between shallow aquifers and rivers exist in other places in the Baikal Basin, for instance in the Onon River Basin.

Hydropower development is also a major concern, as hydropower dams can alter river flows dramatically. In addition, climate change is expected to have significant, transboundary impacts on hydrological flows.

[41] Hydrological flow is the characteristic behaviour and the total quantity of water involved in a drainage basin, determined by measuring such quantities as rainfall, surface and subsurface storage and flow, and evapotranspiration.

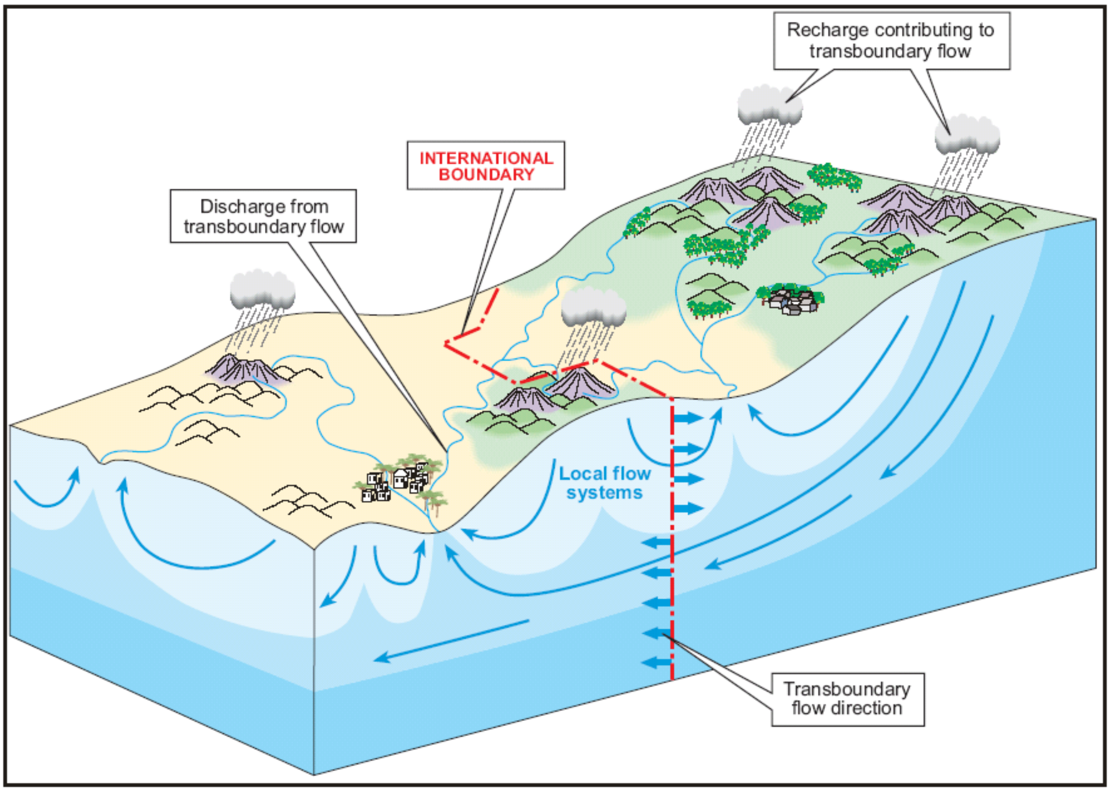


Figure 4.3.1 Simplified diagram demonstrating the transboundary relationship between upstream and downstream surface and groundwater flow systems (UNESCO 2002).

Two major problem areas were identified for the Baikal Basin related to the modification of hydrological flows, with opposite upstream and downstream effects: i) water level increase, and; ii) water level decrease. The decrease of water levels mainly refers to increased use for domestic and industrial purposes, unsustainable landuse practices, climate change variability and the impacts of climate change (surface water and shallow aquifers). The increase of water levels mainly relates to the construction of dams for HPPs and irrigation purposes.

The modification of hydrological flows also links to other transboundary problem areas. Changes in water levels may lead to habitat degradation (4.3), increased concentration of pollutants (4.4), and detrimental effects on fish and wildlife stocks (4.5). Furthermore, the effects of global climate change are predicted to impact hydrological regimes (4.6).

4.3.2 WATER LEVEL DECREASE

The decrease of surface- and groundwater levels is a major concern in the Baikal Basin. The immediate causes of decreased water levels have been identified as withdrawal of water for domestic, agricultural or industrial purposes, as well as the impacts of climate change. Deforestation can result in a decrease in available water through a reduction of soil moisture, as well as changes in the regime of local streamflows and microclimates. In addition, global climate change is expected to affect hydrological flows in the basin.

Ulaanbaatar is the largest consumer of groundwater resources in Mongolia, using 7% of the annual Tuul River discharge. At present, 218 deep wells are connected to the centralized water supply system of Ulaanbaatar, and 576 wells are exploited individually. Exploitable groundwater resources amount to 278,000 m^3/day, whereas the centralized water supply system of Ulaanbaatar presently uses 177,500 m^3/day (JICA, 2010).

The alluvial deposits in the Tuul River basin are also used to provide water supply for gold mines. Furthermore, Erdenet city uses 97,800 m^3/day of groundwater extracted from 23 wells in shallow aquifers that are located in fluvial deposits of the Selenga River, where the exploitable water resource has been estimated to total 247,500 m3/day.

Changes in the flow of the Tuul River have been observed since 1997. In early spring time, the flow of the river has been interrupted in several areas near Ulaanbaatar for periods of 7-22 days. During those periods, the only water flowing through the river bed is derived from the local wastewater treatment plant.

The potential of usable groundwater resources in the Selenga River Basin (SRB) including its tributaries is 3.57 billion m^3/year, or 9.79 m^3/day (Hiller, Jadamba, 2007). In Mongolia, over 60 million m^3 of water is used per year for agricultural irrigation purposes in the SRB. A total of 11 reservoirs and over 20 small ponds were created to control the flow of water for irrigated agriculture. Furthermore, 697 wells were rehabilitated and 300 new wells were constructed in the SRB in 2004. In addition, 255 wells were established between 2011-2012 in peri-urban areas of Ulaanbaatar, Darkhan, Erdenet and Kharkhorin for drinking water and livestock watering, with support from the American Millennium Challenge Corporation.

Due to a growth in industrial water consumption between 1990-2010, the total amount of water intake in the Mongolian territory of the Baikal Basin increased almost 2,5 times, up to a total of 520,000 m^3 per day. This amounts to 5.3% of the total estimated potential groundwater resources in the Mongolian SRB. Long-term plans are underway for construction of additional reservoirs in the Orkhon, Selenga, and Tuul River basins.

A recent census in Mongolia indicated that number of its national water resources is decreasing. In total 852 out of 5,128 rivers and streams, 2,277 out of 9,306 springs, and 1,181 out of 3,747 lakes dried up during the last years (Mongolia Water Authority 2007).

In the Angara-Baikal region, which encompasses 92% of the regional Russian groundwater supplies, 85% of the total available resources are being exploited. In 2011, the total volume of extracted groundwater in the Republic of Buryatia was 266,130 m^3/day, which is an increase of 18% compared to the previous year (MNR 2012).

In the Irkutsk Oblast, the majority of water use is derived from surface water, whereas groundwater resources comprise 20-25% of the total water consumption of housing and communal services[42]. Settlements in the Kabansky district also depend on surface water, and used 8.7 m^3/day for domestic purposes in 2011.

In the Republic of Buryatia, 87.4% of the water supply for domestic use is provided by groundwater resources. The central water supply in Buryatia has a capacity of 433.3 thousand m^3 per day. This water is provided to 72 localities, which is only 11.4% of the total[43]. Many smaller settlements in Selenginsky, Ivolginsky and other districts do not have sufficient access to water sources.

In total, 78.9% of the available water resources in Buryatia are used for industrial production needs, whereas 7.2% is used for irrigation and agricultural purposes, and 10% for domestic purposes (Buryatstat 2011). The established maximum limit for use of surface water resources in Buryatia is 504 million m^3 per year. In 2010, the water withdrawals from surface water bodies in Buryatia amounted to 419.19 million m^3 (83.2% of the maximum limit).

Large areas exist in Buryatia that receive an annual precipitation of 250-350 mm per year, and agriculture in these areas would not be possible without irrigation. A significant part of the water supply is provided by reservoirs and ponds that are filled by rivers and springs. In total, 47 reservoirs and ponds were constructed in Buryatia, as well as a multitude of dams, and 5.6 thousand km of irrigation canals. Droughts over the past few years resulted in the drying up of small rivers, with significant effects on the overall supply for irrigation in the region.

[42] See: www.geol.irk.ru/baikal/rep_2011/content.htm
[43] Office of Rospotrebnadzor of the Republic of Buryatia, 01.01.2011

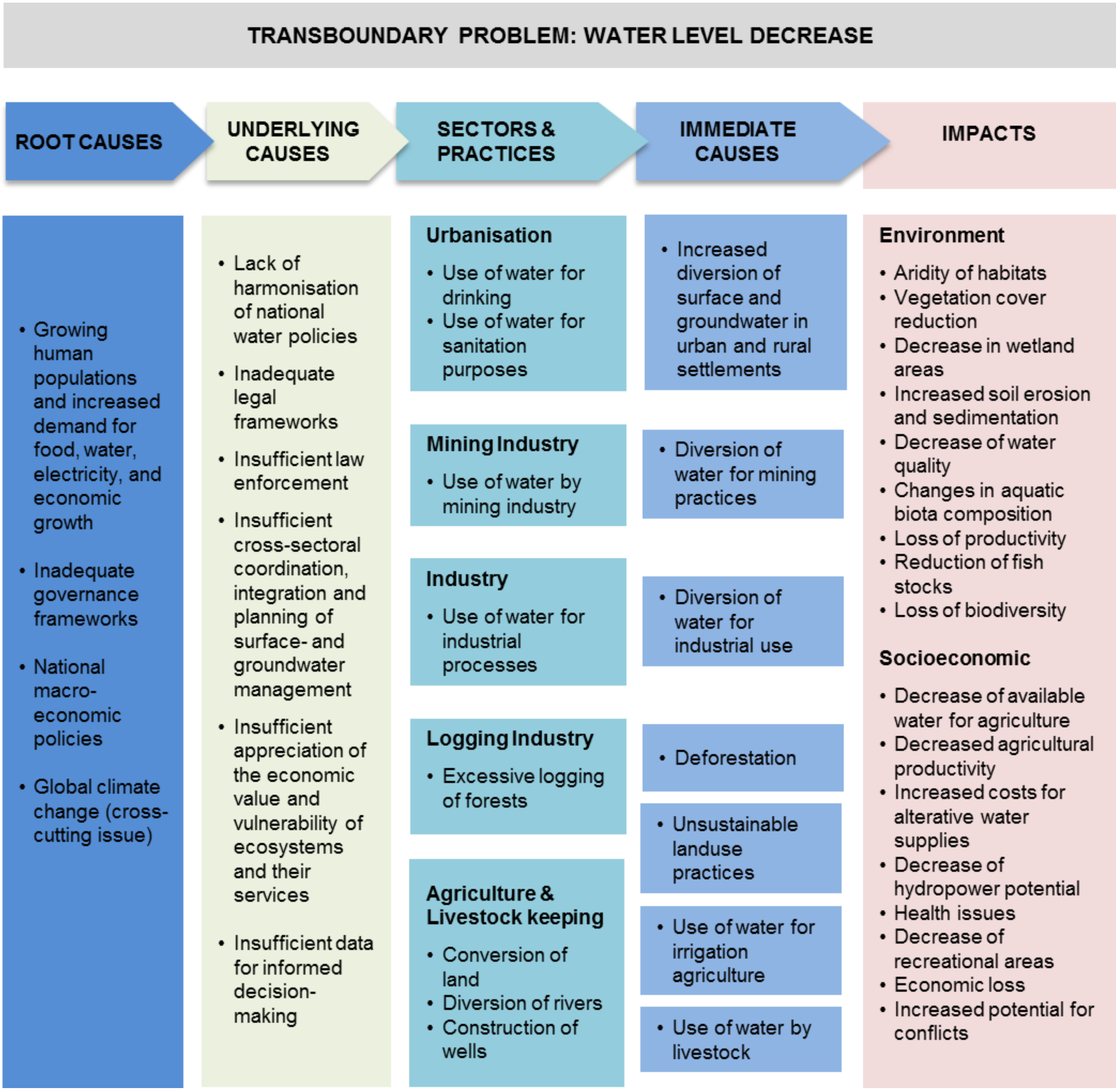


Figure 4.3.2.a Causal chain analysis of water level decrease in the Baikal Basin.

4.3.2.1 Present and Future Impacts

The impacts of decreased surface and groundwater levels is expected to lead to significant economic loss, increased demand for investment in infrastructure that can support alternative water supplies, social consequences, and an increased potential for national and transboundary conflicts.

Although the available resources in the basin are significant, in many of the urban and industrial areas the groundwater use could exceed the viable limit of the local supply. The socio-economic impacts of water shortages for domestic use would be significant, especially for lower-income households. Water shortages could lead to population changes, conflicts between water users (for instance, farmers and urban consumers), and health-related problems as a result of increased pollution (due to cross-connection contamination, diminished sewage flows, and increased pollutant concentration).

Recreation and transport on lakes and rivers will be impacted by decreased water levels. Problems may arise in mooring boats. Infrastructure in harbours and ports will need to be adapted to lower water levels.

A decrease in water levels is expected to have the greatest impacts in the steppe areas that are typically dry during the summer months and suffer from a deficiency of water for irrigation of agricultural lands. This counts especially for the Republic of Buryatia and large parts of Mongolia, which are highly dependent on irrigation for agriculture. Decreased agricultural productivity will lead to significant economic losses. Increased investments will be required to ensure sufficient water supply for agriculture. A subsequent increase in food prices will impact individual households, especially those with lower incomes.

A reduction in the water levels of the Selenga, Eg, Ider and Orkhon River will impact the potential of HPP's in Mongolia. Although the Angara-Yenisei HPP cascade in the Russian part of the Baikal Basin can to some extent be regulated by artificially maintaining the water level of Lake Baikal sufficiently high, it can be expected that the Angara-Yenisei HPP cascade will also be affected.

A decline of surface surface and/or groundwater levels for only a few centimeters can have detrimental effect on riparian and delta ecosystems, which are key habitats for aquatic and semi-aquatic biodiversity. In Lake Baikal, lowering of the water level in river deltas has been observed to result in higher water temperatures and overgrowth with vegetation (Krupnoderov & Molodyh 2011). Healthy river deltas offer important ecosystem services as filters against high levels of nutrients and dissolved sediments. Reduction of water flow in these ecosystems will lead to a reduction of their filtering capacity, and may result in increased pollution and siltation further downstream.

Fish stocks may decrease as a result of a reduction in their spawning grounds and nursery habitats. The species composition and densities of littoral aquatic communities is likely to alter. Populations of wading birds will be affected due to a decrease in food supply. The incidence of diseases in wildlife and cattle may increase due to a higher risk of transfer of pathogens across greater densities of animals at a limited number of sources for drinking water.

Although climate change predictions indicate a gross increase of rainfall in the Baikal Basin, as a result of increased temperatures and evaporation an overall decrease in the volume of water resources expected (see Chapter 4.7). In combination with the growing population and its increasing demand for water and water-related services, this is expected to result in significant decreases in surface and groundwater resources. This increased demand and decreased supply is not sustainable, and underlines the urgent need for improved, transboundary water management.

4.3.2.2 Challenges for Future Sustainable Management

To promote coordinated, cross-sectoral development and sustainable as well as equitable use of ground- and surface water resources, transboundary management of the Baikal Basin should follow an IWRM policy approach that is based on the Dublin-Rio Principles[44], and takes into account the UN Convention on the Protection and Use of Transboundary Watercourses and International lakes (Helsinky,1992) as well as the UNECE Guidelines on Monitoring and Assessment of Transboundary Groundwaters (2000).

To ensure future sustainability of water resource use by upstream as well as downstream populations, adequate planning and coordination at the national as well as transboundary level will be crucial. At present, there is a lack of harmonization of national groundwater management policies, inadequate legal frameworks, and insufficient trans-sectoral integration and planning of surface- and groundwater resource management. A main challenge will be to address these issues in the near future.

Decisions about the use and allocation of surface and groundwater resources in the Baikal Basin should be based on long-term monitoring data. However, little is known about the quality and quantity of groundwater resources that are shared between Mongolia and Russia. Groundwater forms an integrated part of water resources in Baikal Basin and should form an important component of national as well as transboundary integrated water resources management. Combining groundwater monitoring data with surface water monitoring data will allow estimations of total transboundary water runoff, assessment of exploitable groundwater resources and evaluation of water pollution transboundary transport.

Efforts are underway to obtain insight in the status of groundwater resources in Mongolia and Russia, which will be annexed to this TDA (see UNESCO 2013). The design and operation of groundwater monitoring systems in the Baikal Basin should be based on a standardized methodology and harmonized frequency of sampling. Furthermore, there should be regular exchange of monitoring data between the two countries that share the Baikal Basin.

[44] www.gwp.org/The-Challenge/What-is-IWRM/Dublin-Rio-Principles and www.gwptoolbox.org

Linking this initiative to the design of a similar system for surface water monitoring would be beneficial for a more integrated approach to water resource management. Such a collaborative effort would link closely to the Agreement on Protection and Use of Transboundary Waters that was signed by the Governments of Mongolia and Russia in 1995 (also see Section 5.3.2).

Another main challenge for future sustainable management of transboundary water resources is the lack of an overview of the exact amounts of water that are being used by each sector, the economic value of surface and groundwater resources and the expected economic losses in case of a decrease in water supply. An assessment should be done on to predict: i) the increase in water demand by the various sectors; ii) the magnitude of increase of the demand, and iii) the economic impact of continued water pollution.

4.3.3 WATER LEVEL INCREASE

The problem of water level increase in the Baikal Basin is mainly related to the construction of dams and artificial regulation of water flow by hydroelectric power plants (HPPs). In Mongolia, three HPP exist in the Selenga River Basin, the small-sized Erdenebulgan HPP on the Eg River, the small-sized Tosontsengel HPP on the Ider River, and the inactive Kharkhorin HPP on the Orkhon River. In Russia, a cascade of large HPPs was constructed in the Angara (city Irkutsk, Russia) and Yenisei Rivers.

After the construction of the Angara-Yenisei HPP cascade (see 2.2.7), the water level in Lake Baikal increased with 1.30 m (456.80 m asl). The resulting increase of the water level in Lake Baikal has caused major problems for the inhabitants of near-shore settlements in the past, and continues to be a major concern.

Natural water level fluctuations in Lake Baikal are relatively small on an annual basis, due to its large water surface area (31,500 km^2), and the balance between inflow and outflow through the Angara River (60 km^3/year). Clear differences were observed between the inter-annual fluctuations before the construction of the dam and after. Under natural conditions during the period between 1900-1958 the fluctuations of the lake water level did not exceed 80 cm. After construction of the dam near Irkutsk, during the period 1959-2000, the highest levels registered in 200 years were measured. The water level exceeded the 457 m asl mark 17 times, and fell below the 456 m asl mark 18 times (Irkutskenergo report, 2007). On average, the water level was raised 80 cm after construction of the dam (MNR 2002, 2012).

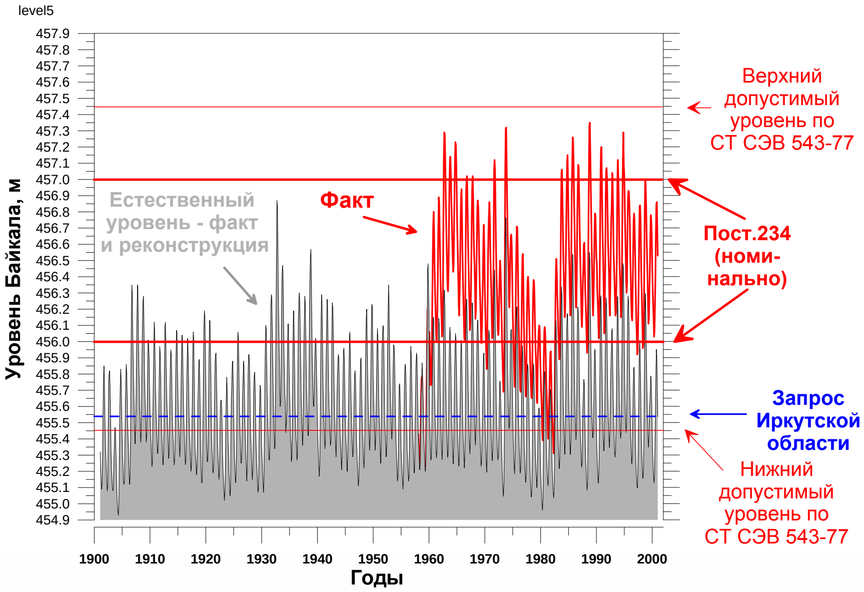


Figure 4.3.3.a Fluctuations of the water level in Lake Baikal before and after reconstruction of the dam for the Irkusts hydropower station between 1956-1958. Nominal permissible levels of 456 m and 457 m asl are denoted with bold red lines (RAS 2003).

Water level increase was identified as a problem for the Russian part of the Baikal Basin, and it is generally assumed that Mongolia is not impacted by this problem, although Mongolia competently takes part in solving of this problem. Nonetheless, as water level increase poses a significant problem for Lake Baikal and its ecosystem, it is considered of transboundary importantce.

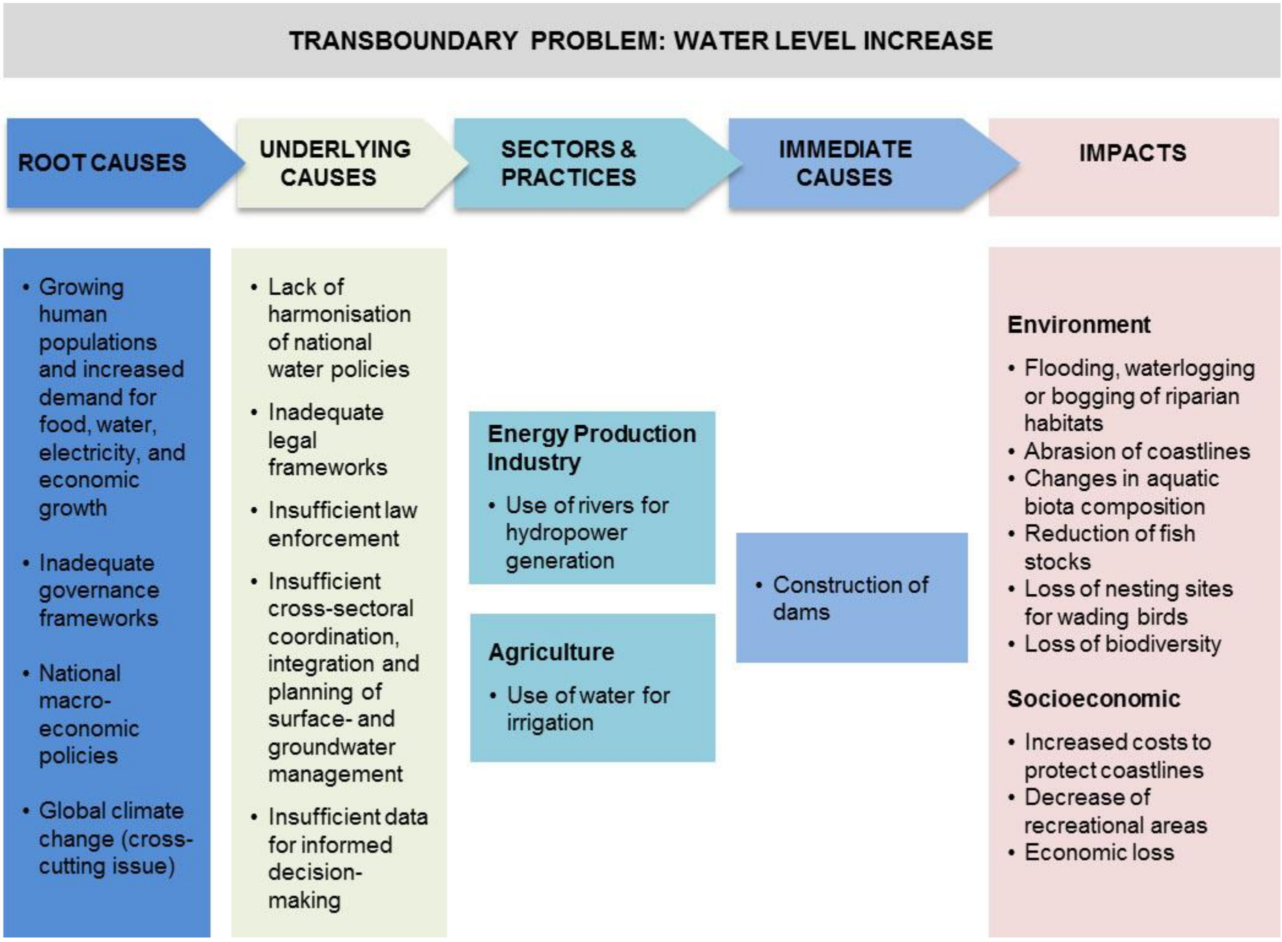


Figure 4.3.3.b Causal chain analysis of water level increase in the Baikal Basin.

4.3.3.1 Present and Future Impacts

The construction of the dam and a water reservoir for hydroelectric power generation in the Angara River in Russia resulted in improved socio-economic circumstances for the people in the region who previously did not have sufficient access to electricity. However, it also resulted in submergence of 123 thousand hectares of land, of which 32 thousand hectares were agricultural areas. In total, 141 settlements were flooded, and eight thousand people had to be relocated (Krupnoderov & Molodyh 2011).

With the increase of the water level in Lake Baikal, the lake's total surface area enlarged approximately 500 km^2. This process was accompanied by flooding of beaches, as well as flooding, waterlogging, and bogging of low coastal areas and estuaries. Waves caused significant abrasion in areas of the coastline that were previously protected, and many mooring constructions and docks were destroyed. On the eastern coast of Lake Baikal, an estimated 400 km^2 of recreational beaches were flooded. In the town of Maksimiha, 110-120 m of coast disappeared over a time span of 35 years since 1962 (Imetkhenov 1994).

Coastal abrasion and undercutting of the shoreline caused landslides and collapses. Coastal railways, roads, communication lines and electricity transmission lines were destroyed. Near the Krugobajkalsky site of the East-Siberian railway, dikes and other protective measures had to be constructed over an area 59 km length.

Flooding and abrasion of the coastline continues to occur during high lake levels, especially during storms in late Autumn (MNRE 2012). It is estimated that 750 m^3/km continues to be eroded every year, adding up to a total of 1.5 million m^3/year for the entire lake. The Russian Railway company spends around 45-50 million rubles annually to protect the East-Siberian railway from the consequences of the lake level fluctuations (Krupnoderov & Molodyh 2010). The total economic losses for the Republic of Buryatiya in biomass, abrasion of beaches, loss of wood and flooding of farmland, are estimated to add up to 14 billion rubles annually.

The fluctuations of the water level in Lake Baikal that resulted from the construction of dams in the Angara River for the generation of hydroelectric power also had detrimental effects on the aquatic, near-shore, and delta ecosystems in the lake basin. Fish spawning sites were destroyed, as well as nesting areas for wading birds. In the Selenga River delta, which is listed as a wetland of international importance according to the Ramsar Convention, over 100 km^2 of shoreline was submerged.

The ecological and socio-economic impacts of the construction of small-sized HPPs in the Eg, Ider and Orkhon Rivers are minimal. Information about the ecological and socio-economic impacts of the construction of dams for irrigation purposes and water supply for the mining industry is also lacking. However, it can be assumed that upstream as well as downstream ecosystems will have been locally impacted.

4.3.3.2 Challenges for Future Sustainable Management

Because the fluctuations of the water level in Lake Baikal have a significant impact on aquatic and near-shore ecosystems as well as on local livelihoods in the Republic of Buryatiya and the Irkutsk region, the Russian Government agreed on 26th March 2001 to limit the water level fluctuations. Resolution № 234 of the Russian Federation states that the minimum water level of Lake Baikal should be kept at 456 m asl and the maximum at 457 m asl. The difference between the minimum and maximum allowed level amounts to a total volume of 31.5 km^3 or 0.14% of the total water volume in Lake Baikal.

Regulating the fluctuations is intended to have positive effects upstream as well as downstream, by i) ensuring that aquatic habitats in and around the lake are protected from extremes; ii) ensuring that water intakes of hydroelectric power stations downstream can function; and iii) that navigation on the Angara and Yenisei Rivers is possible.

One of the problems identified is that the present artificial regulation is not congruent with the natural cycles of the lake. Natural seasonal water fluctuations have a clear annual cycle. From spring to fall, the water level rises, and from late autumn to spring it decreases. After the construction of the HPS in the Angara River, the natural cycle of lake level fluctuations was delayed with one month. Normally, the highest water levels would occur around September. But due to the regulation of the HPP, highest levels now occur in October. Biologists have found indications that this conflicts with the natural cycles of aquatic organisms, including fish. As such the unnatural regulation of the water level may cause long-term risks for biodiversity in Lake Baikal (Shapkhaev 2012).

The regulation of the water levels under extreme weather events has proven to be problematic. Under standard circumstances with medium low an high water levels in Lake Baikal, the agreed minimum and maximum levels should be easily achievable. However, problems arise during extended periods of drought in the region, as well as during extreme floods that typically occur every few decades. Limited water supplies during autumn has caused major problems for the supply of electricity in the Irkutsk region. Since 2003, there have been repeated demands to reduce the minimum permissible discharge level with 20 cm (Shapkhaev 2012). As a result of global climate change, these events may occur more often in the future, which will have important impacts on the regulation of the water levels in Lake Baikal.

Another challenge identified for improved management of the water level fluctuations caused by the functioning of the Angara-Yenisei HPP cascade is a lack of transparency. There is insufficient public access to information about the amount of surpluses of electric power generated in the Irkutsk region versus deficiencies in the Republic of Buryatia, the Transbaikalsky region and Mongolia. Furthermore, while the Irkutsk region clearly benefits socio-economically, the Republic of Buryatia suffers economic losses resulting from the operation of the Angara-Yenisei hydropower station cascade.

In addition, the absence of an adequate monitoring system, and seasonal and long-term forecasts about the lake level and the water storage reservoir for the Angara-Yenisei HPP cascade significantly hampers informed decision-making and management.

Future construction of dams for HPP or irrigation purposes should assure that a transparent Environmental and Social Impact Assessment (ESIA) is implemented according to international standards (e.g. Morgan 2012, Vanclay 2012). This includes an assessment of stakeholders, existing and potential land uses, biodiversity and cultural heritage, as well as an analysis of the social structure of local populations, their needs, capacity and health status. The results of the ESIA should be made public and tabled at the transboundary level.


Photo by Tumurchudur Sodnom

Photo by Zhamyanov

4.4 PROBLEM AREA 3: DECLINE OF WATER QUALITY

4.4.1 DESCRIPTION & TRANSBOUNDARY RELEVANCE

The decline of the quality of surface and groundwater resources resulting from point source and nonpoint source pollution is a significant concern in both Mongolia and Russia. As polluted water can be transported over long distances, it affects downstream areas and is a significant transboundary issue. Once pollutants reach Lake Baikal, they could possibly accumulate for centuries, since water stays in the lake for an estimated 300 years.

Water quality is influenced by the hydro-morphological, hydro-geological and hydro-chemical features of the basin. As a result of the tectonic and geological processes in the region, elevated levels of minerals and heavy metals as well as oil seepages are found in the Baikal Basin. However, it is becoming clear that human activities are increasingly disturbing the natural balance in the basin, and causing increased amounts of pollutants to enter water resources.

In an effort to protect aquatic biodiversity and water resources in Lake Baikal, the Russian Government adopted Resolution № 643 on 30 August 2001, which includes a list of 36 activities that are prohibited in the Central Ecological Zone. Four the banned activities relate to mining and quarrying, which were identified as main culprits for the decline of water quality in the region:

1. Extraction of crude oil and natural gas.
2. Extraction of radioactive ores.
3. Extraction of metallic ores.
4. Other mining and quarrying activities, including:
    - Prospecting and development of new deposits, previously not affected by exploitation works.
    - Extraction of sand, pebble, gravel, and breakstone from within Lake Baikal and its coastal buffer zone, and from fish spawning areas in rivers and their buffer zones (an exception is made for dredging operations).

Although these measures may protect the lake to some extent, it is clear that a much larger scale, basin-wide approach is necessary to limit the effects of pollution. A multitude of land-based sources contribute to the pollution problems in the lake basin, including not only mining and quarrying enterprises, but also industries, agricultural areas, rural and municipal settlements, and sewer systems. There are also other pressures on water quality, such as road construction, construction and operation of pipelines, as well as increased tourism and recreation. In addition, deforestation and unsustainable land use practices cause increased erosion of topsoil, which can lead to increased levels of suspended sediments and sedimentation in rivers and lakes. Furthermore, atmospheric deposition is a source of nonpoint pollution throughout the basin.

Elevated concentrations of chemical pollutants and organic substances have been found in water resources in the Baikal Basin in Mongolia and Russia. In Mongolia, the areas that are most impacted include the valleys of the Tuul, Kharaa and Orkhon Rivers, which form the hydro-geographic network Tuul-Orkhon, Kharaa-Orkhon and Orkhon-Selenga. In Russia, the lower reaches of the Selenga River and tributaries such as the Chikoy, Khilok, Djida, and Uda Rivers, as well as important wetland areas such as the Selenga River Delta are impacted. In Lake Baikal itself, the highest levels of contaminants and eutrophication are found in the southern areas.

At present, surface water quality monitoring occurs in both countries as part of the Transboundary Water Monitoring Programme in the framework of the Agreement between the Government of Mongolia and Russia on the Protection and Use of Transboundary Waters. Both countries have been monitoring water quality in the past, but with varying frequencies and consistency, using varying parameters. The focus of historical monitoring activities has been primarily on surface waters. A transboundary groundwater-monitoring network presently does not exist, and is the focus of an activity implemented by UNESCO within the framework of the present UNDP-supported, GEF-financed project on the transboundary Baikal Basin.

Monitoring of major ions in surface water has been carried out in Mongolia since 1949 in rivers (e.g. Orkhon, Murun). Monitoring of toxic substances started more recently, with focus on rivers that are affected by human activities (e.g. Batima and Davaa 1994, Batima 1998, Dallas 1999). However, monitoring efforts in Mongolia are hampered by a lack of capacity of laboratories, which renders it difficult to determine concentrations of some toxic substances, including heavy metals.

In Russia, water quality monitoring also has a history of several decades, with varying frequencies and parameters. Historical water quality data is available for Lake Baikal (e.g. Galaziy 1980, Plumley 1997, Yoshioka et al. 2002) as well as downstream areas of the Selenga River in Russia (e.g. Munguntsetseg 1984, Ubuganov et al. 1998, Dambiev and Mairanovsky 2001, Garmaeva 2001, Korytny et al. 2003, Khazheeva et al. 2004). Most recently, hydrological monitoring using a network of gauging stations is done by the Institute of Geography of SB RAS (since 2005) and the Faculty of Geography of Lomonosov Moscow State University (since 2011). In the Republic of Buryatia, water quality is regularly monitored at 48 sites in 31 rivers and Lake Baikal.

The lack of long-term sharing and comparing of monitoring data between Mongolia and Russia plays an important role in important factor in the perception of the transboundary problem. The TDA therefore offers an attempt to provide an overview of pollution problems within the Baikal Basin, and to generate a baseline that can be used for future monitoring and transboundary management. With support from UNESCO, evaluations are made of point pollution sources including sanitation and municipal waste treatment facilities, liquid and solid industrial and mining waste treatment facilities, as well as nonpoint pollution sources. The results of these evaluations will be annexed to this TDA as they become available[45]. In addition, a transboundary groundwater-monitoring network will be established to support informed decision making in the future (also see 4.2.2.b).

As part of the TDA, experts identified main hotspots of concern in the Baikal Basin (Figure 4.4.1.a, Table 4.4.1.a), where samples were taken to determine the quality of water resources, which indicate significant point pollution sources in both Mongolian and Russian parts of the basin. The results are further discussed in the following sections (also see Technical Reports in Annex IV and V).

[45] For updated information: h.treidel@unesco.org

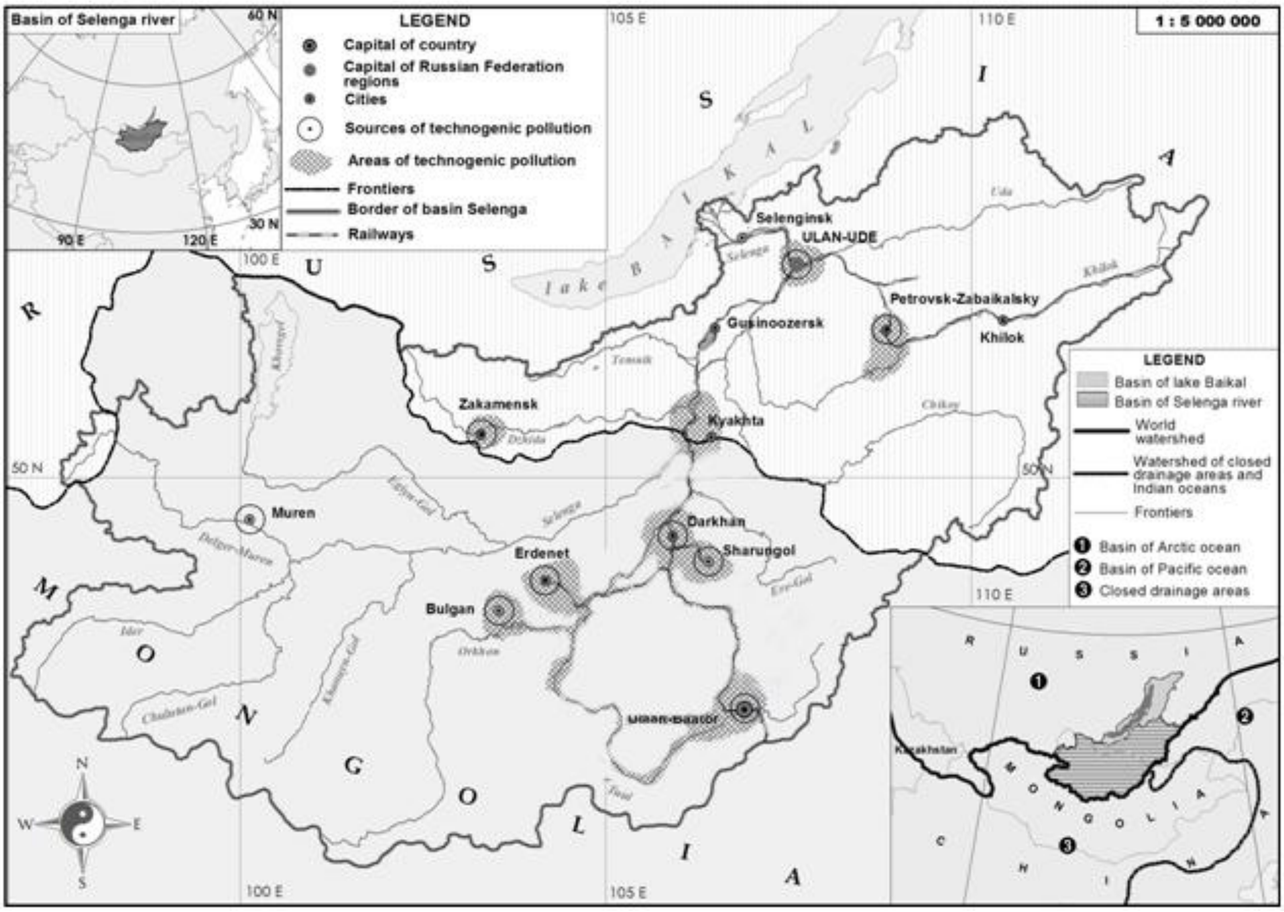


Figure 4.4.1.a Pollution hotspots in the Selenga River Basin.

Water quality parameters are tested on an annual basis at 9 stations at downstream locations in the transboundary Selenga River between Naushki village near the border with Mongolia and Murzino in the Selenga River Delta (Table 4.4.1.b, MNR 2012). In 2005, a total of 31 tons of dissolved zinc compounds and 26 tons of copper were detected in the Selenga River near Naushki. In 2006, these amounts had increased to 81 tons of dissolved zinc, and 52 tons of copper. As such, it is clear that the Selenga River is a main transboundary transporter of pollutants from Mongolia into Russian territories.

Data collected at downstream stations in the Selenga River between 2010 and 2011 indicates that although the concentrations of indicators such as chlorides, fluorides, sulphates, nitrate, and phosphorus were within the permissible levels, several other parameters provide evidence of pollution in the Selenga River (Table 4.4.1.b and 4.4.2.a). There are indications of eutrophication (elevated BOD, ammonium and nitrite levels), and other sources of pollution (high levels of petroleum products, volatile phenols, copper, zinc and lead compounds and iron).

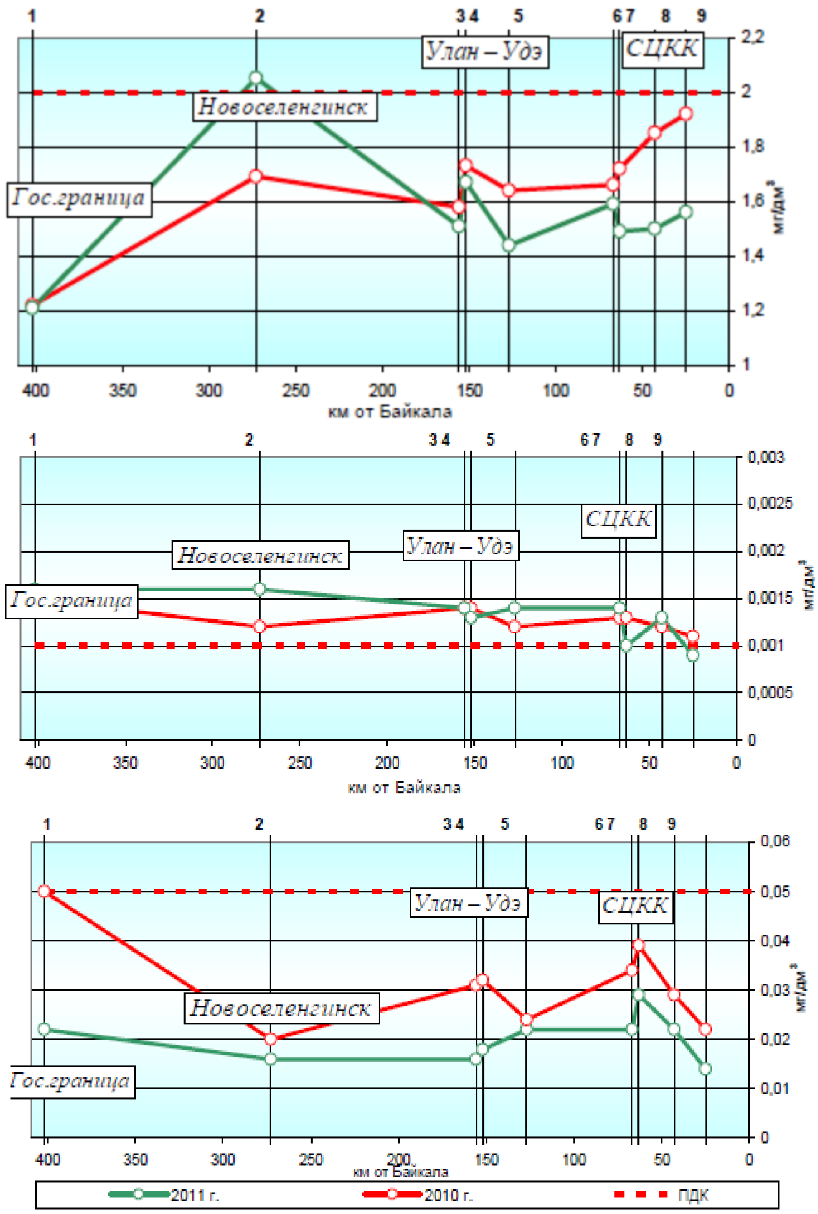


Figure 4.4.1.b Dynamics of pollution indictors measured at four gauging stations in the Selenga River between 2010 (green) and 2011 (red). From top to bottom: BOD; volatile phenols; oil concentration. Dotted line indicates maximum permissible concentration for fisheries. Labels inside the graphs (from left to right): State border; Novoselenginsk; Ulan-Ude; Selenginsk Pulp and Paper Mill.

Groundwater quality parameters measured at several sites within the Russian territory of the Baikal Basin that the areas near the coast of the lake are mostly within permissible levels, although several pollution sources were found, particularly near the Baikal Pulp and Paper Mill and the Kultukskoj industrial complex. Groundwater resources in the Republic of Buryatia do not meet the standards and contain high levels of nitrogen-containing substances and chemical pollutants, particularly near industrial areas.

The decline of surface- and groundwater quality is closely linked with other major transboundary problem areas: the modification of hydrological flows (4.2) and degradation of aquatic and terrestrial habitats (4.3). In addition, pollution and eutrophication can cause a decline in fish stocks, and therefore also affects fisheries (4.5). Furthermore, by causing shifts in floral and faunal composition, a decline of water quality can provide increased opportunities for invasive species to establish themselves (4.6).

Five specific problems were identified that affect the quality of water resources in the Baikal Basin, which are further discussed in the following sections:

- Chemical contamination
- Increased suspended solids and sedimentation
- Microbial pathogenic contamination
- Organic pollution and eutrophication
- Thermal contamination

Table 4.4.1.a: Point source pollution sources in the Baikal Basin in Mongolia and Russia.

	Pollution source	Contaminated water resource	Main pollutants of concern	TDA category
Mongolia	WWTP of Tolgoit, Ulaanbaatar	Tuul River	N, P, chemical pollutants, POPs, pathogens, oxygen-depleting substances, suspended and settleable solids	CC, SS, MP, OP
	WWTP of Songino settlement	Tuul River		
	WWTP of Nalaikh settlement	Tuul River		
	WWTP of Darkhan	Kharaa River		
	WWTP of Sharyn Gol settlement	Kharaa River		
	WWTP of Salkhit settlement	Kharaa River		
	WWTP of Erdenet, Ulaan Tolgoi	Khangal River		
	Biofactory WWTP, Songino	Tuul River	N, pathogens, oxygen-depleting substances.	PM, OP
	Airport WWTP, Songino	Tuul River	Hydrocarbons, chemical pollutants	CC
	Skinnery WWTP, Darkhan	Kharaa River	N, pathogens, oxygen-depleting substances	MP, OP
	Metallurgical smelter WWTP, Darkhan	Kharaa River	Heavy metals, chemical pollutants	CC
	Copper and molybdenum ore dressing and processing plant, Erdenet	Khangal River		
Russia	WWTP of Babushkin	Lake Baikal	N, P, chemical pollutants, POPs, pathogens, oxygen-depleting substances, suspended and settleable solids	CC, SS, MP, OP
	Domestic and industrial waste production, Ulan-Ude	Selenga River		
	Domestic and industrial waste production, villages of Selenginsk and Kamensk	Selenga River		
	Industrial hub, villages of Slydyanka, Kultuk, Vydrino, and Bol'shoe Golostnoe	Lake Baikal		
	Nizhneselenginskii industrial hub	Selenga River		
	Petrov-Zabaikalski industrial hub	Balyaga River		
	Industrial hub, Ulan-Ude	Selenga River		
	Baikal Pribor 1 LLC, and ZHEU Gusinoe Ozero LLC industries, Gusinoozersk	Tsagan-Gol River		
	Pulp and Paper Mill, Baikalsk	Lake Baikal	Chemical pollutants	CC
	Pulp and Paper Mill, Selenginsk	Groundwater		
	Kholodninskoe pyritic lead-zinc deposit, northern Cisbaikalia, Severobaikalskii	Kholodnaya River	Heavy metals, acid mine drainage, suspended and settleable solids	CC, SS
	Dzhida tungsten and molybdenum plant, Zakamensk	Modonkul River		
	Pervomaiskii mine, Zakamensk	Inkur River		
	Gusinoozerskaya brown coal mine, Gusinoozersk	Lake Gusinoe		
	Gusinoozerskaya GRES thermal power plant*,	Lake Gusinoe	N, sulphur, mercury, POPs, Thermal	CC, TC

	Gusinoozersk			
	Steklozavod glass factory	Selenga River	Hydrocarbons, chemical pollutants	CC
	Airport petroleum base, Ulan-Ude	Selenga River	Hydrocarbons, chemical pollutants	CC

WWTP: wastewater treatment plant; CC: chemical contamination; SS: suspended solids and sedimentation; MP: microbial and pathogenic contamination; OP: organic pollution and eutrophication; TC: thermal contamination * Note that an important part of the contamination produced by thermal power plants is nonpoint atmospheric pollution.

Table 4.4.1.b: Water quality parameters measured at 9 locations in the Selenga River, downstream between the Mongolian border and the Selenga River Delta, between 2010 and 2011 (normalised data presented in mg/dm^3, and in µg/dm^3 for copper, zinc and lead). Source: MNR 2012[46].

Indicators (MPC, mg/dm^3)	2010		2011		Average change between 2010-2011	
	Concentration limits	Average in gauging section	Concentration limits	Average in gauging section	mg/dm^3	%
Dissolved oxygen	5,76–13,2	9,10	6,15–13,8	9,25	0,15	2
Mineralization (1000)	94,2–277	126	100–281	137	11	9
Chlorides (300)	1,10–6,50	2,40	1,40–6,90	2,30	-0,1	-4
Fluorides (0,75)	0,37–1,02	0,52	0,39–1,54	0,82	0,3	58
Sulphates (100)	8,00–56,1	11,0	8,30–31,4	12,6	1,6	15
Ammonia nitrogen (0,4)	0,00–0,12	0,01	0,00–0,40	0,01	0	0
Nitrite nitrogen (0,02)	0,00–0,06	0,002	0,000–0,057	0,003	0,001	50
Nitrate nitrogen (0,1)	0,00–0,45	0,05	0,0–1,0	0,05	0	0
The mineral phosphorus	0,00–0,04	0,006	0,000–0,043	0,005	-0,001	-17
Total phosphorus	0,00–0,06	0,021	0,005–0,196	0,019	-0,002	-10
COD	5,00–51,7	17,6	5,00–39,8	16,9	-0,7	-4
BOD $_s(O_2)$ (2,0)	0,50–3,70	1,85	0,57–3,05	1,5	-0,35	-19
Petroleum Products (0,05)	0,00–0,16	0,03	0,00–0,11	0,02	-0,01	-33
Resin + asphaltenes	0,003–0,034	0,009	0,003–0,0134	0,011	0,002	22
Volatile phenols (0,001)	0,000–0,003	0,001	0,000–0,003	0,0013	0,0003	30
SPAW (0,1)	0,00–0,04	0,008	0,002–0,051	0,014	0,006	75
Copper compounds (1 mg/l)	0,2–5,6	2,0	0,5–6,8	1,6	-0,4	-20
Zinc compounds (10 mg/l)	4,8–19	9,8	6,3–14,6	10	0,2	2
Lead compounds (1 mg/l)	0–8,5	1,4	0–4,1	0,7	-0,7	-50
Total iron (0.1)	0,05–1,98	0,46	0,05–0,13	0,55	0,09	20
Dissolved silica	4,80–10,3	7,00	5,00–11,8	7,30	0,3	4
Взвешенные вещества	0,30–196	37,0	0,60–125	34,1	-2,9	-8

MPC, maximum permissible concentration for fisheries. Yellow indicates change within 10% limit, green indicates reduction of more than 10%, orange indicates increase of more than 10%. Red indicates levels above MPC.

4.4.2 CHEMICAL CONTAMINATION

Chemical contamination mainly concerns pollution caused by heavy metals, hydrocarbons, persistent organic pollutants (POPs) and pesticides (Table 4.4.2.a). Although nutrients such as nitrogen, ammonia,

[46] Also see Bazarova et al. 2004 for comparative hydrochemical data in the Selenga River in 2004.

phosphorus and sulphur are also chemicals, they are treated under the problem of organic pollution and eutrophication (section 4.4.5) because they arise through natural processes.

Elevated levels of heavy metals such as copper, molybdenum, zinc, lead and iron have been found in the region. Although it is sometimes difficult to distinguish natural anomalies from anthropogenic contamination, since heavy metals naturally occur in the Baikal Basin, it is clear that the elevated amounts of these substances in the environment are largely caused by human activities such as industrial processing and mining (Figure 4.4.2.a). Petroleum is also naturally present in the soil, and Lake Baikal is known to harbour several sources of natural oil seepage (see 2.2.7). Bacteria populations in Lake Baikal have adapted to feeding on the natural oil seepages, and play an important role in the self-purification of the lake (Pavlova et al. 2008).

The mining industry (see 3.4.6), as well as waste produced by other industries, transport, agriculture, urban settlements, and the defence industry were identified as the main causes of chemical contamination of surface- and groundwater resources in the Baikal Basin (Figure 4.4.2.f, Table 4.4.2.b).

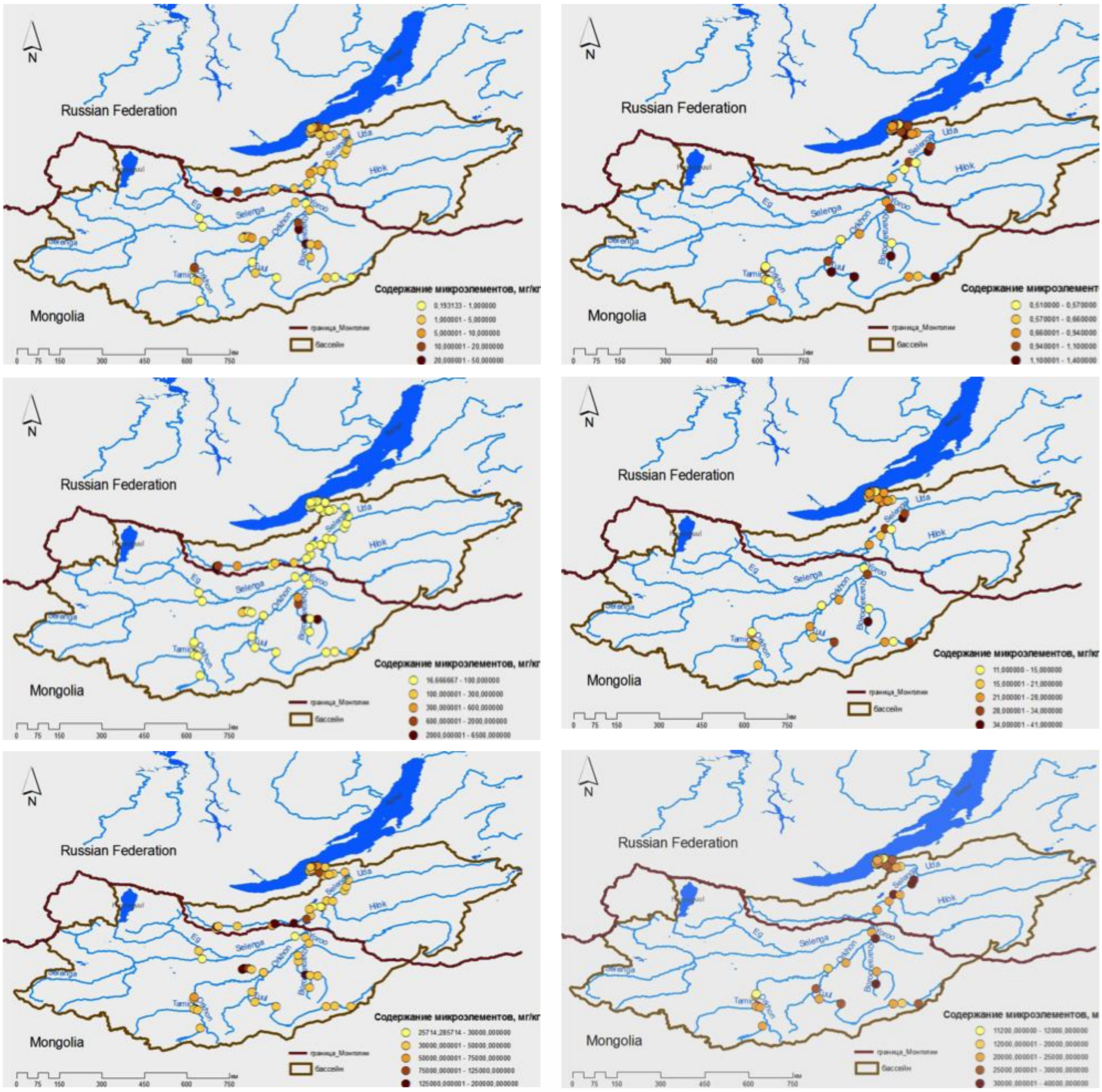


Figure 4.4.2.a Concentration of heavy metals in suspended sediments in the Selenga River Basin between July-Aug 2011. From left to right, top to bottom: molybdenum, copper, and iron (mg/kg).

Table 4.4.2.a: Major substances that may cause chemical contamination, and some of their key characteristics.

Substance	Description
Heavy metals	• Widely used ingredients for chemical compounds used in industry. • Found in fuel, chemicals, waste materials, and batteries. • Naturally present in soil, at low concentrations. • In high concentrations, toxic to humans, animals, and plants.
Hydrocarbons	• Main components of mineral oils (petroleum, diesel, heating and lubricating oil), and chlorinated solvents. Also used for production of pesticides. • Naturally present in soil. • Hydrocarbons can have negative effects on human health, animals, and plants. Some byproducts of petroleum refining and processing are highly toxic.
Persistent organic pollutants (POPs)	• Include substances such as dioxin and PCBs • Many POPs have been used as pesticides (see below). • Capable of long-range transport, and resistant to degradation through chemical, biological and photolytic processes. • Accumulate in human and animal tissue, and have significant impact on human health and the environment, even in low concentrations
Pesticides	• Include herbicides, insecticides, nematicides, rodenticides, and fungicides used in agriculture and gardens • Main groups of chemical pesticides are organophosphates, carbamates, organochlorines (e.g. DDT), and pyrethroids. • Toxic effects on insects, plants and/or animals. Exposure to humans can have negative health impacts, and can affect the nervous system, cause reproductive problems, and cancer.
Industrial fertilisers	• Inorganic fertilisers that are synthetically produced. • Fertilisers typically provide the following components (in varying proportions): N, P, K, Ca, Mg, S. • Often contain impurities such as fluorides, cadmium and uranium. • Can contribute to soil acidification and overfertilisation.

CONTAMINATION CAUSED BY THE MINING INDUSTRY

A principal source of chemical contamination of water resources by mining activities is acid mine drainage. Coal and metal ore seams and their associated rock strata contain pyrite (iron sulphide), which oxidises on contact with air and in the presence of bacteria. As a result, sulphuric acid is formed. Consequently, drainage from coal and metal ore mines has a very low pH (acidity). It also contains high concentrations of sulphur, iron, and a range of heavy metals such as arsenic and cadmium. When acid mine drainage enters streams and rivers, the change in pH causes the iron to precipitate as ferric hydroxide. This is deposited on streambeds as an orange sludge, a process which also depletes the water of its oxygen.

Large deposits of gold exist in the Baikal Basin in both Mongolia and Russia (see 2.2.7 and 3.4.6). In 2006, over 400 gold-mining companies were registered in the Selenga River Basin. Although modern mining companies are obliged to follow environmental safety regulations[47], water samples taken near some of the gold mining sites in Mongolia indicated that the permissible norm for concentrations of contaminants including heavy metals, arsenic and cadmium was significantly exceeded. Among the main pollutant concerns for gold mines are mercury and cyanide. Although these are included in the list of severely restricted chemicals in Mongolia, by Government resolution 2007/95, many artisanal and illegal gold minders continue to use these highly toxic chemicals. In the Boroo and Kharaa River catchments, an area of 37.35 hectares was polluted with almost 200,000 tons of mercury-containing slime. Elevated levels of mercury have also been detected in the urine of the area’s inhabitants (Also see 4.4.2.1).

Other mining enterprises such as the joint Russian-Mongolian copper and molybdenum ore processing plant in Erdenet have also been identified as important polluters. The Erdenet ore dressing plant has been identified as the cause of elevated chemical pollutants in the Orkhon River.

[47] For example, see: www.centerragold.com/operations/environment-and-safety-0

In 1990, mining works at the Kholodninskoe pyritic lead-zinc deposit in the Severobaikalskii district were identified as extremely hazardous for Lake Baikal, due to the high toxicity levels and the close vicinity of the deposits to the lake. However, in 2005, a license was obtained by Invest Euro Company (UDE 13040 TE - УДЭ 13040 ТЭ) for the extraction of polymetallic ores in the Kholodninsky deposit, and mining is ongoing. Furthermore, industrial enterprises in the city of Ulan-Ude and the Gusinoozersky industrial hub continue to cause concern for the quality of water resources in the area.

The Djida tungsten and molybdenum plant near the Zakamensky industrial hub lead to the accumulation of up to 20 million tons of mineralized rocks, and 25 million tons of tailings of the dressing factory. The waste was stored in direct vicinity of the Djida River and its tributary the Modonkul' River, which is currently the most polluted river in Buryatia. In 2002, a total of 2.659 tons of iron, 1.4 tons of copper, 2.467 tons of zinc, 0.151 tons of nickel, 0.171 tons of chromium, and 0.216 tons of cadmium were discharged into the river.

Table 4.4.2.b: Overview of main chemical contamination sources in the Selenga River Basin in Mongolia (Kosheleva et al. 2012).

<table>
<tr><th>Cities</th><th>Ulaanbaatar</th><th>Erdenet</th><th>Darkhan</th><th>Zaamar</th></tr>
<tr><td>Population (thousands pers)</td><td>1,031</td><td>80.1</td><td>87.6</td><td>0.5</td></tr>
<tr><td>Traffic (thousands cars)</td><td>92.7</td><td>5.5</td><td>3.0</td><td>-</td></tr>
<tr><td rowspan="2">Contamination sources</td><td>Multi-industry production</td><td>Cu-Mo ore mining and processing</td><td>Ferrous metallurgy, Au mining, leather tanning</td><td rowspan="2">Au mining</td></tr>
<tr><td colspan="3">Traffic, thermal power plants, cooking stoves and heaters in ger districts, fly ash of brown coal combustion</td></tr>
</table>

CONTAMINATION CAUSED BY INSUFFICIENTLY TREATED INDUSTRIAL AND DOMESTIC WASTE

Chemical (as well as organic) pollution through insufficiently treated solid waste and wastewater is an increasing problem in the Baikal Basin (Annex IV and V). This includes both industrial as well as municipal waste. Multiple factors were identified as causes of the inefficiency of wastewater treatment facilities in the basin:

- Outdated technology and insufficient use of new and improved technologies of waste treatment.
- Non-compliance with technical standards.
- Irregular intake of water
- Incomplete processing of sediments.

In total, 58 wastewater treatment plants (WWTPs) are located in the Mongolian territory of the Selenge River Basin (SRB), but several of those are defunct (Figure 4.4.2.b). Annually, 91 million m^3 of wastewater is treated in the SRB. Insufficiently treated sewage of the cities Darkhan, Zuunkharaa and Ulaanbaatar was identfied as important sources of chemical as well as organic contamination of the Kharaa and Tuul Rivers.

The central WWTP in Darkhan receives 50,000 m^3 per day and has a 90% treatment capacity. Ulaanbaatar has 2 chemical, 4 mechanical and 7 biological WWTPs. In total, 0.3% of treated wastewater in Ulaanbaatar has been processed chemically, 62.1% biologically, and 37.6% mechanically. 95% of the treated water is discharged into the Tuul and Bayangol Rivers. The central WWTP in Ulaanbaatar has a treatment efficiency of only 60-70% and discharges 160,000 m^3 of treated water per day into the Tuul River. Furherore, the majority of households in Ger districts uses outhouse pit latrines, and 70% of the ger inhabitants does not have access to waste disposal facilities.

Water samples taken in the Khangal River downstream from the waste treatment facilities of the city of Erdenet at Ulaan Tolgoi indicated elevated levels of chemical pollutants such as chlorides, sulphates, and chrome (Annex IV, Table 4).

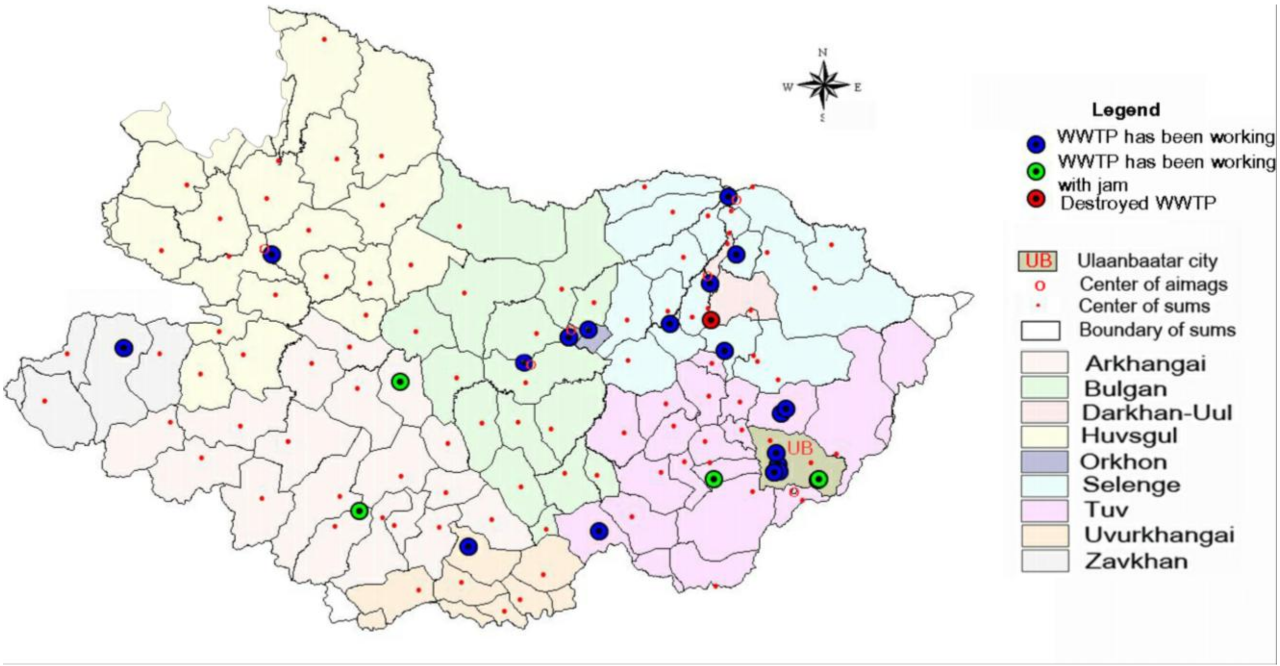


Figure 4.4.2.b: Wastewater treatment plants in the Selenge River Basin, Mongolia.

Figure 4.4.2.c: The central wastewater treatment facilities of Ulaanbaatar, Mongolia. Photo: G.Tamir.

In the Republic of Buryatia in Russia, only 7% of all settlements has access to the centralised sewage discharge system. A total of 58 treatment facilities operate in Buryatia, 33 facilities discharge wastewater directly into water bodies, and 25 facilities discharge on land. In 2006, out of a total of 381.94 million m^3 of sewage, 52.41 million m^3 was still polluted after treatment, and 2.74 million m^3 was discharged without any treatment.

As a result of the limited coverage of the centralised sewage discharge system, large amounts of wastewater are released untreated, or insufficiently treated. In addition, due to a lack of maintenance, the numbers of accidents and spills in sewage treatment plants has increased 5 times over the past decade. In the Republic of Buryatia, the majority of treatment facilities are in need of renovation and modernization. Wastewater treatment facilities in Vydrino, Shaluty, Petropavlovka, Gusinoe, and Ivolginsk are in a poor condition and do not meet modern requirements.

Another pollution problem associated with waste management is the large number of unauthorised dumps of domestic waste.

Waste from the Selenge Pulp and Cardboard Mill 50 km from Lake Baikal, and the Baikalsk Pulp and Paper Mill (BPPM) located on the western lake shore in Irkutsk Oblast are of great concern for the quality of the water in the lake. BPPM has been in operation since 1966, and caused significant contamination of the lake (Table 4.4.2.c and 4.4.2.d). In total, between 225,000-250,000 tons of hazardous slime and waste were dumped in the lake, causing pollution of water resources with silicon, sulphates and chlorides. Although the mill was closed down in October 2008, it resumed operations again late 2009. Since then, BPPM no longer uses chlorine to produce pulp, and switched to and independent water disposal system with a full wastewater circulation cycle. Nonetheless, pollution by the BPPM continues. In 2011, up to 2.6 times the maximum permissible concentrations of chlorine ions were detected, as well as elevated levels of other pollutants, including volatile phenols and mineral substances (Annex V).

In February 2013 the Russian government decided to close the BPPM and the final elimination of its pollution is planned by 2020. The government will then be faced with the complex task of rehabilitating the shore of Lake Baikal, which is an extremely expensive undertaking that requires unique technological solutions.

Figure 4.4.2.d: The Baikalsk Pulp and Paper Mill on the western shore of Lake Baikal.

Table 4.4.2.c: Amounts of pollutants released into Lake Baikal by the Baikalsk Pulp and Paper Mill in 2007 (in metric tons). Source: RIA Novosti[48]

Chemical	Amount (metric tons)	Chemical	Amount (metric tons)
Sulfates	5,921.2	Methanol	5.2
Chlorides	4,203	Terpentine	3.73
COD	1,847	Aluminium	2.69
Lignin	333	Chloroform	2.56
BOD total	317.1	Petroleum products	2.0
Suspended substance	140.7	Formaldehyde	0.35
Sulphate soap	60.8	Phenols	0.29
Nitrates	14.22	Furfural	0.008

[48] http://en.rian.ru/infographics/20100122/157651199.html

Table 4.4.2.c: Production and processing of waste by the Baikalsk Pulp and Paper Mill between 2005-2011

Indicator	Annual amount of waste (tons)						
	2005	2006	2007	2008	2009	2010	2011
Operational period (months)	12	12	12	9	-	6	12
Total waste produced	121,586	145,582	150,057	136,685	15,746	42,382	19,1204
I class of danger	1,081	0,587	0,656	0,510	0,272	0,127	0,589
II class of danger	0,135	0,373	0,567	0,519	0,151	0,260	0,229
III class of danger	82,249	45,808	33,543				
IV class of danger	97,986	54,821	12,1437				
V class of danger	23,516	90,714	28,584				
Waste buried at designated locations	62,398	103,959	no data	no data			no data
Total neutralized waste	66,023	71,373	25,436	26,347	1,130	1,090	19,574
Processed at BPPM	64,281	70,517	no data	26,259	9,578	59,975	no data
Transferred elsewhere for recycling and disposal	1,742	856	no data	88.5	1,120.4	1,030.0	no data

Several industrial hubs exist in the in the Republic of Buryatia, which have been indicated as significant point pollution sources (also see table 4.4.1.a). The Ulan-Udensky industrial hub, which includes thermal power plants, aircraft and locomotive repair enterprises, and oil storage depots, produces approximately 40 million m^3 of wastewater per year. In addition, over 4.5 million ton of hazardous waste has accumulated near this industrial hub.

The Nizhneselenginsky industrial hub, which is located 50 km from the Selenga River Delta, produces over 400 thousand tons of waste per year, and over 3 million ton of hazardous waste has accumulated in its vicinity. Selenginsk village discharges 2 million m^3 of wastewater into the Selenga River every year, with a pollutant mass of approximately 1 thousand ton.

Another important polluter in the Buryatia region is Gusinoozersky industrial hub. In 2005, a total of 3.1 million m^3 wastewater containing 1.5 thousand tons of contaminants were discharged in Lake Gusnoe, which connects to the Selenga River.

Polluted wastewater from metallurgical and woodworking industries in Petrovsk-Zabaykalsky, Zabaykalsky Krai, is released into the Khilok and Chikoy River, which are main tributaries of the Selenga River. In total, industrial enterprises in the Zabaykalsky Krai release over 20 million m^3 of wastewater per year. Furthermore, industries in Zakamensky and Kyahtinsky (i.e. fluorspar mine) contribute substantially to pollution of the Selenga River.

A relatively recent phenomenon is the increasing amount of garbage and liquid waste produced by a growing amount of tourists and recreational visitors of Lake Baikal. Coastal summer recreation centres on the lake shore do not have treatment facilities, which raises concerns about potential pollution.

Figure 4.4.2.e Left: Discharge of polluted water into the Modonkul River, a tributary of the Dzhida River, near the Dzhida tungsten and molybdenum plant. Right: Discharge of polluted water in the Mengen-Sheno River, Republic of Buryatia. Photos by E. Batotsyrenov.

PERSISTENT ORGANIC POLLUTANTS

Persistent organic pollutants (POPs) were also identified as an important threat to the health of ecosystems and people in the Baikal Basin. POPs are notable for their toxicity, and high resistance to photolytic, chemical and biological decomposition. They are characterized by low solubility in water and high solubility in fats, which leads to accumulation in the fatty tissue of organisms.

In Mongolia, 7 POP substances were banned in 2003: aldrine, dieldrine, DDT, chlordane, heptachlor, toxaphen, and aldrine. The Russian Government has banned the production and use of 8 POP pesticides. Besides their presence in pesticides, contamination with POPs can also occur through the use of hexachlorobenzene by the military to produce smoke curtains. Power supply system (transformers, capacitors), as well as hydraulic oil for pumps etc., contain polychlorbiphenyls (PCB). Atmospheric release of dioxins and furanes can occur by burning of waste products under high temperatures.

Between 2004 and 2005, the Government of Mongolia carried out an inventory of possible sources for the generation of dioxins, furans, and other POPs. It was found that slack produced by the mining industry contributed 86.8% of the emission of dioxins and furans. An additional 7% was contributed to the incineration of househould wastes.

Hexachlorocyclohexane (HCCH) isomers are also among the POPs that are of concern in the Baikal Basin. HCCH is a pesticide that is currently banned but was widely used in the past as a forest pest killer. Between 1960-2003, a total of 136 tons of HCCH was used in the Selenge River Basin in Mongolia. The pesticide was also intensively used in Russia. Because of the persistance of these toxines, they continue to be present in soil and water resources in the basin even after their use has been banned.

Several studies demonstrated increasing levels of agro-chemicals such as DDT and others in Lake Baikal, especially towards the southern region of Baikal. Concentrations of DDTs and PCBs were highest in the southern basin and the Selenga region, indicating local sources contributing to both atmospheric and riverine inputs (Kucklick et al. 1994, Iwata et al. 1995).

Furthermore, the Baikal Pulp and Paper Plant uses active chorine for its bleaching process, which leads to the release of a range of persistent and toxix of chlorophenols. In addition, the production of aluminium results in the release of polyaromatic hydrocarbons (PAHs). Aluminum plants in the towns of Shelekhov and Bratsk in Irkutsk Oblast have been identified as the sources of large amounts of toxic PAHs released into the environment.

ATMOSPHERIC POLLUTION

Atmospheric deposition of pollutants is also a growing environmental and human health threat in the region, and it has been suggested that this form of chemical deposition poses an even larger threat to the ecosystems in the Baikal Basin than point-source water pollution (Kokorin and Politov 1991, Galaziy 1989, Stewart 1990). Sources of atmospheric pollution include all the industries in the region. Unlike point-source pollution, which is typically much more localised, atmospheric pollutants have the potential to be carried across very long distances. Therefore, they can have detrimental effects on remote regions in the Baikal Basin, not only directly affecting water quality but also indirectly effecting vegetation in the catchment area. Data obtained from sediment cores in Lake Baikal indicates that significant influxes of atmospheric pollution in the region started around the 1930s and 1940s (Mackay et al. 1998).

Ulaanbaatar is increasingly suffering from smog problems caused by industrial activities as well as rapidly increasing human populations. The majority of the 1.2 million inhabitants of this city do not have access to the city power grid and use charcoal for heating and cooking. As a result of the powerful Siberian winds, air pollution and resulting acid rain can be distributed over many kilometres distance.

Air pollution is also a significant problem in the Russian territory of the Baikal Basin (Table 4.4.2.d and 4.4.2.e). Several of the towns in the Republic of Buryatia are included in the atmospheric pollution priority list of the Russian Federation. Measurements of atmospheric pollution in Ulan-Ude in 2011 indicated that particulate matter was 4.2 above the maximum permissible concentration (MPC), benzo(a)pyrene 10 MPC, and nitrogen dioxide 4.2 MPC.

In Selenginsk, particulate matter was 3.8 MPC, formaldehyde 1.6 MPC, benzo(a)pyrene 9.4 MPC, and nitrogen dioxide 2.8 MPC. Measurements in the city of Gusinoozersk indicated that particulate matter was 2.0 MPC, nitrogen dioxide 1.8 MPC. In the town of Kyakhta, particulate matter was 1.2 MPC, and nitrogen dioxide 1.1 MPC. In Petrovsk-Zabaykalsky the average annual concentration of benzo(a)pyrene exceeded the MPC 3.8 times, and monthly averages were found to exceed the MPC 9.1 times. Particulate matter exceeded the MPC 1.4 times, and carbon monoxide 4.6 times.

Table 4.4.2.d: Sources of atmospheric pollution in the Russian territory of the Baikal Basin. Source: Makuhin and Potyomkin (2012).

Source of emissions	Contribution, mkg/m3	
	Sulphates	Nitrates
Cheremkhovo-Usolye-Siberian-Angarsk	9	10
Irkutsk-Shelekhov	9	5
Slyudyanka	12	9
Baikalsk	41	55
Kamensk-Selenginsk-Ulan-Ude	29	21

In general, over the last 60 years, pollutants indicative of fossil fuel combustion, i.e., spheroidal carbonaceous particles (SCPs) have significantly increased in the Baikal region (Rose et al. 1998). Concentrations of these particles in Baikal show spatial differences, with highest concentrations found in the southern basin, where industrialization and urbanization are highest. Small increases are also evident in the north basin, where new centers of urbanization have been developed in recent decades (e.g. Severobaikalsk). Differences in atmospheric deposition are also related to seasonal aspects, and the non-uniform distribution of precipitation in the Baikal Basin (see 2.1.4).

The contribution of atmospheric deposition to the overall chemical balance in Lake Baikal itself is estimated to range between 2-6%, although for some heavy metals it is 30-40% (Hodzer and Sorokovikova 2007). Near urbanised areas, the majority of metals is deposited in insoluble form, whereas near rural areas solubale metal compounds prevails (Onishchuk and Hodzher 2009).

Depending on the time of the year, precipitation can contain 50-100% acidifying components, which are deposited in Lake Baikal (Hodzher 2005). Waterways in the Baikal Basin show a marked increase in sulphate-ions, and decrease in hydrocarbon-ions as a result of acidification (Sorokikova et al. 2009). Areas that are leeward from the regional industrial centers are the most sensitive to acid precipitation, even if they are at hundreds of kilometers distance (e.g. the northern slopes of the Hamar-Daban ridge, northwest coast of Lake Baikal).

Table 4.4.2.e: Indicators of atmospheric pollution in the Russian territory of the Baikal Basin (mkg/m3), measured between 2000-2011. Source: MNR (2012), FSHEM (2012).

Sample Site	Year	Mineral substances	Organic substances	Almost insoluble substances	Total
Baikalsk	2000	15,8	7,62	19,8	43,22
	2001	37,3	10,8	28,4	76,5
	2002	37,7	17,7	12,6	68
	2003	28,7	2,1	14,7	65,5
	2004	21,6	19,4	22,6	63,6
	2005	19,1	10,7	11,1	40,9
	2006	25,2	16	12,9	54,1
	2007	36,8	21,7	11,8	70,3
	2008	53,2	10,5	50,5	114,2
	2009	10,3	23	112,5	145,8
	2010	26,2	22,9	15,4	64,5
	2011	24,4	12,8	20,2	57,4
Hamar-Daban Station	2000	27,2	9,2	9	45,4
	2001	19,3	3,1	4,9	27,3
	2002	20,1	10,8	16,1	47
	2003	32,2	14	5,1	51,3
	2004	27	12,2	7	46,2
	2005	33,2	7,8	10	51
	2006	23,4	3,7	4,2	31,3
	2007	28,7	15,7	11,3	55,7
	2008	30,9	29,6	73,9	134,4
	2009	29,1	5,2	11,1	45,4
	2010	20,2	5,4	7,8	33,4
	2011	27,4	11,8	11,7	50,9
Head of Angara River Station	2000	9,8	12	34,1	55,9
	2001	6,9	6,9	20,6	34,4
	2002	8,8	3,4	12,8	25
	2003	15,1	15,8	30,1	61
	2004	7	14,6	14	35,6
	2005	7,7	7,7	15	30,4
	2006	10,1	10,2	16,6	36,9
	2007	11,4	14,2	23,8	49,4
	2008	6,7	11,1	28,2	45,9
	2009	7,8	9,4	43	60,2
	2010	7,8	14,3	25,9	48
	2011	7,4	10,1	30,1	47,6
Huzhir Station	2000	5,06	2,9	8,2	16,16
	2001	4,4	3,4	11,1	18,9
	2002	2,1	2,4	7,2	11,7
	2003	2,6	6,7	20,6	29,9
	2004	3,5	2,7	25,1	31,3
	2005	2,3	2	9,9	14,3
	2006	2,9	2,5	6,3	11,7
	2007	3,8	5,1	19,5	28,4
	2008	11,6	8,9	35,6	56,2
	2009	3,5	22	62,5	88
	2010	2,5	24,9	24,8	52,2
	2011	3,7	2	32,9	38,6

TRANSBOUNDARY PROBLEM: CHEMICAL CONTAMINATION

ROOT CAUSES

- Growing human populations and increased demand for food, water, electricity, housing, products, and economic growth
- Inadequate governance frameworks
- National macro-economic policies
- Global climate change (cross-cutting issue)

UNDERLYING CAUSES

- Lack of mainstreaming of biodiversity protection and environmental management objectives into sustainable development actions
- Inadequate legal frameworks
- Insufficient law enforcement
- Insufficient investment in pollution prevention
- Insufficient investment in water treatment
- Lack of adequate water quality monitoring systems

SECTORS & PRACTICES → **IMMEDIATE CAUSES**

Industry
- Production of wastes from heavy and light manufacturing, agro-processing, and petroleum refinement

→ Discharge of harmful pollutants, including heavy metals, POPs, and other toxins

Energy Production Industry
- Burning of charcoal to produce thermal energy

→ Discharge of atmospheric particulates

Mining
- Production of wastes
- Use of toxic chemicals

→ Discharge of harmful pollutants, including mercury

Transport
- Disposal of waste by ships
- Use of petrol

→ Discharge of harmful pollutants
→ Discharge of atmospheric particulates

Agriculture
- Use and storage of pesticides

→ Discharge of harmful pollutants

Urbanisation
- Production of solid and liquid waste
- Use of charcoal for cooking and heating

→ Discharge of harmful pollutants
→ Discharge of atmospheric particulates

Defence
- Storage of chemicals in defective facilities

→ Discharge of harmful pollutants

IMPACTS

Environment
- Pollution of groundwater and surface water systems
- Decreased viability of fish stocks
- Accumulation and bio-magnification of toxins in the food chain
- Loss of biodiversity

Socioeconomic
- Human health issues
- Increased costs for healthcare
- Increased costs for sanitation
- Increased costs for water purification
- Increased costs of alternative water supplies
- Economic loss

Figure 4.4.2.f Causal chain analysis of chemical contamination in the Baikal Basin.

4.4.2.1 Present and Future Impacts

Contamination with chemical pollutants can have grave impacts on the environment as well as on human health. Bioaccumulation and biomagnification, where toxins pass through trophic levels ad become exponentially more concentrated in the process are real concerns with chemical pollution, particularly with pesticides, POPs and heavy metals. Chemical pollution also has economic impacts, including those associated with the costs of healthcare, increased costs for sanitation and drinking water purification, as well as the costs of providing alternative water supplies (Figure 4.4.2.d).

As a result of atmospheric pollution and acid rain, the coniferous forests in the Baikal Basin are increasingly threatened. High altitude forests are especially vulnerable as they are often surrounded by clouds and fog which are more acidic than rain. In the Chandmane' valley in Mongolia, forests that are located in the prevalent wind direction of the municipal heating station have been significantly reduced as a result of contaminated air. Larch and pine forests in the vicinity of Lake Baikal are also exhibiting degradation as a result of air pollution[49]. The lower pH and higher aluminium levels that are associated with acid rain can also cause damage to fish and other aquatic animals. At pH lower than 5, most fish eggs cannot hatch. Soil chemistry and soil biology can also be seriously impacted by acid rain. Acid rain does not directly affect human health. However, the particulates responsible for acid rain (sulfur dioxide and nitrogen oxides) do have an adverse effect. Increased amounts of fine particulate matter in the air do contribute to heart and lung problems including asthma and bronchitis.

The disappearance of rheophil organisms such as the stonefly (Plecoptera) and mayfly (Ephemeroptera) larvae) at several sites in Mongolia has been linked to chemical water pollution by the mining industry. This has also lead to a decrease in the abundance of food for rheophilic fish species, including taimen, lenok, and grayling. In combination with fishing pressure, and degradation of the spawning habitats, this has lead to a drastic reduction of these fish species, which are currently listed as endangered in the Red Books of Mongolia and Russia.

Mercury is a highly toxic element that can effect wildlife as well as humans. Even at very low atmospheric deposition rates in locations remote from point sources, mercury biomagnification can result in toxic effects in consumers at the top of these food chains. The exact mechanisms by which mercury enters the food chain remain largely unknown and may vary among ecosystems. Certain bacteria can convese inorganic mercury to methylmercury, which has a greater toxicity and can be absorbed by plankton. Because animals accumulate methylmercury faster than they eliminate it, animals consume higher concentrations of mercury at each successive level of the food chain. Small environmental concentrations of methylmercury can accumulate to potentially harmful concentrations in fish, fish-eating wildlife and humans. Mercury levels in urine of inhabitants of gold mining areas in Mongolia were found to be above internationally accepted health levels (Steckling et al. 2011). Because mercury has also been used in gold mining in Russia, and because it can be transported through aquatic ecosystems, it is likely that this problem occurs throughout the Baikal Basin.

The elevanted levels of persistent organic pollutants (POPs), polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT) are also a concern in the Baikal Basin. In Lake Baikal itself, the Baikals Pulp and Paper Mill caused locally elevated levels of persistent organic chlorine compounds in the southern basin. Although the interpretation of trends is complicated, research done in 1994 provided indications of organochlorine contaminants in Lake Baikal (Kucklick et al. 1994). Bioaccumulation of organic chlorine compounds, including DDT and PCBs, in the nerpa is clearly a problem, even though the physical environment of Baikal (water and sediments) contains relatively low levels of pollutants. In the late 1980s, thousands of nerpa died from a morbillivirus, and environmentalists suggested that the immune systems of the seals had been compromised by increasing pollution levels, including POPs and heavy metals (Mackay 2002).

The quality of the drinking water in the Baikal Basin is also a real concern. Consumption of drinking water polluted with chemicals such as arsenic, fluoride, selenium, uranium, iron, manganese and agricultural chemicals can cause significant human health issues. In the Republic of Buryatia, 42.9% of the population has access to centralised water supply services (80-85% of these are located in Ulan-Ude and the north Baikal region) (MNR 2012). Analyses in 2011 indicated that the drinking water from the centralised supply sources did not comply with water quality standards.

Due to the degradation of the pipelines, surface water quality in the decentralised distribution networks was worse, with 12.5% of samples below santitary-chemical standards, and 4.7% below microbiological

[49] www.bww.irk.ru/baikalinfo/baikalpollution.html

standards. Furthermore, organoleptic characteristics (color, turbidity) were below standards in 84.1% of samples, and toxic chemicals exceeded the maximum concentration limit in 15.9% of surface water samples. In Tarbagataisky, Selenginsky, Pribaikalsky, Horinsky, Kabansky, and Barguzinsky, water quality indicators were several times worse than the average (State Report Buryatia 2012).

4.4.2.2 Challenges for Future Sustainable Management

There is increasing awereness among key stakeholders in Mongolia and Russia about the environmental and human health issues that are associated with chemical pollution in the Baikal Basin. In both countries laws have been adopted that aim to reduce or control pollution (see 5.3.2). Nonetheless, chemical pollution problems are ongoing. Increased efforts are required to reduce the risks of future pollution, and clean up areas that have been contaminated.

Accidental chemical pollution spills are a major concern for environmental sustainability. In April 2007, the waste treatment plant in the center of Khongor soum north from Ulaanbaatar spilled over, and created a pond of contaminated wastewater of approximately 560 m^2, polluting the soil and a drinking water well. The plant also treats waste from the Mongolian Industrial Chemical Company gold mine that is situated near Khongor. Soil and water analysis done by UNEP demonstrated the presence of heavy metals, boron, chromium and lead in the wastewater, as well as sources of arsenic and mercury. Following the spill, health symptoms were reported by the local population and in livestock. Upon request of the Mongolian government, WHO conducted a field mission to investigate the health impacts associated with the incident. Although the results could not find any direct evidence that the incident had caused measurable health impacts, it does underline the urgent need to implement strict environmental regulations and contingency plans for chemical spills (UN 2008).

The following topics were identified that require urgent action to control chemical pollution in the Russian territory of the Baikal Basin:

- Cleaning up of the pollution caused by the Baikalsky Pulp and Paper Mill.
- Proper disposal of military explosive storage sheds near Gusinoe.
- Cleaning up of the contaminated lake near Ulan-Ude (LVRZ plant).
- Detoxification and cleaning up of slag and ash dumps of boiler and thermal power stations.
- Renovation of waste treatment facilities.
- Renovation of existing and construction of new controlled disposal sites for solid municipal, mining and industrial wastes.
- Establishment of site specific monitoring network around existing and potential pollution sources.

The problem of providing the population in the Baikal Basin with quality drinking water requires a comprehensive and urgent solution within the framework of targeted programs adopted at the national and municipal levels.

The processing of waste and wastewater from mining and other industrial enterprises as well as from domestic sources needs to be improved in both Mongolia and Russia to reduce the risks of environmental and human contamination. Furthermore, reduction of initial pollutant emissions should take place. Air, soil and water pollution can be prevented and controlled through a range of solutions, including the use of better designed equipment.

The design of national and transboundary chemical pollution prevention programs is recommended (also see table 4.4.2.2). The results of such programs should be monitored by environment agencies, and the data should be shared at the transboundary level (see 4.3.2.2). Furthermore, transboundary harmonisation of relevant legislative aspects (5.3) is recommended. In addition, institutional needs assessments should be implemented, and targeted programs developed to enhance the existing capacity for monitoring and enforcement of legislation.

Table 4.4.2.2: Prerequisites and considerations for the implementation of pollution control programmes.

Pollution Control Prerequisite	Consideration for Implementation at the National and Transboundary Level
Pollution control legislation and establishment of administrative bodies.	Level of authority that should be afforded to local and national level.
Environmental standards and emission limits.	Harmonisation at transboundary and international level.
Pollution control by local authorities and CBO's / NGO's	Ability to ensure enforcement of legislation.
Police prosecution and penalties for pollution offences (based on the Polluter Pays Principle)	Ability to ensure enforcement of legislation.
Financial assistance for pollution reduction.	Level of industrial development; Prioritisation of national Government; Commitment from the international community.
Industrial development planning.	Level of industrial development; National and Transboundary planning structures.
Environmental assessments.	Level of available expertise in pollution effects and technologies; Willingness to share results at the transboundary level.
Pollution control research and surveys.	Level of available expertise; Willingness to share data at the transboundary level.
Training of environmental pollution control personnel.	Level of available expertise in pollution control technologies.
Public awareness of pollution issues.	Establishment of public awareness and outreach programs at national and transboundary level.

4.4.3 INCREASED SUSPENDED SOLIDS AND SEDIMENTATION

Over the past decades, increased amounts of suspended solids have been detected in the atmosphere as well as in surface water in the Baikal Basin, which is likely caused by the combined transboundary effects of deforestation, unsustainable landuse practises (see 4.3), mining activities (3.4.6), and inadequate treatment of wastewater (4.4.2).

Between 2011-2012, the Moscow State University together with the Baikal Institute for Nature Management established a database of turbidity and flow weighted turbidity, sediment grain size composition, distribution of turbidity and suspended sediment chemistry and sediment (mineralization, nitrogen and phosphorus, conductivity and heavy metal content) for the Selenga River Basin.

Minimal sediment loads of 1,34-3,74 tons/day were found in small rivers in the SRB, whereas maximal loads of 15,000 tons/day were found in the upper Orkhon River during flood events. At the border between Mongolia and Russia sediment load of 2,220 tons/day was estimated in 2011. The total sediment budget Downstream of Orkhon River (below the confluence with the Tuul River) was 1,145 tons/day. Below the Selenga-Orkhon confluence, the total sediment yield reached 2,515 tons/day (Belozerova 2012).

Deforestation is often a main cause of erosion and sedimentation in catchment areas, and is also a main cause of concern in the Baikal Basin (see 4.2.2). While erosion on mountain slopes typically decreases with several factors during only 3-5 years after logging activities on slopes have ceased, the silt load in rivers can remain high for decades afterwards (Onunchin et al. 2009).

Overgrazing by livestock and other unsustainable landuse practises has been demonstrated to contribute substantially to land degradation and erosion processes in the Baikal Basin (see 4.2.3).

Research done in Zamaar part of Tuul River catchment demonstrated that substantial areas of floodplain had been degraded, and large quantities of suspended sediment have been introduced into the river (Farrington 2000, Stubblefield et al. 2005). These losses and threats are predominantly thought to be the result of the inefficient and noncontemporary mining methods used by mining companies in the region (Figure 4.4.3.a, Dallas 1999; Farrington 2000, Bazuin 2003). Placer mining activity, as currently practiced in parts of the Baikal Basin, results in the disruption of vast floodplain areas. Reseach done in 2002 indicated that in areas in proximity of placer mining activities, large sources of extremely turbid water could be flushed into rivers during flooding events (Stubblefield et al. 2005). Also see Annex V for recent measurements of suspended substances in rivers in the Mongolian territory of the Baikal Basin.

Figure 4.4.3.a Sediment-loaded water is being discharged directly into the Tuul River by a mining company in Mongolia. Photo: Jeff McCusker (1999), in Farrington (2000)

Interestingly, a study that focused on the influences of climate change and landuse on change in fluvial systems in southern East Siberia revealed an increase of erosion process intensity in the first two-thirds of the 20th century in the SRB and a reduction of this intensity in the last third of the century (Korytny et al. 2003). This could be related to improved landuse practices in upstream areas of the Baikal Basin.

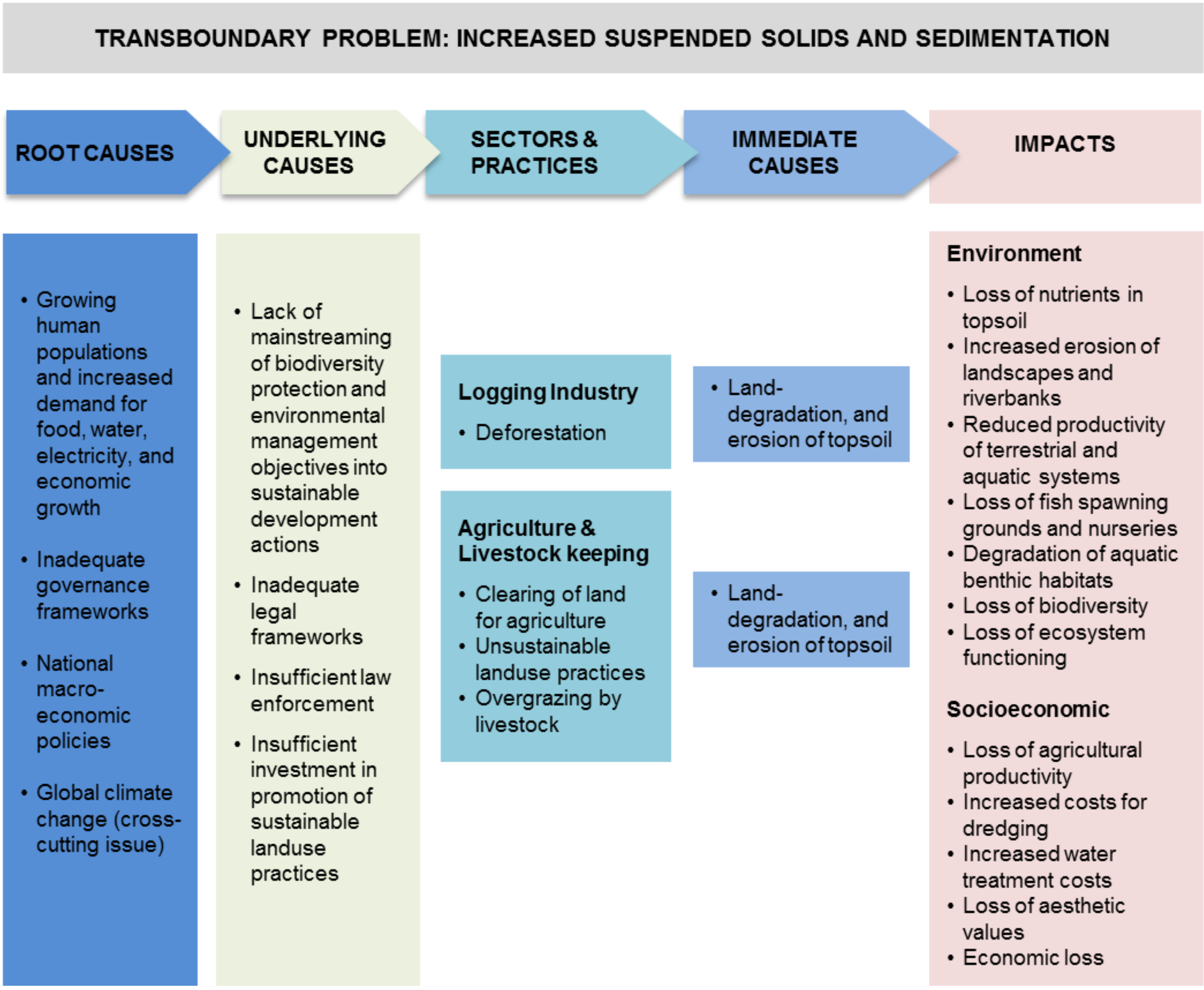


Figure 4.4.3.b Causal chain analysis of increased suspended solids and sedimentation in the Baikal Basin.

4.4.3.1 Present and Future Impacts

Increased erosion and sedimentation may severely degrade the water quality of the rivers in the Baikal Basin, and ultimately also Lake Baikal itself. Erosion of topsoil and loss of nutrients results in reduced productivity of agricultural areas and natural vegetation. Severely erodes areas, particularly mountain slopes, may take many years to recover. Furthermore, severe erosion on mountain slopes can induce landslides, particularly in combination with minor or major earthquakes. In addition, erosion can cause increased instability of river banks, which may partially collapse as a result.

Besides contributing to land degradation and sedimention, one of the problems associated with poor mining practises is that pits are either abandoned after operation closes, or mine reclamation is not performed adequately. Often, mine pits are backfilled with tailings and overburden, and only a thin layer of topsoil is spread over the replaced materials (Farrington 2000). Furthermore, invasive weeds may cover the reclaimed land, further reducing the possibilities for natural vegetation to recover. As a result, it takes a substantial amount of time for natural vegetation to recover, and erosion and sedimentation processes continue for a protracted period after the mine has been closed.

Sedimentation of suspended particles and associated nutrients in aquatic ecosystems can have direct as well as indirect detrimental effects on flora and fauna. Alevated levels of sedimentation in aquatic ecosystems in the Baikal Baisn has been indicated as a potential threat to habitat for taimen, grayling (*Thymallus arcticus arcticus*), lenok (*Brachymystax lenok*), burbot (*Lota lota*), Siberian roach (*Rutilus rutilus*), and the endangered Baikal sturgeon (Matveyev et al. 1998; Baasanjav and Tsend-Agush 2001).

Evidence from the African Rift lakes has shown that high levels of sediment discharge negatively affects species assemblages of fish and benthic invertebrates (Donohue & Irvine 2004, Donohue et al. 2003, Eggermont & Verschuren, 2003; McIntyre et al. 2004). If high levels of sedimentation continues, this could ultimately lead to loss of ecosystem functioning. This counts especially for shallow aquatic ecostems, such as river deltas and marshes.

The increase of suspended solids and sedimentation in aquatic ecosystems also has economic impacts. Loss of agricultural productivity results in increased food prices and costs to find alternative food sources. The blanketing of aquatic habitats can affect fisheries, by causing a loss of fish spawning grounds and fish nurseries. Furthermore, sedimentation near hydropower stations and harbours will lead to increased costs for dredging. In addition, high levels of suspended solids result in increased costs for water purification systems.

4.4.3.2 Challenges for Future Sustainable Management

At present, insufficient data is available to generate a comprehensive overview of the effects of erosion and sedimentation on terrestrial productivity and viability of aquatic biota in the Baikal Basin. A more comprehensive study is needed to determine the magnitude of these impacts on a national and transboundary scale. Furthermore, an assessment is necessary of the overall economic impacts of erosion and sedimentation on the relevant sectors (e.g. agriculture, livestock keeping, hydropower generation, tourism).

A basin-wide analysis of land degradation and erosion hotspots using satellite images would be beneficial. The results could subsequently be used as a basis for a strategy for erosion and sedimentation reduction. Such a strategy could include reforestation and promotion of sustainable land management practes, as well as improved mine reclamation procedures so that natural vegetation can re-establish itself in a shorter time period.

Data derived from regular monitoring of sedimentation parameters in the main rivers of the Baikal Basin should be shared at the transboundary level (see 4.3.2.2).

4.4.4 MICROBIAL PATHOGENIC CONTAMINATION

Microbial pathogenic contamination of water resources may result from insufficiently treated wastewater (also see 4.4.2.1), use of bio-control agents such as bacteria, fungi and viruses, inappropriate discharge of medical waste, and inadequate disposal of infected animal carcasses.

Water quality monitoring data from the centralised drinking water system in Buryatia indicated that in 2011, 10.8% of samples were below santitary-chemical standards, and 2.5% were below microbiological standards. Data collected in Mongolia and Russia in the framework of the Transboundary Waters Monitoring Program in 2012 indicated that 55.5% of the surface water samples were not in compliance with the standards.

In the Russian territory of the Baikal Basin, the most acute pollution according to microbiological indexes was observed within the administrative borders of Ulan-Ude and in the Kyakhta district. In several surface water samples, the content of general coliform bacteria exceeded the ecological norms by 3 times while the content of thermotolerant bacteria exceeded the ecological norms by 14.9 times.

An important concern is the contamination of drinking water with pathogens such as coliform bacteria, Giardia protozoa, and Cryptosporidium parasites that can cause diarrhhoeal diseases. The problem typically arises as a consequence of water contamination by human or animal faecal matter containing pathogenic organisms.

Monitoring data indicated a steady increase of coliform bacteria in water samples over the past 5 years, which is assumed to be the result of insufficient treatment of wastewater. In the Selenge River Delta, the concentration of *Enterococcus* spp. ranged between 12-56 CFU/100 ml in summer and 8-50 CFU/100 ml in autumn.

Contamination of water resources with anthrax is also a concern in the Baikal Basin. Anthrax is an acute infectious disease that can affect almost all warm-blooded animals, including humans. It is caused by the bacterium *Bacillus anthracis*. The spores of B. anthracis can survive adverse environmental conditions. In animals, the disease usually causes sudden death. Cattle in the basin is regularly affected by anthrax outbreaks. Anthrax occurs in 30.5% of the Mongolian territory of the Baikal Basin, indicating a high risk of infection. Around 60% of the animals that were infected with anthrax during the past 10 years were located in the forest-steppe region of the Khovsgol, Zavkhan, Bulgan, and Arkhangai aimags.

From 1995- 2008 a total of 4 anthrax outbreaks were registered in Buryatia. Cattle diseased from anthraxs is buried in dedicated burial sites. In the Republic of Buryatia, a total of 189 sites exist for burial of diseased cattle, including 18 bio-thermal pits.

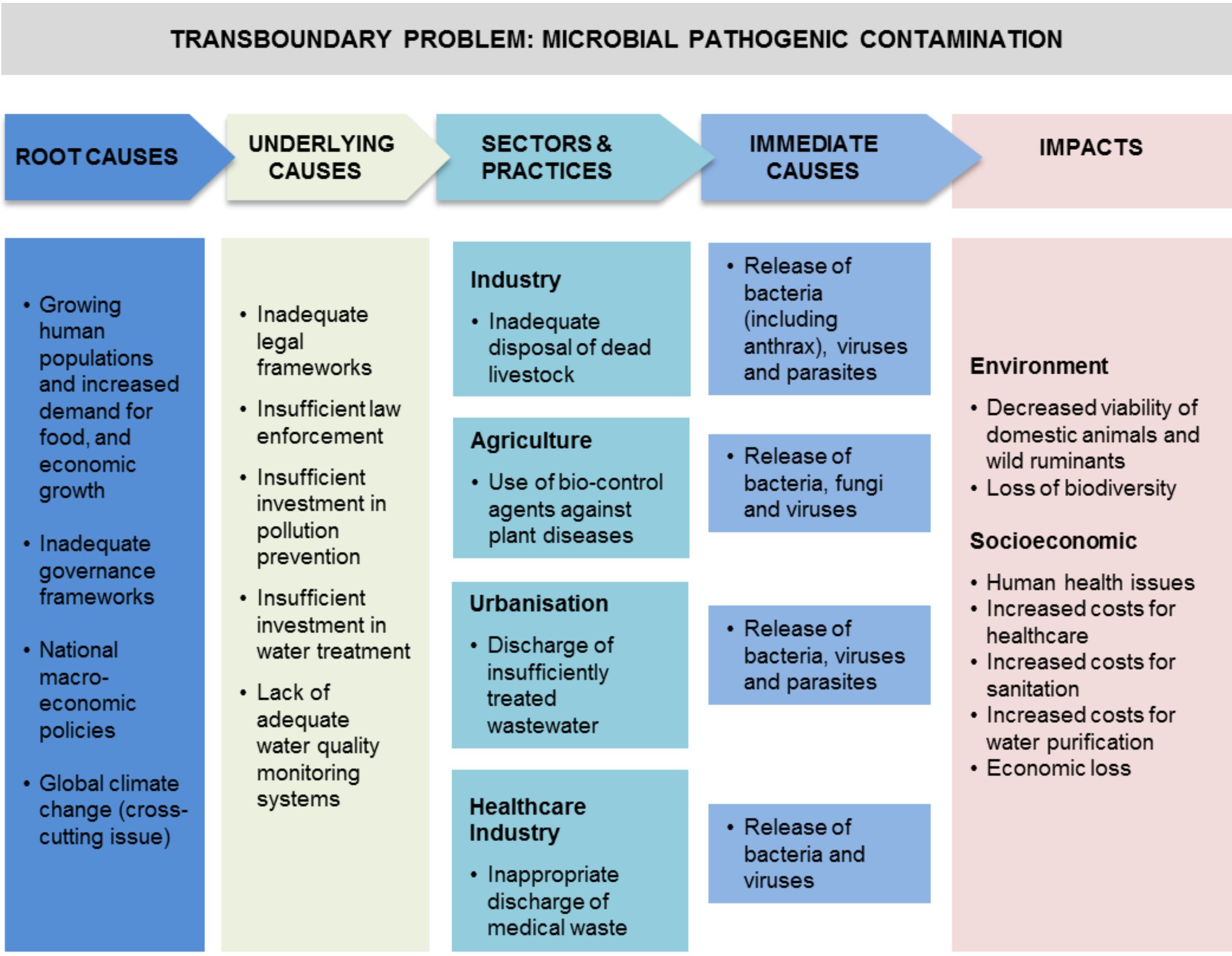


Figure 4.4.4.a Causal chain analysis of microbial pathogenic contamination in the Baikal Basin.

4.4.4.1 Present and Future Impacts

In the Russian territory of the Baikal Basin, high incidence of acute intestinal disorders such as diarrhoea, as well as viral hepatitis (VHA) have been associated with poor quality of drinking water. Children are especially vulnerable to these waterborne diseases. The incidence of acute intestinal disorders is almost 3 times higher, and VHA incidence among children is 2-2.5 times higher than in adults. Sanitary-epidemological parameters are significantly worse during flood periods, and are also worse in areas that are provided by the decentralised water system, compared to the centralised system.

Anthrax infection poses a threat to domestic animals such as cows, horses, goats, sheep, and pigs, as well as to wild ruminants. Anthrax also poses serious health risks to humans. In Mongolia, 291 people were registered to have died from anthrax infection between 1964-2011. Several cases of anthrax infection were registered in Barguzinsky district of the Republic of Buryatia (Russia) in 2008.

Elevated microbial contamination in rivers, including Selenga and its delta, and other nearshore areas in Lake Baikal limit the use of these sites for recreational purposes.

4.4.4.2 Challenges for Future Management

Although it is clear that microbial pathogenic contamination of water resources is a concern in the Baikal Basin, little long-term monitoring data is available about the magnitude of its effects on domestic animals and ruminant wildlife, as well as on human health. It would be recommendable to establish a transboundary mechanism that links water quality monitoring data (see 4.4.2.2) to data about livestock and human health issues.

Sanitation aspects such as improved wastewater and drinking water treatment, as well as the disposal of diseased animal carcasses need to be improved. Pathogenic disinfectation of water is technically difficult and costly. Draining through multiple layers of pebble and sand could be a solution, but it requires increased volumes of water. Because anthrax is extremely persistant and can survive in an inactive form in soil for very long periods, burial sites of diseased animals require strictly limited access and regular bacteriological control. Cleaning of anthrax-infested burial sites is difficult and costly.

4.4.5 ORGANIC POLLUTION AND EUTROPHICATION

Contamination of water resources wit organic substances including nitrogen (N), phosphorus (P) sources can have multiple causes, and can result from point- as well as nonpoint pollution sources. Insufficiently treated wastewater contaminated with faecal matter, detergents and oil hydrocarbons (including fuels and lubricants) forms a point sourcee of organic pollution.

Non-point sources include atmospheric deposition, and runoff from areas treated with fertilisers, herbicides and insecticides. Although herbicides and insectides have been used extensively in the Baikal Basin in the past (also see 4.4.2), the use of fertilizers has been relatively low. In the Mongolian territory of the basin, the total application of fertilisers is on average 1,1 kg per hectare per year (Source: Mongolian National Statistical bulletin, May 2013). Mostly chemical fertilisers are used, including ammonium nitrate, double super phosphate and potassium chloride.

Eutrophication occurs when aquatic environments become over-enriched with nutrients as a result of organic contamination. Eutrophication is a natural process that may occur as lakes age. However, human-caused, accelerated eutrophication (also called "cultural eutrophication") occurs more rapidly, and causes problems in the affected water bodies (see 4.4.5.1).

Significantly elevated levels of BOD_5 and nitrogen and phosphorus were detected in sampling sites along the Tuul, Kharaa, and Kgangal River in Mongolia (Annex IV), which is attributed to runoff from pasture with rapidly growing numbers of livestock (Hyodo et al. 2012, and see 4.2.3) as well as insufficient treatment of wastewater (4.4.2). Similarly, indicators of organic pollution were found in several of the rivers in the Russian territory of the Baikal Basin (Annex V).

Lake Baikal itself exhibits localised eutrophication, particulary in shallow waters near the Selenga River Delta (Tarasova et al. 1998, Mackay et al. 1998, Mackay 2002, Tarasova et al. 2006, Mackay et al. 2013). Furthermore, eutrophication has been observed in Lake Gusinoe, resulting from a combination of organic pollution and thermal pollution (Pronin et al. 1999, Pronin 2004, also see 4.4.6.1). The effluent river of Lake Gusinoe is a tributary of the Selenga River.

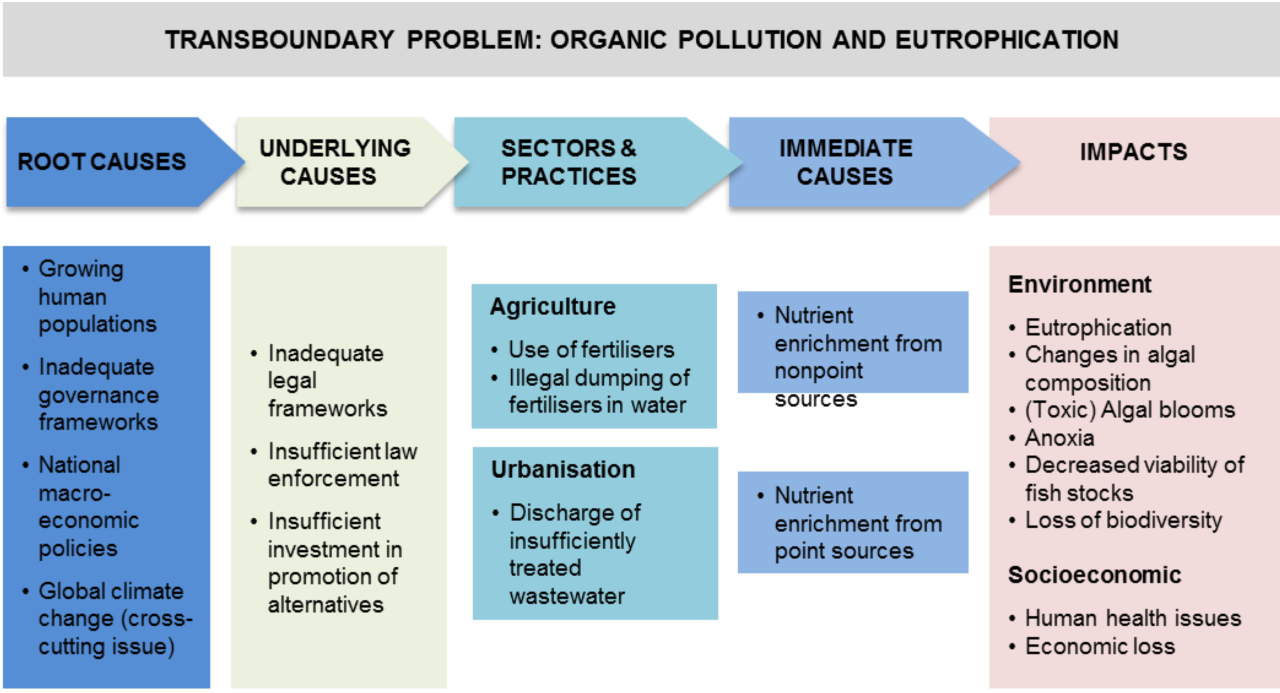


Figure 4.4.5.a Causal chain analysis of organic pollution and eutrophication in the Baikal Basin.

4.4.5.1 Present and Future Impacts

Elevated levels of nitrates are typically common in groundwater sources in agricultural areas. Pollution of water sources with nitrates can cause serious health problems in humans. Nitrate is converted into nitrite in the intestine, and can cause reduced oxygen uptake by the blood. Especially children are sensitive to nitritie poisoning. Furthermore, there are indications that nitrate and nitrite pollution is one of the key causes for the global decline of amphibean species.

Elevated levels of organic contaminants from pointsources and non-point sources in the Baikal Basin has resulted in localised eutrophication of Lake Baikal, particularly near the Selenga River Delta, as well as in Lake Gusinoe in the Republic of Buryatia. No data is available about eutrophication events in rivers in the Baikal Basin.

Eutrophication can cause changes in algal composition, and lead to rapid population explosions (algal "blooms"). In principle, the increase of organic components in the aquatic system has a fertilising effect that stimulates primary production. From a multiple use and sustainable water management perspective, eutrophication can have several undesirable consequences:

- Decrease of light penetration into the water. This occurs when the algae forms mats as a result of being produced faster than they are consumed by zooplankton. Diminished light penetration limits the productivity of plants living in deeper waters.
- Depletion of oxygen (anoxia). When the algae die and decompose, oxygen is consumed by bacteria. In addition, oxygen levels are lowered by the lack of primary production in the water layers that receive insufficient light.
- Death of fish resulting from a lack of dissolved oxygen (DO). Changes in fish community composition will occur, with species tolerant of low DO predominating the fish population. Changes in fish community composition has ramifications for the rest of the aquatic ecosystem as well, through changes in food webs. Essentially, the entire aquatic ecosystem changes with eutrophication, and loss of biodiversity is often the result.
- Some of the algal species that bloom as a result of eutrophication produce toxins. Such algae render the water unpalatable, and are toxic to fish and other animals. People who consume fish that have ingested toxic algae typically develop acute food poisoning.

Altough there are indications that localised eutrophication impacts phytoplankton and diatom communities in the southern parts of Lake Baikal (e.g. Tarasova et al. 2006, Mackay et al. 2013), no data is available on the effects on fish and other aquatic biota. In Lake Gusinoe , the combined effects of eutrophication and thermal pollution have resulted in rapid growth of toxic blue-green algae, as well as increased parasite infestation of fish (Pronin et al. 1999, Pronin 2004).

4.4.5.2 Challenges for Future Management

Although it appears that the amount of eutrophication of aquatic ecosystems in the Baikal Basin is limited at present, the lack of available data renders it difficult to make informed statements about the effects of increased organic pollution on aquatic ecosystems, biodiversity and human health aspects. Furthermore, there is no available data on the effects of organic contamination on groundwater systems in the basin.

4.4.6 THERMAL CONTAMINATION

Thermal contamination can occur when water is used as a coolant near a power or industrial plant and then is returned to the aquatic environment at a higher temperature than it was originally.

Very little data is available about possible termal contamination in the Mongolian terrirory of the Baikal Basin, although it appears that some of the wastewater from industral and domestic treatment facilities may discharge water with a higher temperature than the natural environment. For instance, water temperature measured in the Tuul River at 0.5 km downstream from the central wastewater treatment facility was 5.70°C, whereas 6km further the temperature had decreased to 4.10°C.

In the Republic of Buryatia, Russia, the main source of thermal contamination is the Gusinoozersk State Regional Power Plant (SRPP), which dicharges warm water into Lake Gusinoe. The Gusinoozersk SRPP takes substantial amounts of water[50] from the Zagustai River to produce hot water and steam for its turbines. The warm wastewater is discharged into the Lake Gusinoe, which has an area of 163 km^2 and a maximum depth of 25 meter. The amounts of warm water discharged into Lake Gusino between 2005-2011 ranged from 261.1-442.0 million m^3 (Figure 4.4.6.a).

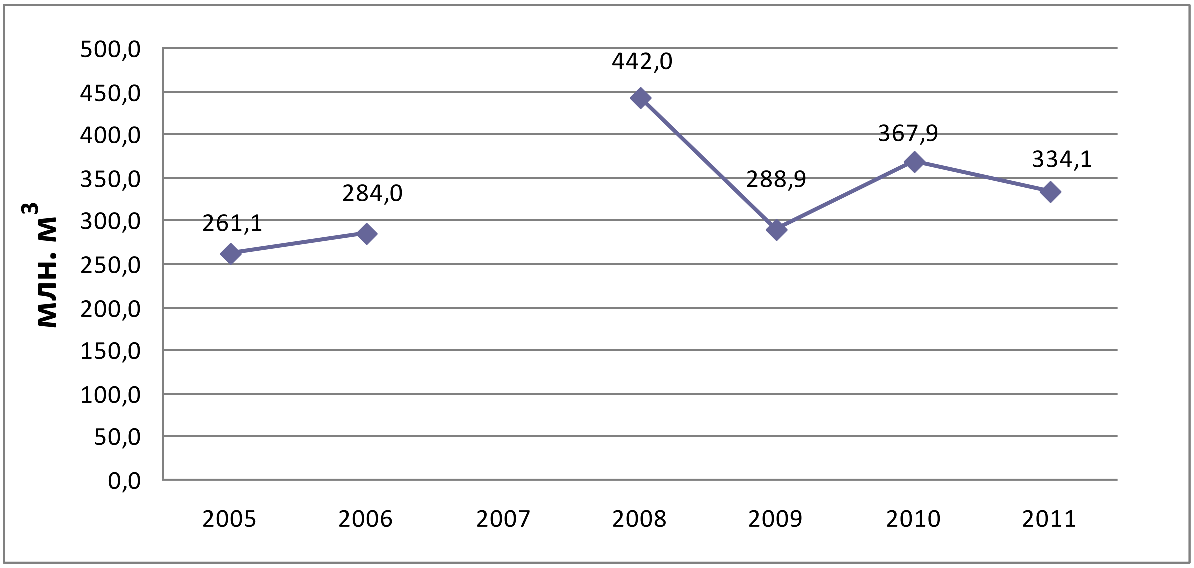


Figure 4.4.6.a Annual discharge of warm water (in million m^3) from the Gusinoozersk State Regional Power Plant in to Lake Gusinoe, Republic of Buryatia, Russia, between 2005-2011.

As a result of the discharge of warm water from the SRPP, the temperature in the upper water layers of the lake is 13–14°C higher than the lower layers. The temperature of the lower water layers in the vicinity of the SRPP is 1.5-2 higher than elsewhere in the lake. An unfrozen patch of water measuring about 2 km^2 is formed on the lake during the winter (Naganawa 2012).

50 Gusinoozersk State Regional Power Plant is estimated to account for 83.8% of the total surface water withdrawel in the Republic of Buryatia.

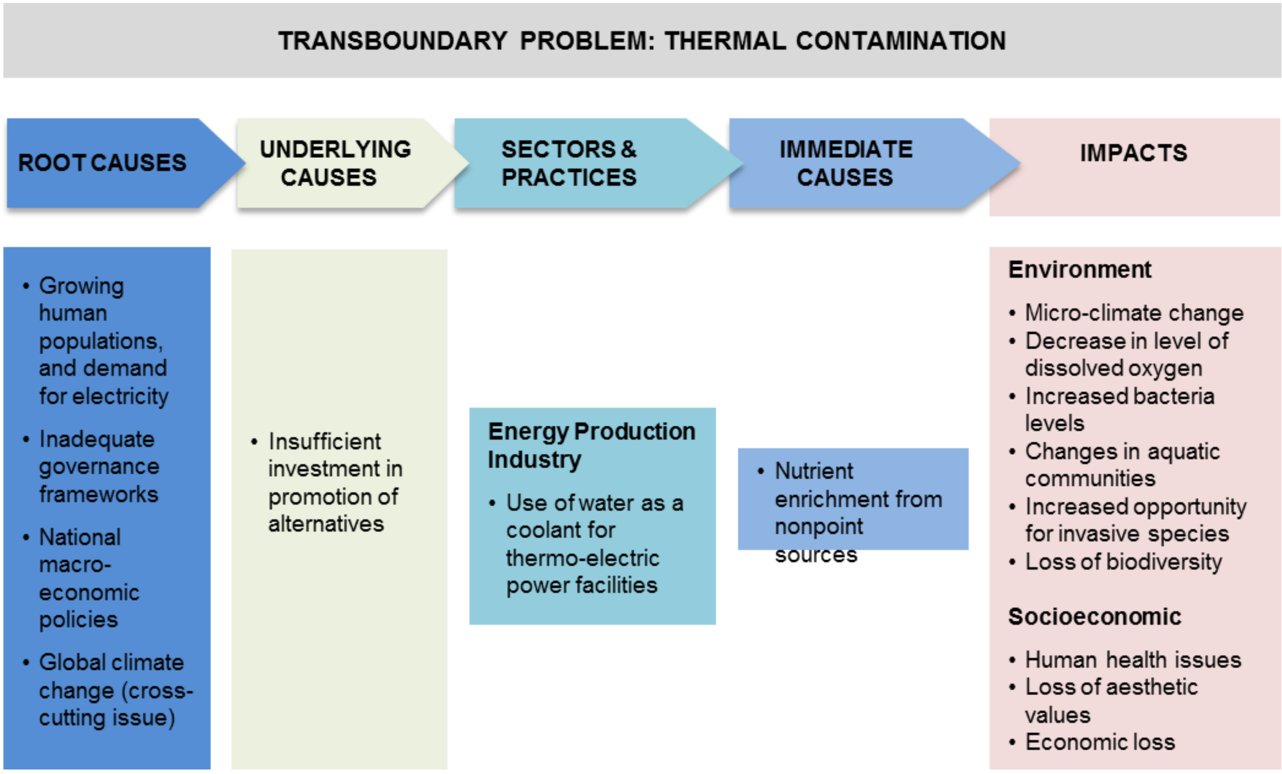


Figure 4.4.6.b Causal chain analysis of thermal contamination in the Baikal Basin.

4.4.6.1 Present and Future Impacts

Thermal contamination can lead to a local decrease in the dissolved oxygen level in the water while also increasing the biological demand of aquatic organisms for oxygen. The combination of increased organic pollutants and thermal contamination was indicated as the cause of toxic blue-green algal blooms in Lake Gusinoe (Pronin et al. 1999, Pronin 2004). Human health problems may result from consumption of fish that ingested toxic algae, including acute food poisoning.

In the 20 years that followed the construction of the Gusinoozersk Thermal Power Plant, the burbot (*Lota lota*) and the Siberian loach (*Noemacheilus barbatulus toni*) disappeared from Lake Gusinoe. Populations of lenok (*Brachymystax lenok*), Siberian grayling (*Thymallus arcticus*), and Amur sazan *Cyprinus carpio* subsp. have significantly declined, possibly due to weakened immune systems and increased parasite infections resulting from the combined effects of pollution, eutrophication and thermal contamination in the lake (Pronin et al. 1999, Pronin 2004, Naganawa 2012).

4.4.6.2 Challenges for Future Management

While thermal pollution does not have any transboundary impacts, its local biological and economic impacts can be severe. Due to the combination of chemical pollution (4.4.2), organic pollution and eutrophication (4.4.5) as well as thermal pollution in Lake Gusinoe, the costs for the production of clean drinking water are very high. An integrated water management approach that focuses on recycling of wastewater, improved wastewater treatment, and reduction of the emission of pollutants would significantly improve the health of the overall aquatic ecosystem, and drastically reduce the costs of water purification. Thermal pollution in other parts of the Baikal Basin should be avoided.


Photo by Urabazaev

4.5 PROBLEM AREA 4: UNSUSTAINABLE FISHERIES and WILDLIFE EXPLOITATION

4.5.1 DESCRIPTION & TRANSBOUNDARY RELEVANCE

Primary concerns around the sustainability of fisheries and wildlife expoitation in the Baikal Basin are the loss of biodiversity, as well as loss of potential stocks for human consumption. Populations of animals that are overexploited often suffer from changes in population structures. Prolonged and extensive overexploitation may result in loss of genetic diversity within a species. As a result, populations become less resilient against environmental changes.

This is a particularly pressing problem in areas that are under pressure from significant habitat degradation and ecosystem modification (see 4.3). Overexploitation of species in aquatic or terrestrial ecosystems where an increasingly limited number of appropriate habitats is available due to deforestation, unsustainable landuse and pollution, may result in biodiversity loss and ultimately the collapse of the ecosystem. As such, ensuring sustainability of fisheries and wildlife exploitation is a concern that is both relevant at the national and the transboundary level.

4.5.2 OVER-EXPLOITATION OF AQUATIC BIOTA

Little information is available about the extent of commercial and sportfishing in the Mongolian territory of the Baikal Basin. The Ministry of Nature and the Environment has been imposing limits for certain fishing activities, but due to the weak monitoring and evaluation, and poor organisational structure and management, there is a large discrepancy between the numbers of fish exported and the actual number of fish reported as caught. There is no wide-spread industrial fishing due to cold weather within 6 months a year.

There is a trend of increasing of illegal fishing on Ugii Lake and on some rivers of Orkhon basin, but without any statistics and monitoring data available. To date, no accurate data and information collection mechanisms exist, and the number, value and type of fish caught and exported. The Mongolian government is now improving fishing net standard and has prohibited import of fishing net to prevent overfishing.

Figure 4.5.2.a: Taimen in Eg River. Photo by M.Erdenebat.

In the Russian territory of the basin, fishing forms an important contribution to the local economy. Commercial and sportfishing mainly focuses on nearshore areas in Lake Baikal, including the Selenga River Delta (see 3.4.1). The total fish catches fluctuate annually and declined significantly between 2003-2007, after which they gradually increased again (Figure 3.4.1).

Overfishing is a major concern in Lake Baikal, particularly on species that are listed as endangered in the Red Books of Mongolia and Russia (e.g. Baikal sturgeon, lenok, taimen) as well as the popular omul, whitefish, and other species that are commercially fished such as roach, dace, perch, and crucian.

In 1995 the Russian Government passed a federal law on the Natural Area of Preferential Protection (NAPP), which bans hunting, commercial fishing and coastal fishing in designated protected areas. As a result if this law, fisheries is prohibited year-round in the Chevyrkujsky Bay area, as well as parts of the Barguzin Bay and Lake Arangatui. In November 2011, the Federal Law on special economic zones in the Russian Federation and certain legislative acts of the Russian Federation was adopted, which made several amendments to the NAPP. One of the amendments was to grant traditional fishing rights only to indigenous people of the region. As a result, non-indigenous inhabitants of settlements on the shores of Lake Baikal are restricted from fishing in the lake.

Illegal fishing is an increasing concern in Lake Baikal. In 2011, it was estimated that around 25% of the omul fishing was done illegally. In 2010, a total of 1,597 violations of fishing regulations were registered, and in 2011 this number had increased to a total of 2,758 registered violations.

In an attempt to counteract the population losses that result from commercial fishing, the Russian Governement encouraged the establishment of several fish farms and hatcheries in the Baikal Basin. Between 1981-2010, the number of larvae that were released into Lake Baikal averaged about 1.5 billion units, which adds up to approximately 40% of the total estimated amount of omul larvae in the lake.

Lake-river whitefish, Baikal lake whitefish, and Baikal white grayling have also been grown in aquaculture farms, but their production ceased between 2007-2011 due to a lack of Government funding. Artificial reproduction of endangered taimen and lenok was also delayed in 2011 as a result of insufficient funding.

At the end of the previous century, the total number of Baikal seals was approximately 60,000. Between 1977-2001, on average 6-7,000 Baikal seals were hunted every year. After a law was enforced that prohibits commercial hunting on the seals, these numbers have decreased. Nonetheless, every year between April and early May, indigenous people are allowed to hunt Baikal seals, which are used for their fur, fat, and meat. In addition, a fixed number of seals may be killed for research and population control purposes. Hunting of seal pups is strictly prohibited. However, pups are preferred by poachers because of their high value white fur.

In 2011, a total of 1,758 (quotum: 2,000) seals were caught by indigenous people, and 500 seals were allowed to be killed for research and population control. The total amount of seals that is allowed to be killed is re-assessed on an annual basis. The estimated population size between 2009-2011 was approximately 95 thousand seals.

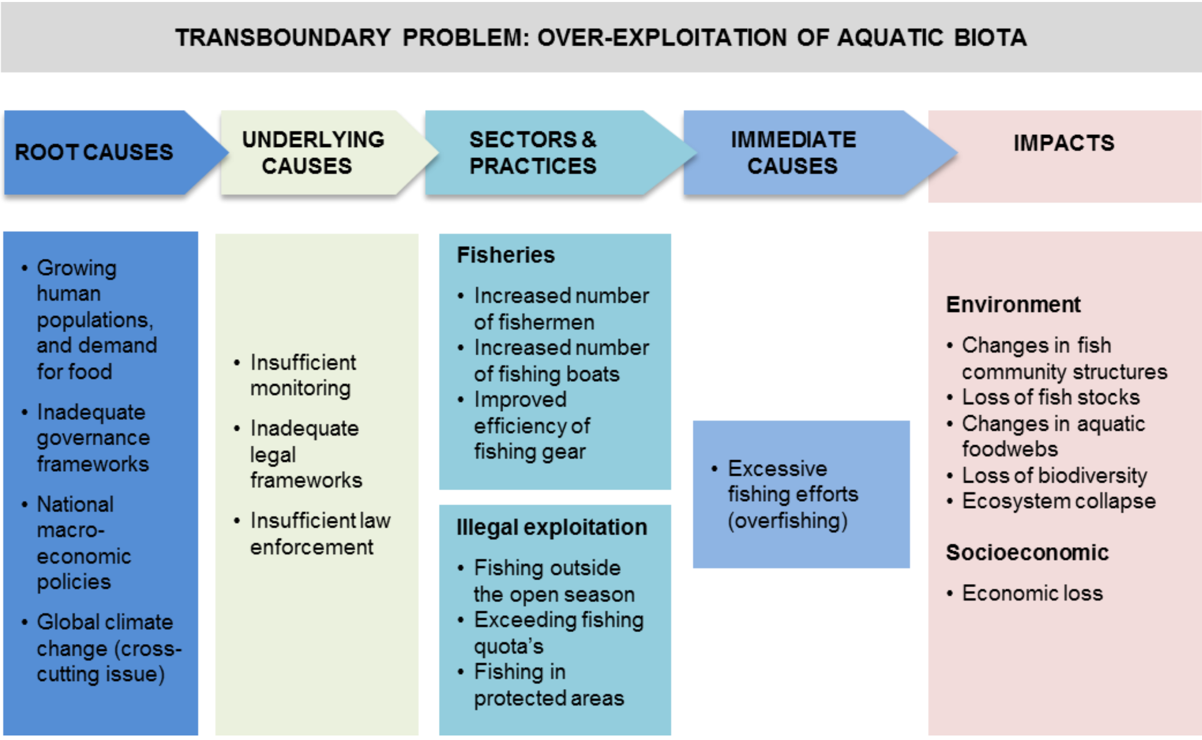


Figure 4.5.2.b Causal chain analysis of over-exploitation of aquatic biota in the Baikal Basin.

4.5.2.1 Present and Predicted Impacts

As a result of the combination of overexploitation, habitat degradation (see 4.3), pollution (4.4) and the impacts of climate change (4.7) the majority of fish species in the Baikal Basin have become endangered or at risk of extinction. Productivity rates have declined, average weight of individual fish is decreasing, and reproduction rates are declining as a result of degradation and pollution of spawning areas and nurseries.

The impacts of climatic and human-induced changes have lead to marked changes in the structure of the fish populations in the Selenga River Basin in Mongolia over the past 20 years. As a result of pollution and fishing, the relative proportion of ichthyophagist fish species versus algal and detritus feeders has declined. At present, the upper reaches of tributaries of the Selenga River that have not been affected by habitat degradation and pollution serve as refuges for taiman (*Hucho taimen*), lenok (*Brachymystax lenok*), Siberian grayling (*Thymallus arcticus*) and other fish species.

Because of the impacts of global climate change, the large (*Comephorus baicalensis*) and small (*C. dybowski*) endemic Baikal oilfish may be at risk. The oilfish occur at great depths of over 1,000 meters, and have a temperature tolerance between 3-13°C. The large and small oilfish are widespread throughout the lake and constitute a key component of the aquatic food chain. Oilfish are the dominant component in the diets of omul and Baikal seals. If populations of oilfish would decline as a result of the warming of the water in Lake Baikal, this could lead to a collapse of the fisheries in the lake.

The decline of the Baikal sturgeon is also of great concern for the fisheries in the Baikal Basin. In 1945, a complete fishing ban was imposed on the Baikal sturgeon after it had become clear that this species had been severely overexploited. However, this did not produce the desired effect, and the Baikal sturgeon population has not recovered. The sturgeon has slow growth and reproduction rates, and adolescents of 1-3 years old are illegally caught before they can contribute to to the reproduction cycle.

Furthermore, the largest populations of the sturgeon are found in the Selenga River Delta, which is increasingly degraded (see 4.3) and polluted (4.4). Populations of sturgeon are also found in other river delta's such as the Barguzin delta, but these are very small and also rapidly declining. In the past few years the Selenge Experimental Sturgeon and Omul Breeding Factory failed to catch sturgeon sires in sufficient numbers for artificial breeding. In future, the breeding of Baikal sturgeon is only possible if a brood stock can be created under artificial conditions.

Populations of other sturgeon species in the Baikal Basin are also declining. This includes the long-beaked sturgeon, the starlet, Amur sturgeon and the great Siberian sturgeon, which have all been listed in Annex 2 of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES).

The past few years a catastrophic reduction has also taken place in the numbers of taimen, which is listed as endangered in both the Mongolian and Russian Red Book. Local populations of this species have completely disappeared in some of Lake Baikal's tributaries, including specially protected sites. Conservation of the population diversity of taimen in the Lake Baikal Basin is impossible without taking special measures; and its protection status should correspond to Category I at the regional level.

Populations of lenok and grayling have also dwindled because of overfishing. The pike is of minor importance for commercial fisheries. However, its populations are at risk due to the invasion of Canadian elodea, which has overgrown the preferred habitats of the pike. In addition, the main food sources of the pike including rotan, roach, yelets and juvenile fish are declining (Molotov 1999).

Omul is the most popular commercially fished species. Its populations are replenished annually by artificial breeding programs. Considering the ongoing degradation and pollution of its preferred habitats and spawning grounds, in combination with the continued fishing pressure, it is not clear if the present artificial breeding rates are high enough to maintain healthy stocks of omul in Lake Baikal.

Figure 4.5.2.1.a Giant taimen speaks to a group of stakeholders during an conservation outreach action in Mongolia. Source: www.rareconservation.org

4.5.2.2 Challenges for Future Management

Because fish populations are not only influenced by fishing pressure but also by habitat degradation, pollution and the impacts of global climate change, sustainable management will require an integrated, cross-sectoral approach that addresses each of these aspects.

Improved fisheries monitoring is needed to ensure that quota and regulations are based on adequate information. Furthermore, improved legislation will be needed as well as enhanced law enforcement to ensure that quota are not breached, and to put a halt to illegal fishing activities.

4.5.3 OVER-EXPLOITATION OF WILDLIFE

Hunting is to a large extent regulated in the Baikal Basin, and licences are required for the majority of species that are preferred by hunters. However, populations of wildlife fluctuate annually as a result of natural processes and food availability, which is affected by climatic events and the changing quality of their habitats. Furthermore, unregulated hunting and poaching poses problems for wildlife in the basin. Hunting and poaching affects a wide range of species, including fur animals, large hoofded animals, predators, and birds. The problem is particularly pressing for populations of wildlife whose habitats are declining as a result of deforestation (see 4.2.3), unsustainable landuse practises (4.3.4), pollution (4.4), and the impacts of climate change (4.7).

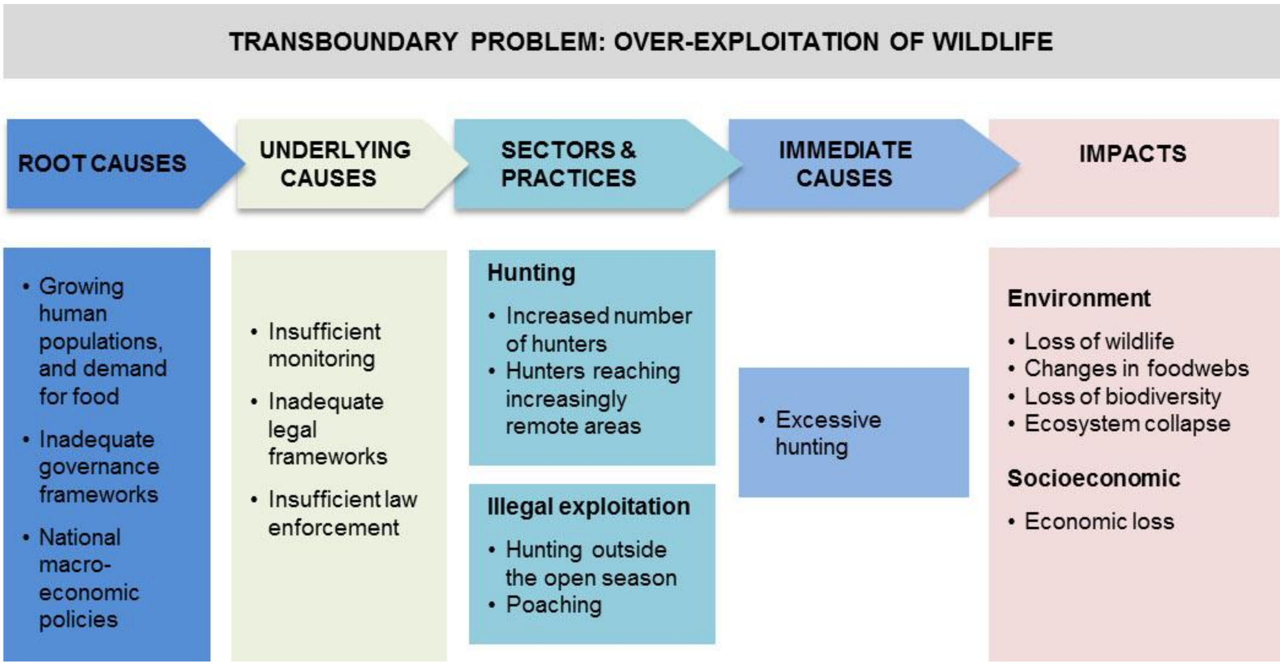


Figure 4.5.3 Causal chain analysis of over-exploitation of terrestrial wildlife in the Baikal Basin.

4.5.3.1 Present and Predicted Impacts

Some of the species that are targeted by hunters have relatively stable populations, whereas others are more sensitive to the combined effects of habitat degradation, climate change and hunting pressure (e.g. Table 4.5.3.1). One of the main concerns with overexploitation and decline of wildlife is the dissapearance of species that have a regulating effect on their environment. The consequences of a lack of keystone predator species such as wolves and/or other predators as well as functionally dominant herbivores can trickle down to the entire foodweb, resulting in collapse of the ecosystem.

Hoofed animals such as the zeren, ibex, Altai wild sheep (argali) and bighorn have declined dramatically in the past. They are listed as vulnerable in the Red Books of Mongolia and Russia and are banned from hunting. Snow leopard is also completely banned from hunting due to their small population sizes and vulnerability.

One of the species that is popular among hunters is the Kabar musk deer. They are mainly targeted for their scent glands, which can fetch up to $45,000/kg on the black market. As a result, the musk deer are subject to substantial poaching pressures, and its population sizes has declined markedly over the past decades.

Populations of the Siberian stag (*Cervus elafhus*), or European red deer decreased more than 10-fold over the past 20 years because of overhunting and poaching for its antlers. This species is currently threatened with extinction and is protected by the state with a total ban on hunting.

In general, the size of ungulate populations increased in recent years, particularly for roe deer, red deer, musk deer, and caribou. At the same time, as a result of increased poaching, the population sizes of fur-bearing animals decreased.

Until 1999, population sizes of the Siberian marmot (*Marmota sibirica*), or tarvaga, stocks were significant. Large numbers of tarvaga fells were sold on the domestic market in Mongolia, as well as exported to Russia. As a result of changes in the economic market, Chinese harvesters started buying tarvaga fells at prices that were 2-3 times higher than the State export prices. As a result, hunting pressure on the tarvaga increased dramatically. In a period of approximately 5-7 years, the population reached a critical decline. To protect the tarvage, the Mongolian Government imposed a complete hunting ban on this species in 2004. However, no notable improvements in the population number have been reported thus far.

Figure 4.5.3.1 Tarvaga

Northern otters (*Lutra lutra*) have been extensively hunted throughout the Baikal Basin for their fur. As a result, their populations declined rapidly. They are included in the Red Book of Mongolia as endangered, and also listed in CITES Annex 1. Illegal trapping of otters continues, and they also frequently die as a result of getting stuck in fishing nets.

Over recent years, increased poaching has occurred on birds. Hunting of birds often occurs from inside a vehicle, which also impacts the environment. Waterfowls and upland fowls have suffered markedly from increased hunting pressure, in addition to population declines resulting from bird flu and other diseases. In steppe habitats, species such as bustard, little bustard, and quails are under increased hunting pressure. Furthemore, illegal transport of birds of prey particularly to the Middle East has impacted species such as the greater spotted eagle (*Aguila clanga*), saker falcon (*Falco cherrug*), and buzzard.

Table 4.5.3.1: Overview of key wildlife species targeted by hunting in the Russian territory of the Baikal Basin (estimates from 2011).

Species	**Nr. of licences issued**	**Population estimate**	**Notes**
Manchurian wapiti	259	15,341	• One of the most common species of hoofed animals in the Baikal Basin. • Adapts relatively easy to habitat changes. • Population declined as a result of decreased food availability, but is slightly increasing again in the past few years.

Wild boar	331	7,000	• Population growth 21% in 2011 compared to 2010.
Kabar musk deers	35	6,799	• Unstable population numbers. • Main target for commercial hunting and poaching.
Roe deer	n.a	35,840	• Decline in 2003 after forest fires, but population recovered • Subject of substantial hunting and poaching
Moose	61	4,944	
Caribou	109	4,670	• Relatively stable population
Tarvaga	0	n.a	• Banned from hunting as a result of dramatic population decline
Baikal squirrel	8,800	122,000	
Northern otter	0	n.a.	• Listed in Red Book of Mongolia • Banned from hunting, but subject to poaching
Sable	2,777	15,000	• Subject to high levels of poaching
Hare	1,857	29,685	• Cyclic population dynamics, 35% decrease in 2011 • Very popular species for hunting
Kolinsky	308	4,666	• Population has increased in recent years
Ermine	132	6,419	
Fox	106	4,941	• Stable population, and small increase in recent years • Actual hunting numbers are assumed to be significantly higher than officially reported numbers • Hunting used as a way to control outbreak of rabies
Lynx	10	950-1,300	• Sensitive to habitat decline and fragmentation
Wolverine	0	242	
Bear	177	3,681	• Stable population
Wolf	371	1,206	• Hunting used as a way to control outbrak of rabies, and reduce impacts of predation on wild ungulates and domestic livestock
Capercaillie	no licence required	63,500	• Hunting in spring is only allowed on males, to protect the breeding population
Hazel grouse	no licence required	472,887	• One of the favourite species for amateur hunting • Estimated amount of individuals hunted per year: 10-20,000
Black grouse	no licence required	145,130	• Population declined due to pesticide use on agricultural land, but recently recovering
White partridge	n.a	32,00	
Daurian partridge	n.a	102,253	• Listed in the Red Book of Russia • Hunting was banned in the Irkutsk region, but due to population recovery the ban was lifted in 2008

n.a.: no data available.

4.5.3.2 Challenges for Future Management

Because populations of wildlife in the Baikal Basin are not only influenced by hunting and poaching pressure but also by habitat degradation, pollution and the impacts of global climate change, sustainable management will require an integrated, cross-sectoral approach that addresses each of these aspects. Furthermore, enhanced law enforcement efforts are required to put a halt to poaching.


Photo by Zhamyanov

4.6 PROBLEM AREA 5: BIOLOGICAL INVASIONS

4.6.1 DESCRIPTION & TRANSBOUNDARY RELEVANCE

Invasive species[51] are animals, plants or other organisms introduced by man into places out of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species. Invasive species can enter ecosystems either through intentional introduction by humans (for instance, for agriculture, agroforestry, or aquaculture production), through unintentional introductions, or by natural dispersal. The introduction of invasive alien species is a global problem that introduces significant threats to biodiversity[52] (McGeoch et al. 2010).

Invasive species affect the biogeochemical pools and fluxes of materials and energy of ecosystems, thereby altering their fundamental structure and function (Ehrenfeld 2010). One of the challenges with the introduction of alien species is that it is very difficult to predict how they will be able to adapt to their new ecological niches, and how they will affect the native flora and fauna. Intentional and unintentional introductions of alien species into new environments can have negative effects and result in substantial biodiversity loss. Invasive plants can also pose risks as catalysts for the spread of human parasites (Mack and Smith 2011).

In total, 38 invasive species are found in Mongolia, and 184 in Russia[53], including plants, fungae, insects, mollusks, birds, mammals and fish. In the Baikal Basin, the extent of biological invasions thus far seems to be limited to 13 fish species and 1 plant species in aquatic systems (see 4.6.2), as well as 3 plant species in terrestrial systems (4.6.3). However, degraded and polluted habitats are more receptive to biological invasions than pristine habitats, due to a loss of local species diversity and resilience to change. Therefore, due to the levels of habitat degradation (4.3) and pollution (4.4) in the Mongolian and Russian territories of the Baikal Basin, the risk of future invasions is high and a level of precaution should be in place (e.g. Pronin and Mills 2001).

4.6.2 SPECIES INVADING AQUATIC HABITATS

Species that have been known to invade aquatic ecosystems and displace native biodiversity include fish, parasites, molluscs, crustaceans and plants. At present, only information on invasions by fish, parasites and an aquatic weed is available for the Baikal Basin.

Multiple non-native fish species have been introduced in lakes and rivers in the Baikal Basin since the 1930s (also see Annex VI). A total of 13 invasive species and subspecies has been intentionally or unintentionally introduced in the Baikal Basin, including 7 species of fish (Table 4.6.2), 3 invertebrate species and 1 species of higher plants (Dgebuadze 2004, Matafonov et al. 2006, Bazarova and Pronin 2007). In 1956-1957

[51] www.issg.org/is_what_are_they.htm
[52] Examples of the world's worst invasive alien species: www.issg.org/database/species/reference_files/100English.pdf
[53] Global Invasive Species database: www.gisp.org

Mongolian researchers brought 14 million grains of roe of Coregonus autumnalis (Baikal omul) from Lake Baikal to start its reproduction in Lake Khovsgol. But the experiment failed due to waters altitude difference and low water temperature (Dashdorj 1962).

In total, 8 of the 30 fish species that occur in the Selenga River are non-native and potentially invasive. The Selenga River Basin acts as an important pathway for the introduction of non-native flora and fauna into Lake Baikal.

In an attempt to increase fisheries yields, scientists previously proposed to “reconstruct” the native ichtyofauna in Lake Baikal by introducing species that might be more commercially interesting than the native fauna. Introduction of plankton-feeding species such as vendace and peled, as well as benthos-feeding chir and muksun was proposed, as well as predatory species such as nelma (Misharin, 1949). In total, 12 species of fish have been introduced to Lake Baikal, namely sprat, salmon, ripus, peled, whitefish, bauntovsky cisco, bauntovskaya vendace, grass carp, silver carp, east bream, carp, Amur carp, and Amur catfish (Pronin 1974, 1982, Neronov et al. 2002).

Table 4.6.2: Overview of alien fish species that have been introduced in the Baikal Basin.

Species	Remarks
Amur sleeper, or rotan (*Peracotus glenii*)	• Unintentionally introduced into Lake Gusinoe in 1969 during release of carp • Expanded into the Selenga River and its tributaries (e.g Barguzin and Udy Rivers)
Amur catfish (*Parasilurus asotus*, Linnaeus, 1758)	• Introduced in 1932 in Lake Shaksha • Subsequent expansion into Tola and Orkhon Rivers in Mongolia • Also expanded into Lake Baikal
Amur-carp (*Cyprinus carpio haematopterus* Temminck et Schlegel, 1842)	• Introduced into Lake Shaksha in 1943, the Selenga River in 1937, and Lake Baikal in 1940s • Currently a common species in the Selenga River, and in the Barguzin River floodplain (second most common fisheries catch after omul)
Eastern bream (*Abramis bramaorientalis* Berg, 1949)	• Introduced in Lake Gusinoe in 1954, Lake Bolshoe Eravninskoe and Lake Okunevoe in 1955, expanded into Lake Baikal in the early 1990s, and also observed in the Selenga River • Hybridises with roach
Peled (*Coregonus peled*, Gmelin, 1789)	• Introduced in Lake Shchuchye in 1968, accidentally introduced in Lake Gusinoe and Lake Baikal • No significant population expansion reported after introduction into Lake Baikal
Mikidza or rainbow trout ((*Parasalmo mykiss* Walbaum 1792)	• Probably escaped or released from aquaculture farms in the Irkutsk Oblast. First reported in rivers in the region in 1992, and subsequently expanded to Groznuha Bay, Uladev Gulf and Kalay Gulf
European whitefish (*Coregonus albula*, Linnaeus, 1758)	• Introduced into Lake Arakhlei in 1955, Lakes Shchuchye and Okunevoe between 1956-1957, and Lake Baikal in 1960 • Entered the Selenga River during flooding of the Ubukun River in 1971 and 1973
Dwarf Altai osman (*Oreoleuciscus cf. humilis*)	• Populations presently occur in small rivers and lakes in the middle reaches of the Selenga River in Mongolia • Expansion range in the Baikal Basin expected as a result of climate change

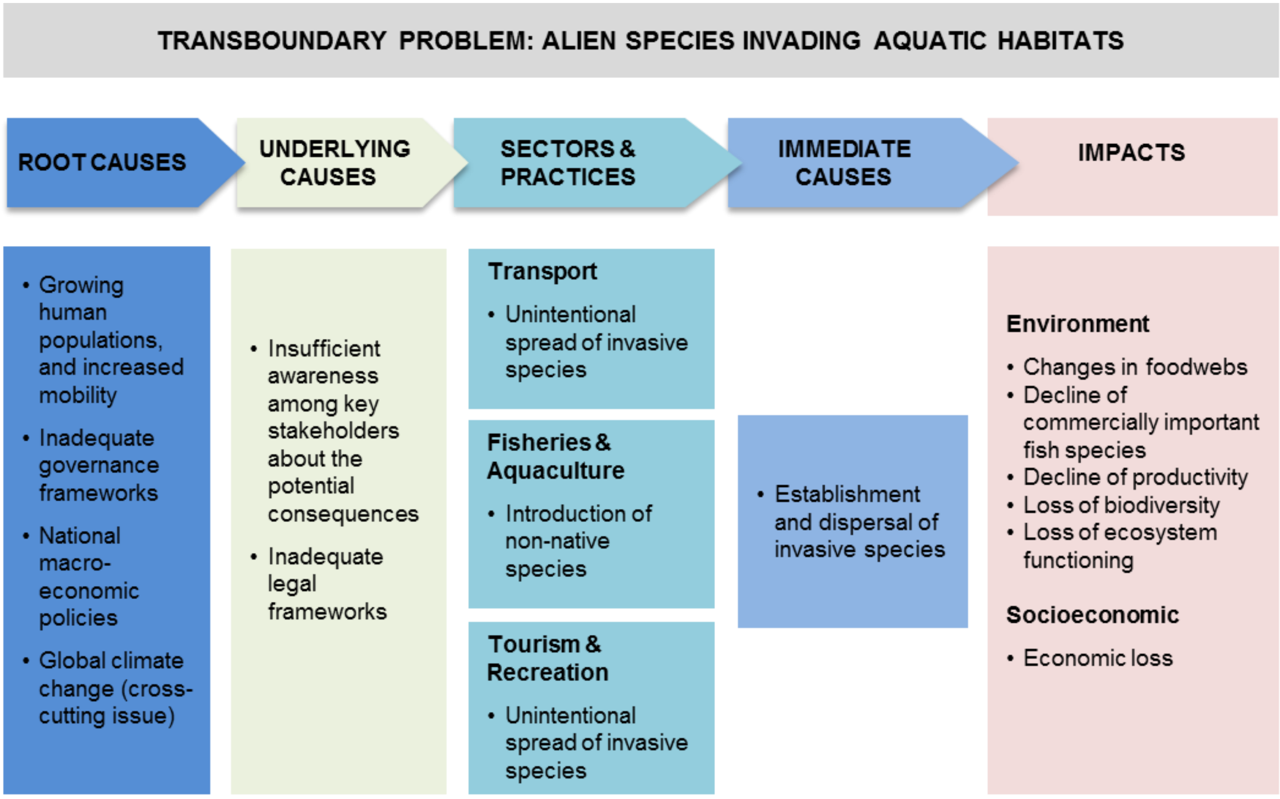


Figure 4.6.2 Causal chain analysis of alien species invading aquatic habitats in the Baikal Basin.

4.6.2.1 Present and Future Impacts

Some of the fish species that were intentionally introduced to the Baikal Basin do not seem to have a significant impact on local biodiversity. An example is the Amur catfish, which migrated into Lake Baikal after its introduction in Lake Shaksha in the Transbaikalia district in Russia. The catfsh is now widespread in Lake Baikal, apparently without causing measurable changes to the local habitats. It's population remains too small to be registered in the official statistics of commercial fisheries in the lake.

However, for many of the intentional and unintentional introductions of non-native species counts that it is difficult to predict if their populations may expand in the future. Many species adapt to their environment over evolutionary time. Species that do not seem invasive initially, may expand their populations in the future and have harmful effects on local biodiversity. The introduction of non-native, potentially invasive species is especially dangerous in Lake Baikal, because of its unique ecosystem and its global value as a hotspot of aquatic biodiversity.

The invasion of habitats in Lake Baikal by the Amur sleeper (*Peracotus glenii*), or rotan, is an important concern for the ichtyofauna of the lake. The rotan occurs naturally in the Amur River[54], but is not native to the Baikal Basin. Its appearance in Lake Baikal is assumed to be the result of dispersal from Lake Gusinoe, where it was unintentionally introduced during the release of carp from a fish farm in 1969. Rotan was observed in the Selenga River in 1982. By 1996 it had invaded significant areas of the littoral zone in the southern and middle parts of Lake Baikal, and it continues to spread further along the shallow parts of the lake.

[54] The Amur River originates in China and flows west into Russia. Its catchment basin also includes parts of Mongolia.

Figure 4.6.2.1.a Amur sleeper, or rotan (*Perccottus glenii* Dybowski, 1877)

The dietary flexibility, adaptability and high fecundity of rotan make this species highly competitive and invasive. Densities of up to 95 speciments per m^2 have been observed. In its natural habitat, rotan is kept in check by predatory fish. In Lake Baikal, populations of large predators such as the taimen, lenok, pike and others have declined significantly, and as a result have limited effect on controlling the rotan. One of the main problems is the competition of rotan for food and habitats with commercially exploited fish species such as omul. Increased artificial breeding of predatory pike is seen as a possible way to control rotan. Furthermore, rotan has become a favored food for herring gulls, whose growing populations may be able to help control this invasive fish.

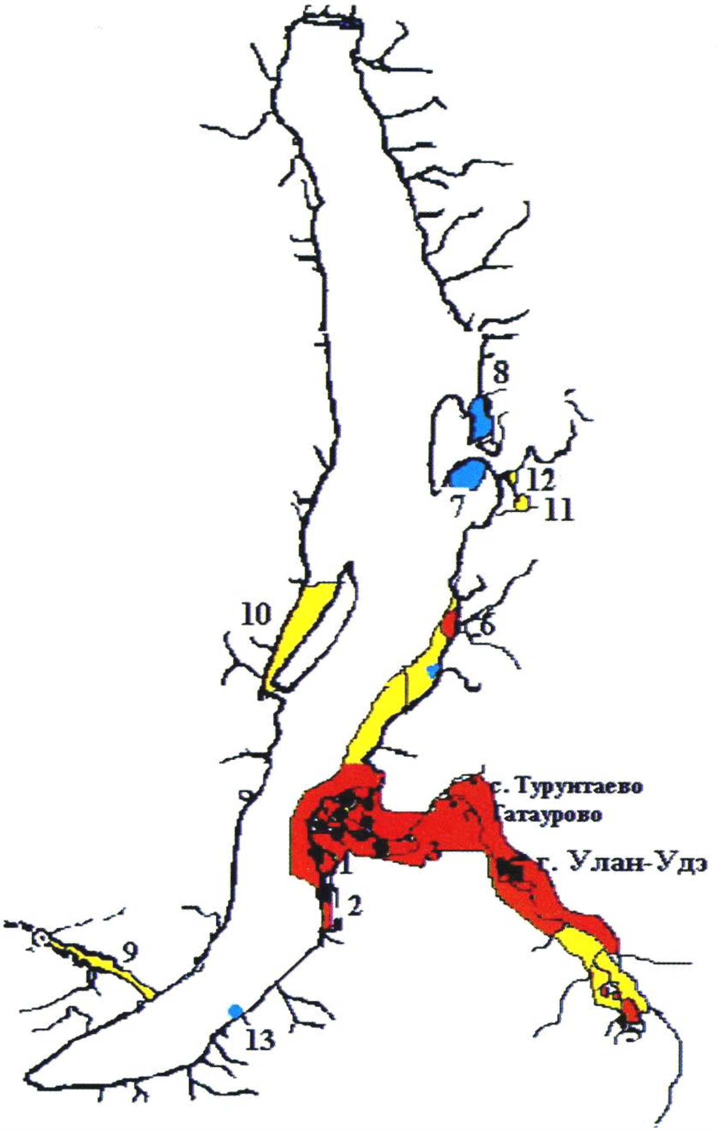


Figure 4.6.2.1.b Spread of rotan (*Peracotus glenii*) in the Selenga River and the littoral zone of Lake Baikal. 4: Proval bay. 5: Lake Gusinoe, Bayan-gol and Tzagan-gol Rivers. 6: Turka River and tributaries. 7: Barguzinsky bay. 8: Chivyrluysky bay. 9: Irkutsk water storage reservoir. 10: Maloye. 11: Lake Dukhovnoye. 12: Lake Shantalyk. 13: Mishikha River.

Rotan mass distribution
Possible invasion
Sporadic detection

As a result of the introduction of non-native fish species in aquatic ecosystems in the Baikal Basin, the composition of fish parasites has also changed. For instance, the Amur catfish has 8 specific species of parasites that are introduced into freshwater systems together with the fish (Cherepanov 1962, Zaika 1965). In Lake Gusinoe, the introduction of carp in combination with habitat degradation and pollution resulted in an increase in parasite infestations (Pronina 1974). In total, 21 new species of parasites have been introduced to the Lake Baikal system as a result of the introduction of non-native fish (Cherepanov 1962, Voznesenskaya 1971, Pronin et al. 1998, Litvinov 1993).

Another concern is the invasion of littoral habitats in Lake Baikal by the Canadian waterweed (*Elodea canadensis* Michaux, 1791). The Canadian waterweed was first observed in the Baikal Basin in the 1960s. It is assumed that the weed reached Lake Baikal from a source near the Irkutsk-Angara area. In 1992, the weed has reached a biomass of up to 92 tons per hectare in Lake Kotokel. Between 2005-2006, a biomass of up to 8 kg m^2 was measured in several sites in the Chevyrkujsky Basy in Lake Baikal.

The Canadian waterweed can obstruct coastal habitats and pose a problem for navigation of small boats. As a result of overgrowth by the weed, the composition, structure, and densities of native aquatic vegetation as well as that of benthic invertebrates is changed (Matafonov et al. 2008). In addition, the weed negatively impacts the availability of feeding areas for littoral fish species. The weed is now also spreading into the Selenga River and other aquatic ecosystems in the region.

Figure 4.6.2.1.c Canadian waterweed (*Elodea Canadensis*). Illustration by C.A.M. Lindman, Bilder ur Nordens Flora, 1917-1926

4.6.2.2 Challenges for Future Management

Understanding the mechanism, or pathway, by which invasive species enter the Baikal Basin is important in order to prevent or minimize additional introductions. One of the main challenges for future prevention and control of biological invasions in aquatic ecosystems in the Baikal Basin is the absence of a monitoring and management system. In addition, there is a lack of information about the impacts on local biodiversity and ecosystem functioning as well as on the economic consequences of biological invasions. Furthermore, appropriate environmental risk assessments and legislation are needed to prevent future introductions of potentially invasive species into the Baikal Basin.

4.6.3 SPECIES INVADING TERRESTRIAL HABITATS

Species that can invade terrestrial ecosystems include plants, micro-organisms, fungi, insects, birds and other animals. At present, 4 species of invasive plants have been described from the Baikal Basin, including dodder (*Cuscuta* sp), redroot (*Cannabis sativa*), ruderal hemp (*Cannabis ruderalis*), and ordinary harmala (*Peganum harmala*). Some of these plants are native to the region, but they can become invasive as a result of habitat degradation an pollution. Invasive plants have in common that they have a large seed production, high levels of dispersal, and high level of adaptivity to new environments.

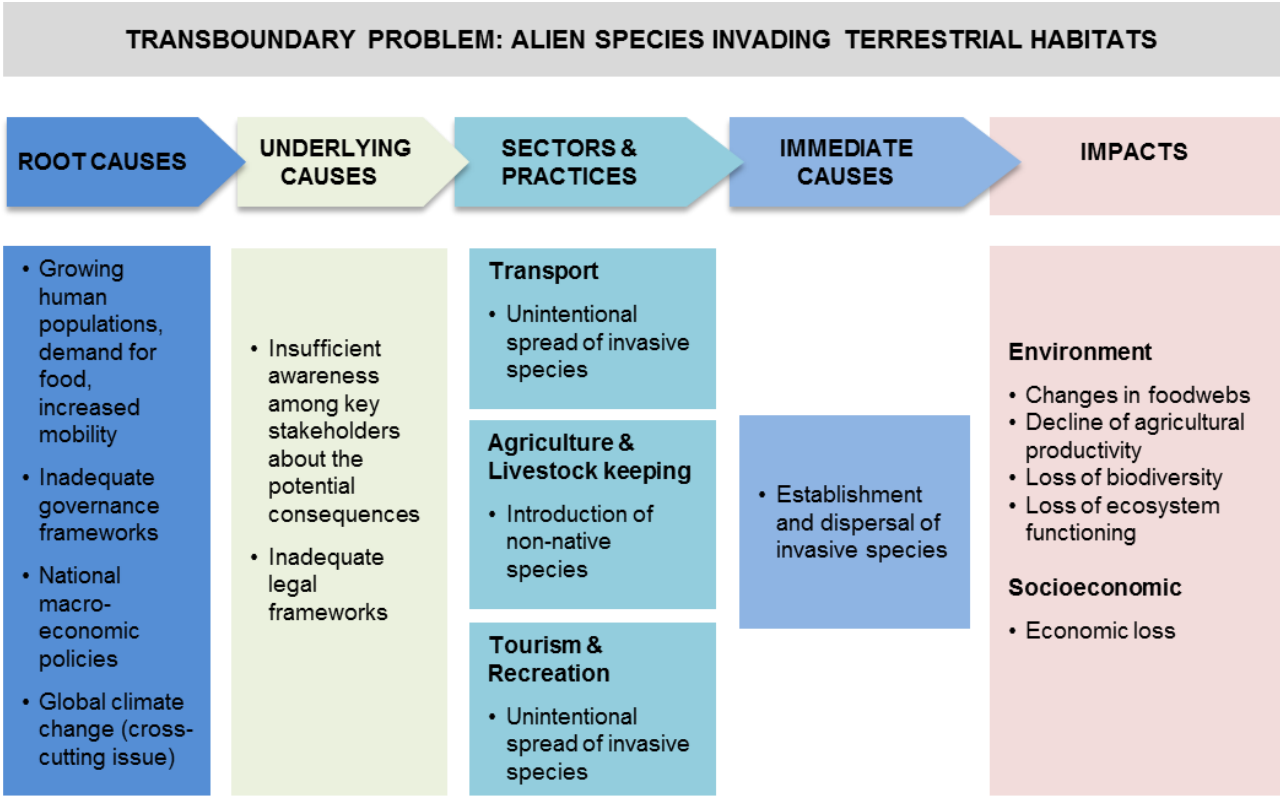


Figure 4.6.3 Causal chain analysis of alien species invading terrestrial habitats in the Baikal Basin.

4.6.3.1 Present and Future Impacts

Two species of cannabis, redroot (*Cannabis sativa*) and ruderal hemp (*Cannabis ruderalis*), occur naturally in the Baikal Basin. Wild cannabis is found between northern Mongolia and the border with Russia, and it is a common plant along roadside ravines, and near farms (Gunin et al. 2002, 2003). However, in degraded habitats, cannabis can rapidly become invasive and dominate the landscape (also see 4.2.4). Animals that eat redroot or ruderal hemp can experience a range of symptoms, including colic, intoxication, muscular spasms, and ultimately death.

The invasion of alkaloid plant species such as cannabis as well as ordinary harmala (*Peganum harmala*) reduces the productivity of agriculture and livestock, causing negative effects on local economies. In addition, these mono-cultures of plants with narcotic qualities can lead to the development of a local drugs scene, which presents a range of socio-economic and medical problems resulting from addition.

Dodder (*Cuscuta* sp) is a parasitic plant that does not have roots or leaves but instead survives by living off a host plant. Because they contain alkaloids, dodders can be poisoneous to animals who consume them. Furthermore, they are a vector for a multitude of plant viruses. Two species of Cuscuta are currently infecting the native flora in Lake Baikal, namely field dodder (*Cuscuta campestris* Yunck) and Chinese Dodder (*Cuscuta chinensis* Lam). Import of dodder seeds is prohibited in Russia. However, dodder has a high capacity of natural migration because its seeds can survive up to 10 years in soil, and they can spread through air, with melt water and with harvest of agricultural crops (Nikitin 1983, Moskalenko 2001).

4.6.3.2 Challenges for Future Management

Similar to the problem of biological invasions in aquatic ecosystems, the main challenge for future prevention and control of terrestrial invasions is the absence of a monitoring and management system, lack of information about the impacts on local biodiversity and ecosystem functioning, lack of information on the economic consequences, and lack of appropriate legislation.

Photo by Urabazaev

4.7 CROSS-CUTTING PROBLEM AREA: CLIMATE CHANGE IMPACTS

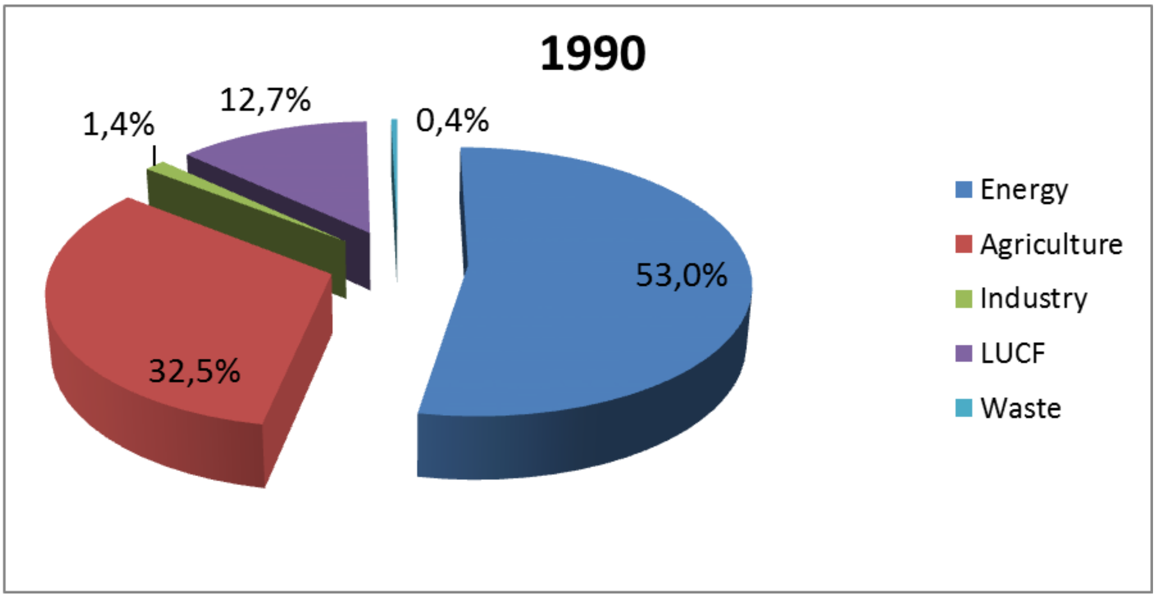
4.7.1 DESCRIPTION AND TRANSBOUNDARY RELEVANCE

There is increased scientific concensus that global warming is presently occurring, and is primarily caused by the increased emission of excess greenhouse gasses (GHG) by human activities. Climate change includes major changes in temperature, precipitation, wind patterns, and other effects that occur over several decades or longer. The global average temperature increased significantly over the last century, and the decade from 2000-2010 was the warmest on record[55].

GHG trap heat in the atmosphere by absorbing energy. There are 4 GHG that contribute to global climate change and are released by industrial activities, transport and agriculture: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gasses (hydrofluorocarbons, perfluorcarbons and sulfur hexafluoride).

In Mongolia, a significant decrease in CO_2 emissions has taken place since 1990, but at the same time the amount of methane increased as a result of the increase in the livestock population (Figure 5 in Annex VII). The energy sector is the main source of GHG emissions, contributing 65% (10,213.09 tons) of heat-trapping gasses in 2006 (Figure 4.7.1.a). Although the GHG emission volumes in Mongolia are relatively low, the volume of emissions per capita is relatively high as a result of the extensive use of charcoal as a source of energy. It is expected that the total volume of GHG emissions in Mongolia will increase more than fivefold by 2020.

[55] www.noaanews.noaa.gov/stories2011/20110112_globalstats.html



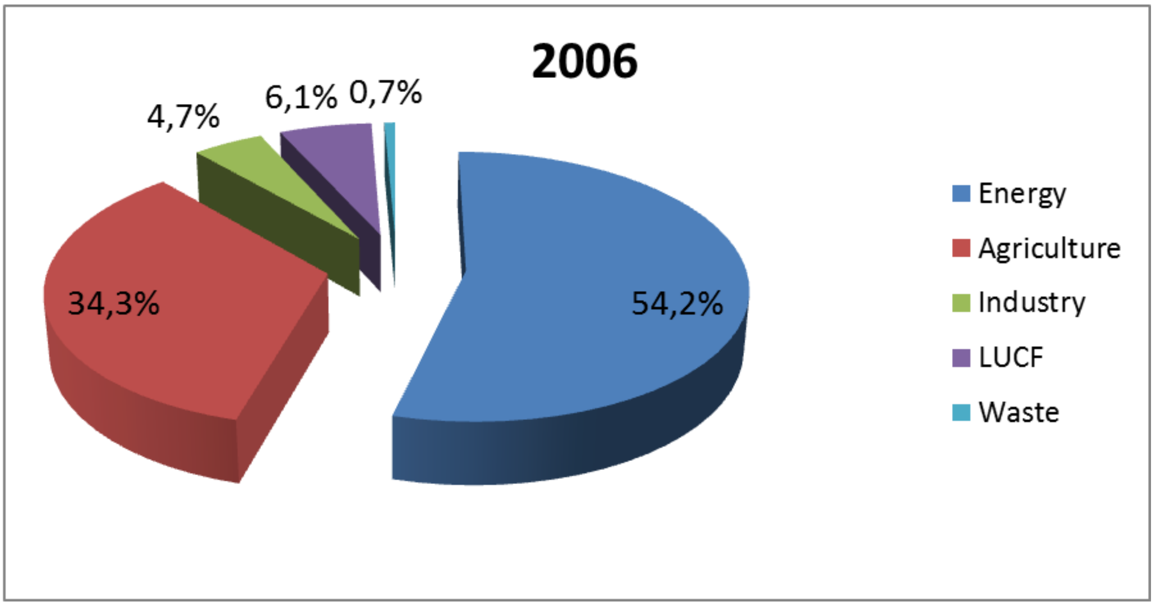


Figure 4.7.1.a Contribution of greenhouse gas emissions per sector in 1990 and 2006 in Mongolia.

In the Republic of Buryatia, the total amount of CO_2 emissions was 18.75 thousand tons in 1990 (Figure 3 in Annex VIII). The largest contribution to the GHG emissions in Buryatia is made by the energy production sector (64% in 1990, and 78.7% in 2004). Forest fires also contribute substantially to the GHG emissions (29% in 2000, 43% in 2003, and 16% in 2004).

Between 1940-2007, the average surface air temperature in Mongolia has increased with 2.1°C (Figure 4.7.1.b), and annual precipitation dropped by 7% (Annex VII, MARCC 2009). The greatest temperature increases occurred in winter, with an average of 3.6°C while summer temperatures increased on average 0.6°Celsius. Climatic forecasts indicate that the average summer temperature is expected to rise 1.2-2.3ºC in 2010-2039, 3.3-3.6ºC in 2040-2069, and 4.0-7.0ºC in 2070-2099 (Gunin et al. 2008).

The average amount of precipitation in Mongolia has decreased with 8.7-12.5% over the last 65 years. Many rivers, marshlands, and lakes are drying up, resulting in degradation and loss of habitat for many fish and bird species (MNET 2009). Between 2003-2005, a total 780 small rivers, 590 lakes, and tens of mineral springs had dried up in the Mongolian territory of the Baikal Basin, as a result of increased surface temperatures and evaporation from waterbodies as well as unsustainable land management practices (see 4.3).

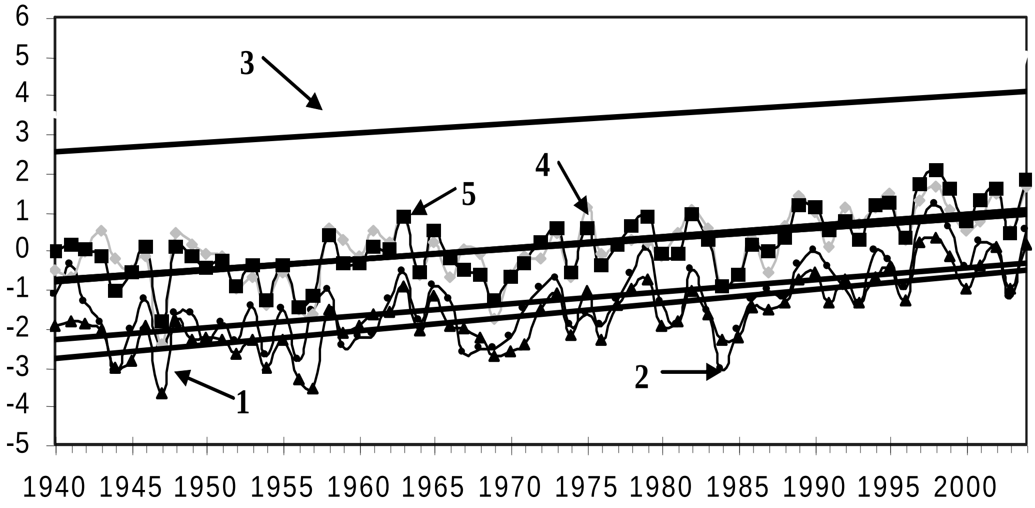


Figure 4.7.1.b Average surface air temperature in Mongolia between 1940-2000. 1. Central; 2. Western; 3. Southern; 4. Eastern; 5. Countrywide.

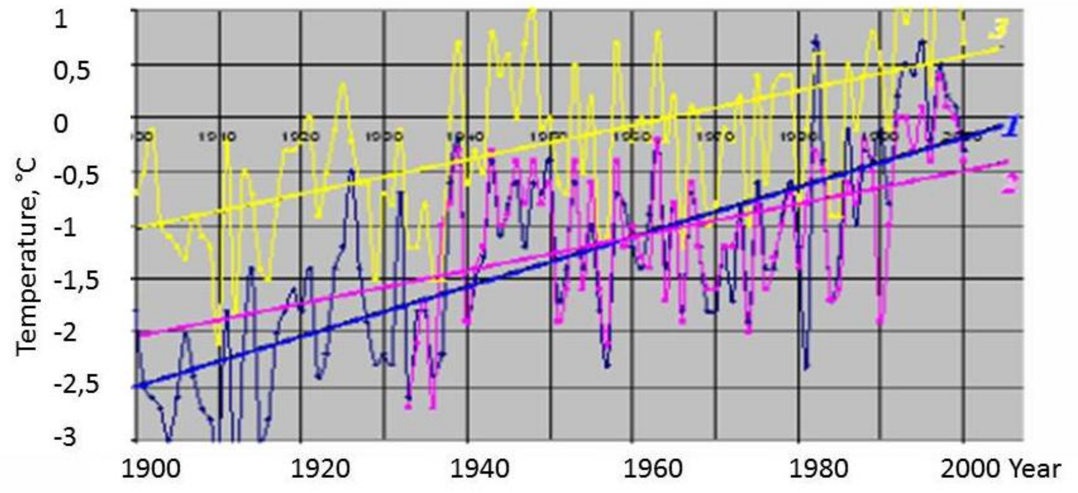


Figure 4.7.1.c Average surface air temperature in western Transbaikalia, Russia between 1900-2000. 1.Ulan-Ude; 2. Novoselenginsk; 3. Kyakhta.

In the Russian territory of the Baikal Basin, the average temperature between 1900-2000 increased with 2.5°C Figure 4.7.1.c). The length of the seasons has also been affected, with an increased length of spring, summer and autum, and consequently a decreased length of the winter period (Figure 2 in Annex VIII). The average annual air temperature in the area is expected to increase 2ºC by 2025, and 4ºC by 2100 (Shimaraev et al. 2002).

The upper water layers in Lake Baikal have increased 1.21ºC since 1946 (Hampton et al. 2008, Shimaraev 2008). An increase in chlorophyll *a* of 300% has been observed since 1979, and an increase of 335% in cladocerans since 1946, which is expected to have important implications for nutrient cycling and food web dynamics in the lake (Hampton et al. 2008).

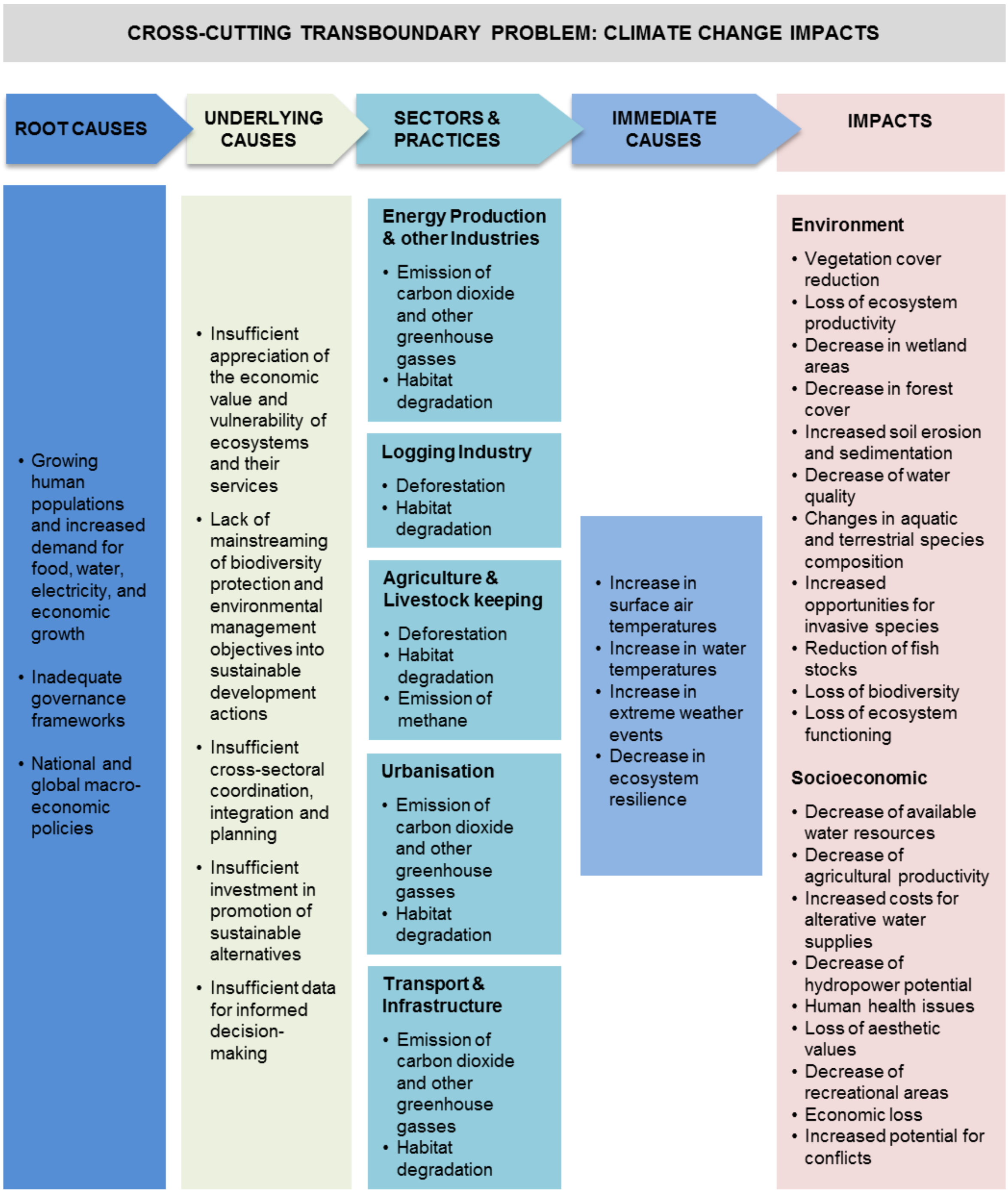


Figure 4.7.1.d Causal chain analysis of climate change impacts in the Baikal Basin.

4.7.1.1 Present and Future Impacts

The impacts of global climate change are cross-cutting, and are expected to affect all the problem areas that have been identified in this TDA (see Chapters 4.2-4.6).

An overall reduction of freshwater flows as a result of increased surface air temperatures and evaporation will lead to a decreased availability of drinking water, as well as water for domestic, urban, industrial, and agricultural use, impacting a wide range of sectors that support local and national economies (see 3.4 and 4.2). The overall combination of reduced water flows, extreme weather events and natural disasters (4.8), forest fires and continued unsustainable landuse practices is expected to result in increased land degradation (4.3) and erosion (4.4.3, Korytny 2003, Heglund et al. 2007).

Soil moisture may increase initially in some areas as the result of melting permafrost. Lake Khovsgol has increased in surface area between 1992-2008, as a result of the meling of glaciers and permasfrost in its catchment area (Figure 7 in Annex VII). Although the predicted patterns are complex and differ within the Baikal Basin (Annex VII and VIII), in general it can be expected that vegetation zones will move northward, and semi-arid as well as steppe zones are likely to expand. In Mongolia, an increase in desertification has occurred over the past 10 years (Figure 4.2.4.1.a), and this phenomenon is expected to worsen. Although in the Russian territory of the Baikal Basin the average amounts of precipitation are expected to increase, a decrease in water availability in Mongolia will have a transboundary effect on surface and groundwater flows.

The impacts of climate change may have both negative and positive consequences for agriculture. In theory, an increased length of the growing season with an average of 11 days in combination with warmer temperatures could result in a larger agricultural yield (Obyazov 2010). At the same time, a decrease in available surface and groundwater resources may result in a decrease of the agricultural productivity.

In Lake Baikal, plankton composition and productivity is expected to be affected by climate change (Shimaraev and Domysheva 2004, Hampton et al. 2008, Sorokovikova et al. 2008), which will affect zooplankton and as a result also the fish fauna in the lake. Changes in ice cover are expected to alter aquatic foodweb dynamics (Hampton et al. 2008, Moore at al. 2009) Furthermore, the shrinking of the ice cover and changes in ice transparency may harm the Baikal seal. Because seals breed on ice, premature melting forces them into the water before they start to cast their winter coat[56]. This will sharply decrease birth rates, and reduce the population size of the Baikal seals.

In general, the consequences are expected to be loss of biodiversity, reduction in ecosystem resilience, and ultimately a possible decrease of ecosystem services. The expected result is an impoverished environment, significant negative impacts on local livelihoods, economic losses, and increased risk for local, national, and transboundary conflicts.

4.7.1.2 Challenges for Future Management

Although global models and scenarios of climatic forecasts are being developed with increasing success over the past few years, they are still insufficient to offered detailed insights in the expected changes in the Baikal Basin region. This leads to substantial uncertainties related to future environmental sustainability and socioeconomic vulnerability issues.

Based on the fact that global climate change is a real and ongoing phenomenon, decision-making processes related to reduction of greenhouse gas emissions, and adaptations to the expected impacts of temperature and precipitation changes should not be delayed. As such, both the Governments of Mongolia and Russia are putting in place a range of policies and measures aimed at mitigation and adaptation to the impacts of global climate change.

The Government of Mongolia ratified the Kyoto Protocol (1999), put in place a National Action Plan on climate change (2000), prepared a first (2001) and second (2010) national communication, and prepared a national assessment programme that includes an assessment of global and national perspectives of climate change and forecasts, impact assessments, legal and institutional mechanisms, measures of mitigation and adaptation to climate change (MARCC 2009).

Mongolia furthermore developed a National Water Program (2010), National Program Against Aridization (2010), National Forest Program, National Global Climate Change Program (2011), National Natural Disaster Protection Program, as well as a general evaluation in order to develop strategic and policy measures for adaptation to the impacts of climate change.

The Government of Russia formulated a comprehensive plan of action for implementation of the Kyoto Protocol, in response to which the Government of the Republic of Buryatia passed two decrees (N46-r and N384-r, 2008) and formed an expert workgroup. An energy saving programme was drafted for 2020 with the objective to reduce energy consumption with 40% compared to 2008.

[56] www.magicbaikal.ru/news/09/news240609.htm

Measures that can be taken to reduce the volume of GHG emissions and mitigate the effects of climate change include:

- Improvement of the quality of coal for energy production
- Modernize electricity generation and transmission processes
- Promote the use of energy-efficient equipment
- Increase control and prevention of electric power theft
- Improve thermal insulation of buildings
- Develop and promite the use of renewable energy sources, such as hydroelectric energy, wind generators, solar energy and biofuels
- Reduce deforestation, and increase reforestation and afforestation efforts
- Promote agroforestry and sustainable landuse methods

The impacts of climate change will affect every transboundary problem area identified in this TDA. An integrated, ecosystem-based adaptation approach is an absolute requisite for facilitating future sustainability. This will require:

- Sufficient data for informed decision making (or following a precautionary approach in absence of sufficient data)
- Cross-sectoral coordination, integration and planning
- Mainstreaming of biodiversity protection and sustainable environmental management principles and objectives into development programmes

Photo by Sergey Kudelya

Photo by Anna Rynkova

4.8 CROSS-CUTTING PROBLEM AREA: NATURAL DISASTERS

4.8.1 DESCRIPTION AND TRANSBOUNDARY RELEVANCE

Although humans can typically do little to stop large-scale natural disasters from happening, processes such as the modification of hydrological flows (see 4.2), deforestation (4.3.3) and land degradation (4.3.4) can contribute to increase the magnitude of the impacts from earthquakes, storms, mudslides, droughts and floods. Furthermore, the impacts of climate change (4.7) are expected to increase the magnitude of natural disasters.

An integrated ecosystem-based resource management approach should also take into account the risks and opportunities associated with natural disasters, as they can have significant effects on biodiversity, environmental sustainability and socio-economic development. Therefore this chapter briefly describes the main challenges that are of concern in the Baikal Basin, and their linkages with the various problem areas that are discussed elsewhere in this TDA. More detailed background information of natural disasters in the Baikal Basin region is presented in Annex IV.

4.8.1.1 Present and Predicted Impacts

EARTHQUAKES

Due to its location in the tectonically active Baikal Rift Zone (BRZ), large parts of the region are subject to regular seismic activity (Figure 4.8.1.a). A network of 34 permanent observation stations was established in the Russian territory of the Baikal Basin, aimed at monitoring and predicting seismic activity in the region. Approximately 3-8 thousand seismic events occur annually in the Baikal Basin. Earthquake epicentres are located at a depth of 12-22 km. On average, an eartquake with a magnitude of 7 in its epicentre takes place approximately every 1-2 years in the area around Lake Baikal, a magnitude of 8 every 5-10 years, magnitude of 9 every 50-100 years, and with a magnitude of 10 once every 150-200 years (Table 1 in Annex IV).

One of the most intense earthquakes experienced in the Lake Baikal area was the Tsagansky earthquake in 1861 which had a magnitude of 7.5 at the surface and 10 in its epicentre. The earthquake cracked the ice that covered Lake Baikal, and generated a 3 m high tsunami that went 2 km landinwards on the Tsagansky steppe. The earthquake was felt in an area of about 2 million km^2, and damage to buildings occurred in a radius of 600 km from the epicentre.

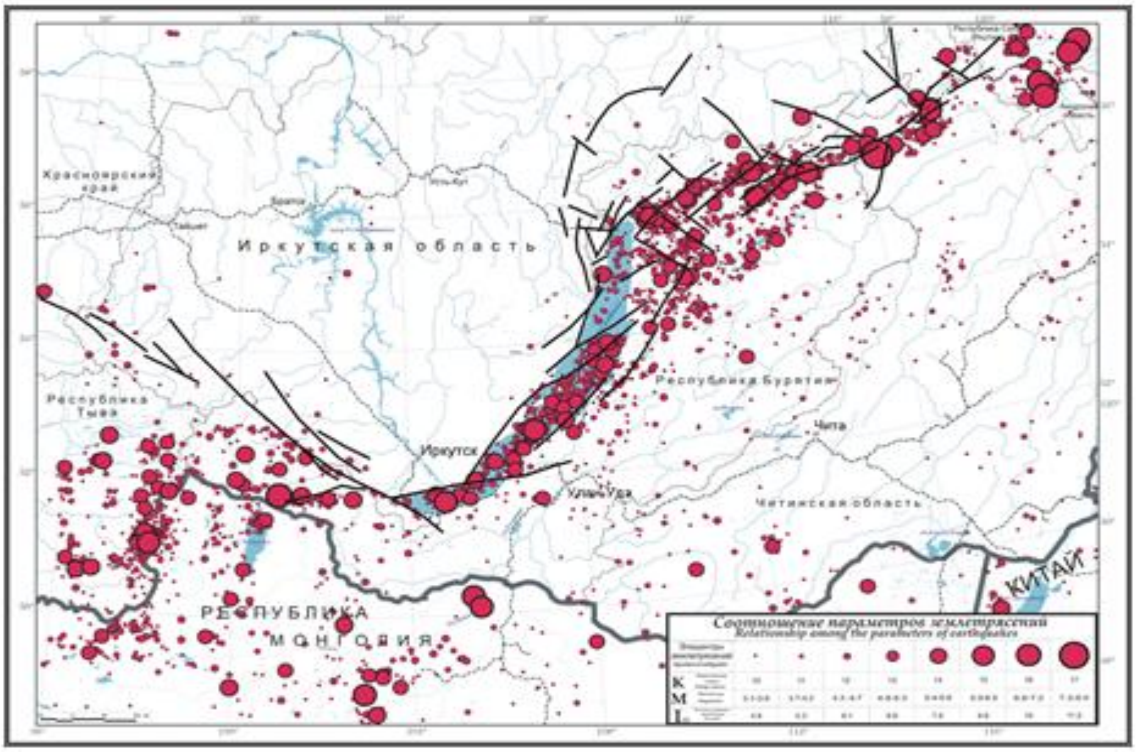


Figure 4.8.1.1.a Earthquake occurrence in Eastern Siberia since 1960. Source: Siberian branch of the Russian Academy of Sciences.

Selenge basin in Mongolia situates in the earthquake zone with magnitude from 6 to 9. There are 3 active earthquake zones in the Basin:

- Minjfault zone, 50-70 km from the Khentii mountain range, with a length of 200-250 km
- Baganuur small lake fault zone, approximately 150 km
- Vibration zone around Ulaanbaatar city

Figure 4.8.1.1.b: Land fault after the earthquake in Mogod area of Bulgan aimag, 1967.

In 1862 an earthquake with a Richter magnitude of 6.5 was registered in the Minjfault zone, and in 1869 with a magnitude of 5.5. The area around Ulaanbaatar is an active earthquake zone with regular tremors. Due to their geological structure, the most dangerous zones near Ulaanbaatar are the marshy areas in the Selbe and Tuul River basin, where earthquakes with a magnitude of 8 may occur.

Some of the risks associated with earthquakes are abrasion, erosion, mudslides, landslides, and avalanches. Mudslides can be particularly dangerous when catastrophic earthquakes coincide with abnormally intensive rainstorms during warmer periods of the year. Endokinetic landslides can displace several millions of m^3 of soil, generating an enormously destructive force. In some of the high risk areas in the Baikal Basin, special dams have been constructed to protect buildings and industrial installations.

In 1971 large mudflows with a height of 2.58 destroyed bridges, roads, railways, underground communication cables, and buildings in the area of Sljudjansko-Baikal, resulting in substantial economic losses (estimated 80 million rubles) as well as loss of human lives. Dams of mud and rocks were formed, reaching 3-3.5 m height, blocking the flow of streams and rivers (Makarov 2012). Between 1971-2011 no large mudflows were reported, but forecasts predict an increased risk of mudflows in the near future (Figure 7 in Annex IV).

EXTREME WEATHER EVENTS

Over the past 20 years, the amount of deadly incidents, environmental damage, and economic losses resulting from extreme weather events such as thunderstorms, floods, and hailstorms. has increased significantly in the Baikal Basin as a result of climatic changes (MARCC 2009).

The amounts of precipitation in the Baikal Basin is unevenly distributed across the region (see 2.1.4), but typically follows a pattern of wet and dry cycles (Figure 2.1.4.b). Flood frequency has increased in recent years. In 1993, extremely high water levels in the Selenga River resulted in the flooding of 30 thousand hectares of agricultural lands, 10 thousand farms, as well as over 8 thousand houses. Extremely high water levels in 1998 resulted in the flooding of 19 districts in Buryatia, including Ulan-Ude. In total, over 10,000 people were affected by the floods, and 12 people died as a result. In 2006, high water levels resulted in the flooding of Djidinsky, Zakamensky and Tunkinsky districts, which impacted approximately 3,000 people ane resulted in an estimated loss of 162 million rubles. In 2012, heavy rainstorms resulted in the flooding of 3,229 houses in Sovetsky and 2,000 in Oktiabrsky. It is estimated that over 5,000 houses located in the Selenga and Uda river catchments in the Russian territory of the Baikal Basin are at risk of future floods.

Besides causing loss of human and animal lives, as well as extensive material damage, floods can also cause pollution hazards if untreated wastewater from industries and treatment plants overflows into neighbouring areas. In addition, floods are often associated with earthquakes and can contribute to mudflows (see above).

Figure 4.8.1.1.c Left: Result of flashfloods near Zabaikalsk town. Right: Flooded area in Ulan-Ude, Republic of Buryatia, Russia.

Droughts are also a concern in the region, particularly in the Mongolian territory of the Baikal Basin. Droughts may lead to increased desertification as a combined result of unsustainable land management practices (see 4.3) and the impacts of climate change (4.7.1.1). Desertification in the region is associated with the following problems:

- Wind erosion
- Water erosion
- Secondary salinization
- Land degradation

Large areas of agricultural lands in both the Mongolian and Russian territory of the Baikal Basin are increasingly subject to desertification processes (4.3 and Table 1 in Annex IV). Droughts and desertification result in a decrease of water availability, changes in soil composition, decrease in soil productivity, decrease of agricultural productivity, loss of biodiversity and economic losses (4.2.2.1 and 4.2.4.1)

4.8.1.2 Challenges for Future Management

Minimizing the environmental and socioeconomic risks of natural disasters such as earthquakes, storms, mudslides, droughts and floods, should form an integrated component of the overall sustainable natural resource management strategy for the transboundary Baikal Basin.

Risks such as earthquakes are fairly well-monitored and understood, but remain difficult to manage due to the magnitude of their potential environmental and socioeconomic impacts. Another challenge is that predicting and understanding the risks associated with extreme weather events, floods, droughts and desertification is very difficult, because of the complex linkages with land management methods, and a lack of credible models (e.g. GAR 2011).

Disaster risk reduction (DRR) strategies should be developed both at the national and transboundary level, in order to prevent or mitigate the impacts of natural disasters. Key elements for successful disaster risk management include environmental protection strategies to enhance ecosystem resilience and ensure future ecosystem services (Figure 4.8.1.2).

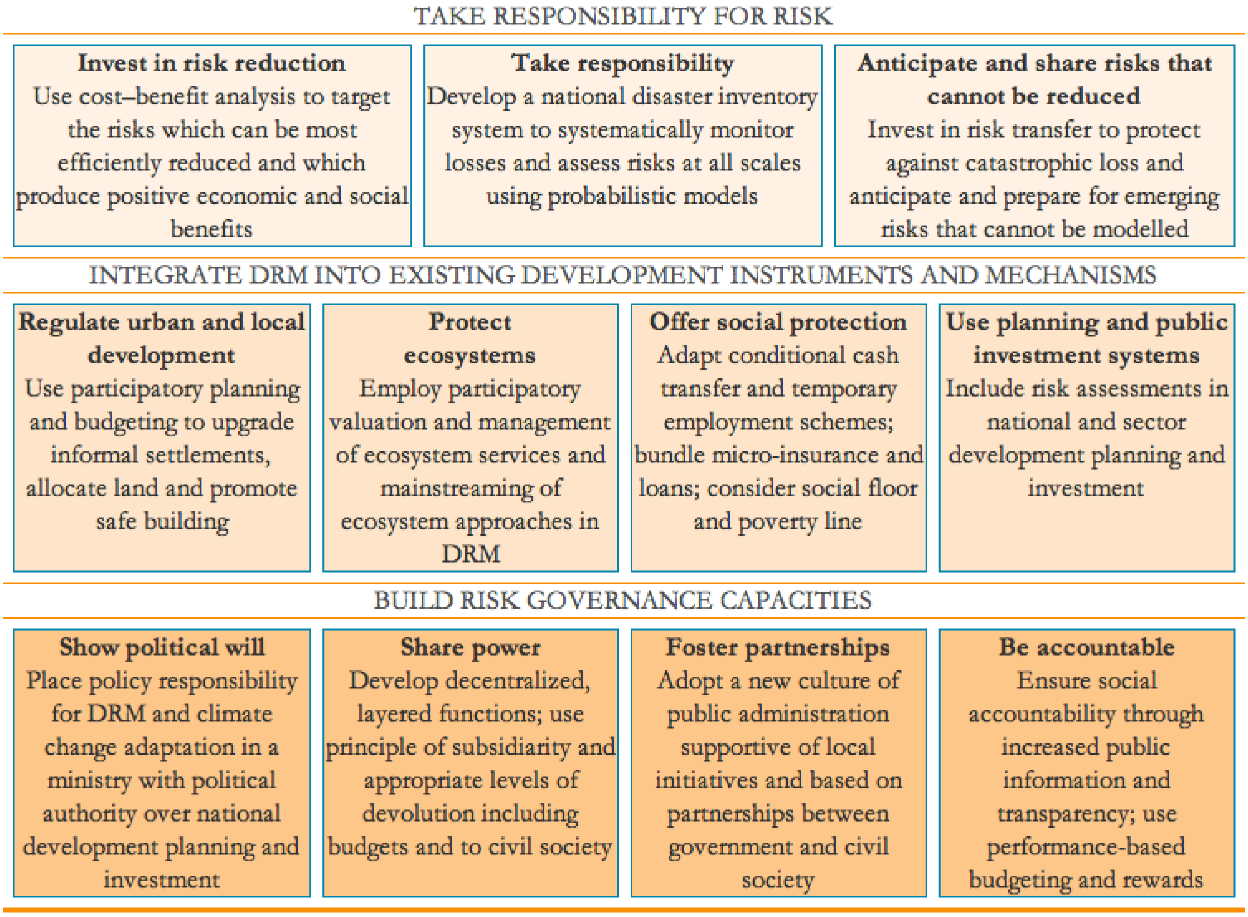


Figure 4.8.1.2 Key elements for successful disaster risk management across governance scales and sectors (GAR 2011).

Photo by Anna Rynkova

Photo by Sergey Kudelya

Governance and Natural Resource Management

5.1 INTRODUCTION

Governance refers to the processes through which decisions are made. Governance involves informed decision making that enables trade-offs between competing users of a given resource in order to balance protection with beneficial use, mitigate conflict, enhance equity, ensure sustainability and hold officials accountable (Turton et al. 2007). It includes the exercise of political authority and control over society, and how that affects the management of a country's economic and social resources for development (Landell-Mills and Serageldin, 1991).

Governance transcends the state by also taking in civic society and the private sector. Both the state and civil society, as well as the private sector are critical for sustaining human development. The state creates a conducive political and legal environment. Civil society facilitates political and social interaction; mobilising groups to participate in economic, social and political activities. The private sector generates jobs and income.

The ability of a state to manage its natural resources in a way that is generally referred to as "*good governance*" is determined by the following issues:

Strategic Vision

- Leaders and the public have a broad, long-term perspective on good governance and sustainable development

Legitimacy

- Existence of relevant national, regional and international goverance frameworks and institutions
- Relevant and fair policy, legal and institutional frameworks, processes and procedures
- Acceptance of the public of the authority of those who are in power

Accountability

- Transparancy of decision-making and management processes
- Ability of the public to exert scrutiny

Equity of Participation

- Equal opportunities of men, women, and different ethnicities to participate in governance processes and influence decision-making (directly or through legitimate intermediate institutions that represent their interests)

Management Effectiveness

- Sufficient technical, administrative, and managerial capacity
- Availability of effective economic tools and financial mechanisms
- Capacity of public bureacraties to skilfully and efficiently transform public resources into services and infractructure that correspond to publicly determined priorities

Information Availability

- Flow of information about laws, procedures and results, between government and civil society
- Monitoring of environmental status, to inform natural resource management decisions
- Sufficient public awareness and education

5.1.1 PRINCIPLES OF SUSTAINABLE NATURAL RESOURCE MANAGEMENT

Management of natural resources such as land, water, minerals, plants, forests, fish, and wildlife should be aimed at ensuring that the consumption and use of these resources and their associated impacts does not exceed the carrying capacity of the environment. Management of natural resources should be based on the fact that aquatic and terrestrial systems do not only represent economical value, but also ecosystem services that are crucial for the sustainability of our environment and for human wellbeing.

Ecosysem services include[57]:

- Provisioning services (food, raw materials, fresh water, medicinal resources)
- Regulating services (local climate and air quality, carbon sequestration and storage, moderation of extreme events, wastewater treatment, erosion prevention and maintenance of soil fertility, pollination, biological control)
- Habitat or supporting services (habitats for species, maintenance of genetic diversity)
- Cultural services (recreation and mental and physical health, tourism, aesthetic appreciation and inspiration for culture, art and design, spiritual experience and sense of place)

To achieve sustainable natural resource management, both environmental and economical components, as well as social components need to be addressed (Figure 5.1.1.a). Ecosystem services can be valued in monetary terms, which forms the basis of the UN-supported global initiative focused on drawing attention to the economic benefits of biodiversity (TEEB[58], Kumar 2012).

The concept of the **green economy**[59] was proposed as a way forward in response to the global financial crisis. The idea of a green economy is built on the three pillars of sustainability, and opportunities to invest in sectors that rely on natural resources and ecosystem services. The green economy is intended to result in improved human well-being and reduced inequalities over the long term, while not exposing future generations to significant environmental risks and ecological scarcities (see Spash 2012 for criticism).

Sustainability of natural resource use can best be achieved by following an ecosystem-based management approach, which recognizes the full array of interactions within or between aquatic and/or terrestrial ecosystems and their living, and non-living components.

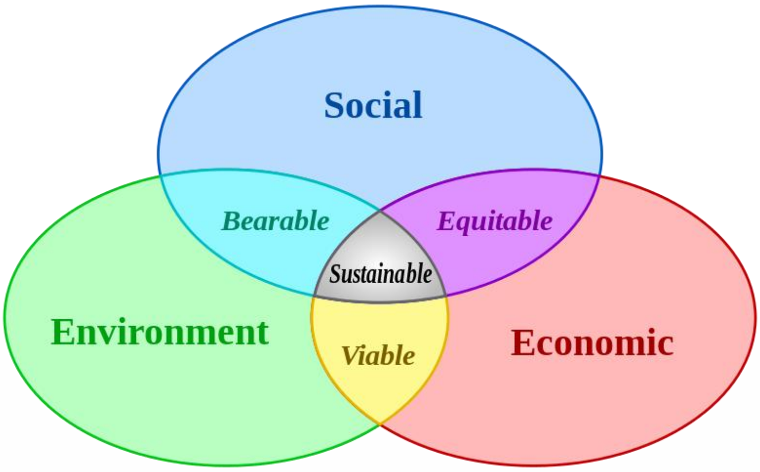


Figure 5.1.1.a The three pillars of sustainability. Source: wikipedia

[57] www.teebweb.org/resources/ecosystem-services
[58] www.teebweb.org
[59] www.unep.org/greeneconomy

Ecosystem-based management (EBM) approaches contain the following key elements (also see UNEP 2006):

- Integration of ecological, social and economic goals
- Recognition of humans as part of the ecosystem
- Accounting for the complexity of natural processes and social systems
- Incorporating a science-based understanding of how ecosystems respond to natural environmental processes and human-caused perturbations (pollution, deforestation, overfishing, land degradation, etc.)
- Using an adaptive management approach
- Engaging multiple stakeholders in a collaborative, equitable process to define problems and find solutions

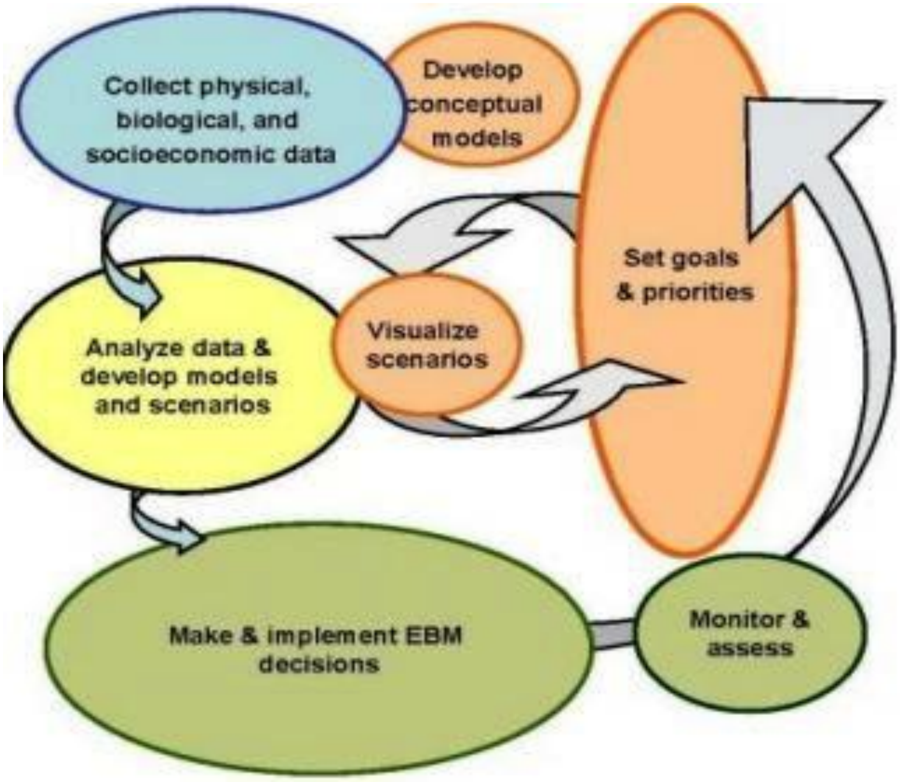


Figure 5.1.1.b Model for an ecosystem-based management approach. Source: www.ebmtools.org

A closely related concept is particularly relevant in the framework of the transboundary Baikal Basin is Integrated Water Resource Management (IWRM)[60]. IWRM is a cross-sectoral policy approach that is based on the understanding that water resources are an integral component of the ecosystem, a natural resource, and a social and economic good.

Integrated Water Resource Management strategies are based on the following principles[61]:

- Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment
- Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels
- Women play a central part in the provision, management and safeguarding of water
- Water is a public good and has a social and economic value in all its competing uses

The primary methodological approach that should be adopted for sustainable natural resource management is adaptive management. Adaptive management is a structured, iterative decision-making approach that aims to reduce uncertainty over time as a result of system monitoring.

60 www.gwp.org/The-Challenge/What-is-IWRM
61 www.gwp.org/en/The-Challenge/What-is-IWRM/Dublin-Rio-Principles

Adaptive management in environmental practice is based on the following components:

- Testing assumptions, and systematically trying different actions to achieve a desired outcome
- Changing assumptions and interventions to respond to new or different information obtained through experience and monitoring
- Explicitly documenting planning and implementation processes, successes, and failures for the purpose of learning and improving

5.1.2 KEY STAKEHOLDERS AND THEIR INTERESTS

Stakeholder analyses were done as part of the preliminary TDA process in 2008, and for the preparation of the UNDP-supported, GEF-financed Project on Integrated Natural Resource Management in the Baikal Basin Transboundary Ecosystem (Table 1, p. 15 in UNDP-GEF 2011). As part of the CCA for the present TDA, an additional analysis was done of key sectors, stakeholder groups as well as the decision-making and governing bodies (Annex X).

An extensive number of stakeholders is directly or indirectly involved in natural resource management processes in the Baikal Basin. Roughly, stakeholders can be divided into three categories of individuals/groups/sectors (Table 5.1.2):

A. Private Sector - Primary users of natural resources, who are directly affected by managerial decisions
B. Public Sector - Governing and decision-making bodies, responsible for management of natural resources
C. Civil Society - Parties who are concerned with conservation and and sustainable natural resource use

In reality, the situation is far more complex, and there can be substantial overlap among stakeholder groups. Nonetheless, although this is a rather unspecific and simplified classification, it can be used as a useful instrument to identify priority interests of stakeholders and opportunities for active engagement in biodiversity conservation and sustainable natural resource management.

There is a clear risk in conflicts of interests between stakeholder groups. The main interests of the private sector is to use natural resources for personal or corporate benefit and financial gain. Protection of these resources is of lesser importance, unless it can result in increased benefits. Furthermore, prevention of pollution and improvement of human health issues are not in the interest of most primary stakeholders, as this is often perceived to result in additional costs. These stakeholders often present strong lobby groups, because they generate financial revenue, offer employment, and contribute to social and economic development.

For the civil society stakeholder group, the main interests are to defend human rights of access to safe water and sanitation, ensure sustainability of natural resource use and the protection of biodiversity. These stakeholder groups do not always have access to substantial financial resources, but they can represent strong lobby groups by appealing to the interests of the general population and using popular media.

Table 5.1.2 Stakeholder categories, their perception of environmental problems, resources and priorities

	INTERESTS AND OPPPORTUNITIES	STAKEHOLDER GROUPS
A. PRIVATE SECTOR	• Interests of **direct users of natural resources** are to receive these resources of guaranteed **consumer quality** in optimal volume and by lowest price • Short-term and long-term interests focused predominantly on **economic perspectives** • Often the **cause of environmental degradation and pollution** • Interests in sustainable environmental management may increase if economic arguments are used • Extremely uneven financial, institutional and communication resources	• Energy industry • Legal and illegal mining industry • Forestry and wood processing industry • Agricultural industry and livestock keepers • Transport industry • Processing industry • Fisheries, aquaculture, and sport fishers • Hunting industry, indigenous hunters and poachers • Tourism and recreation

	INTERESTS AND OPPPORTUNITIES	STAKEHOLDER GROUPS
B. PUBLIC SECTOR	• Short-term interests of **Government** and **natural resource management** institutions focus on regulation, adherence to relevant environmental legislation, and implementation of national and international agreements • Long-term interests in ensuring conditions for **social and economic development** monitoring and reliable forecast of quality and quantity of water resources • Development of database and mechanisms for **informed decision-making** • Institutional, decision-making, administrative and financial resources	• Relevant Ministries and Government Departments • Federal Agencies • Regional and municipal executive authorities • Research institutions and the scientific community
C. CIVIL SOCIETY	• Interests of civil society are **complex** and related to both **national and international** importance of biodiversity conservation and sustainable natural resource management • Institutional, financial and communication resources	• NGOs • CBOs • International multilateral organizations • Media

The risks for conflicts between stakeholder groups are especially high in situations where direct economic interests contradict environmental interests. The key challenge for governing bodies is to resolve potential conflicts by facilitating social and economic development while at the same time protecting biodiversity and ensuring sustainability of natural resource use. In order to do so, these stakeholders have a responsibility to ensure good governance (see 5.1.1) through informed decision-making.

Some of the apparent conflicts between stakeholder groups could be solved by adequate information and encouragement to invest in sustainable solutions. For instance, it has been argued that measures to ensure sustainable management of natural resources reduce the national and international competitiveness of industries. However, the eco-industry is highly competitive, and investments in environmental protection can create millions of jobs (e.g. EEA 2005). Moreover, it is becoming clear that in many cases, sustainable management of natural resources increases long-term financial benefits and reduces economic losses that are associated with pollution, erosion, land degradation, etc.

Legislation and law enforcement can help to reduce stakeholder conflicts. For instance, implementation of the “polluter pays” principle can be helpful to reduce environmental pollution caused by the industry, and transfer the costs of environmental damage and human health issues back to the industry. Enforcement of laws and regulations relevant to fisheries, forestry and landuse can help to reduce pressure on the environment and thus solve conflicts between primary and tertiary stakeholders.

Other conflicting stakeholder interests are more difficult to solve. Although many of the stakeholder groups in the Baikal Basin are aware of environmental problems, the overall social and economic situation limits the possibilities to solve the problems. Furthermore, as a result of the growing human population and their demand for housing, food, energy, etc. there are increasingly less opportunities for indigenous people in the Baikal Basin to live according to their traditional customs (e.g. nomadic cattle-breeding, hunting, and fishing).

A high level of innovation, adequate environmental policies, and establishment of effective economic mechanisms will be required from the secondary stakeholder group to find long-term solutions. Economic growth can lead to social optimism, which can form the basis for increased investments in sustainable solutions as well as increased private and public participation in addressing environmental issues. Such developments will be particularly important for the transition economy in Mongolia and the subsidized sectors in the Russian territory of the Baikal Basin.

Some solutions for preventing or addressing possible conflicts and increasing the sustainability of economic activities in the Baikal Basin could be found in promoting a participatory approach to environmental management through:

- Raising interest of stakeholders to take personal responsibility in protecting biodiversity and ensuring sustainability
- Facilitate community-based land management and conservation
- Enhancing information exchange between business and industry sectors and the academic community as well as regulatory, supervisory and management authorities
- Establishing outreach and awareness raising programmes as well as environmental education curricula to ensure that all stakeholders are sufficiently well-informed about problems as well as their possible solutions
- Enhancing the capacity of key stakeholders to use environmentally-friendly methods, tools, and processes
- Enabling public participation in decision-making processes relevant to landuse-planning, zoning and environmental management issues

5.2 GOVERNANCE IN THE TRANSBOUNDARY BAIKAL BASIN

5.2.1 GOVERNANCE CHALLENGES IN NATURAL RESOURCE MANAGEMENT

There are a number of common challenges related to the existing governance structures related to all problem areas in the TDA (Table 5.2.1). In general, there are shortcomings in the available legislative frameworks, with inadequate or incoherent laws and regulations. A lack of implementation or enforcement is also a common problem. Legislative weaknesses are accentuated by inadequate institutional frameworks, and issues of technical capacity and financial mechanisms.

Insufficient environmental monitoring and data-exchange at the national and transboundary level limits the possibilities for adaptive natural resource management. In addition, a general lack of awareness and recognition of the values of natural resources and services at the level of policy makers and the wider public, contributes to the low priority afforded to sustainability issues at the political level.

Weak coordination between government institutions involved in natural resource management, as well as limited stakeholder involvement are other general issues of concern. Furthermore, a lack of coherence in policies, which are often sector-based rather than integrated across sectors, hampers sustainable natural resource management.

The main challenge is to identify the roots of the challenges for sustainable governance of natural resources, in the context of the legal and institutional frameworks that relate to the problem areas of the TDA.

Table 5.2.1 Common governance challenges for national and transboundary natural resource management (adapted from UNEP/Nairobi Convention Secretariat 2009)

	TRANSBOUNDARY GOVERNANCE	NATIONAL GOVERNANCE
Legal	• Absence and/or shortcomings in regional intergovernmental agreements • Shortcomings in the ratification and implementation of inter-governmental agreements	• Absence and/or shortcomings in national legal and regulatory frameworks • Fragmented (sectoral instead of integrated) legislation • Insufficient enforcement of legislation

Institutional	• Absence of a transboundary apex body providing oversight and coordination of intersectoral governance • Shortcomings in collaboration and coordination between regional institutions • Insufficient transboundary information exchange • Lack of adequate regional financial mechanisms	• Insufficient institutional capacity • Inadequate cooperation and conflicting mandates of national institutions • Lack of stakeholder (including private sector) involvement • Insufficient knowledge management • Insufficient monitoring of environmental and socio-economic processes • Lack of adequate financial mechanisms and resources
Policy & Legislative	• Absence of coherent regional policies and strategies • Insufficient joint-planning and implementation between countries • Lack of awareness and recognition of the (economic) values of natural resources at the level of policy makers	• Absence of coherent national policies and strategies • Lack of awareness and recognition of the (economic) values of natural resources

5.2.2 INTERNATIONAL CONVENTIONS AND TRANSBOUNDARY AGREEMENTS

Both Mongolia and Russia are parties to the Convention on Biological Diversity. Mongolia ratified the Convention in 1993[62], and Russia ratified the Convention in 1995[63]. Mongolia is a party to the Cartagena Protocol by accession, whereas Russia is not a party to this protocol. Both countries have prepared National Biodiversity Strategies and Action Plans.

The Orkhon River Valley Cultural Landscape received the status of World Heritage Site in 2000, and Lake Baikal has received the status of World Heritage Site in 1996. Under the Convention Concerning the Protection of the World Cultural and Natural Heritage[64], the State, by acceding to the Convention, confirms that these values are universal, and all countries are obliged to cooperate to preserve them (Paragraph 1 of article 6 of the Convention).

The history of joint agreements between Mongolia and Russia dates to 1974 wit the Agreement on the Rational Use and Protection of Selenga River Basin Waters. In 1988, an agreement was signed on Cooperation for Water Management in Transboundary Waters. In 1995, the countries signed a bilateral agreement on Protection and Use of Transboundary Waters[65], which addressed:

- Environmentally sound use of water resources, preventing pollution and water depletion
- Research on hydrochemistry, hydrobiology, and riverbed processes
- Joint research, assessment and planning in flood management
- Joint water quality monitoring and pollution prevention
- Preserving conditions for natural migration of fish and other aquatic fauna
- Developing common concepts for river basin water management
- Developing joint pollution and hydrological monitoring standards and procedures
- Information exchange on planned water management measures
- Jointly financed transboundary work and pursuit of international funding to support it
- Sharing of water resources and adopting international standards of water quality
- Prevention/reduction of negative impacts on transboundary water basins in national territories

Progress towards initiating transboundary management of the Baikal Basin has had variable success. Both Mongolia and Russia regularly share information, exchange visits, and have a strategy in place for cooperation in case of emergencies. A Joint Working Group was established, which is chaired by the water

[62] www.cbd.int/countries/default.shtml?country=mn
[63] www.cbd.int/countries/default.shtml?country=ru
[64] http://whc.unesco.org/en/conventiontext
[65] The joint-agreement from 1995 replaced agreements between Mongolia and Russia on Water Management (1988), and on Rational Use and Protection of Selenga River Basin Waters (1974)

resource agencies of the two countries. In 2006, at the meeting of the Joint Working Group, cooperative planning of river basin management was discussed in detail. Mongolia adopted new laws on river basin management, and requested the support of Russia to develop strategies for management of shared river basins, with the Selenga River proposed as the first pilot project.

An extended list of polluting substances was established in 2008 that should be monitored by by both countries (including heavy metals, oil products, and mercury). Furthermore, a bilateral assessment of the transboundary areas of the Selenga River, its tributaries and risk sfor human health in Russia and Mongolia was agreed, but its implementation was stalled. Both countries perform hydro-meteorological monitoring, but the national data protocols remain disparate.

In 2011, a meeting was held in the framework of the Agreement on the Protection and Use of Transboundary Waters, during which the final Protocol for the bilateral collaboration was signed. The Joint Working Group discussed issues related to the regular exchange of information, collaboration for implementation of the Agreement and harmonization of monitoring methods between the two countries as well as a list of controlled pollutant substances and water quality standards.

Although it is clear that there is a long and impressive history of bilateral cooperation between Mongolia and Russia, this has thus far not resulted in measurable change in transboundary planning, cooperation, and sustainable natural resource management. Furthermore, joint initiatives have focused largely on management of the Selenga River and improvement of its water quality. Future management planning and collaboration needs to focus on an ecosystem-based model that integrates terrestrial and aquatic components within the entire Baikal Basin, and subsequently addresses the priority issues presented in this TDA.

5.2.3 NATIONAL INSTITUTIONAL CONTEXT

MONGOLIA

In 1999, the Government of Mongolia launched a National Program for Water Issues and established a National Water Committee with responsibilities to manage, regulate and control the Program. The Law on Water that was passed in 2004 created and detailed the responsibilities of the Water Agency.

The National Water Committee (NWC) was established in 2000. The NWC is a cross-disciplinary group that coordinates and monitors water policy implementation. The NWC is tasked with implementing National water programs through the development and implementation of action plans. The Committee is responsible coordination water policies and actions by the ministries and local governments. This coordination allows the government to keep the links between the policies initiated and implemented by the successive governments.

The NWC supports water policy implementation to ensure sustainable water use, restoration, conservation, pollution prevention and provision of safe and sufficient water to consumers. The NWC's role is also one of crosssectoral coordination of line ministries and the fragmented water management sector, including policy coordination. The NWC administers the National Water Sources Protection Program developed by MNET.

In 2012, the water sector was reorganised. The NWC will fall under the Prime Ministers Office. The Ministry of Nature and Green Development (MNGD), which is responsible for coordination of all water-related Ministries.

Other relevant institutions include the Ministry of City-Planning, which coordinates activities to ensure water supply of cities and settlements, construction of canalization and water treatment facilities. The Ministry of Industry and Agriculture is responsible for agricultural water supply and irrigation programmes. The Agency for Specialised Control has the authority to establish environmental and water quality norms, and exert control through fines in case legislation is violated.

RUSSIA

The elaboration of policies and regulations relevant to environmental protection and monitoring lie with the Ministry of Natural Resources and Environment of the Russian Federation (Minprirody of Russia) as the federal executive body. The Rosprirodnadzor (Federal Service for Surveillance of Nature Use) is the federal executive body that implements the state regulations on the protection of the Lake Baikal. Monitoring is conducted by the Roshydromet (Federal Service for Hydrometeorology and Environmental Monitoring).

Another key authority in the field of environmental protection is the Rosvodresursy (Federal Agency for Water Resources), which has the mandate to coordinate water use and protection, as well as water quality monitoring.

The analysis of authorities of the federal executive bodies showed that around 20 federal agencies are directly related to the issues of the state regulation in the field of protection, conservation and popularization of the Lake Baikal, what makes it necessary to distribute the authorities in this field.

In 2007, an Interdepartmental Commission on Protection of Lake Baikal was established by the Russian Duma. The Commission is comprised of a large group of representatives, including the Minprirody, Rosprirodnadzor, Irkutskaya Oblast, Republic of Buryatiya, Chitinskaya Oblast and Ust-Ordynsky Buryatsky Autonomous District and six Federal Ministries (Natural Resources, Agriculture, Economic Development and Trade, Emergency Situations, Industry and Energy, Foreign Affairs), as well as the Siberian branch of the Russian Academy of Sciences.

The aim of the Commission is to formulate and coordinate the realisation of state policies on the protection of Lake Baikal. The tasks of the Commission include refining and strengthening the legal-regulatory acts in the field of environmental protection and reasonable exploitation of natural resources within the Baikal Natural Territory, ecosystem monitoring, and fulfilling obligations to protect Lake Baikal as a UNESCO world heritage site.

The Commission held 4 meetings after its establishment, but no meeting took place between 2009-2011. Only after personal guidance of the President of Russia, a 5th meeting was organised in April 2012.

5.2.4 LAWS AND LEGISLATIVE FRAMEWORKS

MONGOLIA

In total, 56 laws exist in Mongolia that are relevant to environmental protection, water management and pollution control. Some of the most important laws in the context of the TDA are listed here.

- National Security Concepts (approved by Parliament in 2010)
- Law fees for water pollution (2012)
- Law on fees for mineral resources (water) use (2012)
- MDG based National Development Program (2004)
- Law on water supply and waste water treatment exploitation of settlement (2010)
- Law on Environmental Impact Assessment (2012)
- National Water Program (approved in 2010 by Parliament)
- Action Plan of National Water Program (approved in 2010 by Cabinet)
- Climate change adaptation national program (approved by Great Khural in 2011).

WATER LAW (2004, replaced by new water law 2012)

The Law on Water regulates relations arising out of and in connection with sustainable use, protection and rehabilitation of water and watershed areas. It also regulates wastewater treatment issues and tariffs. The law defines the mandates of the state organizations that are in charge of development and adaptation of IWRM plans. The law opens the way to decentralization of water management. The law facilitates engagement of the private sector in water management activities e.g. through state corporations and public-private partnership arrangements.

There are 8 other laws that are relevant to water related issues, including the Law on Sanitation and Hygiene, Law on Industrial and Household Wastes, and the Law on Urban Water Supply and Sewerage Systems. In total, these laws include more than 40 regulations and water-related standards. Some of the key regulations and standards are:

- Water quality standard. MNS 4586-98
- Standard of wastewater treatment MNS 4943: 2000
- Standard on location of sewerage facility, treatment technology and its basic requirements

- Standard on technological wastewater generateg from tanneries before primary treatment facility MNS 5582:2006
- Water supply and sanitation facilities. MNS 6279: 2011
- Standard on treated wastewater is released to the natural environment. MNS 4943: 2011

- Maximum acceptable level of residuals and composition is connected to the Secondady sewerage facilities.

LAW ON SPECIAL PROTECTED AREAS (1994)

Provides for the establishment of Protected Area (PA) systems at national and local levels, and establishes management regulations for national PA. The law regulates the use and procurement of land for special protection and conservation of its original conditions in order to preserve the specific values, including biological, scenic and scientific. Specifies sources of financing for PA including: state/local budgets; income from tourism and other activities and services; donations and aid by citizens, economic entities and organizations, and; fines.

LAW ON ENVIRONMENTAL PROTECTION (1995)

Focuses on principles such as protection, sustainable use and restoration of natural resources. Clarifies ownership of natural resources, stating: “the land, its underground resources, forests, water, animals, plants and other natural resources shall be protected by the State and unless owned by citizens of Mongolia, shall be the property of the State.” Allows citizens and legal entities to use natural resources upon payment of fees. The law enables State environmental inspectors to stop operations that adversely affect the environment in breach of law, standards and permissible levels and to impose penalties.

LAW ON FORESTS (2007)

Regulates the protection, possession, sustainable use and reproduction of forests. Law on Special PA covers forests within PA. In protected forests, all activities are prohibited “except for the construction of necessary infrastructure, forest restoration, cleaning and use of non-timber resources.”

MINERALS LAW (1997)

Regulates exploration and mining activities within Mongolia.Article 30 specifies the environmental protection responsibilities of mining licence holders, including the requirement to conduct an environmental impact assessment (EIA) and prepare an environmental management plan (EMP).

The EIA must identify the expected adverse environmental impacts to land, water, air, and plant/animal and human life and determine measures to minimize and mitigate such impacts. These responsibilities include providing specific measures to ensure that mining minimizes damage to the environment: a) Controlling toxic substances and hazardous materials; b) Conserving, protecting surface water and groundwater; and c) Constructing and maintaining safe tailings dams if necessary. The EMP must also specify measures for rehabilitation of the land to productive use.

LAW ON PROHIBITION OF MINING OPERATIONS IN HEADWATERS OF RIVERS, PROTECTED ZONES OF WATER RESERVOIRS AND FORESTED AREAS (2009)

This law restricts mining activities within critical watershed areas and revokes licenses for mines already operating in these areas.

RUSSIA

LAW ON THE PROTECTION OF LAKE BAIKAL (1999, revised in 2004, 2006, 2008 and 2011)

The “Baikal Law” was the first federal landuse regulation for a specific Russian territory in an attempt to coordinate resource use and protection efforts within the Russian territory of the Baikal Basin.

The law includes four main sections:

1) Main clauses, which identify Baikal Nature Territory including Central Ecological Zone, Buffer zone, catchment area of Lake Baikal in Russia and zone of atmospheric impact.
2) Baikal Nature Territory protection regime, which prohibits or limits certain kinds of activity, peculiarities of protection of endemic animals and plants, use of land and forest resources, organization of tourism and recreation.

3) Standards of maximum permissible hazardous impact on unique ecological system of Baikal and its nature territory.
4) State regulation in the sphere of Lake Baikal protection, which specifies development of complex schemes of protection and use of nature resources of Baikal Nature Territory, issuance of ecological passports for economic objects, liquidation or reshaping of most dangerous of them, holding of state ecological supervision and ecological monitoring.

The Baikal Law provides the foundation and coordinating framework for protection of Lake Baikal. Support and performance of concrete instructions of the Law, are regulated by passed subordinate acts. The Russian government resolution # 661 (year of 2000) specifies procedure of organization of Baikal Nature territory borders and its ecological zones. The Russian government order # 4641-p (year of 2006) states the borders of Baikal Nature territory and its ecological zones – central, buffer zones and zones of atmospheric impacts.

Federal Order 234 of the Russian Federation (2001) regulates the required water level of Lake Baikal (controlled by the Irkutsk Hydropower Plant). The Russian government resolution # 67 (2002) limits hunting on aquatic animals, collection of endemic water plants, and regulates their protection. State ecological supervision of Baikal Nature territory is held according to the rules of state ecological control in the sphere of environmental protection, which were upheld by the Russian government resolution # 285.

Federal Order 234 of the Russian Federation (2001) regulates the required water level of Lake Baikal (controlled by the Irkutsk Hydropower Plant). The Russian government resolution # 67 (year of 2002) determined the order of catch of endemic water animals, collection of endemic water plants and their protection. State ecological supervision of Baikal Nature territory is held according to the rules of state ecological control in the sphere of environmental protection, which were upheld by the Russian government resolution # 285. Those rules are unitary for all objects of the Russian Federation. State ecological monitoring of unique ecological system of system of Lake Baikal is a subsystem of unitary system of state ecological monitoring, which was upheld by Federal law # 331 in 2011.

In 2002, a decree was passed providing a list of forbidden activities in the Central Ecological Zone. However, till present days, regulations for maximum permissible impacts on unique ecological system of Lake Baikal and Baikal Nature territory are not enacted yet.

LAW ON PROTECTION OF THE NATURAL ENVIRONMENT (2002)

Determines legal grounds of the state policy in the field of environmental protection by seeking to balance socio-economic development with environmental conservation. The law determines basic notions, mechanisms and tools (legal, institutional, economic) applied to achieve these goals. The law determines priorities for environmental protection, including surface and groundwater, forests and other vegetation, protected areas and biodiversity. This law also defines the standards for environmental quality. Its practical implementation requires the elaboration of implementable regulations.

LAW ON WILDLIFE (1995)

Regulates relations in the field of protection and use of wildlife, as well as conservation and restoration of its habitats aimed at provision of biological diversity, sustainable use of all its components, establishment of conditions for sustainable wildlife populations and the conservation of biological diversity.

Wildlife within Russia is seen as state property. Some wildlife is considered to be federal property, including rare and endangered species, as well as those recorded in the Russian Red Book, as well as wildlife inhabiting the specially protected areas at the federal level.

FOREST CODE (2006)

Specifies the protection and defense of forest, preservation of its biological diversity, use of forest considering its global ecological significance, forest reproduction, improvement of forest quality and raising of its productivity, preservation of environment forming, water protection, defensive, sanitary-hygienic, recreational functions of forest.
Use, protection, defense and reproduction of forest are performed on the basis of concept of forest as an ecological system or a nature resource. The codex specifies the determination of legal regime of forest, located on nature conservation areas, water protection areas.

WATER CODE (2007)

Provides for the protection of riparian lands and along the shorelines of water bodies. The Code calls for the application of the catchment basin approach to water resource management, and determines responsibilities and levels of authority for government organizations in the field of water management. The code calls for the establishment of environmental quality standards, and objectives for surface and groundwater resources. However, no specific norms or practical guidance is offered on how to implement such provisions.

LAW ON FISHING AND PROTECTION OF AQUATIC BIO-RESOURCES (2004)

The law regulates the establishment of water quality norms for water bodies of fishery significance, and water requirements for water regime of fishery objects. The law also regulates the establishment of annual total permissible catches of aquatic bioresources, and, enables the protection of water bodies (all or portions thereof) of fishery significance for the purpose of conserving valuable fish species and other aquatic resources.

To do this, the law allows for the establishment of fishery reserve zones (i.e. fish refuges). Implementation of this aspect of the law has been hampered by a lack of specific norms on how these fish refuge zones could be created, managed or mainstreamed into the production landscape.

PROTECTED AREAS LAW

Federal targeted program “Protection of Lake Baikal and socio-economic development of Baikal nature territory for 2012-2020 period”.

By decree # 847 dated 21 August 2012 the Russian government approved the Federal targeted program “Protection of Lake Baikal and socio-economic development of Baikal nature territory for 2012-2020 period”. During these 8 years according to the Program 58 billion roubles, including 48,381 billion dollars (83,2%), are to be expended for three regions – Irkutskaya oblastj, the Republic of Buryatia, Zabaikalsky krai. This allows solving fewer than 80% of all ecological tasks on Baikal nature territory.

The program should solve such tasks as 50% reduction of pollutant discharge into Lake Baikal and on its shore, rehabilitation of under 80% of Baikal nature territory, which was in danger of pollution. Moreover, task of reduction of current negative impacts and task of improvement of system of ecological monitoring of Baikal nature territory condition. Also, the Program includes a set of activities for biodiversity preservation, minimization of nature risks, typical for this region, and eco-tourism development. According to the Program, the following primary activities are to be held on Baikal using the Federal budget funds: development of Nature conservation areas and realization of nature protection activities on the territory of former Dzhidinsky plant in Buryatia, Baikal pulp and paper plant and other significant objects.

Russia also has national procedures for assessing environmental impacts, as well as for territorial planning to ensure effective environmental protection (see Annex D in UNDP-GEF 2011).

5.3 THE ROLE OF CIVIL SOCIETY

Two options exist for environmental management, which each have different degrees of involvement from civil society: i) strengthening of regulatory enforcement regimes, so that environmental laws and standards can produce a stabilized or reduced amount of environmental degradation, or ii) a civil society environmental management regime.

The second option requires a robust democratic process, open print media, available and affordable communications technology, and active public participation in governance. This alternative environmental management regime places greater responsibility on local citizen involvement and public-private partnerships as ways to maintain governmental accountability, increase transparency, and deliver environmental sustainability (Taylor, 2008).

For the sustainable management of the transboundary Baikal Basin, perhaps a combination of the two options would produce the best results. Civil society movements are steadily emerging in the region, and increasingly able to influence general public opinion as well as governance, in spite of obstacles or state-imposed constraints.

In general, some of the key groups from civil society that are relevant to the protection of biodiversity and sustainable management of natural resources in the Baikal Basin are:

- National NGOs and CBOs
- International NGOs (e.g. WWF, IUCN, Greenpeace, TNC)
- Tourism, hunting and sportfishing organisations
- Associations of manufacturers and businessmen whose activities have a relevant environmental aspect
- Public and political parties, movements and organizations
- Religious organisations

The Russian-Mongolian Agreement on Cooperation in Environmental Protection (1994) and the Agreement on the Protection and Use of Transboundary Waters (1995) both envisage public participation in their implementation through the establishment of thematic task forces. This demonstrates the commitment of both Governments to recognize the important role that representatives from civil society can play in informing and guiding environmental management decisions.

The civil society arena in Mongolia is increasingly diverse and vibrant, with a growing number of NGOs, grassroot groups and social movements (CIVICUS 2006). Official statistics in Mongolia show that there are more than 500 environmental NGOs, however it is assumed that about 20% of these organizations are actually in existence and functioning. Until recently, environmental NGOs in Mongolia were dominated by scientists and ecologists. In recent years, especially since the mid-2000s, this situation has been changing, due to the active involvement of grassroots organizations and activists. In addition, some domestic and international NGOs that previously worked in different issue areas have turned their attention to environmental problems.

In 2006, the Homeland and Water Protection Coalition was established in Mongolia by eleven local movement organizations. Local movement organizations grew out of environmental problems caused by mining operations in specific local areas. The formation of a coalition enabled them to transcend localism and frame the solution of local problems broadly. Since 2008, these movements have organized campaigns to ban mining operations in headwater areas and water basins. After the movements organised a series of actions including hunger strikes, the Mongolian parliament passed a law that prohibits mining operations in headwater areas, river basins, and forest zones in July, 2009.

In addition, the role of the media in Mongolia is increasingly strong and there have been several prominent journalists who expressed a strong voice of concern for the environment. For instance, in the late 1980s, an article in *Today* newspaper about the environmental effects of phosphor extraction in the Lake Khovsgol area resulted in public outrage upon which the Government revoked its plans.

In Russia, there has been an increased number of environmental groups since the mid-1990s. The Socio-Ecological Union, an umbrella group in Moscow, claims to have over 250 organisations across Russia as its members (Sharpe 2006). Despite a lack of resources, obstacles from state-imposed constraints on their activities, and reluctance of Government agencies to discuss management decisions, the environmental movement in Russia has achieved real successes in promotion and protection of the environment.

Successes of the environmental movement include the halting an oil pipeline in Siberia, and raising global awareness about pollution issues in Lake Baikal. With support from the global community, NGOs in Russia are playing an increasingly important role in attracting attention to issues of environmental management and protection in Russia. The scope of interests and activities organised by the environmental movement include:

- Environmentally oriented tourism, including fishing and game hunting
- Environmental education and outreach
- Shoreline clean-up activities
- Population health issues
- Promotion of sustainable landuse methods
- Promotion of environmentally-friendly technologies
- Promotion of community-based ecotourism initiatives
- Local ethnography
- Restoration of folk traditions and trades based on sustainable use of natural resources
- Scientific studies and activities aimed at the protection of Lake Baikal and its biodiversity
- Training and capity building
- Organisation of national conferences, congresses and referenda on environmental protection and environmental safety
- Campaigns using the mass media
- Promotion of the development and operation of SPAs

The Russian Ministry of Natural Resources relies on support from the environmental movement. Representatives of the environmental movement sit on councils at the Ministry of Natural Resources and the Ministry of Atomic Energy, as well as at the Federation Council and the Duma. They also participate in the Interagency Commission of the National Security Council of the Russian Federation on Environmental Safety. Finally, a representative of the environmental movement sits on the Presidential Human Rights Commission.

Environmental movement representatives thus have roles in most legislative and executive bodies of Government, though they sometimes lack sufficient determination to make the government hear their arguments. Environmental activists also try to work together with business structures, including the Chamber of Commerce and Industry of the Russian Federation, the Russian Union of Industrialists and Entrepreneurs, and other business associations and individual companies as well as various NGOs (UNDP 2007).

Environmentalists in Russia have also been successful in monitoring environmental violations by the private industry, and documenting the lack of enforcement of environmental laws and regulations. Many of Russia's environmental organisations are also active in conducting outreach and awareness programs (see 5.4).
The most influential public organizations in the Baikal region include: Buryatia Regional Branch for Baikal (BRB), regional public organization *Ecoliga* located in Ulan-Ude, public organization *Turka*, inter-regional public organization *Big Baikal Trail*, *Baikal Ecological Wave* from Irkutsk, and Public Environmental Center *Dauria* from Chita.

5.4 ENVIRONMENTAL AWARENESS AND EDUCATION

Environmental education activities and public awareness campaigns can help to sensitize and empower people about issues relevant to the protection of biodiversity, management of natural resources and sustainable development opportunities. Ultimately, the achievement of truly sustainable development depends on the level of education of the overall society.

A variety of public awareness raising, education activities and training programmes are being implemented at the national level in both Mongolia and Russia. Environmental education and outreach programs focus on the following objectives:

- Reforming environmental education curricula and publishing of environmental educational textbooks
- Organisation of extracurricular educational activities, summer schools and conferences;
- Environmental outreach through the mass media, and publication of specialized popular science magazines;
- Outreach and awareness raising activities (e.g. festive events during World Environment Day, World Water Day, International Bird Day, and Baikal Day);
- Training of environmental personnel of regional and municipal levels.

Mongolia designated 2013 as the environmental education year to promote public awareness of environmental protection. A relatively broad knowledge base and skill sets has been developed among stakeholders in the environmental sector in Mongolia. Communication and public awareness activities have been organised for many years, supported by international projects, local NGOs, and research organizations as well as the local community.

Mongolia recently started an attempt to boost environmental education via implementation of the Education for Sustainable Development[66] (ESD) concept. ESD is regulated by various national programs and policies. However, a lack of implementation mechanisms, and human resources previously hampered the full realisation of this initiative. With support from the Coping with Desertification Project funded by the Swiss Agency for Development and Cooperation (SDC), in total 77 secondary schools in Mongolia are currently testing this new educational approach[67].

In Russia, importance of environmental education is referred to in various legislative frameworks. Both the Law on the Protection of Lake Baikal (1999) and the Law on the Protection of the Natural Environment (2002) refer to the role of environmental education.

Federal environmental programmes also link to the development of educational activities. For instance, the programme on Ecology and Natural Resources of the Republic of Buryatia 2004-2010 included extracurricular activities with students, popular science publications, and media coverage. A new strategy was developed for 2012-2016 by the Ministry of Natural Resources of the Republic of Buryatia, which aims at continued environmental education.

[66] www.unesco.org/new/en/education/themes/leading-the-international-agenda/education-for-sustainable-development
[67] www.swiss-cooperation.admin.ch/mongolia/en/Home/News/News_Detail?itemID=220141

In general, environmental education appears to be well-integrated in school curricula in the Russian territory of the Baikal Basin. Children at pre-school, primary and secondary school learn about the environment of Lake Baikal through a series of special classes. The Baikal Interregional Center Ecological Health School was established to offer programs and projects on environmental education. The Small Academy of Sciences and International Eco-Educational Center *Istomino* organise special summer schools. Furthermore, a conference on sustainable development for young scientists is organised on a regular basis by the Baikal Institute for Nature SB RAS.

Environmental movements play an important role in implementing environmental education and outreach programs both in Mongolia and Russia. These programs appear in many forms, and may be developed as part of school curricula, after-school programs, or organised around summer camps or nature expeditions. Some organisations also offer training seminars for teachers, publishing journals on environmental education, and establishing small libraries for schools.

In the Russian territory of the Baikal Basin, the Department of Natural Resources and Environmental Protection of the Ulan-Ude City Administration, Baikal Informational Center *Gran*, the Buryatia Museum of Nature, public environmental organizations and volunteers regularly organize environmental outreach and awareness raising events. This includes annual campaigns to clean up the shoreline of Lake Baikal.

The White Book of the Baikal Region provides an overview of environmental organizations in Irkutsk oblast, Republic of Buryatia and Zabaikalsky krai and the activities that they implemented in recent years. It offers a useful reference manual for non-profit organizations, students, teachers, and representatives of business, governmental authorities and other stakeholders. Furthermore, the monthly magazine *World of Baikal*, which has been published since 2004 offers information and outreach relevant to the environmental issues in the region. In 2010, a digest of thematic publications of this magazine was published with support from UNEP.

A number of outreach and education activities have also been implemented with support from the international community. Under coordination of UNESCO, research, education and awareness raising activities are being organised aimed at involving the general public and increasing knowledge about the environmental problems that affect Laka Baikal. Public awareness raising actions were also implemented under a EU-TACIS project from 1998-2000, which included the establishment of a GIS-based knowledge management system and development of environmental education programs.

In addition, the UNDP-supported, GEF-financed Project on Biodiversity Conservation in the Baikal Region included environmental education activities. Furthermore, as part of the present UNDP-GEF Project on Integrated Natural Resource Management in the Baikal Basin Transboundary Ecosystem, communication and public awareness strategies have been prepared by Mongolia and Russia (Annex XII and XIII).

5.5 ENVIRONMENTAL MONITORING and ADAPTIVE MANAGEMENT

5.5.1 M&E IN THE CONTEXT OF NATURAL RESOURCE MANAGEMENT

Monitoring and evaluation (M&E) of progress is a crucial component of successful adaptive, results-based management (see 5.5.2), and forms an integrated part of all GEF International Waters projects. Baseline data collected as part of the TDA provides the basis of the M&E framework for measuring the effectiveness of SAP interventions.

During the development of the SAP, a logical framework (logframe) will be developed for the implementation of interventions. The indicators that were developed on the basis of data collected during the TDA and evaluated as part of the SAP will subsequently form the basis of further M&E activities as part of project implementation.

The design of any M&E system and identification of suitable indicators should be derived from the project development goals and the design of a logical framework, or logframe, which organizes project components into inputs, activities, outputs, outcomes and impacts. All M&E frameworks should include indicators that are Specific, Measurable, Realistic, and Time-bound (SMART). Indicators for natural resource management and transboundary water basin interventions fall into a number of categories, which are listed in Table 5.5.1.

In order to promote sustainable natural resource management, it is important that gender issues are explicitly addressed. As such, the indicator groups listed below should, to the extent possible, be developed with the aim of creating awareness of the different impacts of interventions on men and women (e.g. FAO 2004).

One of the key requirements for successful M&E for adaptive natural resource management is the presence of quality baseline data as well as ongoing monitoring of agreed indicators. In the context of the Baikal Basin, GIS-based information systems of changes in landuse patterns (e.g. forest cover, land degradation hotspots) would be greatly beneficial for future monitoring.

Biodiversity indicators, and indicators of the health of fish populations need to be measured on a regular basis using harmonized methods, and the data should be shared between Mongolia and Russia. Surface water monitoring frameworks need to be improved, and should be based on methods that are standardized and harmonized. Furthermore, joint-groundwater monitoring frameworks need to be established, and linked to surface water monitoring databases.

Table 5.5.1. Indicators for M&E of environmental management interventions. Adapted from Duda (2002).

Type of Indicator	Description	Example
Process	Measurements of **institutional and political changes** in integrated natural resource management	• Establishment of interministerial committees • Completion of TDA establishing priorities, identifies root causes and is endorsed by the involved countries • Completion of SAP containing national and regional policy,

	processes	legal, and institutional reforms and priority investments to address priority transboundary issues • Adoption of a harmonized M&E framework • Adoption of a joint legal/institutional framework • National adoption of policy/legal reforms in key sectors • National ratification of regional or global conventions and protocols pertinent to the TDA and SAP • Country commitments to report progress in achieving reduction in environmental stressors, and improvement of environmental and socioeconomic status
Governance	Measurements of **changes in the capability to govern** integrated natural resource management issues	• Ability to implement NRM interventions, and service the needs of society • Ability to manage water finance and budget • Responsiveness and feedback between providers and society • Equality in rights and benefits • Accountability, scrutinizing of existing situations, public access to existing information • Stakeholder participation in decision-making processes
Stress	Measurements of **changes in environmental stressors**	• Parameters relevant to point or non-point source pollution (e.g. kilo pollutants per year) • Surface and/or groundwater quality parameters • Erosion or sedimentation parameters • Area covered with forest/agroforestry species/other vegetation aimed at reducing environmental stressors • Amount of catchment or aquatic area placed into protected management (including the establishment of no fishing zones) • Amount of fishing pressures reduced (e.g. reduced number of boats) • Numbers of fishermen using larger mesh sizes or other measures aimed at reducing fishing pressure
Environmental Status	Measurements of **results of integrated water basin management interventions**:	• Improvement in trophic status of a specific terrestrial or aquatic ecosystem • Changes in measurable ecological or biological indices (e.g. Water Quality Index) • Improved flow regimes (e.g. hydrological parameters, incl. parameters related to groundwater use and catchment area protection) • Ecological parameters (e.g. age classes of fish, improved recruitment classes of targeted fish species, improved aquatic species diversity) • Reduction of POPs throughout the food chain
Socioeconomic Indicators	Measurements of changes in the **socioeconomic status** of human populations in the catchment basin	• Increased stakeholder awareness and documented stakeholder involvement • Local income status • Increased access to clean water and sanitation • Increases in sustainable livelihood generation opportunities • Increased use of sustainable energy alternatives by households and industries • Social conditions
Catalytic Indicators	Measurements of **changes resulting from combined interventions**, which have a wider	• Replication of project interventions outside the demonstration sites

	development impact	
Proxy Indicators	Measurements that provide **indirect information of changes** related to the environmental or socio-economic situation	• Decrease in water quality related diseases
Cross-cutting Indicators	**Combination of a number of the abovementioned indicators** to provide snapshot information on progress, and which are relevant to at least two sectors at the same time	• Reduction in pollution through improved sanitation, leading to decrease in water quality related diseases

5.5.2 MECHANISMS FOR ADAPTIVE MANAGEMENT

There are various models for adaptive management, but they all share a cyclic nature (Figure 5.5.2.a). Adaptive management is intended as a flexible system that is designed to cope with uncertainties and complexities in natural environment and social systems. Adaptive management offers a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. The process has two vital components: i) Knowledge generation through monitoring of progress using a set of agreed indicators; ii) Learning and response system that enables changes in management actions as a result of feedback from the system.

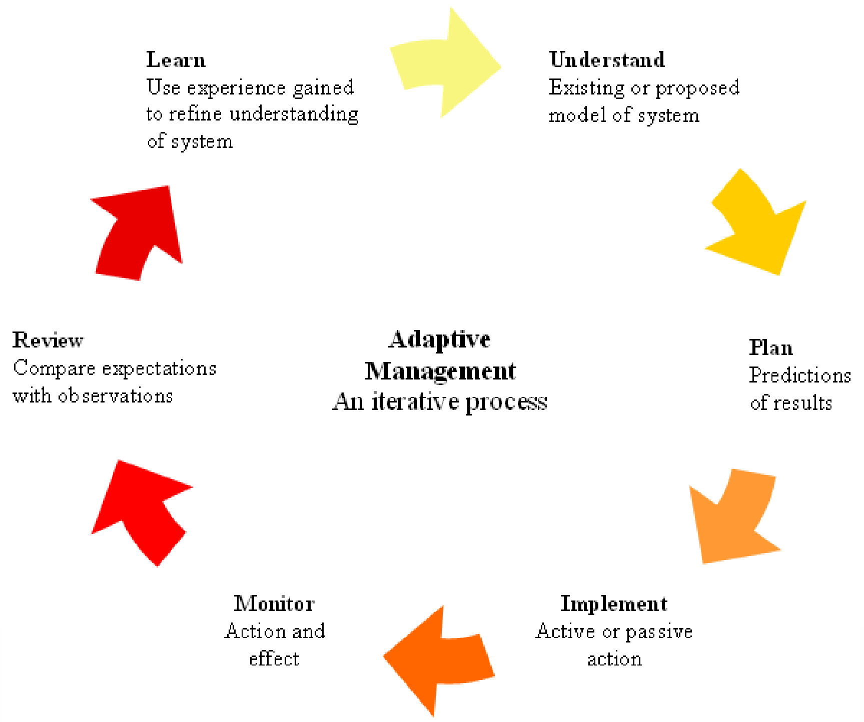


Figure 5.5.2.a Model for adaptive management

The concept of adapative management seems simple, but it is complicated at the transboundary level due to the need to establish joint monitoring, reviewing, planning and implementation processes. In the context of the TDA and SAP, the adaptive management process has two feed-back loops (Figure 5.5.2.b).

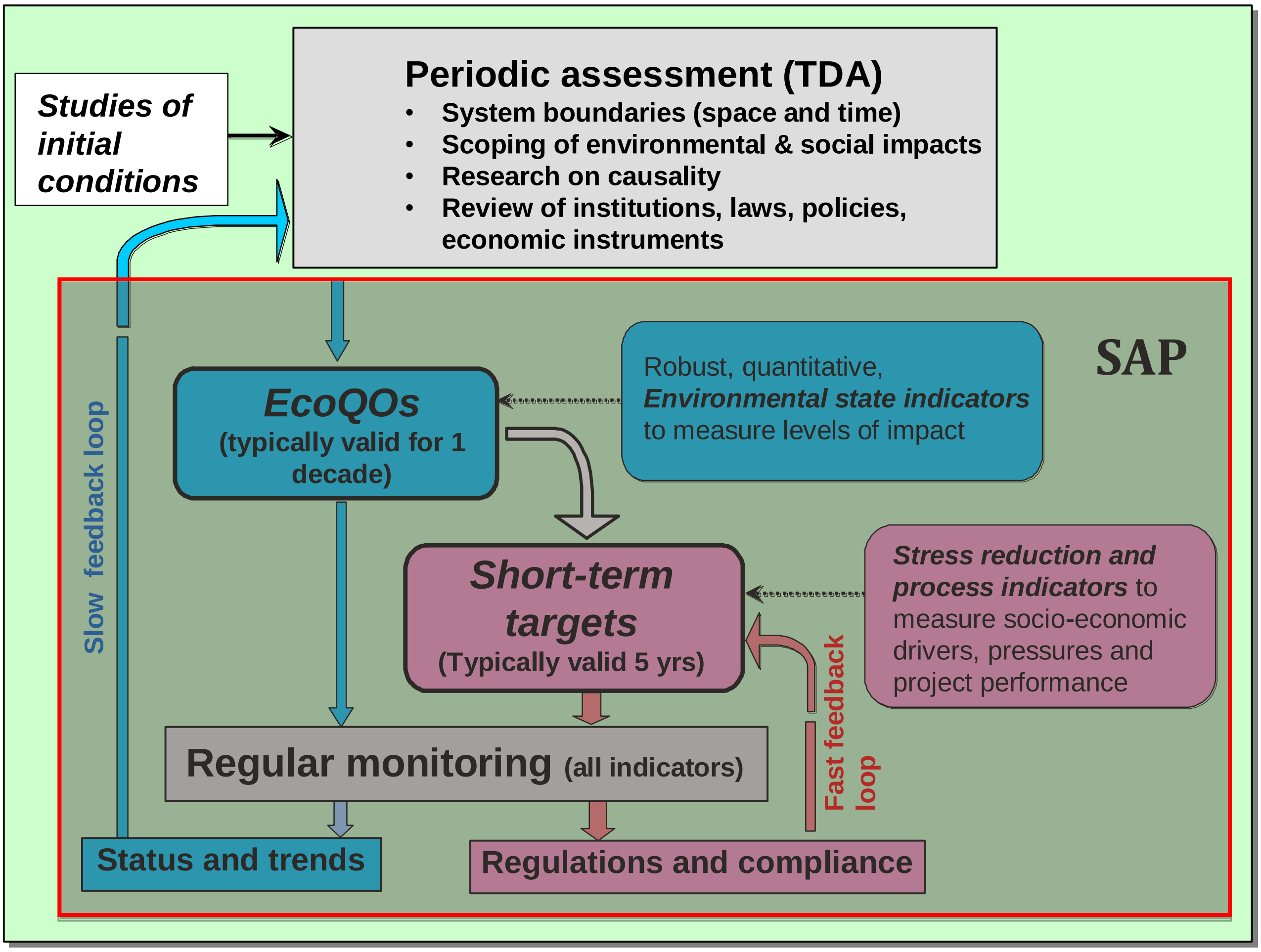


Figure 5.5.2.b Model for adaptive management in the context of the TDA and SAP

The first step consists of the selection of Ecosystem Quality Objectives (EcoQOs) based upon the results of the Transboundary Diagnostic Analysis. The second step consists of the negotiation of short-term targets, set within the timescale of a project implementation cycle, in order to achieve the EcoQOs. Both the EcoQOs and the short-term targets require quantitative indicators and these are incorporated within a regular monitoring programme.

The results of the monitoring programme are used for: i) implementing regulations and checking compliance with the operational objectives; and ii) measuring the status and trends of key system state indicators (environmental and socio-economic) in order to assess progress towards the EcoQOs and ultimately the relevance of the EcoQOs themselves.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ANNEX II PRIORITISATION OF TRANSBOUNDARY CHALLENGE

MAIN CONCERN (PROBLEM AREA)	SPECIFIC PROBLEM	SCOPE	SEVERITY	TOTAL	TOTAL Average	TOTAL Severity
DEGRADATION OF AQUATIC AND TERRESTRIAL HABITATS	Deforestation (including resulting from forest fires and insects)	9	10	**10**	**9**	**9**
	Depletion of pasture lands by livestock	9	9	**9**		
	Ecosystem change	8	9	**9**		
HYDROLOGICAL REGIME CHANGE	Water level decrease in the catchment basin (including underground water supplies)	8	9	**9**	**9**	**9**
	Water level increase in the catchment basin (including underground water supplies)	7	9	**9**		
DECLINE OF WATER AND SOIL QUALITY	Chemical contamination	11	9	**10**	**7**	**7**
	Increased suspended solids and sedimentation	8	9	**9**		
	Microbial contamination	7	7	**7**		
	Eutrophication	8	6	**7**		
	Thermal contamination	3	6	**5**		
UNSUSTAINABLE FISHERIES AND WILDLIFE EXPLOITATION	Over-exploitation of aquatic biota in Lake Baikal, Lake Hovsgol and rivers	8	8	**8**	**8**	**8**
	Over-exploitation of terrestrial wildlife	8	8	**8**		
BIOLOGICAL INVASIONS	Alien (non-native) species invading aquatic habitats in Lake Baikal, Lake Hovsgol, and rivers	7	6	**7**	**7**	**7**
	Alien (non-native) species invading terrestrial habitats	8	8	**8**		
IMPACTS OF GLOBAL CLIMATE CHANGE ON A REGIONAL SCALE	Fluctuations in freshwater flow (e.g. droughts and floods)	8	9	**9**	**11**	**13**
	Increased extreme weather events such as storms	7	8	**8**		
	Cross-cutting issue that affects all the above-mentioned problems	5	8	**7**		

ANNEX III TECHNICAL REPORT: ISSUES CONNECTED WITH THE HABITATS AND HEALTH OF THE BENTHIC ZONE IN THE SELENGA RIVER BASIN

http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_3.pdf

ANNEX IV **TECHNICAL REPORT: THE POLLUTION OF SURFACE WATERS AT HOTSPOTS IN THE MONGOLIAN TERRITORY OF THE BAIKAL BASIN**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_4.pdf

ANNEX V **TECHNICAL REPORT: SURFACE WATER POLLUTION IN THE RUSSIAN TERRITORY OF THE BAIKAL BASIN**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_5.pdf

ANNEX VI **TECHNICAL REPORT: AQUATIC INVASIVE SPECIES IN THE BAIKAL BASIN**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_6.pdf

ANNEX VII **TECHNICAL REPORT: CLIMATE CHANGE TRENDS IN THE MONGOLIAN TERRITORY OF THE BAIKAL BASIN**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_7.pdf

ANNEX VIII **TECHNICAL REPORT: CLIMATE CHANGE TRENDS IN THE RUSSIAN TERRITORY OF THE BAIKAL BASIN**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_8.pdf

ANNEX IX **TECHNICAL REPORT: NATURAL DISASTERS IN THE BAIKAL BASIN**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_9.pdf

ANNEX X **STAKEHOLDERS FOR SUSTAINABLE MANAGEMENT IN THE BAIKAL BASIN**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_10.pdf

ANNEX XI **LEGAL AND INSTITUTIONAL FRAMEWORKS CONCEPT PAPER**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_11.pdf

ANNEX XII **COMMUNICATION AND PUBLIC AWARENESS PLAN FOR CONSERVATION AND NATURAL RESOURCE MANAGEMENT IN THE MONGOLIAN TERRITORY OF THE BAIKAL BASIN**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_12.pdf

ANNEX XIII **COMMUNICATION AND PUBLIC AWARENESS PLAN FOR CONSERVATION AND NATURAL RESOURCE MANAGEMENT IN THE RUSSIAN TERRITORY OF THE BAIKAL BASIN**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_13.pdf

ANNEX XIV **UNESCO (2013) INTEGRATED NATURAL RESOURCES MANAGEMENT IN THE BAIKAL BASIN TRANSBOUNDARY ECOSYSTEM, GROUNDWATER RESOURCES ASSESSMENT AS A CONTRIBUTION TO THE TDA**
http://baikal.iwlearn.org/en/project/tda/LB_TDA_ANNEX_14.pdf

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