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"Baikal Information Center (BIC) Conception for Mongolia"

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MONGOLIAN INSTITUTE OF WATER RESEARCH AND DEVELOPMENT

Integrated Natural Resource Management in the Baikal Basin Transboundary Ecosystem

Baikal Information Center conception and data structure report for Mongolia

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Introduction

Lake Baikal and its trans boundary basin including Lake Khuvsgul represent an unparalleled global benefit in terms of international waters and biodiversity values. While past and current efforts to protect and sustainably utilize the environment and its natural resources are impressive, they are insufficient to the task of addressing the threats to the health of the Baikal Basin's interconnected aquatic ecosystems. These threats include: climate change, pollution and sedimentation, nutrient loading, and habitat destruction. To address these threats successfully conservation work must move beyond the protected area limits and into the 87% of the Basin that is not protected where natural resource exploitation continues without regard to ecosystem health and biodiversity conservation objectives.

1. Selenge River Basin

1.1. Geography

The Selenge River is the biggest river system of Mongolia with order of 9. Total basin area of the Selenge river 425245 km^2 and 282154.1 km^2 of this is located within Mongolian territory which is about 66 percent of total basin area of the river. Length of the Selenge River within Mongolian territory is 1095 km. The Selenge catchment area is surrounded by the Khentii mountain range on the east, the Khangai mountain range on the south-west, and the Khuvsgul mountain range on the north-west.

The Selenge basin area belongs to the continental climate zone, which is characterized by wide variations of annual, monthly and diurnal temperatures, low range of air humidity, non uniform distribution of precipitation within a year, and cold and long lasting winters and warm summers. Permafrost cover is significant and plays an important role in water regulation. Annual precipitation in the upper river reaches of the basin (Khangai, Khentii and Khuvsgul mountains) is 350-400 mm, while in the Orkhon, Selenge, and Kharaa River downstream valleys, annual precipitation is just 250-300 mm. Of the total annual precipitation, approximately 70% falls during the summer, typically in the form of thunderstorms.

The Selenge River basin includes river systems like Yeruu, Kharaa, Tuul, Orkhon, Khanui, Chuluut, Ider, Delgermurun, Eg Rivers and these basins are different along them depending on geographical, geomorphologic condition such as altitude, land cover and biological character etc. Therefore each basin has distinctive hydrological circumstance which leading to exclusive flow regime and water resources.

The Selenge River basin has geographical zones from high land forest to steppe including medium, low hills and wide valleys which directs to specific provision to form surface run off. Instance, in the upper part Selenge basin surrounding altitudes are around 3000-4000m above sea level, mountains in the midst of the average 1500-2500 m, while in the lower part of basin comprise 800-1200m above sea level (Figure1).

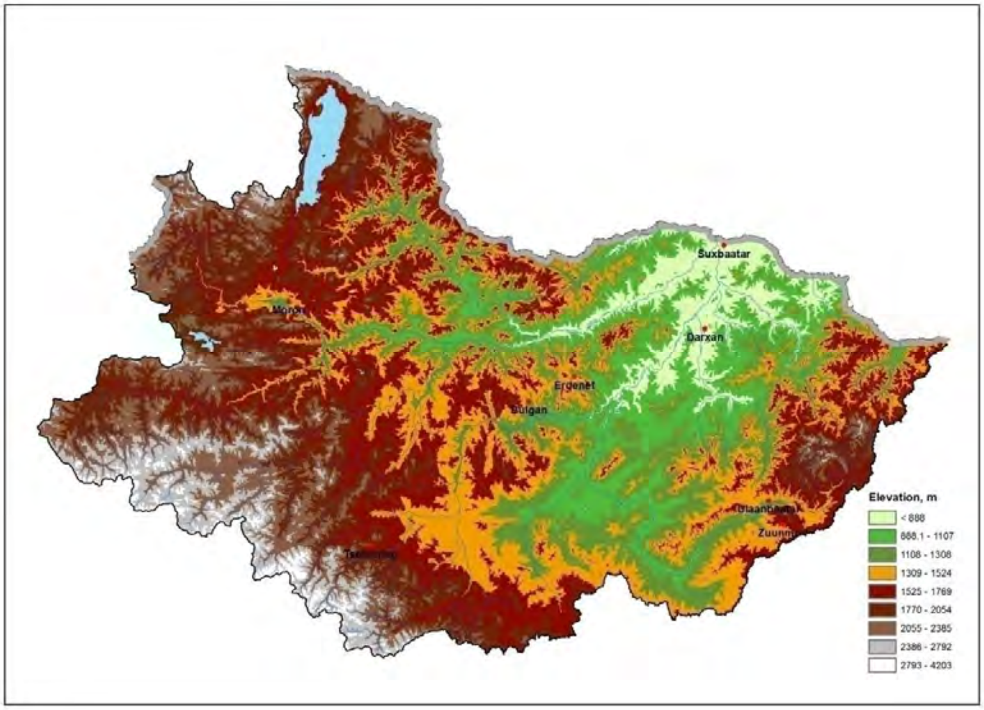

Figure 1. Elevation map of Selenge basin

The most important source of run-off for these rivers is rainfall, ranging from 40% (Kharaa River in Baruunkharaa) to almost 70% (Tuul River in Ulaanbaatar) of total run off. Due to the concentration of annual rainfall during summer months, analysis of average monthly discharges of the Selenge River indicates that about 50-70% of total annual discharge is concentrated in three summer months, and around 20% is recorded in the spring. Due to intense and short precipitation, rivers in the Selenge River Basin experience mudflows and morphogenetic flooding.

The Selenge basin covers the territories of 3 main cities Ulaanbaatar, Darkhan and Erdenet and 8 aimags. These basins are heavily populated compare to the national average. More than 1.8 million residents live in this area, representing 65% of the total Mongolian population in 2010. However population is unevenly distributed, as 74% of the basins population concentrated in the three biggest urban centers Ulaanbaatar (64%), Darkhan (4,3%) and Erdenet (4.7%), respectively on the shores of the Tuul, Kharaa and Khangal river in Orkhon basin (Figure 2).

Main cities of the Selenge River Basin host almost all the big industries, hosting more than 80% of business establishments registered in Mongolia, hence water pollution from industrial activities can be a bigger issue than in any other basin. Most of industrial sites in urban area were developed during the last 30 years. Erdenet, Ulaanbaatar, and Darkhan hold main industrial infrastructure.

Figure 2. Administrative units in the Selenge basin

1.2. __River network__

The basins in Selenge River have a high density of river network with main river systems like Yeruu, Kharaa, Tuul, Orkhon Khanui and others (Figure 3).As expected, many temporary torrents flows from the mountainous areas while in the floodplain rivers are often large with braided channel morphology.

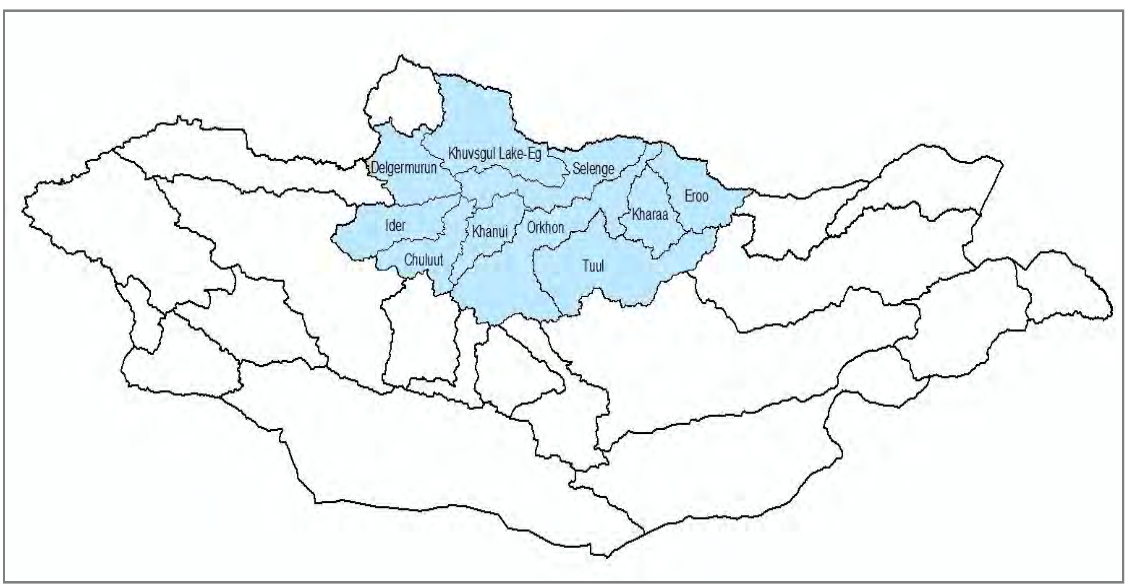

Figure 3. Selenge River sub basins in Mongolia

Table 1. Characteristics of main rivers in Selenge basin

River Basin	Basin area, *km²*	Main river length, *km*	Mean slope, *‰*	Mean basin elevation, *m*	Total length of river network, *km*	River network density, *km/km²*
Selenge	282154.1	1095	0.0019	1500	107692,8	0.38
Ider	22419.9	465	0.0047	1780	22230.3	0.99
Delgermurun	18670.6	439.7	0.0035	1921	8002.3	0.43
Eg	38354.1	509.5	0.0016	1624	13551.3	0.35
Orkhon	131105.6	1124	0.002	1300	85869.5	0.23
Tuul	48909.2	898	0.0015	1300	11046.5	0.23
Kharaa	14400	352	0.004	1272	5358.8	0.37
Yeruu	10905.2	388	0.004	1320	5735.4	0.53

1.3. Land cover

The Selenge River basins locate within wide range of geographical zones including taiga, high mountains, forest-steppe, and steppe zones. Due to the large expanse of the basin, the soil conditions and formation processes differ greatly from one basin to another basin. Within the Khangai, Khentii, and Khuvsgul mountains, taiga, tundra, and mountain soil prevails, while in the wide valley areas of the Orkhon and Selenge Rivers, dry-steppe soil is dominant. Approximately 87% is forest steppe and, 14% is steppe zone (Figure 4).

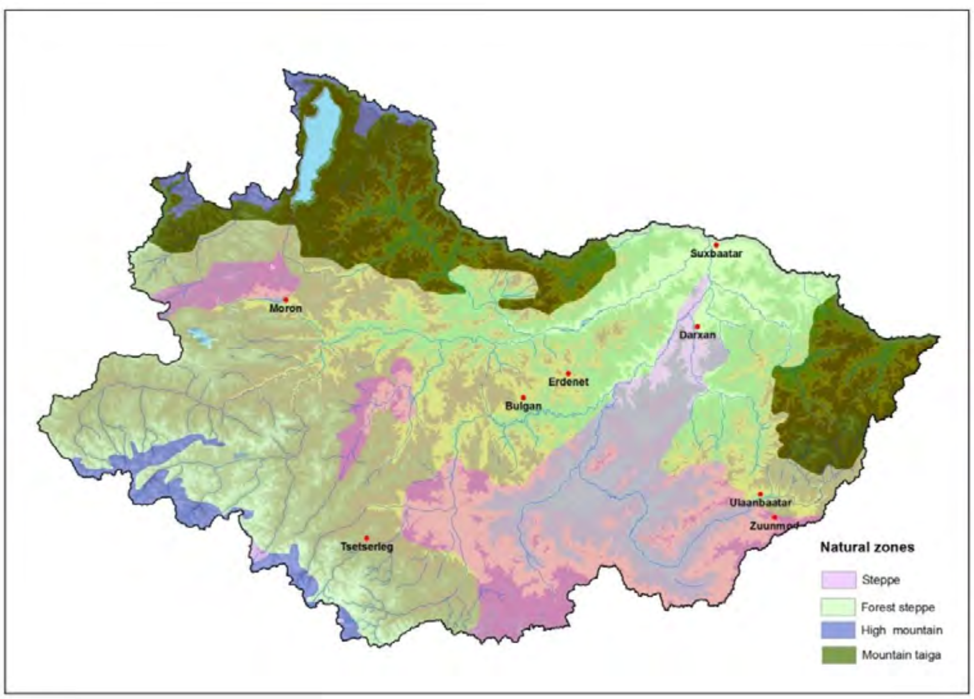

Figure 4. Natural zones in Selenge basin

These river basins present a large percentage of forest cover compared to the national average (Figure 5). The forests are dominated by Siberian larch trees and birch trees. Forest cover has decreased in these basins, due to the demand cities like Ulaanbaatar, Darkhan and Erdenet (commercial logging), forest fire, and impact of forest pests.

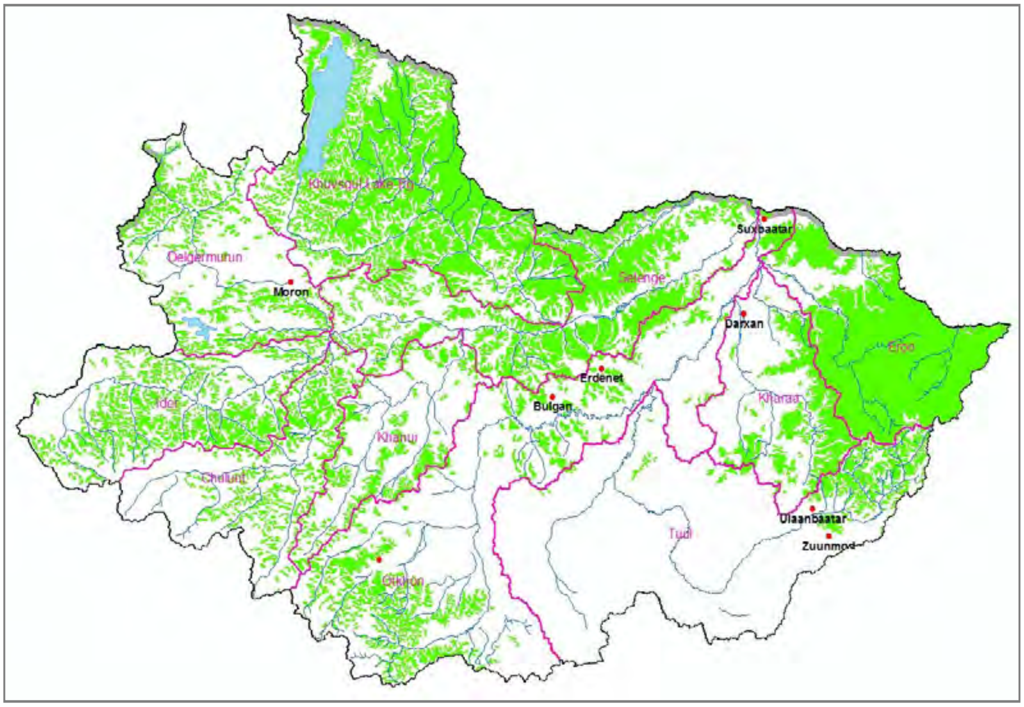

Figure 5. Forest area in the Selenge basin

1.4. Ecological condition

Compared to the national average, strictly protected area cover is low in these basins, covering less than 7% of the total area, including the area of Lake Khuvsgul as well. Downstream parts of the rivers are not represented in the strictly protected areas, but are often under a local protected status (Figure 6).

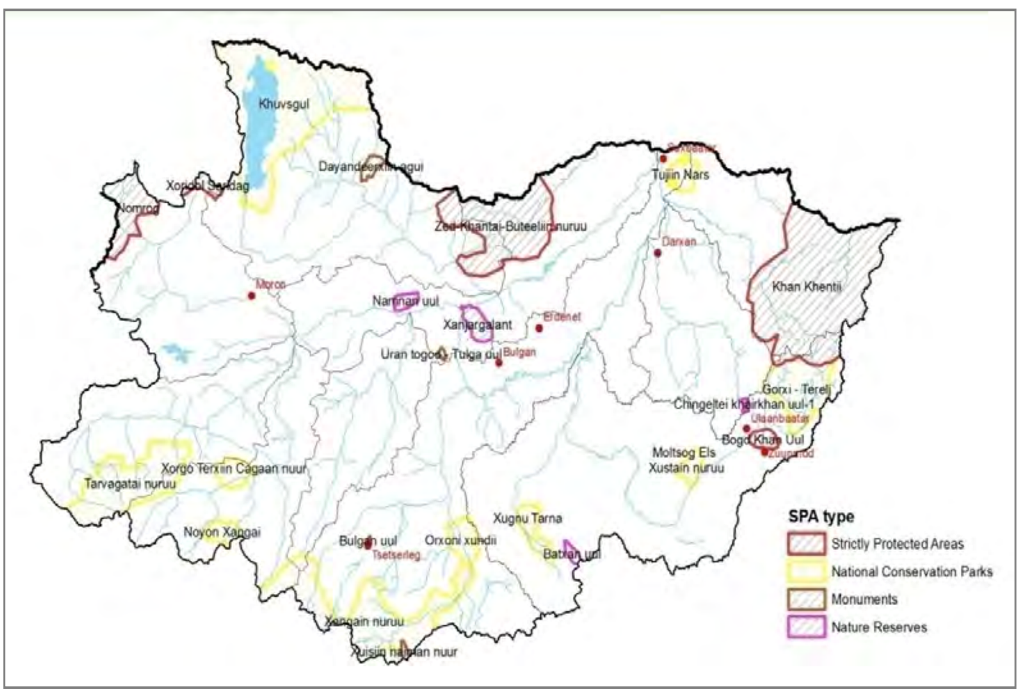

Figure 6. Areas under the protected status in Selenge basin

The different types of ecosystems are not equally represented, with the majority of the area with protected status outside Lake Khuvsgul consisting of alpine tundra.

Main threats to the protection of the areas are forest fire, harvest of wood, overgrazing in some parks, impact of tourism, and lack of training and funding for the rangers. There are a number of land related violations due to the illegal permission of land tenure right inside the strictly protected area site.

Tourists looking for pristine environments can be a major threat to the ecosystems. Impact from tourism is significantly increasing in some of the protected areas, despite clear regulation of the activities. However public awareness and information campaign are often lacking, due to a lack of infrastructure (e.g. demarcation marks) and communication plans. Implementation of new “eco-tourists” camps increased in protected areas in the last year. This will increase disturbances caused by direct pollution transfer to the water, fishing, and risks of forest fires in protected areas.

Moreover protected areas under represent some specific ecosystems in these basins and only a very small percentage of the protected areas are under the highest protection status (core zone status). Projects to extend or create new protected areas are being carried out, but do not necessarily focus on the Arctic catchment area. A better application of the existing environmental policies in national parks is needed to maintain biological reservoirs.

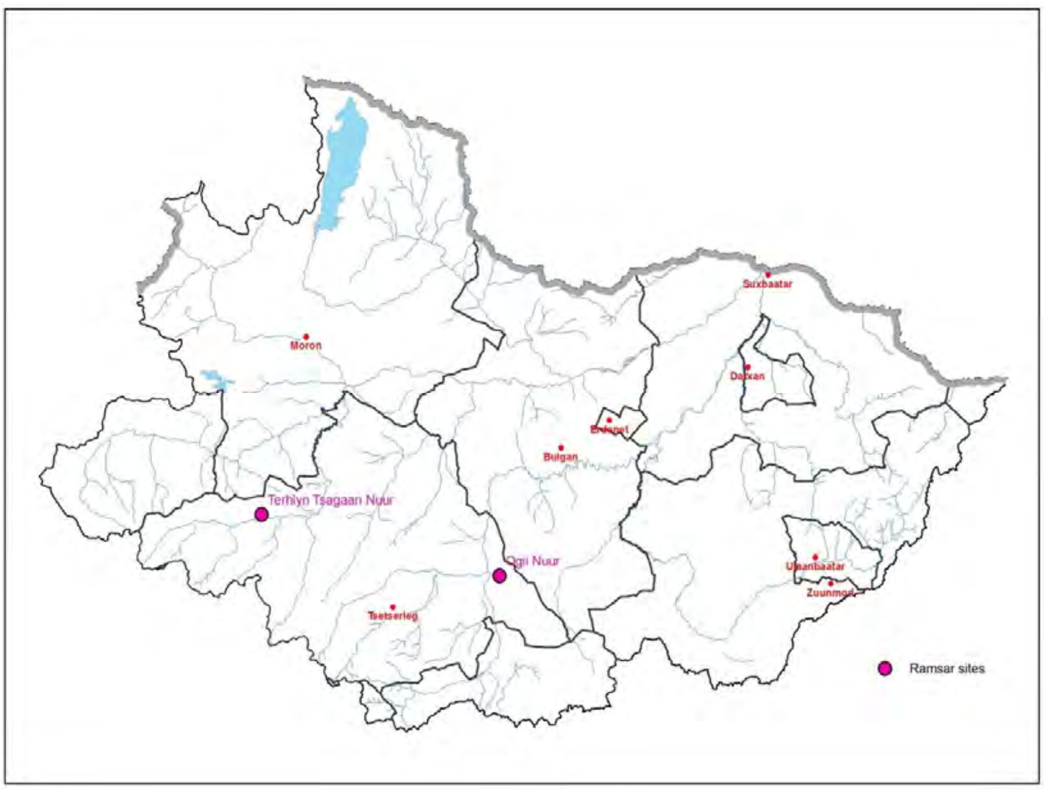

Figure 7. Ramsar sites in the Selenge basin

Important birds areas linked with aquatic systems are located mainly in the Orkhon, Selenge, and Khuvsgul and Shishkhed river basins. Recent studies reported that loss of riparian along wetlands and rivers, mainly due to livestock, has a significant impact on nesting capacity and finally on bird diversity.

Two RAMSAR sites lay in the arctic catchment area, Ogii Lake and Terhiyn Tsagaan Lake sites. The Terhiyn Tsagaan Lake located in the valley of the Suman River (Chuluut river basin) in the central Khangai Mountains. The maximum depth of the lake is 20 m. The shallow zone, up to 2 m deep, comprises 40% of the lake area. Lake area is then very sensitive to any drop of water levels. Water levels slightly decreased (about 80cm) in the last 15 years due to climate change. It is an oligotrophic lake, and its altitude (above 2000m) limits temperature and then the risk of eutrophication. The lake hosted a small fishery mainly for pike and perches, but activities stopped in 1991. It is not known if small scale commercial fishing still occurs. The lake does not harbor vulnerable or endangered species of fish. The marshes at the west end of the lake are however an important breeding and staging area for migratory waterfowl.

The site is under the Khorgo Terkh national park protection status, but the area of the park is too big for only one ranger and the pastureland carrying capacity is overloaded by 2 times and more in the national park. Furthermore tourist pressure increased in the last decade and 4 tourist camps lay now inside the National park, producing untreated garbage, increasing risk of forest fires, and disturbing bird migration.

The second Ramsar site, Ugii Lake, is located in the valley of the Orkhon River. It is a shallow, freshwater lake with an extensive alluvial area of grassland, river channels, and pools and marshes at the western end. The maximum depth of the lake is 16 m, but about 40% of the lake is less than 3 m deep, and 50% supports macrophitic growth. It supports an important community of fishes, mainly cyprinids but some salmonids such as Taimen have been reported to occur in the lake. Recreational fishing significantly increased in the last decade, but it is not known if fishing pressure has an impact on fish population. Concentration of livestock around the lake leads to a loss of habitats for rare migratory birds nesting around the lake.

National parks and strictly protected areas generally suffer from a lack of staff, tools and training to manage a proper protection of the areas. It is important to reinforce the protection of these areas which can act as biological reservoirs.

Ecological monitoring

There has been several recent studies monitoring and analyzing the biological compartments, mostly in basins impacted by anthropogenic activities. Surveys on biological compartments, such as macro-invertebrates and fish are recent, making it hard to establish comparisons on biological conditions before and after the increase of human activities from the 1990s.

Moreover, a specific macro invertebrate index should be created to take into account the specificity of Mongolian streams and type of impacts. Macro invertebrates indexes used are better to represent effects of organic pollution, which is not the biggest issue in Mongolia. The Mongolian Aquatic Insect Survey research project is currently trying to build up a biotic index and to document aquatic macro invertebrate diversity and relate that diversity to patterns in evolution, ecology and water quality in Mongolia.

The most documented issue in the basins is the impact of mining activities on biological compartment and habitats. Long term studies on the changes of habitats (riparian vegetation, sediment balance, hydro morphology…) are lacking.

1.5. Surface water quality

Monitoring network

Monitoring of major ions in surface water has been carried out since 1949 in some rivers (e.g. Muren and Orkhon river). Monitoring of toxic substances such as heavy metal is much more recent, and only occurs in some river basins affected by human activities.

The MoMo project is carrying out monthly monitoring of surface water chemistry on 4 points of the Kharaa valley since august 2007. They underline the lack of laboratories able to determine concentrations of toxic substances such as heavy metals.

Several one or two time monitoring studies have been carried out, mainly focusing on effects on mining activities.

Monitoring of surface water focused as well on the impact of wastewater treatment plants in Darkhan, Erdenet and Ulaanbaatar, but often failed to assess the distance on which water quality is degraded (self-purification capacity) and its variation during the year due to a lack of monitoring points. The same remark can be applied on impacts from mining activities. As Mongolian rivers have a high variability of self-purification capacity in time and space, the same pollution or pressure on the ecosystem can affect a variable distance of rivers and have different effects on biological compartments. It is then important to know what basins and parts of the rivers are more vulnerable to define priority of actions.

Asian found carried out several years monitoring program on surface water but data are currently not accessible. Sampling on representative points of the river basins is necessary to determine trends, and should be completed by biological monitoring (e.g. macro invertebrates and fish population).

Trends in surface water quality

The surface water in the Selenge river and its tributaries is soft, with mineralization ranging from 100 to 250 mg/l, calcium and bicarbonate being the dominant ions.

Rivers flowing from the Khentii and the Khangai mountain range have a lower mineralization than rivers flowing from the Bulnai and the southern slope of the Khuvsgul Lake. This is due to the abundance of limestone and granite at Khuvsgul Lake, plus the important forest cover giving more soluble.

Due to the low level of mineralization, surface water does not often meet the lower limits for $Ca^{2+}$and Mg^{2+} for drinking water. The seasonal variation of surface water chemistry is marked, with highest concentration of HCO_3^-, Ca^{2+} and Mg^{2+} observed at the end of winter before decreasing and reaching the lowest value in July or August. SO_4^{2-} and Cl concentration are extremely variable as well through the year but does not show a clear seasonal pattern.

Long term observation (1949-1990) did not show general trends in ion composition in these basins. Recent changes have been observed in some stretches, due to anthropogenic impacts. The major change is the increasing content of fine particles in surface water. Changes are more pronounced in tributaries, where the dilution capacity is lower. A recent increasing in sulphate concentration has been observed in the lower reach of the Orkhon River.

Bacteriological contamination is a concern as surface water is often used for dinking without treatment. Analysis carried out in 2006 reported no bacteriological contamination in the Selenge river catchment. However due to the high density of streams and the mobility of livestock, the more frequent cause of bacterial contamination, it is not possible to have a good monitoring of sanitary issues regarding surface water quality.

Concentration of ammonium and nitrite were reported to exceed the standards in Kharaa valley and in the Orkhon, but other studies at a different period revealed that concentrations of these elements were below the standards. As many studies are just a one time monitoring and concentrations show a high variability linked to discharge condition, it is hard to determine a trend for ammonium and nitrite.

Heavy metals pollution is a raising problem, with concentrations of mercury, arsenic, and exceeding the norms for surface water in some points. Hence, heavy metal concentration can show a great temporal and spatial variability in surface water, and a one-time analysis cannot represent the actual level of pollution. Analysis of sediments and biotic compartments (aquatic vegetation, macro invertebrates, and fish tissues) can be more relevant as they represent the long term exposition to heavy metals. Furthermore it would help to understand the capacity of heavy metal to be transferred from surface water and sediments to biological components.

Highest concentrations of heavy metals have been found in the basins where legal and illegal mining occur. According to the Integrated Water Management Model on the Selenge River Basin survey, the Tuul river basin had the highest level of disturbance due to gold mining activities. However there is still a lack of general monitoring to determine hot spots of pollution and zones that are still untouched.

An increase of sulphate concentration has been observed downstream of the Orkhon River. Sulphates are often due to agricultural activities and use of fertilizer, and may come from crops on the right bank of the Orkhon valley. Furthermore Erdenet copper mine releases high content of sulphate in its waste water in Khangal River, a tributary of the Orkhon.

The resilience of the pollution in its spatial dimension is a key to assess the impact to the aquatic environment, but few studies assess the capacity of self-purification of Mongolian rivers. The same activities can have different degree of impact depending on the receiving water body.

1.6. Groundwater quality

Monitoring network

Data are available for major ions, pH and sometimes nitrogen based molecules in some deep and shallow wells in the area. Data available for this report have been recorded from 1971 until 1990. The small number of analysis on nitrogen based molecules does help to establish clear conclusions on the whole area. Data from bacteriological analysis are scare.

Trends in groundwater quality

Groundwater ion composition is generally suitable for human uses in these basins. Average mineralization is around 0.5 mg/l, mainly composed of HCO_3^- and Cl ions, with pH value ranging from 7.3 to 8. Nitrogen based molecules concentration shows a much higher variability; with concentration of nitrite and ammonium sometimes exceeding standards. No clear trend in time or spatial dimension can be observed with the data available, but it shows that shallow groundwater can easily be polluted, probably from livestock.

Recent studies showed significant amount of arsenic, mercury, and cyanide in shallow groundwater. Pollution was reported in Kharaa river basin but below drinkable water standards. However use of heavy metals is still recent and there are risks that other shallow wells become polluted in the future. As the number of livestock reliable of groundwater increases, pollution of aquifer can become a threat for food safety, as heavy metals has a tendency to concentrate in fatty elements, such as meat and milk. This issue needs to be solved rapidly in basins that are known to support illegal of heavy metals, as Kharaa and Yeruu River basins. Contamination of shallow groundwater can go on for decades and strongly affect as well the economy based on livestock.

Recent bacteriological survey showed no signs of contamination but the number of sampling points was not significant to draw a clear conclusion in the whole area. Concentration of livestock around remaining wells and soum centers has increase the risk of contamination. This can be a threat to human health as groundwater is not often treated in rural areas.

1.7. Climate change

Temperatures in the northern part of Mongolia are expected to increase. There are also clear changes in surface soil freeze in autumn and spring thaw in the mountains. The date of the freeze in autumn was delayed by 2-6 days when the date of the thaw in spring advanced by 2-6 days. Annual mean temperature of permafrost has increased. Permafrost has a very important role for the hydrology of the rivers in these basins as it avoids infiltration and loss of water in soil during the snow melting process.
Surface run off should increase in these basins but will show a even higher variability than in the current situation. Changes in biological cycles and distribution of aquatic species will occur. Higher variability of runoff will favor species that can leave in a wide range of conditions, and might impact species with needs for specific habitats.

1.8. Human activities linked to the ecosystems

Domestic uses

Ulaanbaatar, Darkhan and Erdenet are the three bigger cities in Mongolia, with a growing population. A good wastewater treatment management is hence more important in these urban areas than any other place in Mongolia. Industries and mining sites often have their own wastewater treatment plant, due to the particular characteristics of the effluents. In these three major cities, problems have been reported concerning treatment efficiency.

Ulaanbaatar wastewater treatment plant efficiency is around 60/70%, due to poor maintenance, outdated equipment and power shortage. Even short power shortage can have significant impact on the treatment efficiency; for instance, a one hour power cut leads to 4500m^3 of untreated wastewater pouring into the river. The process suffers also from non pre-treated industrial effluents which significantly perturb ate the treatment of the domestic effluents.

Trends in water quality through showed that quality was steadily deteriorating downstream of the WWTP between 1996 and 2006. The impact of Ulaanbaatar city waste waters affect then a very long stretch of the Tuul river, and water quality is deteriorating from year to year. Moreover, industrial waste water is not properly pre-treated, which affects significantly the effectiveness of the central treatment plant.

Erdenet city wastewater treatment plant is in under capacity. However data on water quality do not show signs of degradation in the Khangal River, concerning indicators such as DOB and nutrients.

In the Kharaa valley, cities with inefficient wastewater treatment plant leads to a severe degradation of surface water quality, with increasing nutrient and organic pollution in the mid and downstream reaches of the river.

Due to the lack of data, it is hard to assess whether or not other domestic pollution represent a significant threat to the aquatic systems. Many soums center do not have proper waste water treatment facilities but water use and density are low, reducing the risk of pollution to nearby water bodies.

Waste water treatment plants are very often outdated and in under capacity. The self-purification capacity of the receiving water body can sometimes compensate the lack of waste water treatment but this is not the case for the biggest cities which are located in these basins. Furthermore demography still tends to grow and there is an urgent need to implement proper wastewater treatment facilities taking into account the future development of the cities.

Agriculture and irrigated areas

Agriculture is developed mainly around the main cities such as Ulaanbaatar, Darkhan, and Erdenet. The wide open valleys are very suitable for the implementation of irrigated areas. Main areas of agro-industrial farming are concentrated in the Kharaa valley and on the right bank downstream of the Orkhon River.

No significant use of fertilizers has been reported until now. Batimaa reported that fertilizer application to arable land in Mongolia is low compared to some other countries where arable land is well developed. The total application of fertilizers is on average 30-40 kg ha-1 (2000). Mainly chemical fertilizers such as ammonium nitrate, double super phosphate and potassium chloride are used.

Nutrient concentration, such as nitrogen and phosphorus, are low in most of the basins. Increasing concentrations of phosphorus and nitrogen have been reported downstream of the Orkhon and in the Kharaa river basin, but are below the water standards.

This trend could also be explained by domestic pollution or concentration of livestock in the vicinity of the river. However, as cropping production is meant to develop in Mongolia and as soils in these basins do not contain a major content of nitrogen and phosphorus, fertilizer application could drastically increase in the next years. The majority of the fields are in the vicinity of the rivers, where land is flat and water availability high. Fertilizer transfer can easily occur to the water bodies, especially as intense precipitation occurs in the valleys.

Some practices increase the erosion process. For instance, furrows are often in the direction of the steepest slope, which increase the erosion of the fields, leading to higher particle content and increasing concentration of nutrient in the river. Training for better agricultural practices would limit this problem and avoid the loss of rich and valuable soil during summer rainfall.

Development of irrigated area in the Kharaa valley is planned by current national land-use policies, which are aiming at (re-)converting additional 50,000 ha for agriculture in the next years, with most of the land being located in the Kharaa and neighboring catchments. Simultaneously, due to the ongoing intensification, an increase in water abstraction for irrigation purposes is expected. Irrigated crop production might be limited by water availability, even if increasing demands of other water users are not considered. Water demand for irrigation will change the environmental flow and might reduce habitat availability.

Even though agriculture does not appear as an issue for environment or water quality nowadays, the development of cultivated areas and the future need for fertilizer to ensure a good production will have significant impacts, especially in Kharaa valley and downstream of the Orkhon river.

Pasture

Livestock number has significantly increased in these basins from 1992 to 2000, before a brief decrease due to harsh winters. Proportion of goats for cashmere production has increased significantly. Goats have a stronger impact on soil degradation than any specie of livestock as they have a wider range of food source and due to their natural grazing behavior which involves uprooting vegetation.

For the purpose of watering pasture land, more than 7,000 wells were built between 1954 and 1990 in the Selenge drainage basin. At present, about 40% of all these wells are not functional, and the amount of pasture land decreased. Even though data on areas used for mining purpose are not well defined due to a high part of illegal mining sites, development of this activity especially in the northern basins of Mongolia has reduced access to pasture areas and migration ways. As in the rest of the country, this leads to a greater concentration of livestock in the vicinity of surface water bodies, mainly around soum centers. Impact from livestock dung on bacteriological quality has not been observed yet, but just a few studies exist. Moreover, in springtime the frozen manure is washed to the river course by melting water. This event lead to high nutrient input. The related fecal contamination of river water may cause sanitary problems for the drinking water especially for livestock drinking water straight from the river.

Trampling and consumption by the livestock of the riparian vegetation is another type of impact that should be taken into account as it leads to a higher erosion, increasing turbidity in surface water and a significant loss of habitats for aquatic species.

Mining

Gold deposit of both hydrothermal and placer types occurs in many valleys, especially in the Yeruu, Kharaa, Tuul and Orkhon river, though registered exploitation sites take place in every basin except the Ider river basin. Copper deposit occurs in Erdenet, in the Orkhon river basin. Other types of mineral deposits such as iron and vein type tungsten also occur in the study area, but those are minor in economic importance. These basins supports different types of mining activities, from small scale illegal mining to large scale mining.

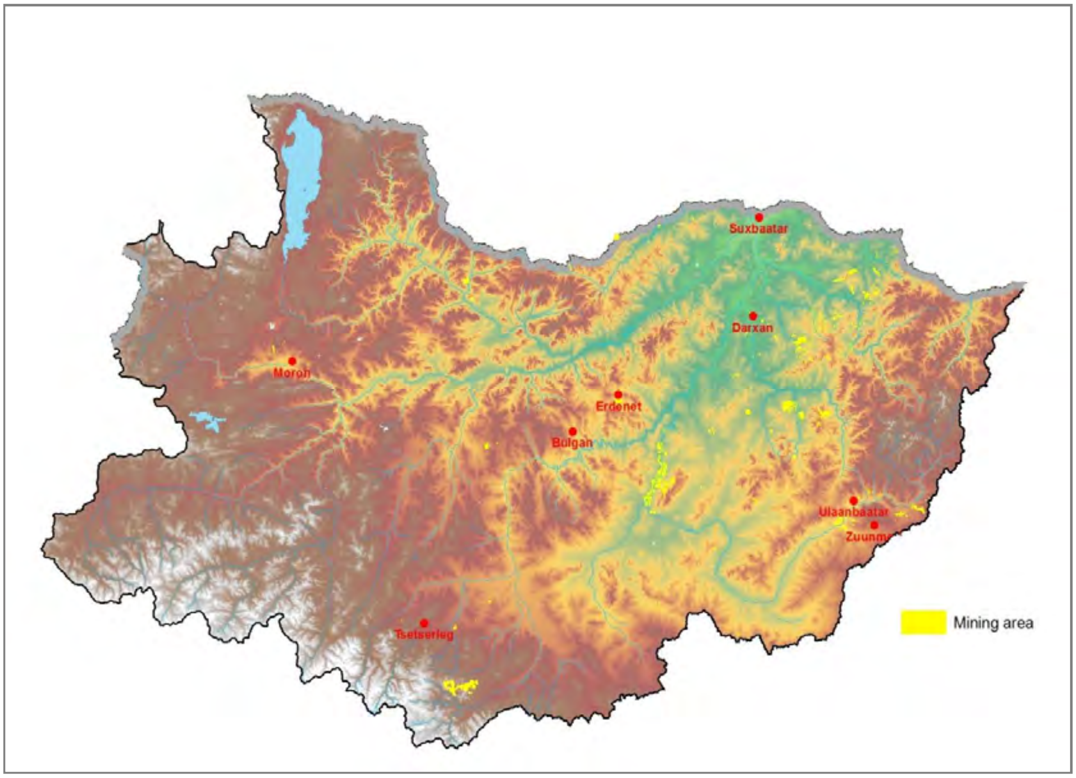

Figure 8. Mining exploitation in the Selenge basin

Implementation of mining sites resulted in the loss of riparian vegetation, changes of river morphology, removal of fertile soil, and straightening of the river bed. Mining activities has heavy impacts on the surface water quality, turbidity. Additionally to the physical impact of turbidity, transfer of nutrients, especially phosphorus occurs. Heavy concentrations were found to be significantly higher than the permissible levels for all points near mining sites, as well for phosphate, ammonium and cyanide.

Technological impacts of the Zaamar goldfield along the Tuul river have been studied by Byambaa et al. in 2011. They reported than the type of recovery process had a significant importance regarding the release of heavy metals in the river, with dredge being the most pollutant type of recovery process, whereas sluices and scrubber were significantly less pollutant regarding heavy metals concentrations in the surface water. Taking into account combined pollution, including release of nutrients and cyanide, scrubber was the least impacting recovery method. This shows that the type process used in Zaamar goldfield has a strong influence on the degradation of water quality. However the same study reported that the results from the empirical analysis and show that domestic owned mines have more impact on the water quality than the mines run by foreign companies, usually using newer technology such as dredges.

It is not clear yet what the self-purification capacity is of the Tuul River at this site and how many kilometers of river is impacted. High pH values in water found on this site lower the mobility of the heavy metal in the water, however they might travel downstream bound with fine soil particles. Nevertheless, the disturbance creates a reverie fragmentation, which limits the possibility for aquatic species to migrate upstream of downstream of the Tuul or to the tributaries.

However recent increasing mining activities in the tributaries of the Orkhon valley steadily impact water quality on the whole length of the river. Once the concentrations of toxic substance reach a certain threshold, loss of biodiversity will rapidly decrease and the capacity of recovery of the system will be severely impacted.

A large number of belowground and open pit (gold-) mining concessions have been issued during recent years within the catchment of the Kharaa River, mainly in the upstream tributaries. As many of these mining sites are concentrated in a small area, impacts on the water quality and habitats are significant in this basin, as continuous effects along the streams do not allow a proper self-purification.

Due to the illegal nature of the activity, it is not possible to find records of the number of ninjas in Mongolia. Some reports state around 50,000 ninjas in Mongolia (2004). The causes of regional variations in distribution of ninjas are fairly clear. The MBDA survey demonstrated a close correlation between the geographical distribution of ninjas and formal gold mining. With the ongoing spread of formal gold mining, it is anticipated that ninjas will rapidly increase in those areas also.

Impacts on surface and ground water are various, mainly affecting river banks and releasing fine particles in streams. Use of heavy metal, such as mercury, is widespread but do not occur in every informal placer mining site.

Though Mongolian laws include that land that has been damaged from digging for mining purposes is to be restored, remediation is not often carried out, or not properly. This is often due to a lack of a proper environmental monitoring program, and a lack of knowledge regarding proper remediation techniques.

Due to fish specific biological cycles, proper spawning sites are limited along a stream. Destruction of these sites, for instance by clogging process due to the release of fine particles would have an immediate impact on fish population, even if other habitats are left undisturbed. Monitoring of such sites is needed and actions should focus on their preservation. Mining concession should not be permitted within these sites to allow renewal of fish population, especially for salmonids, as Taimen, lenok and Arctic graylings are a valuable resource of income due to recreational fishing.

Chromium (Cr) has toxic effects at low concentration, in soil and water, and a strong capacity to bioaccumulate in plants, macroinvertebrates and fish. Chromium can be found into two stable forms, trivalent chromium (Cr (III)) and the hexavalent Chromium (Cr (VI)) which is more toxic. Chromium was not detected in river water samples, but ranged from 15 to 64 mg/kg in sediment samples downstream from the central WWTP outfall.

Forest management

Though logging is steadily increasing, the main threat to forest cover remains the occurrence of forest fire in Mongolia. According to Krasnoshekov, about 75% of loss of forest area is due to forest fires, though percentage of area impacted by logging might be higher in the Selenge due to the high demand of wood close to the urban centers.

Mongolia has two fire season peaks, one from March to mid June which accounts for 80% of all fires, while the other peak is from September to October which accounts for 5% of all fires. On average about 50-60 fires occur annually and the largest occurrence of the fires are human caused though not intentionally. Number of forest fires increased in the last decade, but proportionally number of hectares destroyed by fires increased even more. Main causes are the use of equipment such as chainsaws which produce sparks, as well as exhaust pipes of vehicles used for transportation of wood. Fires often start far from inhabited areas.

Other causes reported are campfire left carelessly and use of tracer bullets for hunting. Recent rise of the temperatures due to climate change can increasing the risk of forest fire, by lowering moisture content in vegetation.

Actual tools to fight against forest fire are not adequate in Mongolia, with a lack of equipment, surveillance and training reported by different studies.

Some 70% of the sources of rivers and streams of these basins come from the mountain forest zones, therefore decreases in the forest stock and area would have adverse effects on the diverse functions of the basin in terms of ecological hazards and socio-economic impacts. Forest cover is the most important runoff generation area in the basins (Figure 9). It has a damping effect on river discharge, reducing surface run off. Reduced forest density will lead to an acceleration of the snow and permafrost melting process in spring, as shadow cover reduced. Forest cover prevents soil erosion during heavy rainfall occurring in spring and summer, and limits transfer of nutrient to the streams.

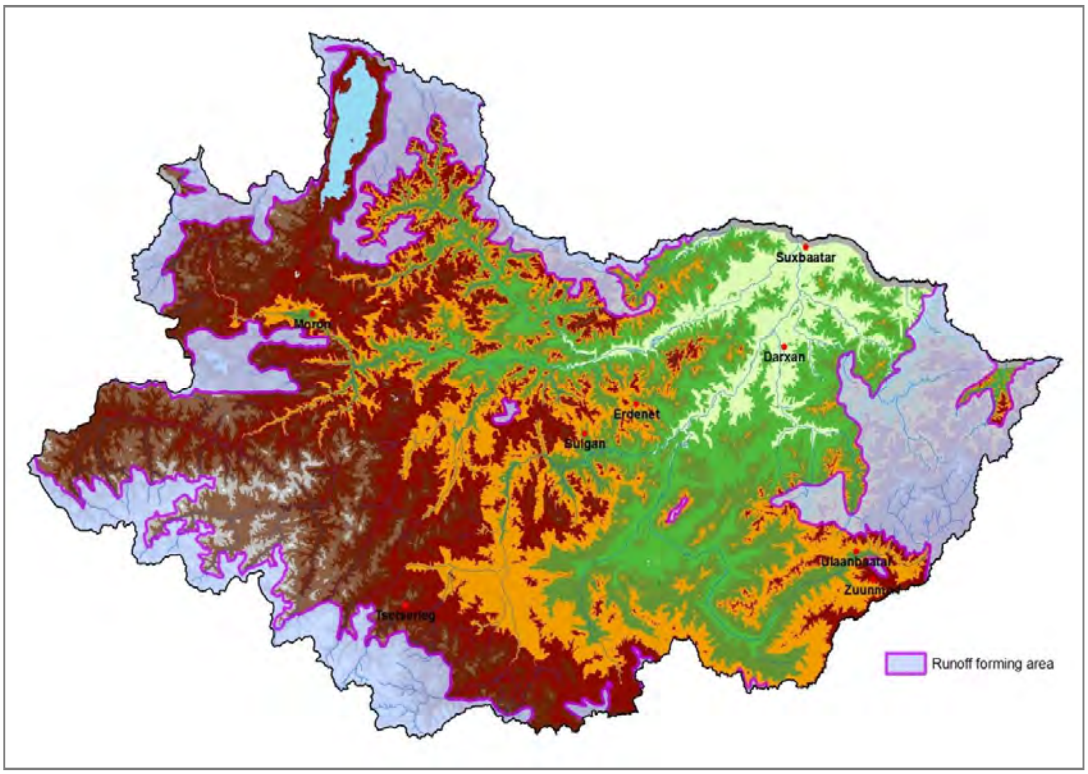

Figure 9. Runoff forming areas in Selenge basin

Forest pest is an increasing problem as well in Mongolia, mainly affecting pine trees. Pest outbreaks historically occur approximately every 10-12 years with increasing intensity. In recent years, the drought conditions have contributed to a reduction in time between cyclic outbreaks. Suran D. reported that in long term massive insect defoliation occurred in each 13-15 from 1970s to 1930s in the Bogh Khan area, but also that almost each 3-year outbreaks had occurred in each sites of this forested area since 2000.

Pest incidence is affected by climatic conditions compounded by wildfires, logging damage, and permafrost, which all weaken the trees and make them more susceptible to insect infestation. Forest impact is widespread in these basins as northern forest areas including Selenge, Tuv, Khentii, Dornod, Arkhangai and Bulgan experienced rapidly increasing populations. Gypsy moth (*Lymantria dispar L.*) and Siberian moth *Dendrolimus superans sibiricus* are the major pests in the forest-steppe zone of Mongolia .

Increasing deforestation has a wide range of negative impacts on natural conditions in these basins; significant changes in natural river regime, increasing concentration of nutrients and fine particles in the water will affect ecological processes on long stretches. Reinforcement of patrols during forest fire seasons and better forest harvesting techniques would reduce risk and the damages caused by forest fires.

Tourism

Due to the vicinity of large urban centers and better transport infrastructures, tourism Selenge basin is generally more developed than in other part of Mongolia. Impacts from tourism can be various: point source pollution from tourist camps with wastewater or solid wastes, disturbance of areas with a specific ecological interest (e.g. strictly protected areas or migratory birds nesting sites), direct pressure on aquatic species, such as recreational fishing..

Very few studies exist on a province level to assess the income generated by tourism and the kind of pressure related to environmental issues. As wilderness is one of the most attractive aspects of Mongolia for foreigners, tourists will tend to access areas that are still preserved from human impacts. Number of tourist camps steadily increased, especially in natural park and protected areas. Even though environmental policies are clear in these areas and number of rangers sometimes sufficient, a lack of public awareness and infrastructures limit their application. Implementation of new tourist camps in protected areas should be limited and accompanied with proper management of tourist practices.

Fishing

Commercial fishing of Taimen has been reported to increase in the last decade. Most fish are caught by local fishers who sell them at local markets or illegally export them to China and Russia. Most of the poaching happens in winter when Taimen gather in deep ponds when rivers are frozen. Due to the illegal practice, no records exist on catches of Taimen in these basins.

Recreational fishing, mainly done by foreign tourists during summer time, is suspected to have an impact as well on the Taimen population. The growth and natural mortality estimates and the population model results done by Jensen et al. suggests that Taimen populations are likely to be very sensitive to fishing mortality. Recreational pressure increased in the last years with increased access to organized tours, fishing supplies and all-terrain vehicles.

Migrations of Taimen have been to occur most in May and June (spawning and postspawning period), with another peak period of movement in September and October when Taimen return to deep ponds. Changes in land cover, mainly loss of forest cover may trigger changes in migration pattern of Taimen. Reduce shadow cover will accelerate snow melting process in spring, changing the hydrology of the rivers; as Taimen migration is influenced by temperature and discharge changes, current changes of natural regime driven by deforestation and climate change will have an impact on biological cycles.

Mining practices not only affect some parts of river suitable for valuable fish, but lead as well to a concentration of fishing pressures in on disturbed areas. Tuul, Yeruu, Kharaa and Orkhon fish population seems to be the most heavily impacted by large-scale placer mining operation. Sedimentation and clogging of fish habitats associated with overgrazing appears to be the main threat in Orkhon, Selenge, Ider and Chuluut rivers, and organic pollution is being discharged in sections of Tuul and Kharaa rivers.

There has been concern over impacts due to the use of jet boats by tourists in the bigger rivers such as Selenge, Eg and Uur. However recent studies suggested that jet boats do not have a significant impact on bank erosion. Water pollution might come from leakage of fuel or oil from the boats but it is not reported as an issue yet.

Many organized fisheries started several decades ago, but it is not easy to have recent data on caught fish and composition of the fish stock. Nowadays commercial fishing occurs mainly under the form of illegal commercial fishing at a small scale, as a seasonal complement for income. This makes it difficult to establish zones where it has the biggest impact.

The GEF "Conservation of the Eg-Uur Watershed" project reported in 2003 that commercial fishing run by locals is a minor threat for fish population compared to recreational fishing in the Eg-uur river basin. But according to the UICN red book of fish, commercial fishing in these basins is a threat for several rare of endangered species. High occurrence of valuable fish and proximity with Russia for export might favor this activity in the most northern basins such as Eg, Shishkhid River basins. Due to the lack of data concerning number and composition of catches, it is not possible to assess if commercial fishing has an impact on fish species composition in the area.

Dams and flow regulation

Three small hydro power plants are present in the basin. Production is limited, ranging from 200kWt for the Erdenebulgan in Eg river basin to 528kWt for the hydropower plant of Kharkhorin on the Orkhon River.

Table 2. Hydropower plants in the Selenge basin

Name	**River**	**Basin**	**Capacity**	**Estimated head, *m***	**Fishway**	**Flushing-gate**
Tosontsengel	Ider	Ider	380	3	No	No
Erdenebulgan	Eg	Eg	200	4,5	No	No
Kharkhorin	Orkhon	Orkhon	528	11	No	No

1.9. River basin organizations

Within framework of "Strengthening integrated water resources management in Mongolia" project the whole Mongolian territory was divided into 29 basins with the purpose of water management planning in which the Selenge River basin alienated into 10 sub basins like Yeruu, Kharaa, Tuul, Orkhon, Khanui, Chuluut, Ider, Delgermurun, Khuvsgul Lake-Eg, Selenge River. The Shishkhed River basin is not part of the Selenge basin but it belongs to Arctic Ocean basin (Figure 10).

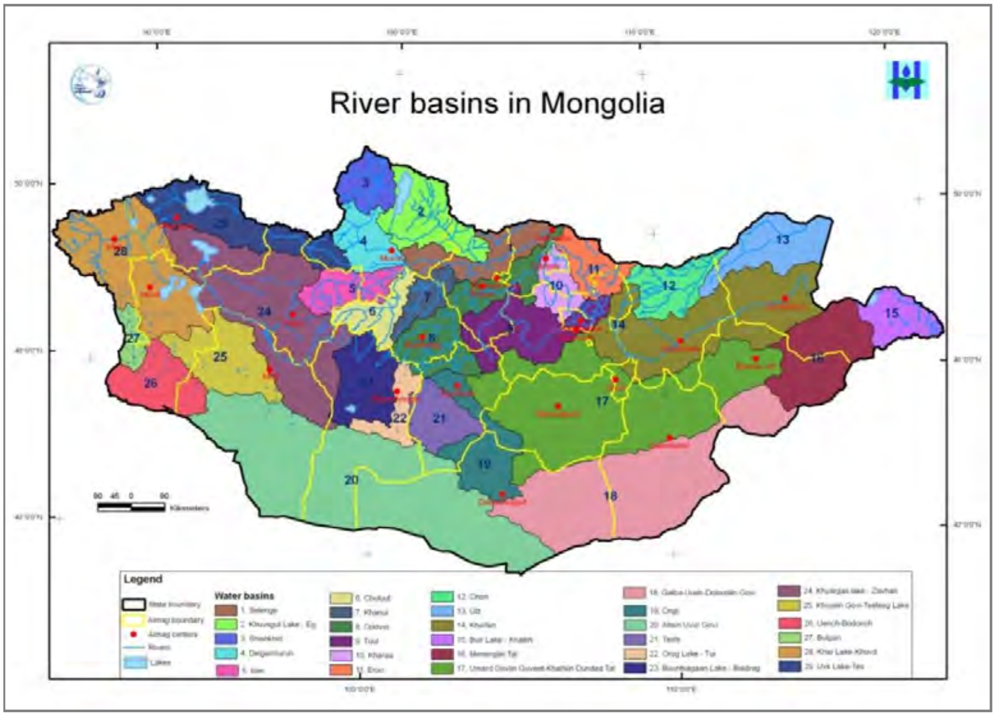

Figure 10. Water management river basins

All water management basins will have the own water authority organization named River Basin Administration (RBA) governmental organization which will implement the Integrated Water Resources Management Plan and manage available surface and ground water resources according to the Mongolian Water law and other water related regulations. Besides RBA of these river basins and their sub basins will have River Basin Council (RBC) which consists from chairman, secretary, 5-15 members representing stakeholders like local administration, governmental environmental departments, nongovernment organizations, movements, scientists, inspection agencies, professional organizations, citizens etc.

Table 3. The existing RBC and RBA in the Selenge basin

No	Name of RBC/RBA	Sub basin RBC/RBA	Established date
1	Tuul RBC		Aug 2010
2		Selbe RBC	May 2008
3	Orkhon RBC		Dec 2011
4	Yeruu RBC		July 2010
5	Kharaa RBC		Sep 2011
6	Tuul RBA		Sep 2012

1.10. Legislation

There are totally eight laws that specifically regulate the effective use, protection, and restoration of water resources; water use fees and water supply (Table 4).

Table 4. Laws related to water resources

No	Name of law	Promulgated	Amended
1.	Water Law	2004-04-22	2005-01-27 2009-08-25
2.	Law on Springs	2003-11-07	
3.	Law on Meteorology and Environment Monitoring	1997-11-13	2003-01-02
4.	Law on Urban Water Supply, Sanitation Sewerage Use	2002-06-13	2004-04-22 2005-01-27
5.	Law on Water Transportation	2003-11-28	
6.	Law on Prohibition of Mineral Prospecting Exploration in Water Basin Areas and Forest Areas	2009-07-16	
7.	Law of Mongolia on Payment for Use of Natural Resources		17 May, 2012
8.	Law on Payment for Water Pollution	17 May, 2012	

The Government of Mongolia has adopted the Millennium Development Goals-based Comprehensive National Development Strategy of Mongolia on 31 January 2008. Within this framework the 'National Program on Water' was adopted on 20 May, 2010 and action plan for implementing the NWP on 01 August 2011.

Mongolia has signed trans boundary agreements to protect, utilize and prevent from the pollution the above mentioned international river basins with the governments of the neighbouring countries. The Agreement between the Government of Mongolia and the Government of the Russian Federation on the Protection and Utilization of Trans boundary Waters was signed on 11 February, 1995.

1.11. Conduct needs BIC assessment study for Mongolia

The picture of water quality threats from industrial and mining sites remains incomplete and measures on how best to handle residual pollution problems from abandoned mining sites have not been defined clearly in policies on either side of the border. EIA do not properly address biodiversity risks, and sectorial programs are operating without standard for minimization or reduction of impacts to biodiversity.

- The development and the impacts of informal mining are however hard to monitor and may have a stronger impact than formal mining activities. Moreover, due to the illegal nature of the activity, it is much harder to implement public awareness or less impacting technology. Choice of recovery technologies seems crucial limit impacts on surface water quality, regarding heavy metals and turbidity. A better knowledge of the process used for each mine and the potential impact for each technology is needed. Simple and easy to implement techniques such as better design of settling ponds to increase sedimentation of particles, as well as a better maintenance of the settlings ponds would have a significant effect on the reduction of turbidity and concentration of nutrients and heavy metals in the surface water.
- Increasing use of heavy metals is a great concern not only for aquatic species but for human health as well as consumption of contaminated fish can trigger adverse effects including neurological dysfunction. Livestock or products from

irrigation can be impacted with the intake of polluted surface water. Furthermore contamination of the soil can occur downstream as fine particles containing heavy metals will deposit in the floodplain during floods. This can lead to long term contamination of valuable pasture land and affect livestock productivity and quality. Further studies should focus on heavy metal transfer through the food chain including livestock and crops.

- Management of forest resources and production of timber should be improved. Forests should be managed under long-term plans that identify the appropriate harvestable forest areas and optimum harvest rate. Industrial use of relatively abundant and fast-growing species such as birch could also be increased, as these trees are currently not often utilized.

- Tourism brings a significant source of income for population, and number of tourists attracted by the natural aspects of Mongolia is increasing. It is therefore necessary to maintain a certain degree of ecological protection to maintain the attractiveness of the ecosystems.

- Data on variation of river discharge, sediment balance, habitats and occurrence of flooding are missing now to carry out a proper assessment of the ecological impacts for each project. However some impacts can be qualitatively described.

- Public awareness about capture size would need reinforcement as well. As many of the species in these basins reach sexual maturity late, uptake of non mature fish has a big impact on renewal capacity. Promote catch-and-release amongst all anglers (foreign and Mongolian) and publish catch-and-release guidelines is needed to ensure the sustainability of fish composition in these basins.

- Implementation of dams will result in a multitude of impacts for the natural conditions of the river, even if measures such as implementation of flushing doors, fish ways or regulation of the discharge to mimic natural conditions are implemented. This effect will not just occur just downstream off the dam. The lack of sediment coming from the upstream part of the basin will trigger erosion and incision of the river bed. Loss of morphogenetic discharge will impact as well the braided characteristic of the rivers and reduce habitat changes and biodiversity. Self-purification capacity will decrease as well, as discharge and lateral connectivity will reduce. Protection should focus on some yet undisturbed areas suitable for spawning, where fish stock could regenerate and then develop downstream. Protection of these zones should be accompanied with a proper protection of forests and illegal mining. Existing protected areas are not sufficient to guaranty a proper protection of rare and valuable fish such as Taimen.

- Dam will flood long stretches of rivers that may harbor spawning sites for endangered species. Dams create a lentic environment up stream of the dam, where particles will sediment rather than being transported downstream with the flow. Fish population will shift from salmonids to cyprinids in the reservoir. Biodiversity, as the distribution of different species in a river might increase, but this will be due only to the creation of an artificial system. On one hand, these artificial lakes may attract recreational fishermen on the site but on the other hand the loss of other habitats and reduction of more symbolic fish populations upstream and downstream might have a bigger impact on recreational fishing. Water will warm up and concentration of nutrients might induce eutrophication and appearance of anoxic conditions in the bottom of the reservoir. Sediments in the reservoir should be analyzed before any flushing operation. If a flushing door is implemented, operation should be carefully studied as the release of a high content of fine particles in a short time, possibly contaminated by mining operations upstream will have harmful impacts on biology and water quality.

- Even if groundwater quality often fits the standards, contamination of shallow aquifers from heavy metals is a raising issue. Actions should be implemented to avoid a long term contamination of groundwater, especially in the basins where use of mercury or cyanide for mining activities is increasing. Taking into account the mobility and remoteness of illegal mining activities, patrolling for illegal miners using heavy metals can be difficult and not effective. Limiting the availability of heavy metals on the market before they reach mining sites could be an efficient way to decrease mercury and cyanide use, hence the risks of pollution.

- Concerning legal mining sites, choice of recovery technologies seems crucial to limit impacts on surface water quality. However, due to a lack of general survey, it is not clear yet what recovery techniques are the best to implement. Future authorizations for mining activities should take into account the choice of the recovery technology and favor technologies with the lowest impacts. Efforts on land rehabilitation should be emphasized. This would not only reduce the risk of apparition of invasive species and recreate new habitats, but would limit illegal mining that often occurs on former mining sites.

- Impacts from recreational fishing increased tremendously in the last decade, leading to a major loss of vulnerable and endangered fish population. This activity brings a valuable and growing economical resource via tourism. Decrease of fish stock due to a high mortality rate, degradation of water quality and loss of habitats will reduce the attractiveness of the region. Public awareness on catch-and-release techniques, and a better management and protection of salmonids population, especially Taimen are urgently needed.

2. Data structure of BIC for Mongolia

Data structure of BIC for the both side of Baikal basin should contain main data which will present the general environmental aspects in the basin at current situation and the data is expected to cover many entities: such as surface and ground water data, water quality, institutional and legal information, data on projects, etc. Clearly this set of entities will require a custom-made database. This section describes shortly about the type of data sources and their holders.

The description of the Meta data sources should contain information about data type, data source, and name of contact person, description and availability of that information. The data updating regularity thoroughly depends on data holders and not as much of information about updating constancy.

2.1. General description

Brief description and presentation of following conditions:

- Administrative boundaries/aimag and soum centres/river basin boundaries
- Basin Characteristics
- Hydrological (surface water and groundwater) condition
- Biological (vegetation, animals)

- Socio-economical (population distribution, industrial areas)
- Environmental (protected areas, urban areas, agricultural areas) properties of the basin.

Table 5. Data sources for general natural condition

Data	Data type	Data source	***Availability /Charge***
Administrative boundaries	vector	http://geodata.mne-ngic.mn	*Availability /free*
Soil	vector	http://geodata.mne-ngic.mn	*Availability / free*
Vegetation	vector	http://geodata.mne-ngic.mn	*Availability / free*
Natural zones	vector	http://geodata.mne-ngic.mn	*Availability / free*
Forest	vector	Forest agency, MENT	*Availability / free*
Land use	vector	http://geodata.mne-ngic.mn	*Availability / free*
Protected areas	vector	http://geodata.mne-ngic.mn	*Availability / free*
Land cover	jpeg	http://geodata.mne-ngic.mn	*Availability / free*
Pasture degradation	jpeg	National atlas of Mongolia, 2009	*Availability / free*
Desertification	jpeg	Institute of Geo-ecology, MAS	*Availability / n/a*

The described properties should have a clear relation to water quality or ecological conditions. Existing or planned structures and facilities (treatment plants, dams, diversions, etc.) affecting water quality or ecological conditions must be described here as well.

2.2. Monitoring Network

The environmental monitoring network in Selenge basin comprises 54 surface water gauging stations approximately 45 sampling points for analyzing surface water quality in 72 rivers and 9 lakes, 20 sampling sites for analyzing waste water from waste water treatment plant and 22 sampling points for precipitation.

2.3. Water Quality and Quantity Data and Their Sources

This paragraph describes in general the data sources of surface water and groundwater quality.

The general description should make clear what kind of data is available:

- Pollution sources
- Which water quality parameters
- Period from which data is available
- Frequency of observations
- Trends in Surface Water Quality
- Results of harmonised water quality measurements in corporation with IMHE of Mongolia
- Etc.

Surface and ground water quality data are available from institutes, state agencies such as Central Environmental Laboratory under the NAMHEM, Asian foundation, Mongolian Nature and Environment consortium, Geo-ecology Institute of MAS and laboratory under the State Inspection Agency and others. List of organization with data available are shown in the following table.

Table 6. Data sources on water quality and quantity

Data type	Data source	Description	Availability /Charge
Surface water quality data	Central Environmental Laboratory	14 monitoring points, monthly data from 1986: general substances, cations and anions and heavy metals	Available/paid
	Asian Foundation: database	Data from 2007, 2008 and 2009	Not available for all the stations/n/a information on payment
	Korea Environment Institute / Mongolian Nature and Environment consortium	Data in the Arctic Ocean basins (2005 and 2006)	Available /n/a
Ground water quality data	Geo-Ecology Institute	Data on mineral concentrations, pH, NH_4, NO_2 and NO_3 from 1960 to 2006, depending on locations	Available/paid
Surface water quantity	Institute of Meteorology, Hydrology and Environment	Runoff data at 54 stations for different periods 1942-2010	Available/paid

2.4. Ecological Data and Their Sources

This section describes in general the sources of ecological and environmental data. It describes the data sources of:

- *Protected areas (incl. Ramsar sites)*
- *Biological data (fish, insects, birds, vegetation, etc.)*
- *Land use and land condition (forests, desertification, etc.)*

The monitoring of ecological conditions considerably improved during the last decade. Studies cover an array of ecological issues such as land cover degradation, changes in river regime, distribution of species, etc.

Table 7. Data sources for Ecology

Data type	Data source	Description	Availability status/charge
Protected area data and specific sites	Ministry of Environment and Green development	Planning and provincial protected area data	Available/n/a
	National Geo Information Center	Provincial protected area data	Available/ n/a

	RAMSAR bureau	Description of ecologically important wetlands sites (RAMSAR sites)	Available/ n/a
River Basin(s) study case	Mo-Mo project	Kharaa river case study	Available/ n/a
	WWF	Description of ecological changes in the Great Lakes basins region	Available/ n/a
Biological data (fish, insects, birds, vegetation)	Asian Foundation	Physical assessment of riverside conditions for Tuul and Orkhon	Available/ n/a
	IUCN / Institute of Geo-Ecology	Mongolian Red book of Fish and Summary Conservation Action Plans for Mongolian Fishes Mongolian Red List of Reptiles and Amphibians (List of endangered species and their locations in Mongolia)	Available/ n/a
	Directory of Important Bird Areas	Important Bird Areas in Mongolia: Key Sites for Conservation (List of area recognized as Important Bird Areas (IBAs) and their bird populations)	Available n/a
Fisheries		Description of the fisheries and fish stocks in Mongolia (1991)	Available/ n/a

However, due to the immense size of the territory that needs to be covered and the relatively recent efforts on this subject, the information is still scattered, constraining efforts to put together a detailed picture of the ecological conditions and their recent changes in each river basin. Moreover there is little information on undisturbed areas that could be used as references. Local studies do bring out valuable information that, to some extent, can be extrapolated to the river basins.

2.5. *Hydro-Constructions*

Waste water treatment plants, ponds and reservoirs hydro power plant, flood protection, existing and planning dams etc. Information related to proposed dam and hydro constructions are available at the action plan of Mongolian Water Programme.

Table 8. Data sources for Hydro constructions

Data type	**Data sources**	**Availability status/charge**
Roads and transport	Ministry of Roads, Transportation, Construction and Urban Development	Available/ n/a
Flood protection	MRTCUD, municipalities	Available/ n/a
Dams and weirs	Ministry of Food, Agriculture and Light Industry (MFALI)	Available/ n/a
Hydro power constructions	Ministry of Mineral Resources and Energy	Available/ n/a

2.6. *Socio-Economic data*

The most important data types for this section are as following:

- Industrial data
- Mining data
- Tourist data
- Water tariffs
- Water use
- Irrigation area
- Impacts of climate change and other changing conditions

Table 9. Data sources used for the socio-economic analysis

Type of data	Sources	Availability/charge
Population	National Statistical Office (NSO) www.statistic.mn Statistical Yearbooks	Availability/free (partly paid)
Macroeconomic	WB, IMF. NSO, Ministry of Finance, MFALI, www.pmis.gov.mn www.statistic.mn, other related web sites	Availability/free (partly paid)
Agriculture	NSO, MFALI, MF, www.pmis.gov.mn www.statistic.mn,	Availability/free (partly paid)
Industry	NSO, MFALI, MF, www.pmis.gov.mn www.statistic.mn	Availability/free (partly paid)
Tourist	NSO www.statistic.mn	Availability/ n/a
Water tariff and fee	MF, Administration of Land Affairs, Construction, Geodesy and Cartography (ALACGC), Water Supply and Sewage Company of Ulaanbaatar (USUG), Public Urban Services Organization, related web sites, government offices	Availability/free (partly paid)

One of the main sources of socio-economic data is the yearly brochure from National Statistic committee and also can be collected from other government agencies such as Mineral resources authority, Land Affairs, Construction, Geodesy, Cartography Authority and others.

2.7. *Major Issues in relation to water quality and ecological conditions*

This information should include a preliminary overview of the issues regarding the quality of surface and groundwater in the river basin.

Current Impacts on Pollution, Flow regime changes, Climate change, Desertification and other Disturbances are available from different sources mainly from project implementing information as Mo-Mo, Strengthening IWRM in Mongolia and others.

2.8. *Maps, GIS and Remote Sensing data and their sources*

This paragraph describes the data sources providing maps, GIS, remote sensing and other spatial data. The most important data types are:

- *Land use maps*
- *Land degradation maps*
- *Desertification maps*
- *Etc.*

The description should make clear what kind of data is available:

- *Type of data: map, shape file, raster, image*
- *Map legend*
- *Period from which data is available*
- *Quality and accuracy of the data*
- *Etc.*

Map, shape file, raster, image are available at http://geodata.mne-ngic.mn and free of charge.

2.9. Reports and other documents and their sources

This paragraph should be describing the general the documents which are available from different sources such a project reports, research books, internet information

2.10. Water Inventory data

Mongolian water authority agency implements water inventory of country every four years and the water inventory information and data available at Water monitoring and management division of Department of Policy Implementing at Ministry of Environment and Green Development.

2.11. Randomly measured data and their sources

This paragraph describes the data sources providing data from special surveys and research.

The description should make clear what kind of data is available:

- Period from which data is available
- Frequency of observations
- Quality and accuracy of the data
- Missing data
- Etc.

2. Overview of concepts and approaches on data structure of BIC for Mongolia

This section contains a very brief overview of concepts and approaches relevant to BIC data for Mongolia.

The main objective of BIC data is to create environmental and ecological information sources for the both side of Baikal basin. These data will be used by the wide range of users from both sides of governmental organizations to personals. Therefore data should be from reliable sources and verified by responsible organizations or personals.

The BIC data should contain many entities such as surface water and groundwater data, water use and water demand, hydro constructions, institutional and legal information, data on projects, result of research studies etc.

The data should be authorised and easy to use with forms with functions of data verification (metadata) and reports and graphs for data presentation.

The data will be developed using common interface software such as Microsoft Access easier to update and enter data.

Data should be exchangeable from file-based databases like Access or Paradox to high-speed client-server database management systems like Oracle and SQL Server.

The main approaches for creating the BIC data should be based on existing ecological approaches which have relevance to the main objective of the BIC concept. Several of those are:

- WFD – because of the many different basins in Mongolia, it will be useful to set up a framework for developing river basin plans as part of the National Water Management Plan. The WFD can serve as an example.
- IWRM – IWRM is the underlying concept – the balancing of all interests and the required stakeholder process are key at all levels – in drawing a National Water Management Plan as a framework for River Basin Management Plans, as well as for the development, analysis and selection of more concrete measures at river basin, or even smaller scales.
- Ecosystem based approach – involving ecological and environmental specialists from the beginning of the process. This is a way of performing the IWRM process. Within the IWRM project water quality and ecology are recognised as important issues. This approach should also be taken to the IWRM stakeholder process that will take place.

To apply these concepts widely use the systems analysis through the development of strategies with clear objectives, indicators, and measurable targets are defined, based on which the current and future situation can be assessed.

The required ecological and environmental expertise covers a wide range of (sub-) disciplines. Generally such knowledge is not available with a single specialist or even within one institute. Because ecological response are often specific for a region, local ecological knowledge is requires, which requires the involvement of various local specialists.

A possible approach is to collect as much information as possible and structure this information according to the selected approaches and needs. Then, organise a workshop to discuss the information, agree on the first steps and the approach for the next steps.

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