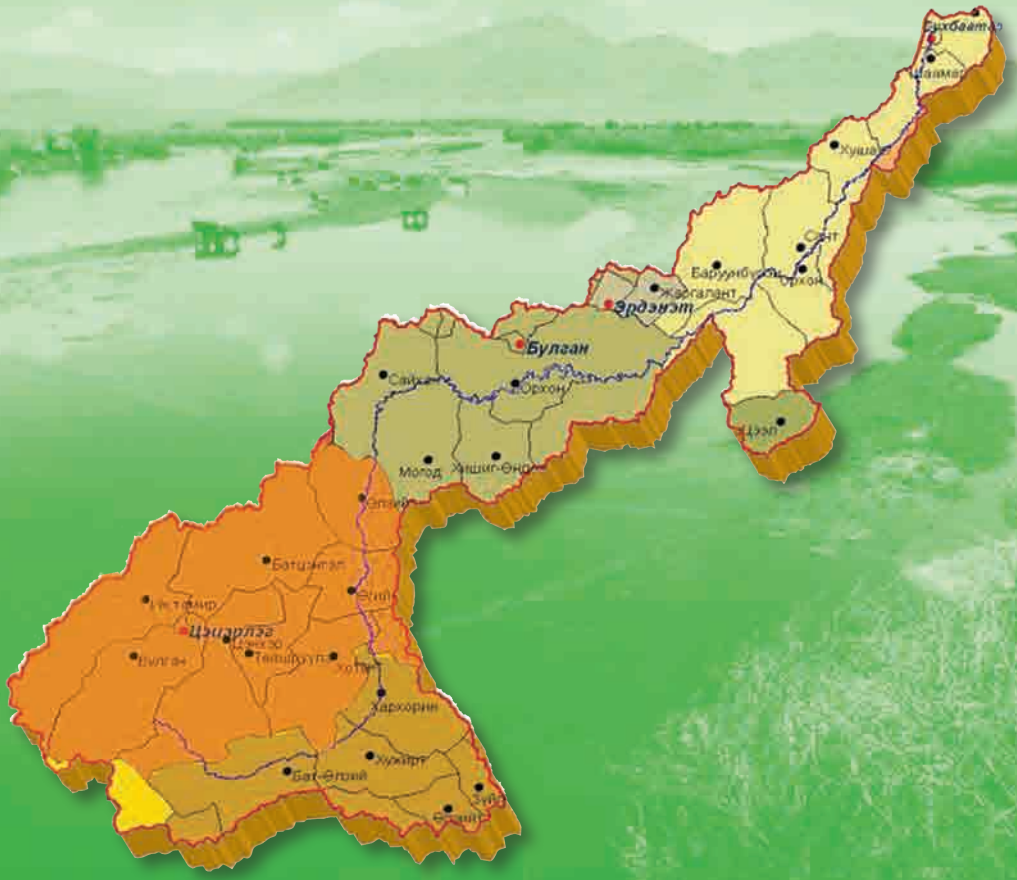
GOVERNMENT OF MONGOLIA

MINISTRY OF ENVIRONMENT AND GREEN DEVELOPMENT

ORKHON RIVER BASIN
INTEGRATED WATER MANAGEMENT PLAN



Ulaanbaatar
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(Phase 1, 2013–2015; Phase 2, 2016–2021)

Ulaanbaatar 2012

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This plan was developed within the framework of the "Strengthening Integrated Water Resources Management in Mongolia" project, funded by the Government of the Kingdom of the Netherlands at Ministry of Environment and Green Development of Mongolia

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ORKHON RIVER BASIN INTEGRATED WATER MANAGEMENT PLAN

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PREFACE

The human race is not the owner of all natural resources but the owner is mother earth itself. Our duty is to assess the permitted usable quantity of the natural resources and use it by known technologies.

Defining the approved quantity of water resources is not easy. It is very difficult for our country which has a vast territory, an extreme and dry climate, and uneven distributed water resources in terms of region and space. Global climate change and aridity have negative impacts on agricultural production results. It also impacts the natural water resources and its regime. In some regions, river water levels and flood damages increased. In general in Mongolia, water resources are depleted.

This condition expands the border of desertification and reduces the comfortable living environment of the people. As for Mongolia, the natural water resources and its regime need to be studied and the reasons of change need to be defined. Natural water resources are to be protected and used wisely. More attention needs to be paid to expansion and rehabilitation of water resources and the establishment of a "Green Development" basis. Until now, we did not pay much attention to this issue and we could not conduct useful measures in this sector except trying some administration structure and organizational measures.

According to the 2007 agreement between the Governments of Mongolia and the Netherlands, the "Strengthening Integrated Water Resources Management in Mongolia" project was financed with a grant of the Government of the Netherlands. One of the measures planned within the framework of the project is to develop the integrated water resources management plan of Mongolia. The activity to develop a model plan of the Orkhon river basin integrated water resources management was included and implemented.

The Orkhon river basin occupies 3.4 percent of the country's territory and 17 percent of the GDP is produced here. Of the total population, 8.6 percent resides in the basin and Erdenet city, a big mining production center is located in the basin as well. Some 30 percent of the country's total export products are produced here.

The Orkhon river basin integrated water management plan estimates the basin's potential exploitable and possible usable resources, the sectors' water demand and water use. These were calculated by three scenarios including high, middle and low. Based on this, the water resources and demand balance was made for the years 2015 and 2021. The plan was made for the whole basin including assessments, conclusions, definite activities and measures required for protecting water resources, using water resources wisely, and rehabilitating and expanding water resources.

Relevant sectors', professional organizations' and experts' recommendations, and residents' complaints were included in the plan being the basis for the full implementation of the plan. All local state organizations, sectors' representatives, NGO's and their member's initiatives and participation will play a vital role in the implementation of the Orkhon river basin integrated water management plan.

I thank all the water sector experts and scientists, project team experts and consultants who actively participated in the development of the plan on behalf of the Ministry of Environment and Green Development.

Member of Mongolian Parliament
Minister of Environment and Green Development **S.Oyun**

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ABBREVIATIONS

ADB	Asian Development Bank
ALACGC	Administration of Land Affairs, Construction, Geodesy and Cartography
CRM	Citizen Representative Khural
GDP	Gross Domestic Production
GEI	Geo Ecological Institute
GIS	Geographical Information System
GO	Governor Office
HDI	Human Development Index
IG	Institute of Geography
IMH	Institute of Meteorology and Hydrology
IWRM	Integrated Water Resource Management
MAS	Mongolian Academy of Science
MCUD	Ministry of Construction and Urban Development
MDG	Millennium Development Goals
MES	Ministry of Education and Science
MECS	Ministry of Education, Culture and Science (former)
MEGD	Ministry of Environment and Green Development
MF	Ministry of Finance
MFALI	Ministry of Food, Agriculture and Light Industry (former)
MIA	Ministry of Industry and Agriculture
MMRE	Ministry of Mineral Resources and Energy
MNET	Ministry of Nature, Environment and Tourism (former)
MNS	Mongolian National Standard
MNT	Mongolian Tugrug
MRTCUD	Ministry of Roads, Transportation, Construction and Urban Development (former)
NAMHEM	National Agency for Meteorology, Hydrology, and Environmental Monitoring
NDIC	National Development and Innovation Committee
NEMO	Netherlands-Mongolia Trust Fund for Environmental Reform
NETD	Nature Environment and Tourism Department
NGIC	National Geo-Information Centre for Natural Resource Management
NGO	Non-governmental Organization
NSO	National Statistical Office
NUM	National University of Mongolia
RB	River Basin
RBA	River Basin Administration
RBC	River Basin Council
SPC	State Property Committee
ORB	Orkhon River Basin
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
WA	Water Authority
WB	World Bank
WHO	World Health Organization
WMO	World Meteorological Organisation
WPI	Water Poverty Index
WWF	World Wildlife Fund
WWTP	Waste Water Treatment Plant
NCPCSW	Normative to Classify Purity level of Surface Water

1. PHYSICAL, GEOGRAPHICAL AND NATURAL CONDITION OF ORKHON RIVER BASIN

1.1. Natural and physical geographical condition

The Orkhon River is a major tributary of the Selenge River. It rises on the south side of the Suvarga Khairkhan Mountain which is part of the Khangai Mountains. The head of the river is Ult stream, tributary of the Ikh Teel River. The Orkhon River flows in the beginning through mountainous area, in the middle part through rolling hills and then through flat valleys. In the valleys there are deep canyons and when the river flows wider, it is having many streams until the mouth of the river.

The Orkhon River basin has few forests. The maximum elevation of the basin is 3539.9 m above sea level, the top of the Angarkha Mountain, and the minimum elevation is 601.1 m, where the Orkhon River flows into the Selenge River.

The Mongolian physical geographical regions according Sh.Tsevegmed (1962, 1969) are: I. Altai mountainous region, II. Khangai-Khentii mountainous region, III. Gobi region, IV. Mongolian east steppe region. Each region is divided into subregions in total 12 subregions which are also divided into districts, counted at 27.

The Orkhon River basin is included in the Khangai sub-region of Khangai–Khentii mountain region. The head part of the river is located in the Khangai district; the middle and low part of the river is included in the Selenge-Orkhon Khangai district.

The Orkhon river basin has several high mountain tops, such as Tarvagatain mountain, Angarkhai mountain (3540 m), Erkhet Khairkhan mountain (3535 m), Suvarga Khairkhan mountain (3179 m), Zuun Khairkhan mountain (2408 m), Myangan Ugalzat mountain (3482 m), Ikh Shivert mountain (3166 m), Ulaan Baits mountain (2404 m) and Zurkh mountain (2338 m).

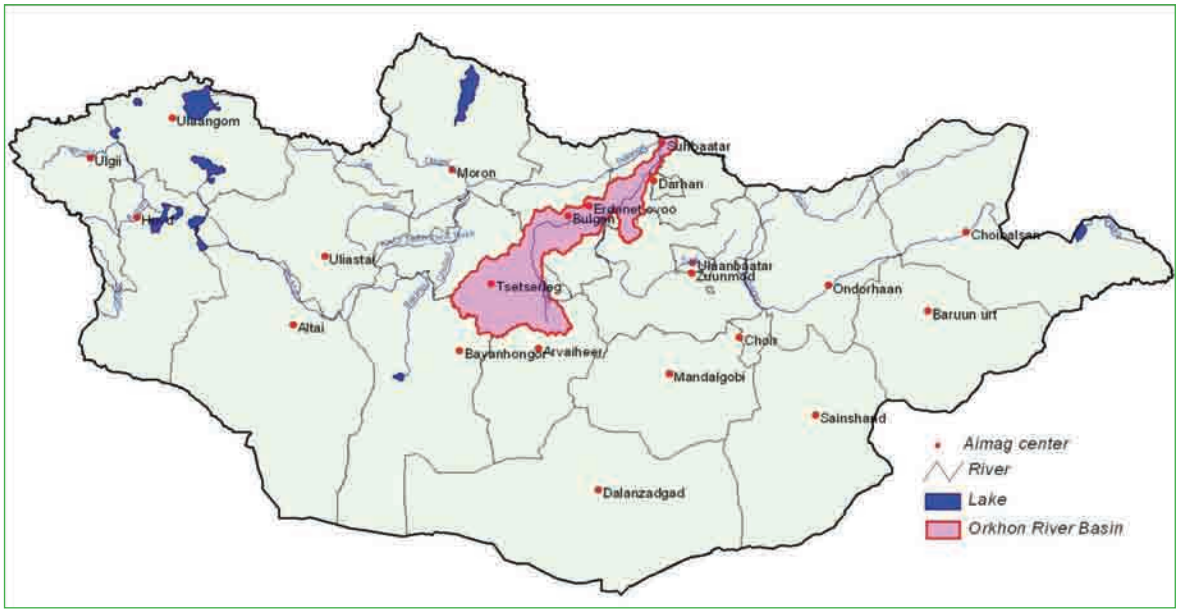


Figure 1. Location of Orkhon river basin

The Orkhon River basin is covered by 53 soums of 8 aimags. Bulgan, Ulziit, Tuvshruulekh and Khotont soum of Arkhangai aimag, Bayan-Undur soum of Orkhon aimag and Khujirt soum of Uvurkhangai aimag are fully included in The Orkhon River basin. It was decided that Undur-Ulaan, Chuluut, Erdenemandal soums of Arkhangai aimag, Galuut soum of Bayankhongor aimag, Gurvanbulag, Selenge soums of Bulgan aimag, Jargalant, Zaamar, Ugtaal soums of Tuv aimag will not be included for IWRM planning, because less than 0.5% of those soums area comes to the Orkhon river basin.

The length of the Orkhon River is 1066 km, it is calculated by GIS methodology using topographical map with scale 1:100 000. Figure 1 shows the location of the Orkhon River basin.

The geographical coordinates of the origin of the Orkhon River are101°20’13”E., 47°03’07”N. The Orkhon confluence with the Selenge River is at 106°08’55”E., 50°14’42”N.

Table 1 shows area of aimag and soums which are included in the Orkhon River basin.

Of the Orkhon River basin area 38.2% is occupied by Arkhangai aimag. 22.1% by Bulgan, 18.4% by Selenge, 15.9% by Uvurkhangai, 1.9% by Tuv aimag, 1.6% by Bayankhongor, 1.6% by Orkhon, 0.4% by Darkhan-Uul aimag each separately.

Table 1. Area of soums in Orkhon river basin

No	ID	Aimag	Soum	Area in basin, km²	Total soum area, km²	Percentage (area in basin)	Percentage (of basin area)
1	201	Arkhangai	Battsengel	3,378.52	3,519.29	96.0	6.3
2	202		Bulgan	3,218.81	3,218.81	100.0	6.0
3	204		Ikhtamir	3,591.82	4,873.57	73.7	6.7
4	205		Ugiinuur	1,385.92	1,681.94	82.4	2.6
5	206		Olziit	1,717.54	1,717.54	100.0	3.2
6	207		Undur-Ulaan	0.05		0.0	0.0
7	209		Tuvshruulekh	1,185.41	1,185.41	100.0	2.2
8	211		Khairkhan	72.85	2,512.07	2.9	0.1
9	212		Khashaat	424.93	2,591.04	16.4	0.8
10	213		Khotont	2,343.07	2,343.07	100.0	4.4
11	214		Chuluut	6.87	3,435.00	0.2	0.0
12	216		Tsenkher	3,147.09	3,147.09	100.0	5.9
13	218		Erdenebulgan	62.68	62.68	100.0	0.1
14	219		Erdenemandal	0.45		0.0	0.0
15	412	Bayankhongor	Galuut	6.33	6,330.00	0.1	0.0
16	420		Erdenetsogt	836.75	4,061.89	20.6	1.6
17	503	Bulgan	Bugat	476.82	3,200.13	14.9	0.9
18	504		Bulgan	88.76	88.76	100.0	0.2
19	505		Buregkhangai	1,468.35	3,487.77	42.1	2.7
20	506		Gurvanbulag	0.06		0.0	0.0
21	508		Mogod	2,199.26	2,819.56	78.0	4.1
22	509		Orkhon	4,080.08	4,092.36	99.7	7.6
23	511		Saikhan	1,849.19	2,759.99	67.0	3.4
24	512		Selenge	18.60	4,650.00	0.4	0.0
25	514		Khangal	91.87	1,640.54	5.6	0.2
26	515		Khishig-Undur	1,476.71	2,436.82	60.6	2.8
27	516		Khutag-Undur	113.39	5,669.50	2.0	0.2
28	802	Darkhan-Uul	Orkhon	214.33	461.92	46.4	0.4
29	1302	Orkhon	Jargalant	562.94	567.48	99.2	1.1
30	1301		Bayan-Undur	273.00	273.00	100.0	0.5
31	1403	Uvurkhangai	Bat-Ulzii	2,579.14	2,586.90	99.7	4.8
32	1407		Burd	24.37	2,707.78	0.9	0.1

No	ID	Aimag	Soum	Area in basin, km²	Total soum area, km²	Percentage (area in basin)	Percentage (of basin area)
33	1409		Sensual	566.74	1,961.04	28.9	1.1
34	1410		Zuunbayan-Ulaan	540.17	2,512.42	21.5	1.0
35	1412		Olziit	733.71	1,967.05	37.3	1.4
36	1416		Uyanga	405.27	3,047.14	13.3	0.8
37	1418		Kharkhorin	2,043.52	2,301.26	88.8	3.8
38	1419		Khujirt	1,661.41	1,661.41	100.0	3.1
39	1701	Selenge	Altanbulag	674.59	2,435.34	27.7	1.3
40	1702		Baruunburen	2,334.34	2,805.70	83.2	4.3
41	1706		Zuunburen	609.05	1,191.88	51.1	1.1
42	1708		Orkhon	1,040.87	1,264.73	82.3	1.9
43	1709		Orkhontuul	2,001.72	2,935.07	68.2	3.7
44	1710		Saikhan	546.27	1,306.87	41.8	1.0
45	1711		Sant	1,337.48	1,350.99	99.0	2.5
46	1712		Sukhbaatar	46.47	46.89	99.1	0.1
47	1714		Khushaat	856.88	2,002.06	42.8	1.6
48	1717		Shaamar	474.53	617.88	76.8	0.9
49	1816	Tuv	Jargalant	7.36	1,840.00	0.4	0.0
50	1817		Zaamar	1.90	1,900.00	0.1	0.0
51	1823		Sumber	4.22	527.50	0.8	0.0
52	1824		Ugtaal	1.68	1,680.00	0.1	0.0
53	1825		Tseel	1,002.75	1,641.16	61.1	1.9
			Total	**53,786.89**			**100.0**

1.2. Climate

1.2.1. Climate condition

B.Jambaajamts (1989) divided Mongolia into 3 climate zones. A humid-cold zone, which is elevated more than 1800 m, a subhumid-cool zone - elevated between 1300 m and 1800 m, and a semidry-cooler zone - which is elevated between 700 m and 1300 m above sea level. The Orkhon River basin area is divided in 45.0% of the subhumid-cool climate zone, 27.3% of the semidry-cooler climate zone and 27.7% of the humid-cold climate zone (Figure 2).

The Khangai mountainous region is located in the humid-cold zone and the mean monthly temperature in the warmest month, July does not exceed 15˚C. During the summer it is possible to observe a sudden drop of temperature. The duration of the warm period is about 30-80 days. The heat resource with temperature more than 10˚C is less than 1250˚C, and the total annual precipitation is more than 350 mm.

The Khangai–Khentii middle elevated mountains are located in the subhumid-cool zone and consist of valleys between mountains and basins of rivers. The zone is characterized by mountain taiga and mountain steppe region landscape. The mean monthly temperature in July is 15-17˚C; the duration of the warm period is about 70-80 days. The heat resource with temperature more than 10˚C is 1250-1750˚C and the total annual precipitation is 300-350 mm, but 250-280 mm in mountain steppe area.

The forest steppe region is located in the semidry-cooler zone. Here, the heat resource is sufficient for vegetation and soil humidity. The mean monthly temperature in the warmest month July is 17-20˚C. The duration of the warm period is about 80-100 days. The heat resource accumulates 1750-2250˚C during the vegetation period. For that period the total annual precipitation is 250-300 mm.

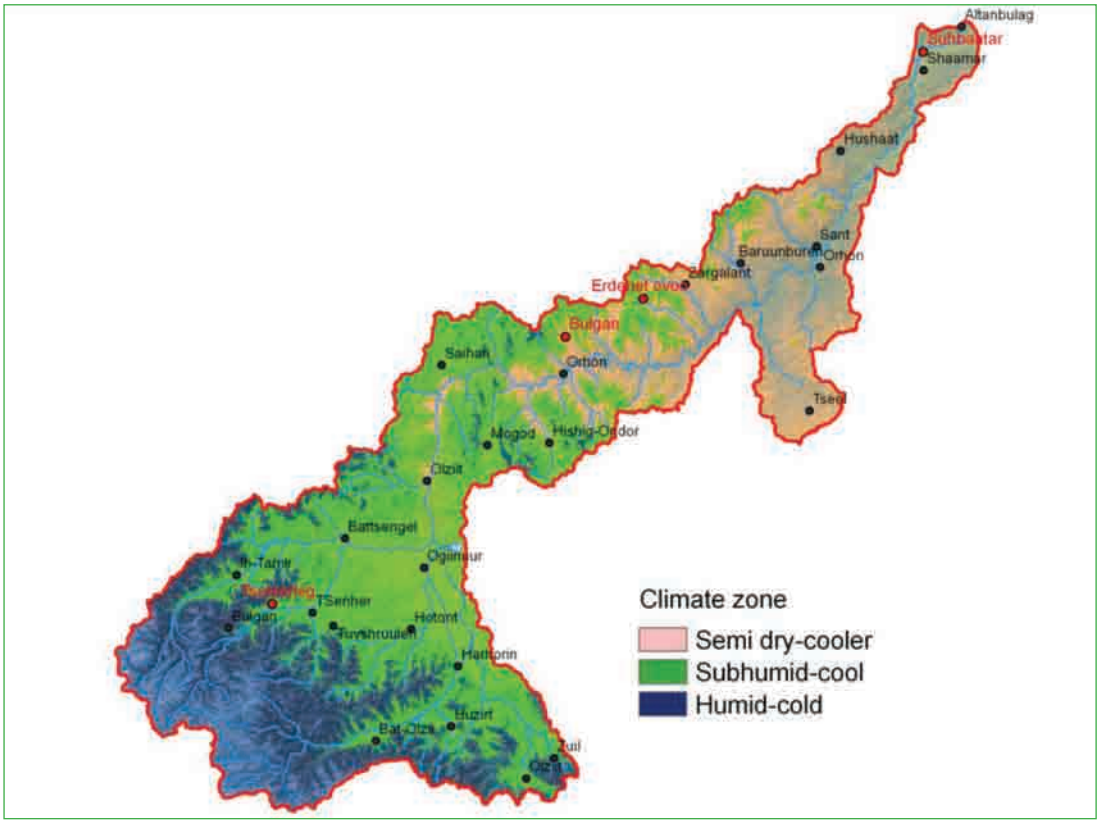


Figure 2. Climate zones of Orkhon river basin

The warmest annual mean temperature is 20-25˚C in dry-warmer zone in steppe region. The heat source accumulates 2250-2750^{0}C during the vegetation period. The duration of the warm period is about 110-140 days. The total annual precipitation is 150-250 mm.

1.2.2. Air temperature

The warming of the air caused by the global warming pattern is increasing depending on the geographical location of Mongolia and especially there is high intensity value in the Orkhon river basin. By the last 40 years of observation data of meteorological stations in the Orkhon river basin, the mean annual air temperature increased by 0.8-1.3˚C, with the highest increase in elevated places.

The warming of the air in winter time is less and some places even became colder. The warming is more noticeable in summer. Due to the warming, the number of hot days is increasing and the observed maximum air temperature since 1940 happened in the last few years.

Table 2. Mean monthly air temperature at meteorological stations, ^{0}C

Station name	Month												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1. Khujirt	-20.8	-18.2	-8.7	0.6	8.2	13.0	14.5	12.8	6.9	-0.8	-11.1	-18.3	-1.8
2. Tsetserleg	-14.9	-13.6	-6.8	1.1	8.7	13.0	14.3	12.8	7.5	0.6	-7.6	-12.9	0.2
3.Bulgan	-20.3	-18.2	-8.6	1.1	9.1	14.2	16.0	13.9	7.2	-0.9	-10.9	-17.9	-1.3
4.Erdenet	-16.8	-14.8	-7.7	1.1	9.0	13.8	15.5	13.9	8.3	0.8	-8.7	-14.6	0.0
5. Orkhon	-24.9	-21.4	-9.0	2.8	10.7	16.6	18.6	16.2	9.2	0.5	-11.3	-21.0	-1.1
6. Sukhbaatar	-23.1	-19.3	-7.4	3.0	10.9	17.0	18.9	16.8	9.8	1.0	-10.7	-18.9	-0.2

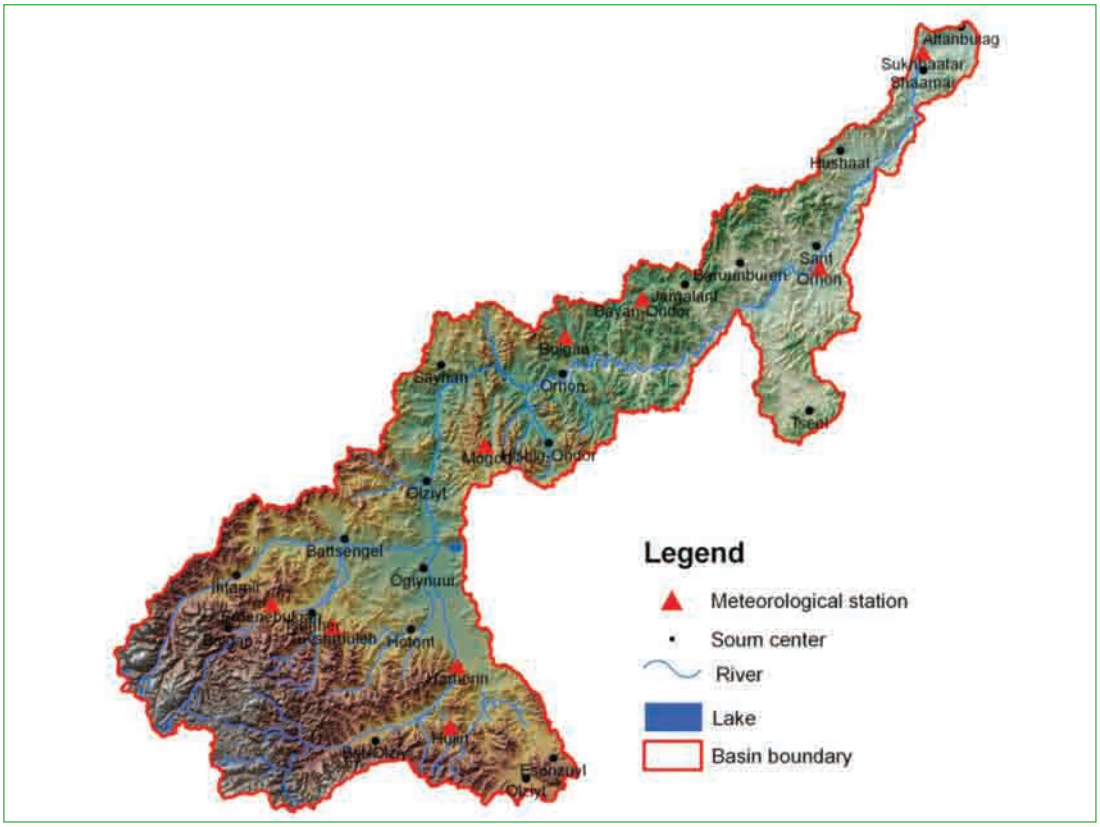


Figure 3. Location of meteorological stations in Orkhon river basin

1.2.3. Precipitation

The Orkhon river basin has a more humid climate compared to other regions of the country. The total annual precipitation is around 200-400 mm. In the high mountains or runoff forming areas the precipitation is more than 350 mm per year. 85-90% of total precipitation falls in the summer period.

The total precipitation and the duration of rainfall during the summer season are decreasing in the Orkhon River Basin. Figure 4 shows the total precipitation duration during the summer season at Tsetserleg station.

It shows an average precipitation duration during the 3 month summer of 220 hours but since 1975 the duration decreased by about one third. Another change is the increased frequency of thunderstorms during the summer (L.Natsagdorj, 2009).

Table 3. Precipitation, mm

N	Station name	Month												Sum
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	Tsetserleg	2.0	2.8	6.1	16.9	32.7	69.0	90.4	82.6	27.3	13.5	6.0	2.8	352.1
2	Tuvshruulekh	2.1	2.1	5.8	6.8	23.0	49.0	67.4	39.8	17.5	8.8	4.5	2.2	229.0
3	Bulgan	1.4	2.1	3.2	10.7	25.5	57.7	108.0	81.8	32.4	12.5	3.9	2.0	341.2
4	Mogod	0.3	0.2	1.2	4.4	10.7	35.2	62.9	42.2	16.6	3.9	1.9	0.6	180.1
5	Erdenet	2.0	1.7	5.0	13.8	23.7	70.7	100.5	81.3	41.2	13.0	7.6	3.3	363.8
6	Khujirt	1.2	2.0	3.9	10.1	24.9	53.5	91.5	73.4	25.6	7.4	3.5	2.2	299.2
7	Kharkhorin	3.9	3.0	7.4	13.2	28.9	60.0	79.7	49.8	24.4	13.2	5.6	4.0	293.1
8	Orkhon	3.4	1.9	3.2	6.1	19.2	69.0	77.2	72.0	41.8	8.3	5.8	4.5	312.4
9	Sukhbaatar	3.2	2.6	3.1	11.6	18.9	49.0	84.7	74.7	35.9	14.3	6.1	3.1	307.2

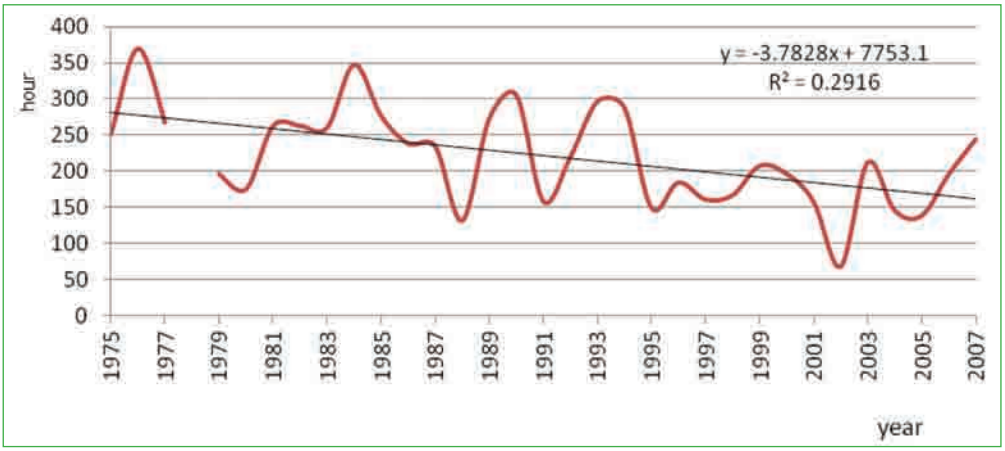


Figure 4. Variability of precipitation duration during the summer at Tsetserleg

1.2.4. Evaporation

The main reason of the aridity in the Orkhon River basin generally is global warming. Nowadays the increasing evaporation (Eo) is causing aridity in the basin. The deficiency of the vegetation water supply affects the vegetation cover.

The difference in evaporation and precipitation (Eo-P) is becoming larger since 1990. In the period 1991-2008 compared with the period 1961-1990 mean values decreased by 30-40% in the runoff forming area of Orkhon river basin.

The change in evaporation and precipitation affects the river discharge. The discharge in the upper part of the Orkhon River was 24.8 mm between 1961-1990 at Khujirt gauging station data. However, the discharge was reduced to 16.6 mm between 1991-2008.

1.3. Soil, vegetation, forest, land resource and wildlife

1.3.1. Land cover

Three natural zones occur in the Orkhon Rver Basin: the forest-steppe zone occupying 71.4% of the area, the steppe zone occupying 26.0% of the area and the high mountainous zone covering 2.6% of the basin area (Figure 5).

From the land cover map prepared by the Information Center for Natural Environment of the Ministry of Nature, Environment and Tourism in 2008 for which data was used from the MODIS satellite with resolution of 250 meters, it is determined that about 18% of the area is classified as forest, about 43.7% as pasture land and about 35% as desert-steppe (Figure 7).

Land cover data of 1992 and 2002 taken from the MODIS satellite shows considerable changes in land cover that can be attributed to natural causes, climate change and human activity. Analysis of these data reveal that 32% of the grassland steppe has changed into desert-steppe during this period. The maps clearly show that the desertification process is moving from the south to the north (Figure 8).

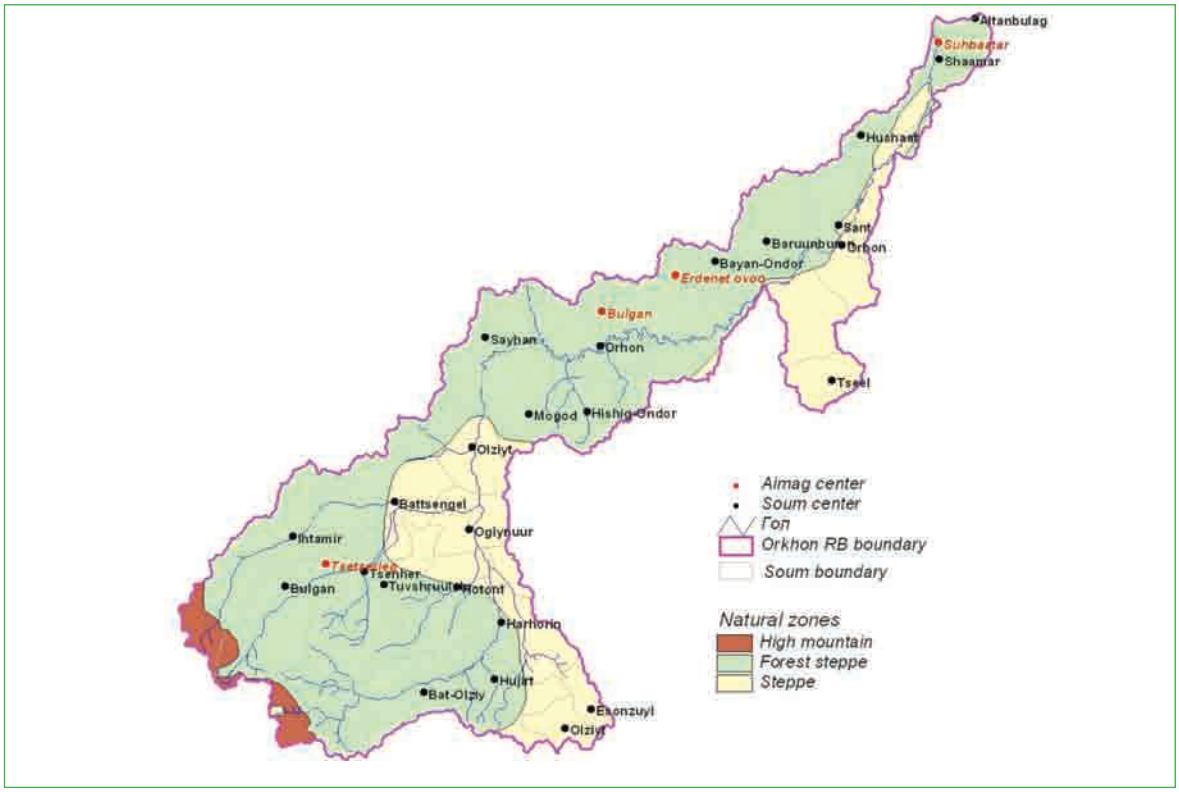


Figure 5. Natural zones of Orkhon river basin

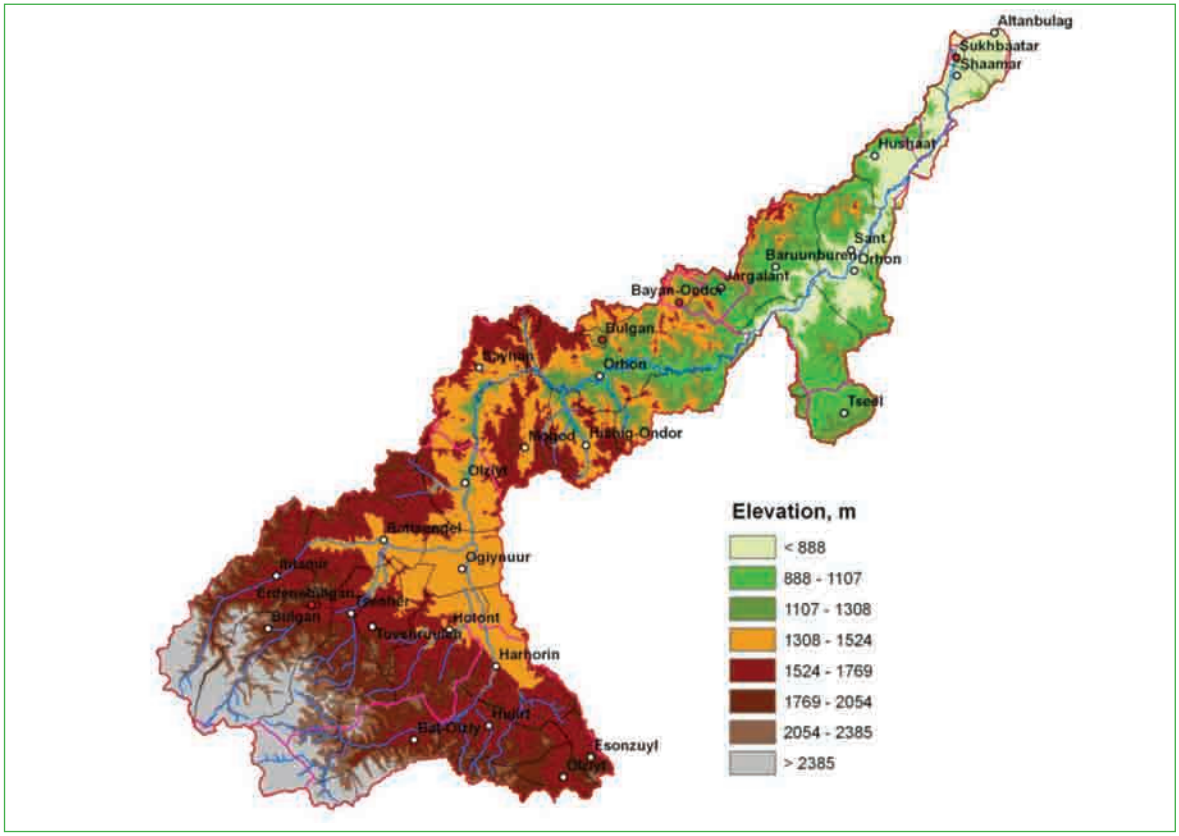


Figure 6. Digital elevation model

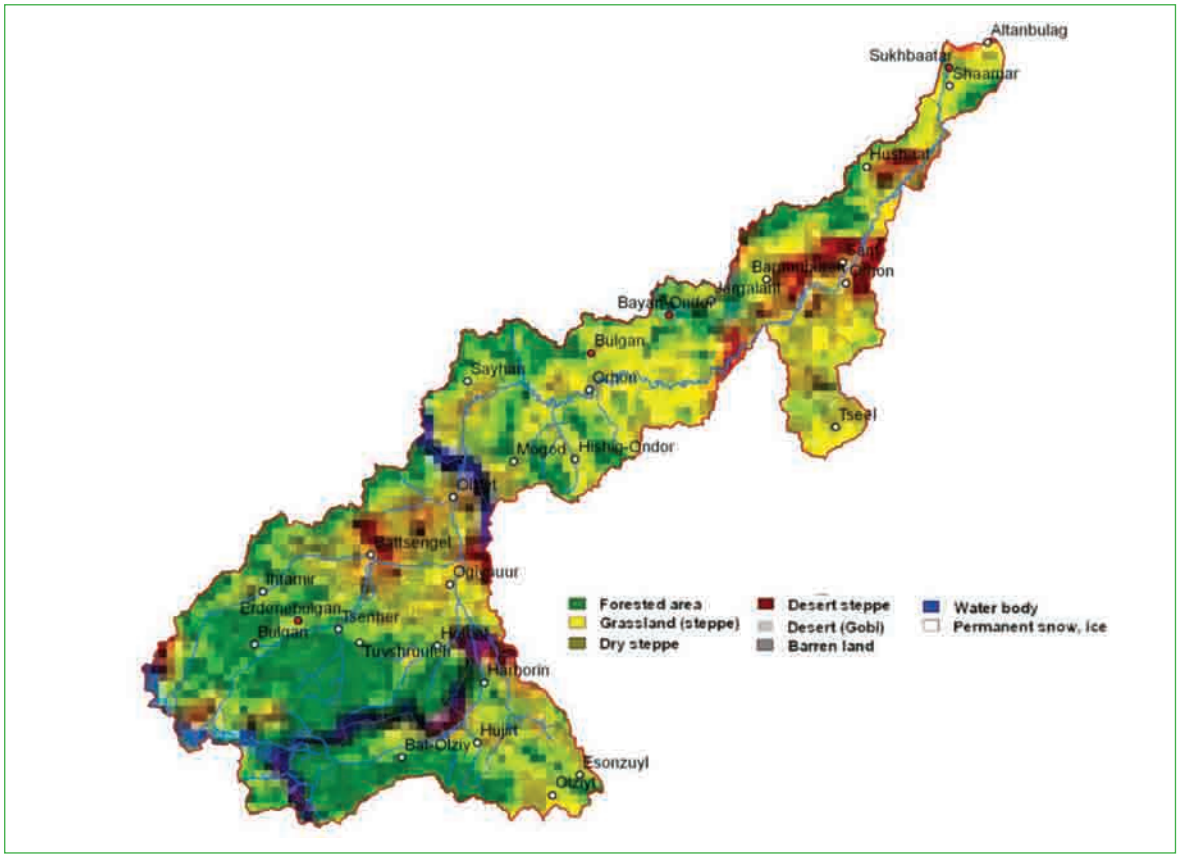


Figure 7. Land cover (by MODIS data, 2008)

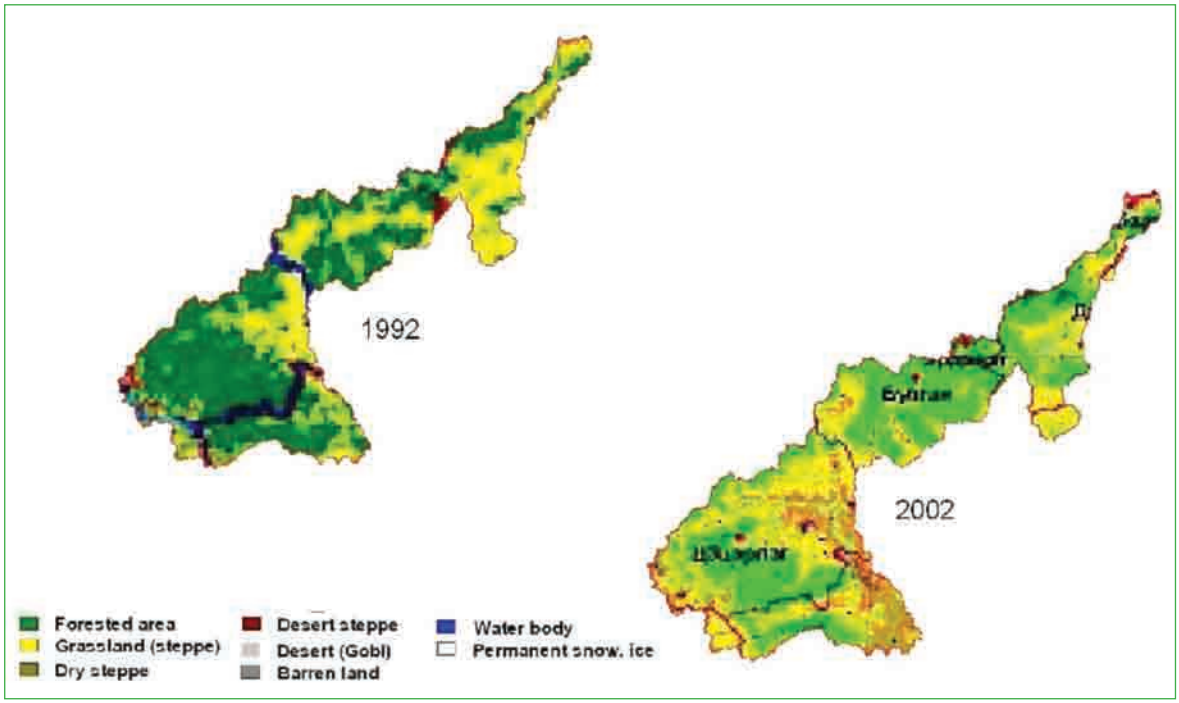


Figure 8. Land cover (1992, 2002)

1.3.2. Types of soil cover

The soil-geography in the basin is dominated by mountain soil and steppe-valley soil. The soil types in the basin are shown in the table below.

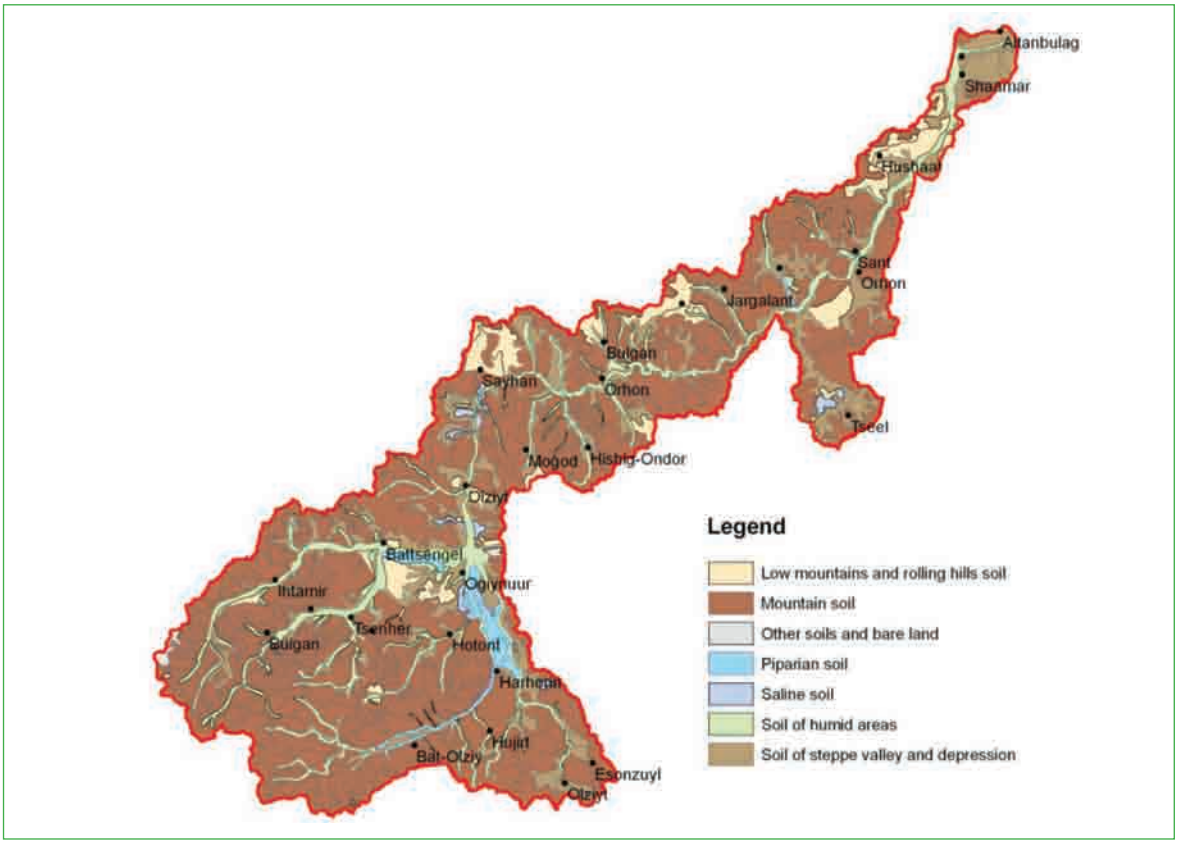


Figure 9. Soil types of Orkhon river basin

Table 4. Soil types

no	Soil types	Area, (km²)	%
1	Mountain soil	35,056.58	65.2
2	Low mountains and rolling hills soil	3,390.12	6.3
3	Soil of steppe valley and depression	8,686.28	16.1
4	Soil of humid areas	5,309.86	9.9
5	Riparian soil	809.77	1.5
6	Saline soil	384.71	0.7
7	Other soils and bare land	148.14	0.3

1.3.3. Vegetation

More than 40% of the basin is covered by mountain steppe vegetation and the downstream part has a high occurrence of bushes, swamps and spotted grass. The distribution of the vegetation types in the basin is shown in Figure 10 and Table 5.

Table 5. Vegetation types

No	Vegetation type	Area, (km²)	%
1	Desert	1748.4	3.2
2	Desert steppe	6820.4	12.7
3	High Mountain	2480.5	4.6

No	Vegetation type	Area, (km²)	%
4	Mountain desert steppe	574.9	1.1
5	Mountain forest steppe	19722.7	36.7
6	Mountain steppe	2217.4	4.1
7	Mountain taiga	169.1	0.3
8	Steppe and dry steppe	10529.5	19.6

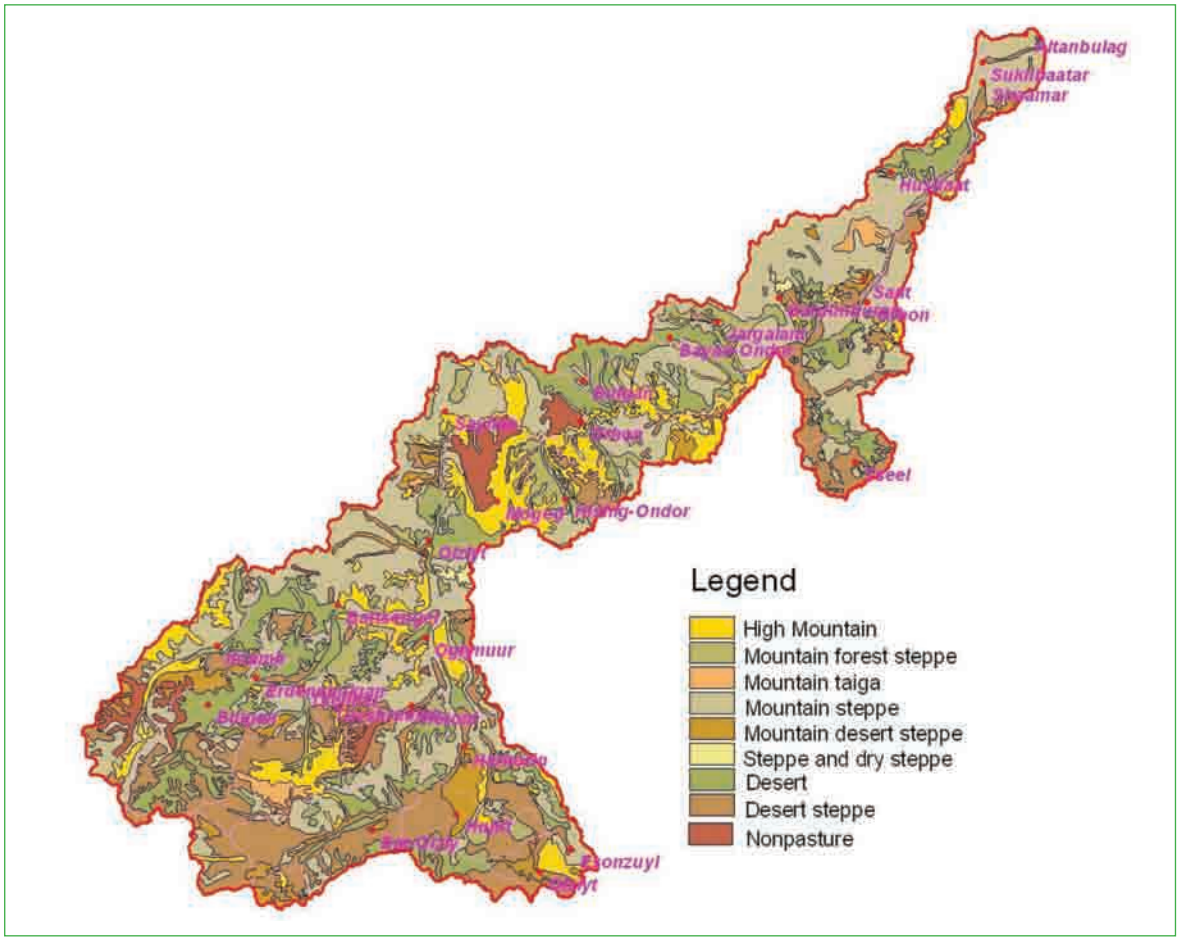


Figure 10. Vegetation types

1.3.4. Forest resource

According to the Law on Land forest resources include "forests, saxaul wood, logged areas, forest strips, as well as land for growing forests and areas adjacent to forests to allow forest expansion". The forest distribution of the Orkhon basin is shown in Figure 11.

Ecosystems change and the change of the forest in the last 100 years depends on global warming, climate change, and human impacts. About 40% of the forest resources have changed due to insect pests, forest fires and illegal logging.

Since the 1970s environmental protection issues became important in Mongolia, and reforestation works were started every year by government funding. However the reforested area is only 90 thousand hectare or some 30% of the production forest area.

The main reasons of the forest ecosystem changes are global warming, climate change, forest insect pests and adverse human activities such as forest fires and illegal logging /A.Avirmed/.

The estimation of the forest change shows that within the Orkhon River Basin the forest area decreased by 8.6% from 2000 to 2010 which is 0.9% per year on average.

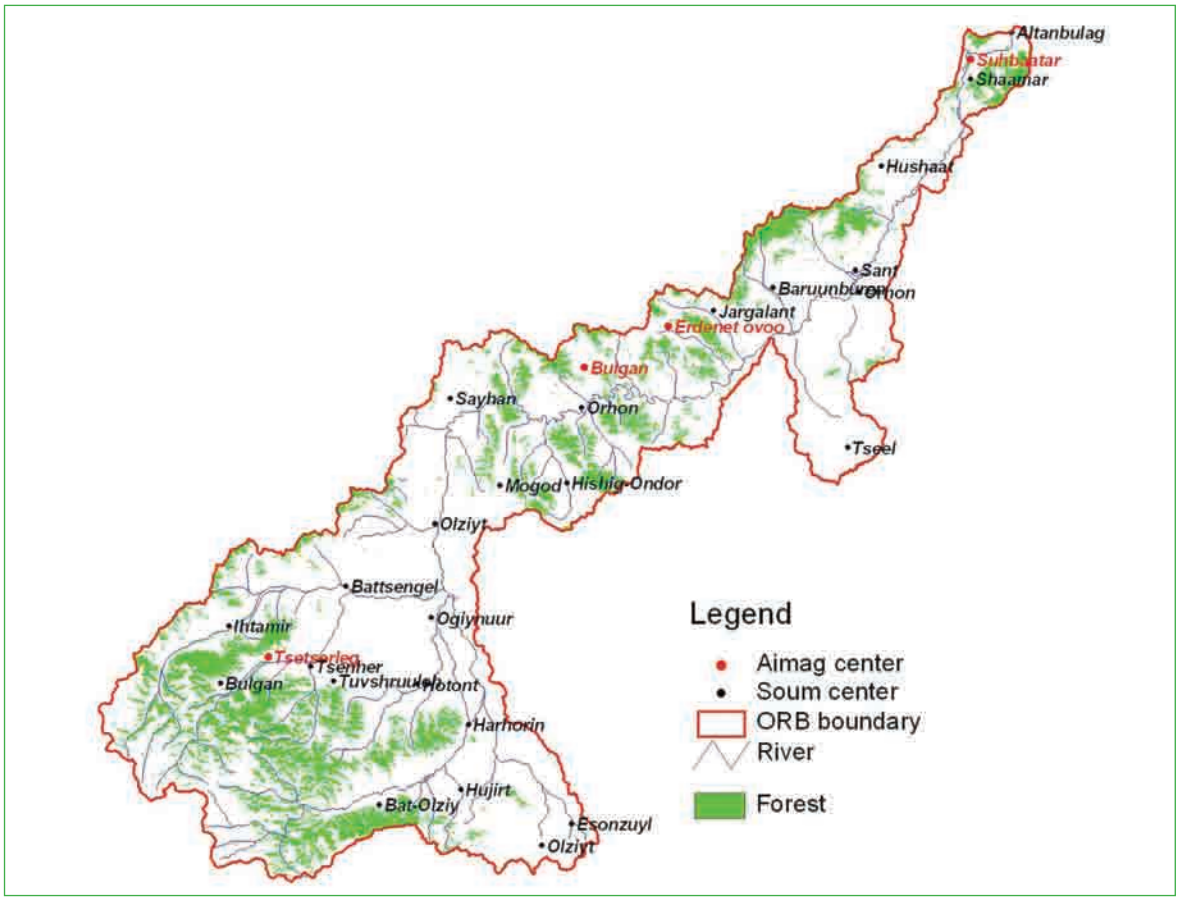


Figure 11. Forest in Orkhon River Basin

1.3.5. Wildlife

There is no specific study on wildlife at Orkhon River Basin level. However some studies have been carried out on biodiversity and fauna in Mongolia at different levels in total territories. Therefore, some data and results of study works which were previously done by scientists which may subject to the Orkhon River Basin have been selected and included in this report. In order to determine distribution of animals in the basin, the basin is divided into the following three parts and determined by fauna location in each part by considering the basin's natural zones, population settlement along the river, tributaries, distribution of fauna and their habitats, etc.

1. Orkhon River upstream – Kharkhorin (Orkhon River upstream part)
2. Kharkhorin – Orkhon-Tuul confluence (midstream part)
3. Orkhon-Tuul confluence – Orkhon-Selenge confluence (downstream part)

The Orkhon River basin is located in areas of high mountains, forest-steppe and steppe. The fauna in the basin keeps general features of these natural regions' fauna distribution. The natural diversity of the fauna distribution is being changed in some ways. It is required to survey this in a very detailed way. 71.4 percent of the total basin's territory is forest-steppe, 26 percent is steppe region and 2.6 percent is high mountain region.

A biodiversity database has been created and published online by the Steppe Forward Program implemented under the National University of Mongolia /NUM/ in cooperation with NUM, Academy of Science and Association of Ornithology, etc. It has been financed from the World Bank's NEMO project and contributed by UK Association of Zoology. By using this biodiversity database, the fauna in upstream, midstream and downstream parts of the basin is precisely considered as mammal, fish, amphibians and reptile classes. Also bird species in the basin have been precisely determined based on the Mongolia's Red List of Birds published in 2011.

There are 8 fish species, 44 mammal species and 1 amphibian species in upstream part, 12 fish species, 51 mammal species and 3 amphibian/reptile species in midstream part, 17 fish species, 50 mammal species and 3 amphibian/reptile species in downstream part of the basin.

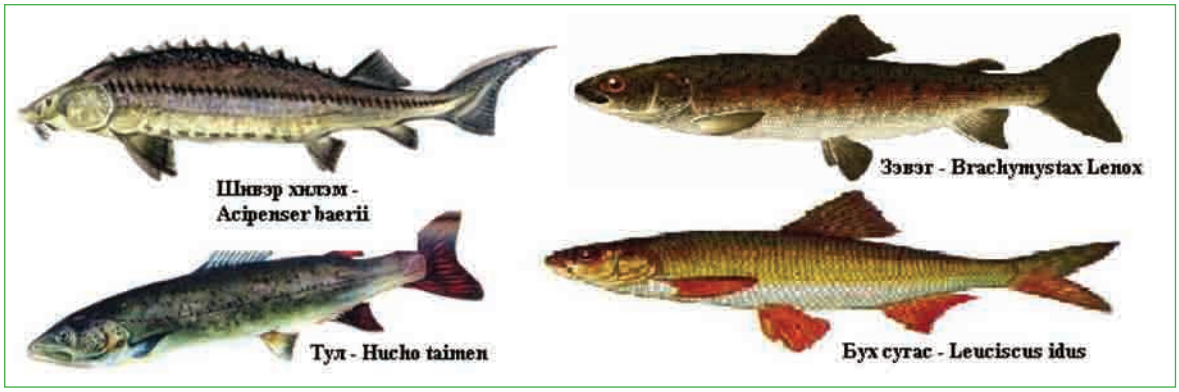
As we can see from above fauna distribution in three parts, approximately 70% of fish species and 60% of mammal species are overlapped.

Fish

Depending on geographical location, living habits and characteristic of habitats, variety of fish species is differentiated from one another. There are 17 fish species of 12 families in the Orkhon River basin in total.

Fishing started in Ugii Lake located in the basin many years ago. Then-food factory and small enterprises in Arkhangai aimag and some organisations of Ulaanbaatar used to fish in the Ugii Lake between 1932 and 1947. Later on, then-meat factory of Ulaanbaatar had solely fished in the Ugii Lake from 1955 until late 1980s. Then since 1990, only locals started to fish on their own. There are 16 fish species of 10 families in the Ugii Lake - Old Orkhon River basin and 9 species are mainly caught for commercial purpose.

Taimen (Hucho Taimen), lenok (Brachymystax Lenok), grayling (Thymallus), common minnow (Phoxinus phoxinus), Siberian stone loach (Barbatula toni) and burbot (Lota lota) are distributed in upstream part located fast-flowing downstream of Ulaan Tsutgalan waterfall which is a confluence of Ulaan, Khyatruun and Tsagaan Azarga Rivers.



Some 30% of all the fishes in this basin (Siberian sturgeon (Acipenser bearii), ide (Leuciscus idus), lenok (Brachymystax lenok), taimen (Hucho Taimen) and arctic grayling (Thymallus arcticus)) are rare and endangered species according to the Mongolia's Red List of Fishes and included in the Mongolian Red Book as well. Main cause of a scarcity of these fishes is active gold mining activities based in the Orkhon River and its tributaries, change in the river bed, increase of suspended solids in the river water and change in the river bed morphology. Due to above causes, there is a change in variety of fish species in the Orkhon River and decline in population

and growth of salmonids such as taimen, lenok and arctic grayling which hunted for recreational purpose. Instead, population of non-hunting cyprinids which are tolerant to any habitat change is being increasing.

Amphibians and reptiles

Variety of reptile and amphibian species is found few in the basin and is distributed along areas with a convenient habitat condition on a limited scale. Amphibian and reptile species such as Mongolian toad (Bufo Raddei), Mongolian lizard (Eremias argus), steppes rat snake (Elaphe dione) and Asian viper (Gloydius Halys) have been reported in the basin.

Mongolian toad (Bufo raddei). This is one of the most widespread species in Mongolia. It essentially relies on wetlands such as river, lakes, springs and oasis in Gobi desert, steppe and forest zones. Also it has been reported in Khangai Mountain's Baidrag, Tui, Taats and Ongi River's upstream, and Shargaljuut, Tsagaan Sum, Khukh sum and Tsenkher hot springs, and Orkhon River basin as well.

There is a probability that its population might become rare recently due to degradation of its habitats, water pollution, mining of natural resources, drought of rivers and lakes. But Mongolian toad is unlikely to reach critical level of scarcity.

Steppes rat snake (elephe dione). The steppes rat snake is inhabited in a wide area covered from desert region to north taiga in various natural zones elevated at 600-3000 m above sea level.

This species is widespread in areas with a variety of biotope and obviously there are many causes of becoming rare. Main natural factor to negatively affect this species is a malnutrition related to winter cold weather, drought and crop reduction as well as threat to become a prey of wild animals such as fox, corsac fox and bird of prey. Another main factor to decline distribution of this species, degrade habitat quality and reduce its population is a degradation of its habitat due to establishment of infrastructure such as urban settlement, paved road, hydropower station etc and various human activities such as exploration and mining of natural recourses.

Asian viper (Gloydius Halys). This is one of the most widespread in Mongolia. It has been reported in the Orkhon River basin of Khangai Mountain, Mogoi and Khyatruunii River valleys, and Shargaljuut and Tsagaan Turuut River gorges, respectively. Asian viper is mainly fed by various small rodents. When this species in steppe zone it is fed by field mouse (or gerbil) and in Gobi desert fed by young wall-creeper and dwarf hamster. As we see from above, this species is mainly fed by rodents especially pests widespread in pasture and crop field, it certainly plays a particular role in limiting population of variety of rodents. Due to exploration and mining of natural resources (mining industry, hay harvesting, wood cutting, crop activity, etc), scarcity and degradation occur in its habitats and this is the main cause of decline in distribution and population of Asian viper.

Mammals

There are 128 'Endemic' mammal species, 4 'Invasive' mammal species and totally 132 mammal species in Mongolia. Of these, some 70 mammal species of 17 families of 7 orders are in the Orkhon River basin. These include some 8 insectivore species, 21 species of simple toothed rodents, 5 species of double toothed rodents, 8 species of winghanded animals, 16 carnivore species and 9 artiodactyla orders.

Some 30% of overall 70 mammal species in the Orkhon River basin are included in the Mongolian Red List of Mammals as rare, near rare and endangered classes, as well as in Mongolian Red Book and Mongolian Law on Fauna as rare and very rare classes. A brief introduction of some representatives of these rare animals as follows:

Eurasian otter (Lutra lutra). It is inhabited in the vicinity of the rivers of Khangai and Khentii Mountains and Khuvsgul Mountain of northern Mongolia, Ikh Khyangsan Mountain in the east, north-west taiga forest mountain of Mongol Altai, Khalkh River basin, Tes River basin of northern part of Khangai Mountain, Eg and Khurimt River basins of Khuvsgul Mountains, and this species is also seen in the Orkhon River basin downstream.

Since 1930 it was prohibited to hunt Eurasian otter and included in the Red List of 1995 law on hunting as very rare. It was registered in two editions of the Mongolian Red Book as rare and very rare.

It is written in the Mongolian Red List of Mammals that main cause of Eurasian otter becoming rare is related to pollution of its habitat (water) ecosystem due to illegal hunting and mining activities.

Red deer (Cervuis elaphus). Red deer inhabit the middle and downstream of the basin. According to census in 1986, there were 130'000 populations in 115000 km square of territory. But in 2004, only 8000-10000 population of 15 orders were counted and it was dramatically decreased by 92% in 18 years time. Therefore red deer is included in the Mongolian Red List of Mammals as critically endangered as its population was decreased by 80% due to uncontrolled hunting and habitat scarcity. Also it has been included in rare animals' class according to Mongolian Law on Fauna.

Siberian ibex (Capra sibirica). It is mainly inhabited in south-eastern and eastern parts of Gobi Altai, Orkhon River upstream part, Khangai and Khuvsgul Mountain ranges. Siberian ibex is currently found in east of Northern Gobi, distributed in Khurkh Mountain in Alashan Gobi Desert and rock mountains of Altai. However there are some separated population in central and eastern parts of Mongolia. An operation to introduce its population at Bogd Khan Mountain strictly protected area in Khentii Mountain was successfully completed in 1980s.

It was protected and listed as rare class under the Mongolian Law on Hunting in 1995. The Government of Mongolia has set fees rate to get hunting permission at US$800 for Altai ibex and US$720 for Gobi ibex, respectively. Siberian ibex has been included in two editions of the Mongolian Red Book of Mongolia as rare class.

Siberian musk deer (Moschus moschiferus). It is found in upstream and midstream parts of the basin. Siberian musk deer is the smallest in deer family. This animal is inhabited in forest area as well as rocks and dead wood area near boundary of the forest which is

difficult to access. It was listed as very rare in the Mongolian Red Book. Illegal hunting for musk in order to get its must is considered as main threat.

Birds

Approximately 245 bird species have been reported in the Orkhon River basin. Some 42 bird species of them are non-migratory and 203 species are migratory birds. Totally 205 bird species lay eggs in the basin. Also some 8 bird species such as bean goose (Anser albifrons), mute swan (Cygnus olor), ferruginous duck (Aythya nyroca), smew (Mergus albellus), red necked grebe (Podiceps grisegena), hooded crane (Grus monacha) and terek sandpiper (Xenus cinereus) stopover here in summertime. But 11 bird species winter here such as Japanese quail (coturnix japonica), mallard (anas platyrhynchos), goosander (mergus merganser), merlin (falco amurencis), rough legged buzzard (buteo lagopus), solitary snipe (gallinago megala), dark throated trush (turdus ruficollis), arctic redpoll (acanthis hornemanni), yellow bunting (emberiza citrenilla), Lapland bunting (calcarius lapponicus), snow bunting (plectrophenax nivalis).

Two reasons of why 203 bird species or 82.8% of total birds are migratory birds is firstly, main migration way of migratory birds in Mongolia is passed by the Orkhon River basin and secondly, some areas such as Ugii Lake and Sangiin Dalai Lake with a good shelter and habitat for birds to nest and lay eggs are located in the basin.

There are 17 rare species, 5 very rare species such as whooper swan (Cygnus Cygnus), Siberian crane (Grus leucogeranus), white naped crane (Grus vipio), hooded crane (Grus monacha), black winged (himantopus himantopus) in this basin. As we see from here, some 8.98% of overall birds that found in the basin are subject to rare and very rare species.

Changes in quantity, regime and quality of surface water not only affect the habitats of aforementioned fauna but certainly affect their population and species at a particular amount.

1.4. Land use

1.4.1. Land use types

The Orkhon River Basin includes the “Tujiin Nars”, the “Khangain nuruu” mountain range and the “Orkhon valley” Natural Parks, and the “Khuisiin Naiman Nuur” and “Bulgan Uul” Natural Historic Monuments. The total of the special protected areas occupy about 7461.4 km^2 of land, which amounts to about 13.8% of the Orkhon River Basin (Figure 12).

Table 6. Area of Protected Areas

Protected Area	Area(km^2)
Tujiin nars NP	425.3
Khangai mountain NP	5,995.7
Naiman lake NHM	108.2
Bulgan mountain NHM	20.0
Orkhon valley NP	912.2

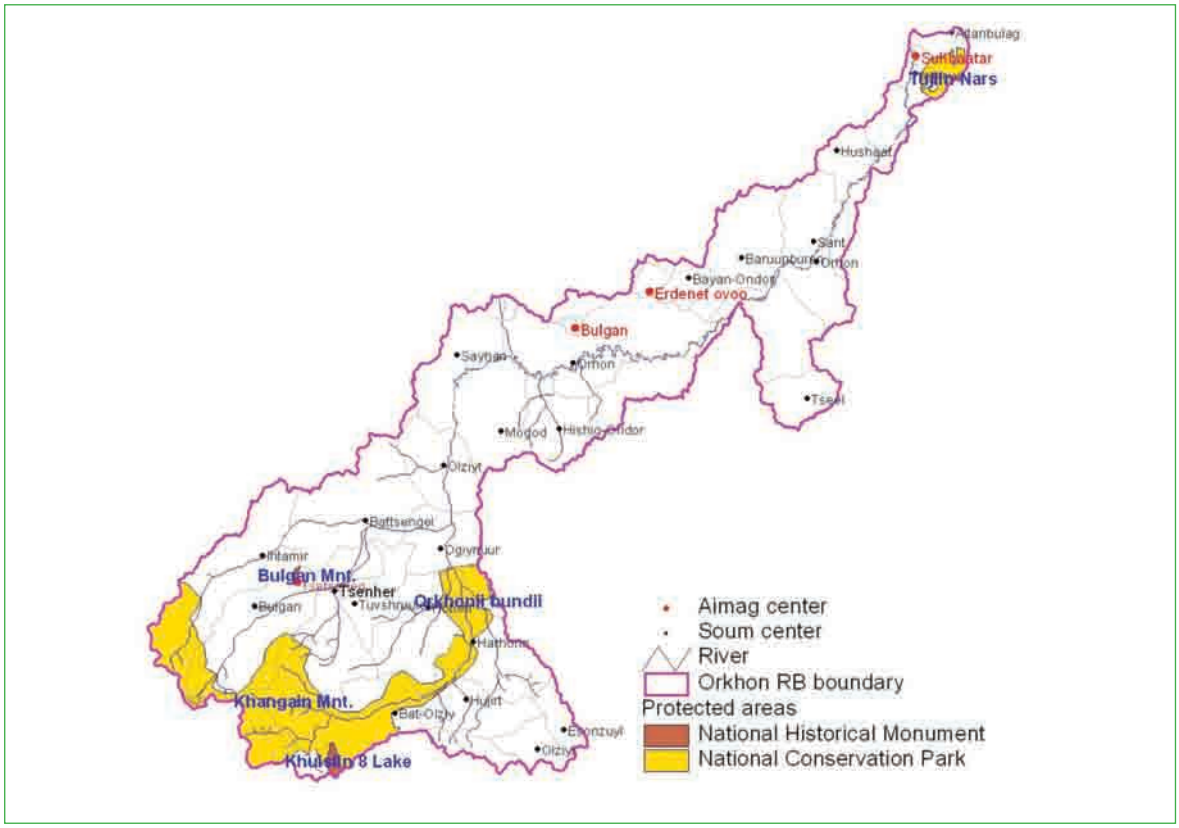


Figure 12. Location of Protected Areas

Following the developments in social needs and requirements, as well as the economic developments that have taken place there is a noticeable change in land use. As of today land use in the Orkhon River Basin includes the following 10 main types:

1. Pasture
2. Abandoned land
3. Hayland
4. Crop land
5. Bare land (sand, rock cliff, etc.)
6. Settlement
7. Roads
8. Forest
9. Water
10. Manufacturing and mining

By land use type the largest area is occupied by pasture land: in total 41572.0 km^2 or 77.3% of the total basin area. Crop land, settlement, road and forest area occupy a varied area between 0.2 – 14.9 percent. River and lake areas occupy in total 392.8 km^2 from which 356.3 km^2 is occupied by rivers and 36.5 km^2 by lakes. The land use map of the Orkhon River Basin is given in Figure 13.

Table 7 presents the detailed distribution of the land use types in the Orkhon River basin.

Table 7. Land use types in the Orkhon River basin

No	Land use type	Area, (km²)	%
1	Pasture	41,572.0	77.3%
2	Abandoned land	1,658.6	3.1%
3	Bare land	99.6	0.2%^
4	Crop	298.5	0.6%
5	Forest	8,005.3	14.9%
6	Urban	408.8	0.8%
7	Water	392.8	0.7%
8	Road	132.6	0.2%
9	Industry/Mining	153.9	0.3%
10	Hay land	1,064.9	2.0%
	Total	**53,786.9**	**100%**

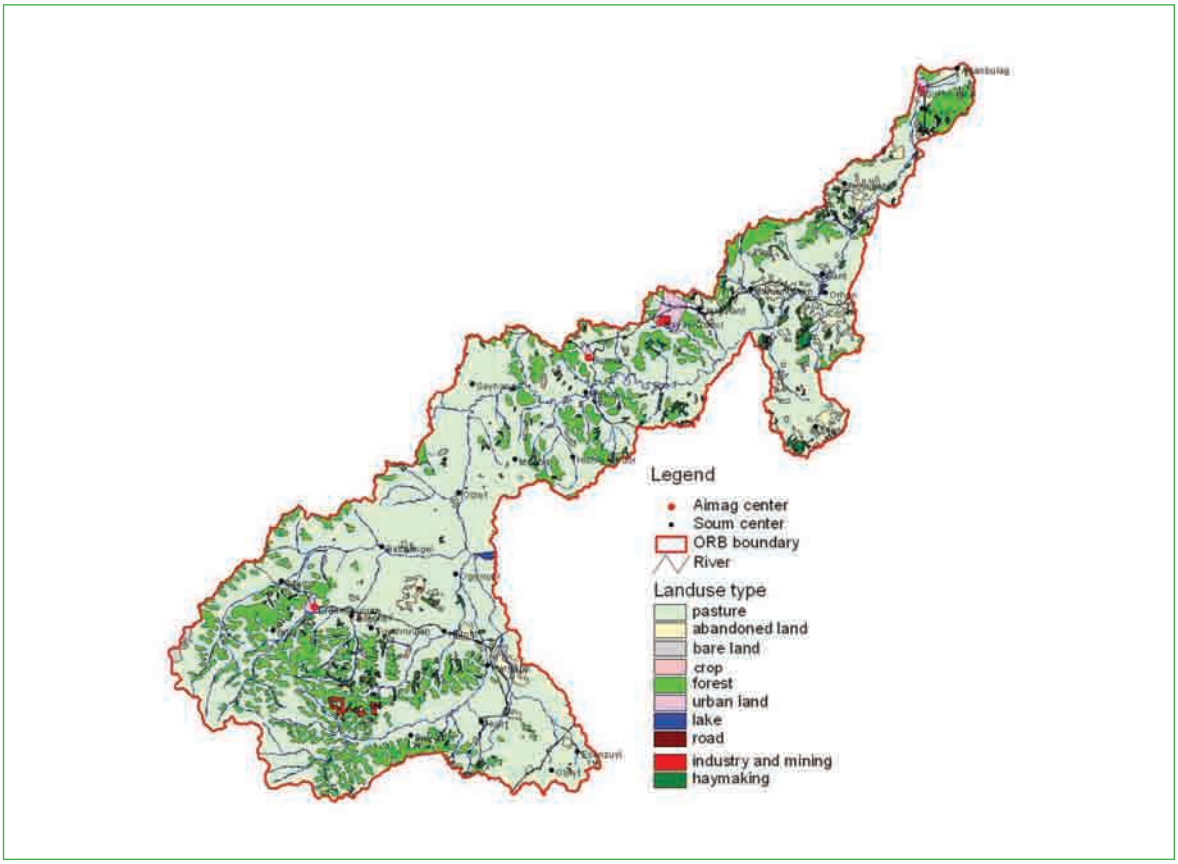


Figure 13. Location of the land use types in the Orkhon River Basin

1.4.2. Current status of land relations

Following changes in the social conditions it became necessary to reform the legislation governing land issues in Mongolia. For this purpose a package law about land of Mongolia was approved. In the framework of this law, the main condition on land ownership, utilization or land protection is formed to regulate relations between citizens, entities, enterprises and state. At the same time a government policy on land issues is implemented that includes comprehensive organisational measures for the protection of land reserves, its pattern and quality; to keep its nature; to provide mapping making its registration and providing research study; to define land tariff, land fee and restoration of degraded lands.

In the Land Law of Mongolia it is specified that the terminology of land relations should be used and understood as follows:

- To "own" land means to be in legitimate control of land with the right to dispose of this land;
- To "possess" land means to be in legitimate control of land in accordance with the purpose of its use and terms and conditions specified in respective contracts;
- To "use" land means to undertake a legitimate and concrete activity to make use of some of the land's characteristics in accordance with contracts made with owners and /or possessors of land.

It has been 10 years since citizens, entities or enterprises can own and use land with a legal right in Mongolia. By the end of each year information on land owners, land users and holders is submitted, as well as information about lands that are under land relations by aimags and in the whole country. By the end of 2010 about 8000 citizens in the Orkhon River basin owned land totaling about 11.2 km^2.

Measures for land protection include restoration of damaged or excavated land, destruction of rodents, forest cleaning and cleaning wastes. Also to protect the land it is required to implement a centralized plan within the framework of the aimag and soum center annual plan of land structure. As of 2010, several protection measures covering an area over 3061 km^2 have been implemented such as pasture rotation in about 700 km^2, extermination of rodents on 1800 km^2, new trees and bushes were planted on 500 hectares of land and restoration work was carried out. On other lands steps were taken to remove household waste; strip cultivation, enrichment with fertilizer, and leveling of trenches and holes.

The report of land protection measures for 2010 reports that protective measures have been taken on damaged lands of 59.8 percent. However, holes and destroyed land caused by mining or private activities are not reflected in the plan for rehabilitation work, because they do not comply with the legal specifications as stated in the report.

1.5. Conclusions on physical geography and natural condition:

- It is likely that air temperature will increase, especially in summer; precipitation will increase, the rainfall period will be shortened and evaporation will increase in the Orkhon River basin.
- Some 70 percent of the basin is pasture area and 0.7 percent is open water. In total 13.8 percent of the basin is under state special protection.
- There are 17 fish species of 12 families, 4 amphibian species, 70 mammal species of 17 families of 7 orders, and 245 bird species in the Orkhon River basin. Of these, some 4 fish species and 8 mammal species are listed as near rare, 1 fish species and 3 mammal species are as critically endangered, 2 mammal species and 17 bird species are as rare, and 2 bird species and 5 bird species are as very rare, respectively.
- There are more than 20 mining companies such as Erdenet mining industry, Altandornod Mongol LLC, Altan Yondoi LLC, Mongol Gazar LLC and Gatsuurt LLC, etc which run gold mining operation on Mongolian large deposits in the basin as well as coal mining operation in Ereenii mining site in Saikhan sum of Bulgan aimag. Due to these mining activities, the Orkhon River water is polluted and it negatively affects the basin ecosystem degrading habitats of wild animals in the basin such as fish and aquatic microorganism, and changing variety of these species.

- To stop gold mining activities in the upstream part of the Orkhon River and to oblige those mining companies to restore used land and recover environmental damages.
- Due to changes in population and habitat condition of wild animals, birds, fishes and aquatic microorganisms in the basin, it is necessary to carry out the detailed study on their location, population, species and possibility to improve their habitat conditions, and to make actions clear to take in the future.
- It would be appropriate if especial attention is paid on completely providing the required habitats to regional wild animals, birds and fishes, etc when organizing any manufacturing and operational activity in the territory of the basin.

2. ORKHON RIVER BASIN WATER RESOURCES, REGIME AND WATER QUALITY

2.1. Surface water

Orkhon River basin includes river systems like Khugshin Orkhon, Khoit Tamir, Urd Tamir, Asgat, Khulj, Maanit, Khangal, Burgaltai, Tuul, Kharaa and Eroo. Due to different geographical and geomorphologic conditions each river basin has a distinctive landscape and ecosystem. The drainage density in the Orkhon River basin ranges between 180-650 m/km^2. It has the highest density in the upper part of the catchment and the lowest in the steppe and lowland areas.

Systematic continuous and instrumental observation of water resources and flow regime began in the Orkhon River from 1942 by establishing the first hydrological gauging station at Orkhon-Orkhon. Since then, 13 hydrological gauging stations are operating in the Orkhon river basin (Table 8 and Figure 14). There are 10 river stations, one lake station, one groundwater gauging station and one spring station. There are 5 stations operating along the Orkhon River at Bat-Ulzii, Kharkhorin, Orkhon (Bulgan), Orkhon (Selenge) and Sukhbaatar. Others are located on tributary rivers including Khoid and Urd Tamir, Khangal, Achuut and Zuunturuu.

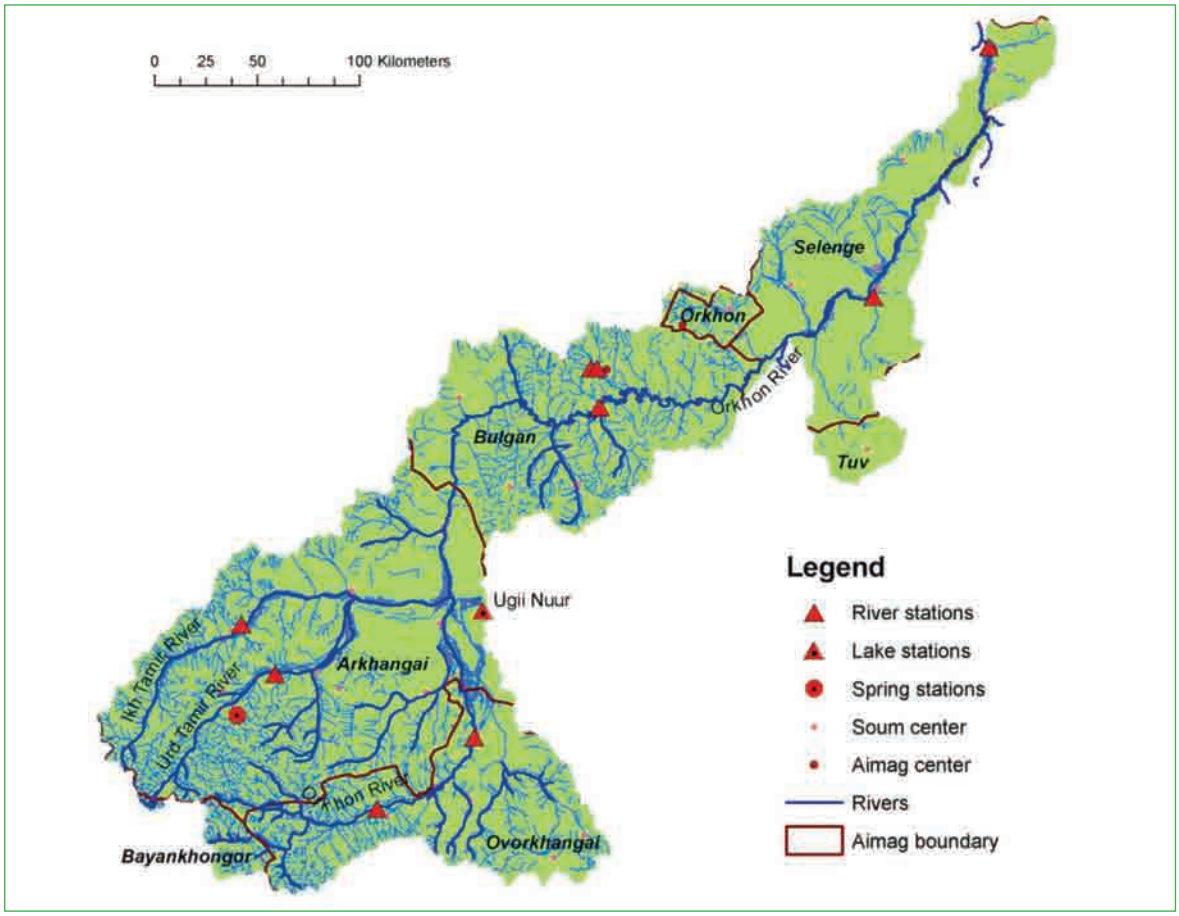


Figure 14. Hydrological gauging station locations in the Orkhon river basin

Table 8. Description of hydrological gauging stations in the Orkhon river basin

No.	River	Station	Coordinates		Period of observation
			Lat.	Long.	
1	Orkhon	Bat-Ulzii	46.87583	102.19056	2006
2	Orkhon	Kharkhorin	47.20222	102.80000	1967.VI.14
3	Orkhon	Orkhon	48.66000	103.56778	1942.X.20
4	Orkhon	Orkhon	49.15178	105.38522	1970.X.01
5	Orkhon	Sukhbaatar	50.23986	106.18211	1973.XI.01
6	Khoid Tamir	Ikh Tamir	47.65694	101.26833	1959.VIII.16
7	Urd Tamir	Tsetserleg	47.44722	101.5025	1973.VIII.10
8	Achuut	Bulgan	48.82917	103.50306	1991.V.01
9	Zuunturuu	Bulgan	48.82917	103.54583	1991.V.01
10	Khangal	Jargalant	49.28722	104.4825	1997.VI.20

2.1.1. Perennial rivers

The hierarchy of stream segments was quantified according to an ordering classification system. In this system, channel segments are ordered numerically from a stream's headwater to a point somewhere downstream. Numerical ordering begins with the tributaries at the stream's headwaters being assigned the value 1. A stream segment that resulted from the joining of two 1st order segments is given an order of 2. Two 2nd order streams form a 3rd order stream, and so on (A.E. Horton, 1948).

Due to Horton's Law the Orkhon is a 6th order river and there are 1806 small rivers with order 1, 468 rivers with order 2, 117 rivers with order 3, 30 rivers with order 4 and 8 rivers with order 5th in the Orkhon river basin.

The runoff of the Orkhon and its tributaries is formed in humid, cool and mountainous regions. The runoff in the steppe regions and mountain valleys disperses due to the dry and warm climate as well as other geographical factors. The specific runoff of the river or the drainage rate per unit area increases with increase of basin elevation (Figure 15).

The runoff of the Orkhon and its tributaries Tuul, Kharaa, Eroo and Tamir, is formed in the forest and the forest-steppe zone. It indicates the influence of physical geographical elements including forest, soil, plants and geology. These natural factors define the water regime and the spatial distribution.

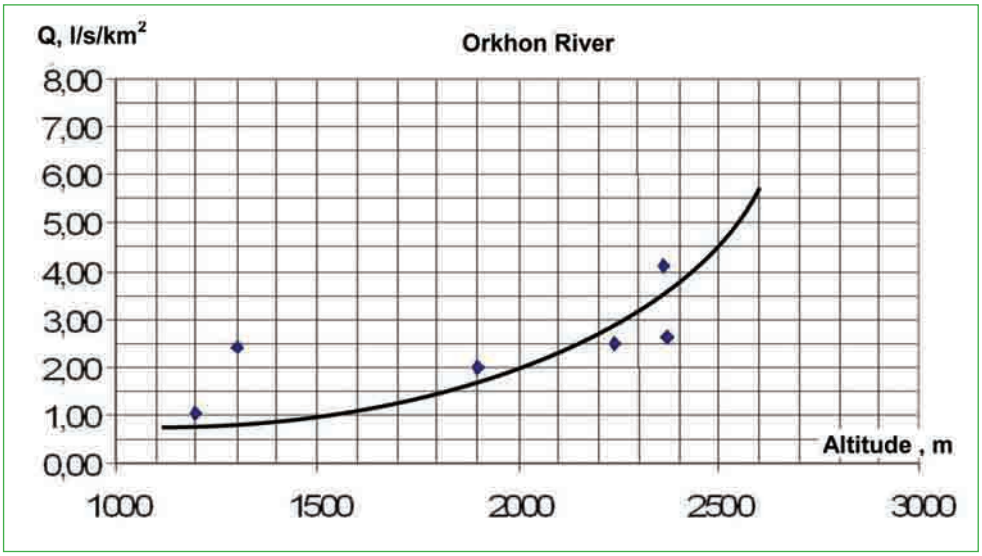


Figure 15. Relationship between mean basin altitude and runoff in the Orkhon river basin

All rivers of the Orkhon river basin are in the category of rivers with spring yellow water flood and summer rain water flood. Typical flow annual hydrographs are presented below of Orkhon-Kharkhorin, Orkhon-Orkhon and Orkhon-Sukhbaatar gauging stations.

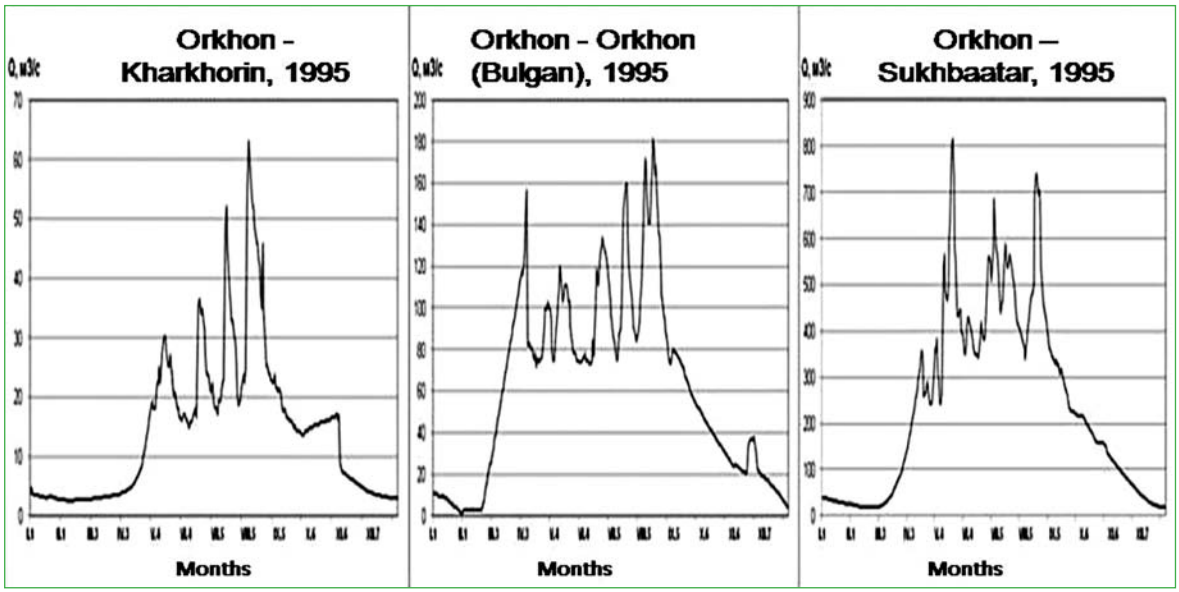


Figure 16. Typical annual hydrograph along the Orkhon River

Of the annual runoff 80 percent is in spring and summer, 0.8-3 percent is in winter and the rest is in autumn.

Due to a lack of research studies and monitoring network for groundwater it is hard to estimate the contribution of the groundwater to the Orkhon river runoff. The groundwater component of the river runoff can be estimated by the hydrograph separation method (linear and trend methods). The results of hydrograph separation by linear method of the runoff at Orkhon-Kharkhorin, Orkhon-Orkhon and Urd Tamir-Tsetserleg are presented in Table 9.

Table 9. Runoff components of the Orkhon river

River station location	unit	Groundwater	Spring melting	Rainfall sources
Orkhon-Kharkhorin	%	32.3	9.3	58.4
	m^3	404,533,440.0	116,568,557.0	732,842,803.0
Urd Tamir-Tsetserleg	%	37.7	7.4	54.9
	m^3	95,997,744.0	18,812,304.0	139,619,808.0
Orkhon-Orkhon	%	25.2	15.0	59.8
	M^3	100,822,752.0	60,104,399.1	238,946,736.9

The contribution of the groundwater to the river runoff varies from 25 to 37 percent in the Orkhon River depending on flow regime condition. Studies are needed in future in the Orkhon river basin to get more accurate information on runoff sources.

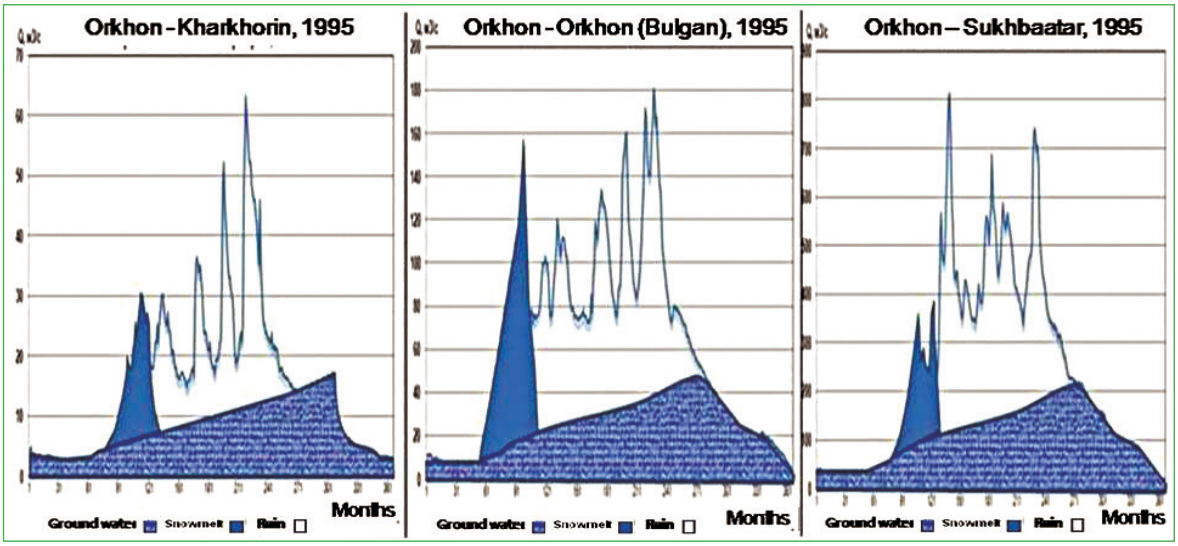


Figure 17. Annual hydrograph separation

Long term mean runoff:

The long term mean runoff is estimated as arithmetic mean of statistical series. Monthly and annual mean runoff is a key and basic parameter for water resources related issues including research, design, use and protection etc.

The period for estimation the long term mean runoff should cover multiple entire cycles like two or four and the accuracy of the estimation increases with the record length. The long term mean runoff is a stable and consistent parameter of runoff and also expresses the potential water resources of the basin.

The long term mean runoff of the Orkhon River at Kharkhorin is 13.3 m^3/sec. This value increases three times at Orkhon (Bulgan) and even more by 9 times at the end station at Sukhbaatar. Such increase of the mean runoff along the Orkhon River is due to the basin area increase and the inflow from tributaries along the river (Figure 18).

Table 10. Annual mean runoff of Orkhon and its tributaries

				Basin		Observed mean			Estimated mean				
No	River-station	Period of observation	Period of estimation	Area (km^2)	Basin elevation	Q m^3/s	q l/s km^2	h mm	Q m^3/s	q l/s km^2	h mm	Cv	Cs
1	Orkhon-Kharkhorin	1970-2008	39	6,257	2115	13.2	2.13	67	13.3	2.112	66	0.47	0.95
2	Orkhon -Orkhon	1945-2008	64	37,177	1480	41.5	1.12	35	41.6	1.119	35	0.62	1.54
3	Orkhon -Orkhontuul	1971-2008	38	96,000	1880	76.04	0.84	27	81.1	0.792	25	0.60	1.21
4	Orkhon -Sukhbaatar	1950-2008	59	131,691	1080	124.5	0.98	31	129.4	0.945	30	0.40	0.80
5	Achuut-Bulgan	1993-2007	15	138.7	1410	0.23	1.64	52	0.23	1.64	52	1.56	0.78
6	Zuunturuu-Bulgan	1992-2008	17	136	1350	0.19	1.38	43	0.19	1.38	43	0.97	1.45
7	Khangal-Jargalant	1998-2008	11	647	1200	0.62	0.96	30	0.62	0.96	30	0.30	0.60
8	Urd Tamir-Tsetserleg	1967-2008	42	3,058	2370	6.45	2.09	66	6.39	2.11	67	0.56	1.12
9	Khoit Tamir-Ikh Tamir	1969-2008	40	2,507	2580	8.49	3.39	107	8.5	3.39	107	0.49	0.89

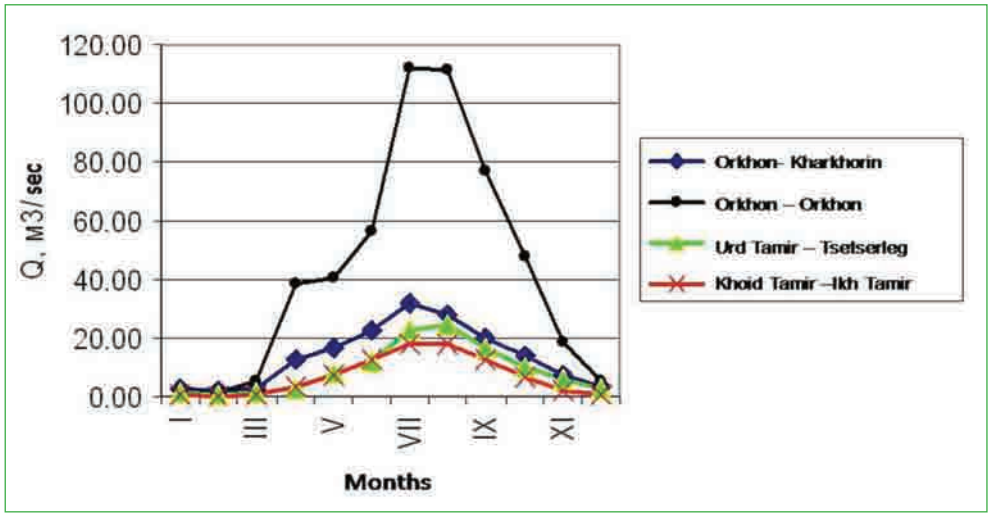


Figure 18. Monthly mean runoff of some rivers in the Orkhon river basin

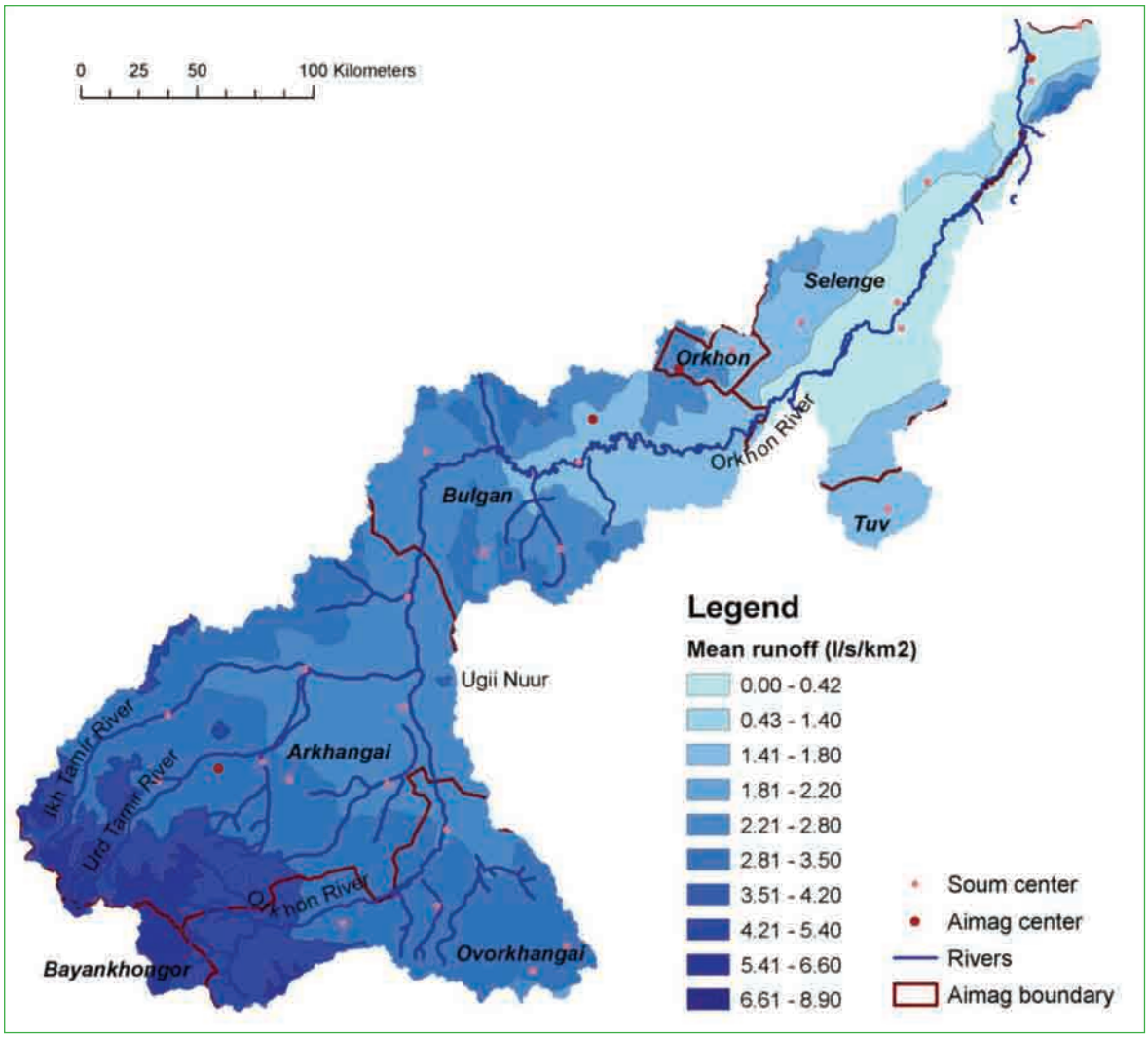


Figure 19. Long term mean runoff map of the Orkhon river basin

The following factors impact on the annual distribution of the river runoff: precipitation, evaporation, snow cover, humidity, soil, geological formation and geomorphological conditions. The seasonal and monthly runoff amount is different due to river basin altitude and flow situation. Monthly and seasonal distribution of runoff in the Orkhon River are presented in Table 11.

The number of days with flow exceeding the long term mean runoff varies from 120 to 150 days in the biggest tributaries of the Orkhon River and this period becomes longer with increase of basin area.

Table 11. Annual runoff distribution in the Orkhon river basin

River station locations	Spring-Summer						Autumn		Winter			
	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III
Orkhon-Kharkhorin	6.46	11.06	11.35	16.70	18.81	13.05	10.5	5.47	2.08	1.62	1.25	1.64
Khoid Tamir-Ikh Tamir	4.77	10.73	13.15	20.81	24.19	13.53	7.15	2.75	1.01	0.74	0.46	0.72
Urd Tamir-Tsetserleg	2.51	7.55	10.43	17.36	23.59	16.59	10.4	6.41	2.31	1.08	0.86	0.93
Orkhon-Orkhon soum	7.88	9.31	9.91	18.81	21.45	16.78	9.73	3.57	0.94	0.32	0.21	1.09
Achuut-Bulgan	14.42	12.00	11.01	16.73	13.99	16.12	9.99	3.73	0.68	0.21	0.21	0.91
Zuunturuu-Bulgan	15.09	12.33	9.14	11.90	13.50	11.16	9.46	4.78	2.76	4.14	2.13	3.61
Khangal-Jargalant	11.80	11.92	9.32	12.25	10.67	9.80	9.66	6.67	4.87	4.04	3.68	5.30
Orkhon-Orkhon bag	8.67	9.73	9.79	15.09	18.67	15.66	10.8	5.57	2.35	1.23	0.97	1.71
Orkhon-Sukhbaatar	7.69	10.99	11.09	17.35	21.18	15.29	9.48	4.02	1.22	0.54	0.36	0.78

Most rivers' water resources, regime, quality and ecological condition are being changed due to uneven concentration of Mongolia's population and industrial development. The long term runoff variation shows that from 1952 to 1966 for 14 years high flow years continued in the Orkhon River and then upto 1983-1984 for 18 years low flow years were observed. Since mid 1990s up to today low flow years continue in the Orkhon river basin (Figure 20).

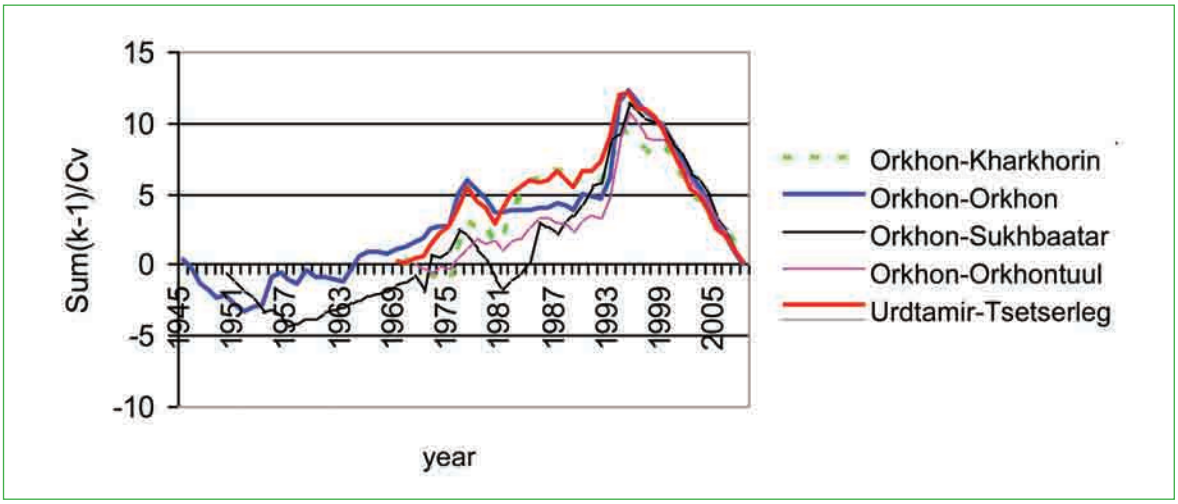


Figure 20. Long term runoff variation in the Orkhon river basin

Due to negative human impacts in the river basin such as wood logging, forest fire, and pasture degradation and as a consequence a reduction of forest resources and negative changes to soil and vegetation cover, desertification took place in the Arctic Ocean basin and this affects strongly the flow regime and the runoff of the biggest rivers.

The moisture field capacity is reduced in the surface layer of the soil due to the long dry season, compaction of the soil cover and sparse vegetation cover. Such changes

reduce penetration of rain water in the soil and to the groundwater and increase more direct runoff. Also the frequency of heavy rainfall has increased. Thus, runoff coefficient values are increasing and at the same time, the groundwater recharge rate is decreasing in the river basin.

So far, there has been no possibility to quantify the distinguished influences of each mentioned human impact to the flow regime and water resources in the river basin.

Maximum flow and floods:

According to the flow regime, the Orkhon River belongs to the rivers with spring snow melting and summer rainfall flood. The maximum discharge of the rainfall flood always exceeds the maximum of the spring flood. The natural condition of the river basin increases the risk of rainfall and flash flooding in the river basin and threats to the population and properties.

Winter precipitation (October to April) plays a key role in the formation of the spring flood and in the basins with average altitude higher than 2500 m above sea level spring flood is observed in the first decade of May.

The maximum discharge of the rainfall and spring flood with different probability of occurrence of some selected rivers in the Orkhon River basin are presented in Table 12 and Table 13. In case of rainfall flood, the probability of occurrence is 0.1, 1, 2, 5, 10 and 25 percent which corresponds to a return period of 1000,100, 50, 20, 10 and 4 years.

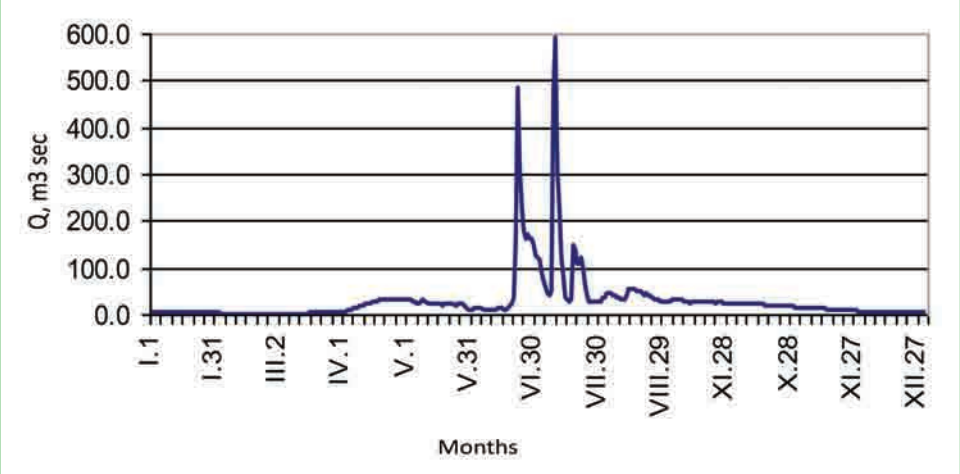


Figure 21. Flow hydrograph during a high flow year (Orkhon-Kharkhorin, 1994)

The maximum rainfall flood happens 2 to 4 times in a year and its amount always exceeds the yellow water spring flood.

Table 12. Maximum discharge of spring flood with probability of occurrence, m^3/sec

River station names and locations	Percent of probability of occurrence					
	0.1	1.0	2.0	5.0	10.0	20.0
	1000 years	100 years	50 years	20 years	10 years	5 years
Orkhon-Kharkhorin	168.2	117.2	101.1	79.6	64.8	47.8
Khoid Tamir - Ikh Tamir	62.8	44.2	38.5	31.1	25.3	19.2
Urd Tamir - Tsetserleg	69.3	49.3	43.3	35.3	29.1	22.5
Orkhon-Orkhon bag	755.6	625.5	453.6	363.5	289.1	213.2
Orkhon-Sukhbaatar	1101.2	771.5	684.3	563.0	473.0	376.5

Table 13. Maximum discharge of rainfall flood with probability of occurrence, m^3/sec

River station names and locations	Percent of probability of occurrence					
	0.1	1.0	2.0	5.0	10.0	25.0
	1000 years	100 years	50 years	20 years	10 years	4 years
Orkhon-Kharkhorin	807.65	532.9	471.3	353.91	280.3	185.8
Khoid Tamir-Ikh Tamir	451.3	298.8	264.56	199.2	158.1	105.3
Urd Tamir-Tsetserleg	564.5	375.8	331.2	245.1	187.9	113.5
Orkhon-Orkhon soum	2215.1	1199.9	1024.2	709.2	540.0	346.8
Achuut-Bulgan	11.85	9.01	8.24	6.70	5.57	3.85
Zuunturuu-Bulgan	6.37	5.27	4.93	4.22	3.62	2.59
Orkhon-Orkhon bag	2120.6	1240.3	1080.8	789.9	627.6	433.2
Orkhon-Sukhbaatar	2370.1	1677.0	1514.8	1201.8	995.0	715.5

The estimated maximum rainfall flood discharge of the Orkhon River with 100 year return period varies from 500 to 1700 m^3/sec.

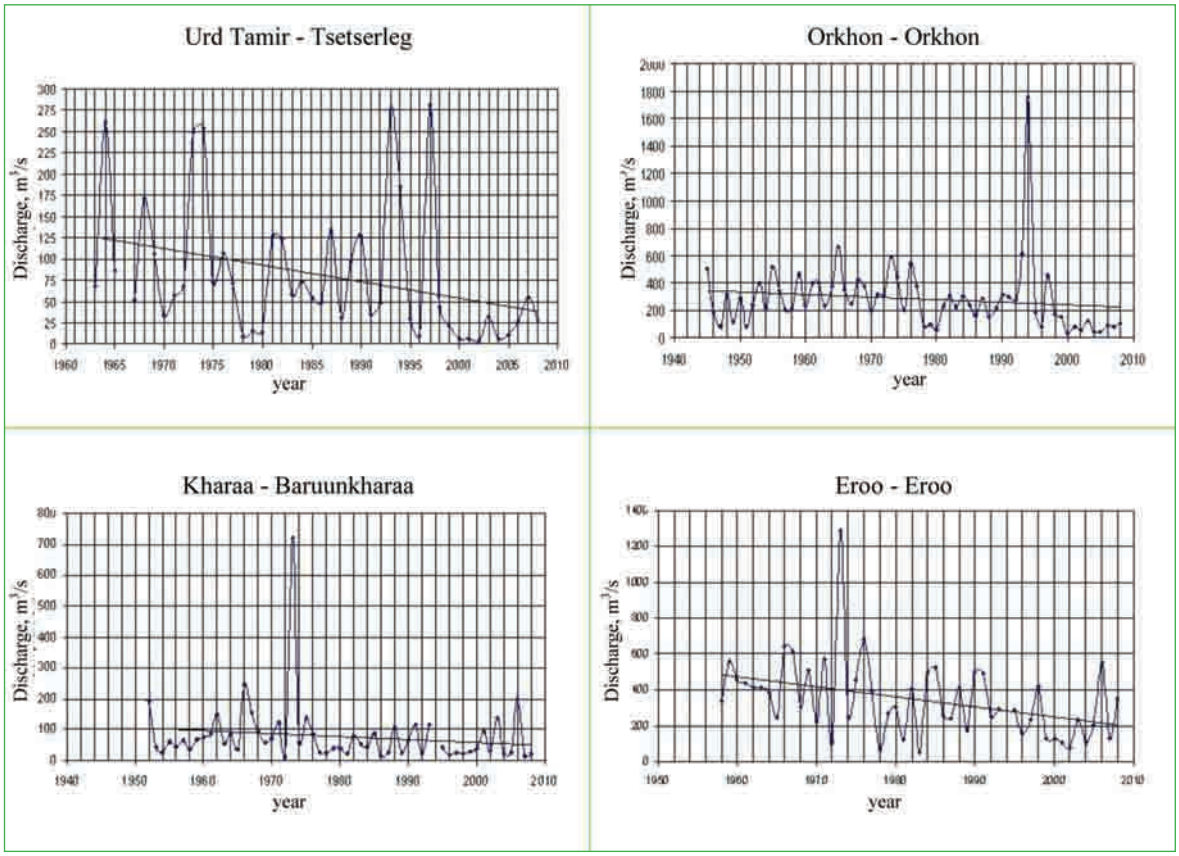


Figure 22. Change in maximum discharge of rainfall floods

For the last 20 years, low flow years continued. Yellow water spring flood and rainfall flood amounts are decreasing according to Figure 22 and Figure 23. This affects the estimation of the maximum discharge by the different mathematical-statistical methods.

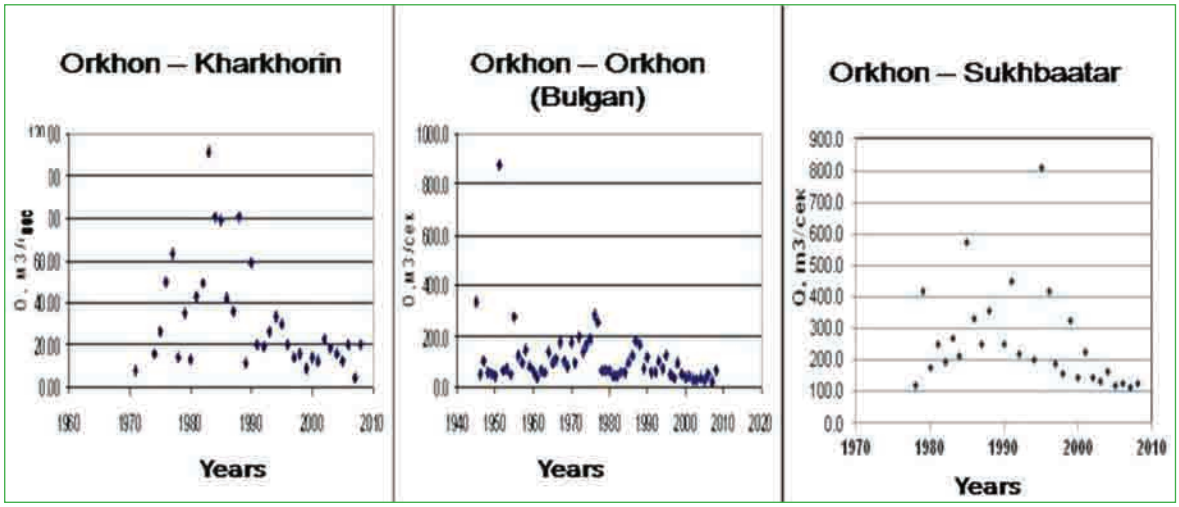


Figure 23. Changes of maximum discharge of spring floods

Low flow:

The rivers are frozen continuously during the cold season in Mongolia. The rainfall is flashy in the warm season. Low flow periods may be observed in the flow regime of the Orkhon River in winter and in summer. The lowest runoff in winter is 0.069 m^3/sec while the lowest runoff in summer varies around 0.258 m^3/sec. The low runoff decreases along the river in downstream direction and in some cases the river freezes up to the riverbed cutting all runoff near the Orkhontuul site. A slight increase in low flow can be observed after entering Eroo River.

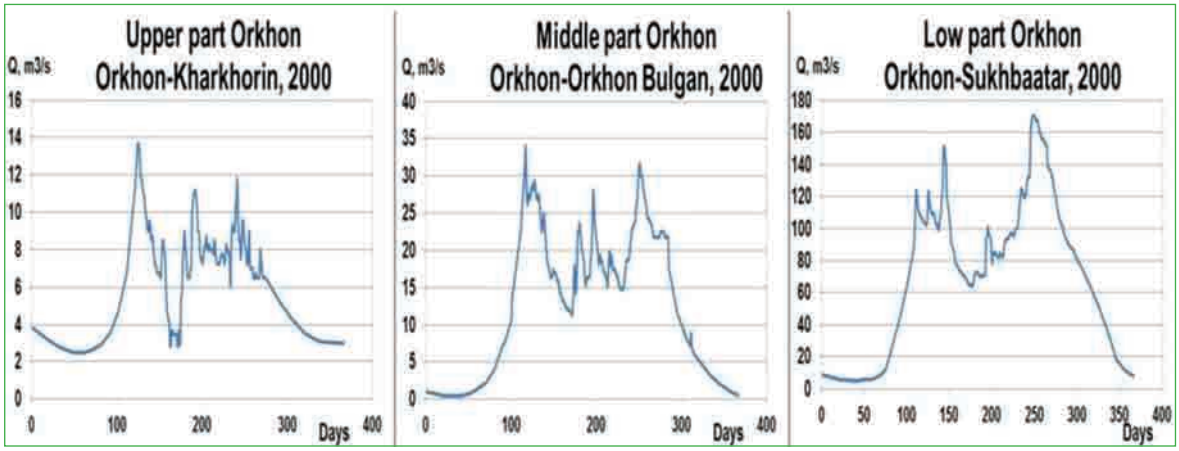


Figure 24. Typical hydrograph during the low water year

The low flow gradually increases in downstream direction from the mountains to the mid part of the basin. It stabilizes in the lower part of the basin.

The summer low flow period usually continuous about 50-80 days in Orkhon, Urd and Khoit Tamir Rivers. The mean warm season specific runoff is 0.5-2.0 l/sec km^2 in the Orkhon river basin. In case of winter low flow, its duration varies from 160 to 170 days and even longer for the small rivers reaching 190-200 days.

Table 14. Low flow discharge with different probability of occurrence, m^3/sec

River station names and locations	Flow periods	Percent of probability of occurrence					
		50.0	75.0	80.0	90.0	95.0	97.0
Orkhon-Kharkhorin	warm	1.82	0.94	0.83	0.61	0.32	0.30
	cold	0.14	0.07	0.05	0.029	0.012	0.0
Khoid Tamir-Ikh Tamir	warm	1.67	1.00	0.90	0.64	0.50	0.43
	cold	0.07	0.04	0.03	0.02	0.01	0.00
Urd Tamir-Tsetserleg	warm	2.43	1.58	1.46	1.01	0.73	0.62
	cold	0.24	0.11	0.09	0.05	0.03	0.02
Orkhon-Orkhon soum	warm	0.83	0.59	0.53	0.38	0,30	0.26
	cold	0.016	0.007	0.005	0.002	0.00	0.00

2.1.2. Intermittent rivers

Flash floods are highly intensive turbulent flows with rocks, sediments and other surface materials due to heavy rain along the steep dry beds and small rivers. The average annual precipitation in Orkhon basin is 250-350 mm and 80-95 percent of the precipitation falls within the April-October months. Due to global warming, total precipitation and its duration has a decreasing trend in the last years.

The Orkhon River is the main surface water resource of Central Mongolia and the most affected river basin in terms of human influences. Of the basin 45.9 percent has desertification problems, 23 percent is affected by overgrazing and 11.6 percent is affected by mining. This contributes to a clear decline in surface water resources and to a change in flow regime in the Orkhon river basin due to climate change and human impacts.

The catchment belongs to the region with intensive sediment flow and floods have high flow velocities due to short intensive rains. The maximum rainfall water runoff for unexplored catchments (rivers, streams, dry riverbeds) may be calculated by the following formula.

The maximum water discharge in dry riverbeds and channels with a catchment area less than 200 km^2 has been estimated by the method of rainfall intensity (Mongolian method) in accordance with the "Norms and Regulations on Hydrological Estimation" (CNR 2.01.14-86):

$$Q_{1\%} = q_{1\%} * \varphi H_{1\%} * \delta * p_{\%} * F$$

Where: Q1% - flood maximum discharge of 1 percent probability, m3/sec
q1% - specific discharge of 1percent probability, l/sec km^2
φ - runoff coefficient
H1% - daily maximum precipitation of 1percent probability, mm
δ - coefficient, considered lake, forest and marshland area
p% - transitive coefficient from 1percent probability
F - catchment area, km^2

The flood discharge estimate can be obtained by processing the digital elevation model in specific software. HEC-GeoHMS hydraulic model together with GIS is able to determine the flood flow discharge. The map of areas prone to flooding may be made along the rivers during rain floods of 1 percent probability.

2.1.3. Lakes

There are around 1730 lakes, small lakes and shallow waters in the Orkhon basin with around 100 of those having an area of more than 0.1 km^2 (1984). The biggest lake is the Ugii Lake which locates in the Ugii Nuur soum, Arkhangai aimag. There are many small and medium size lakes such as Khukh, Shireet, Shorvog, Doitiin Tsagaan, Sangiin Dalai and Tsaidam Lakes.

Lakes can originate from tectonic uplift, landslides, by glacial blockages or by natural erosion processes. The fresh water Ugii Lake is formed when a wide meander from a stream or a river was cut off to form a lake.

The surface area of Ugii Lake is 25.8 km^2 (Figure 25). One gauging station is operating on Ugii Lake. By historical data of this station Ugii Lake level has decreased 150 cm in last few years.

The Ugii Lake has a 25.4 km shore length with numerous wetlands. JICA studies executed in 2005 determined 14 fish species, 129 species bird, and 266 species of plants in Ugii Lake.

Figure 25. Location of Ugii Lake

Morphometric and chemical characteristics of some studied lakes in the Orkhon River basin are shown in Table 15.

Table 15. Morphometric and chemical characteristics of lakes in the Orkhon river basin

No	Lake name	Location		Area, km^2	Level, m	Water regime	Chemical (2010)			
		Aimag	Coordinates				pH	Conduc-tivity	Turbidity	Colour
1	Ugii	Arkhangai	102.77, 47.77	25.8	1327	perennial	8.8	430	slightly	grey
2	Shorvog	Arkhangai	102.37, 47.64	6.4	1346	Temporary	10.2	29,200	clear	colorless
3	Bulan	Arkhangai	101.87, 47.57	0.82	1527	Temporary	9.85	743	high	Grey brown
4	Ar	Arkhangai	101.98, 47.45	0.13	1544	Temporary	9.4	27,900	clear	yellowish
5	Khuiten	Arkhangai	101.82, 87.34	0.29	1691	perennial	9.1	240	slightly	grey
6	Khunt	Bulgan	102.56, 48.46	1.30	1258	perennial	9.6	15,500	slightly	greenish
7	Ishgent	Selenge	105.76, 49.62	1.28	-	Temporary	9.03	2040	slightly	grey
8	Khuduu	Selenge	106.29, 50.20	0.21	-	Temporary	9.46	1330	clear	grey
9	Gyalaan	Selenge	106.53, 50.25	0.35	-	Temporary	10.25	450	slightly	green
10	Tukhmiin gun	Selenge	106.62, 50.26	0.39	-	Temporary	9.35	740	slightly	green
11	Sangiin Dalai	Uvurkhangai	103.31, 46.65	2.69	1694	Temporary	9.60	710	slightly	grey
12	Shireet	Uvurkhangai	101.83, 46.51	3.74	2432	perennial	7.40	30	clear	colorless
13	Bugat	Uvurkhangai	101.77, 46.57	1.32	2304	Temporary	8.0	60	slightly	greenish

2.1.4. Ice and thermal regime of the Orkhon River

Water temperature: Ice phenomena begin at Mongolian rivers usually in the first decade of November and end by the first decade of April. The water temperature of rivers in the Orkhon river basin warm up after spring ice phenomena and exceed the value of 4°C in the mid of May. Monthly mean water temperatures in the river basin vary from 10.2 to 19.6 °C in the summer.

After the equilibrium of the air and water temperature which happens around mid August the water temperature drops following the air temperature decrease. By September, water temperature cools down till 6-8 °C and goes below 0.2 °C in the first half of November. Usually water temperature is cooler than the air temperature in the spring and summer season while it exceeds the air temperature in the autumn season.

The mean water temperature of the Orkhon River in May is 10.1-10.9 °C and the maximum of the water temperature is observed in July with a mean value of 19.0-20.1 °C.

The mean water temperature of the Orkhon River in the warm season (May-October) has increased by 1.6 °C in the last 60 years. When comparing Orkhon-Orkhon river station data from 1945 to those of 2008, the monthly mean water temperature increased by 1.1 °C in the warm season (Table 16).

Table 16. Change of water temperature Orkhon-Orkhon station

Date	Mean temperature °C							
	V	VI	VII	VIII	IX	X	IV-X	Mean
1945	9.1	15.1	18.2	15.2	9.2	3.1	12.2	11.7
2008	10.2	16.2	19.6	16.3	10.2	3.5	13.8	12.8

According to the greenhouse emission scenario of A1B, mean water temperature of the warm period is expected to increase by 1.7-1.9 °C in 2020 and further continue to increase by 2.2-2.5 °C and 2.7-3.1 °C by 2050 and 2080, respectively.

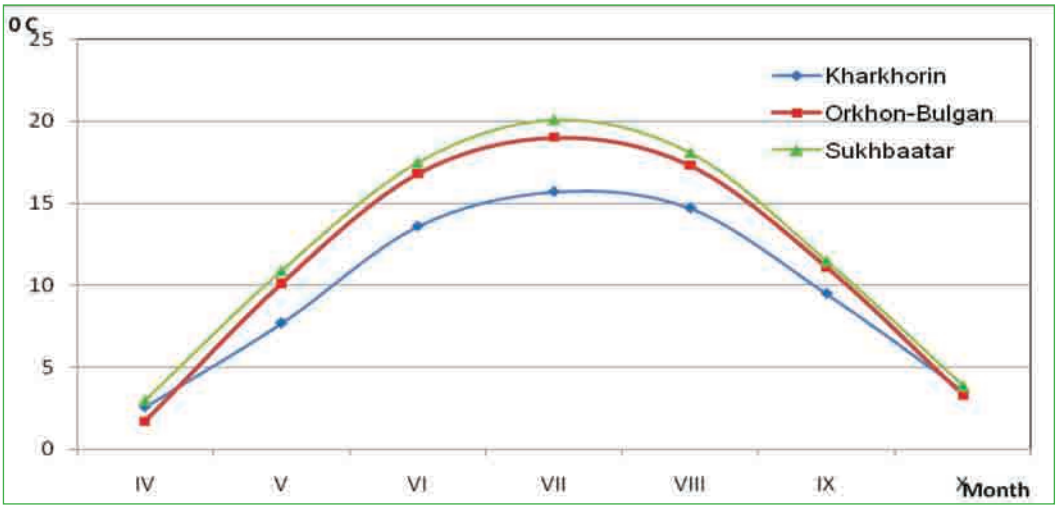


Figure 26. Monthly average water temperature

Ice: the maximum depth of the ice cover has a decreasing trend and in recent years since mid of 1990s, the maximum ice depth of the Orkhon River has decreased by 10 cm, on average.

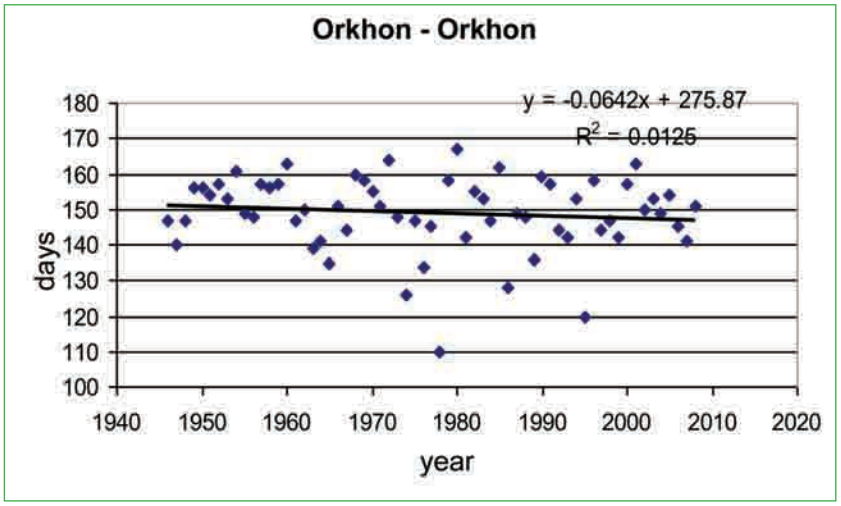


Figure 27. Change of duration of ice cover at Orkhon-Orkhon

The thickest ice of Orkhon river basin's large rivers reaches 150-200 cm. The average size of the thickest ice is 40-130 cm. The thickest part of the small rivers' ice is 90 cm.

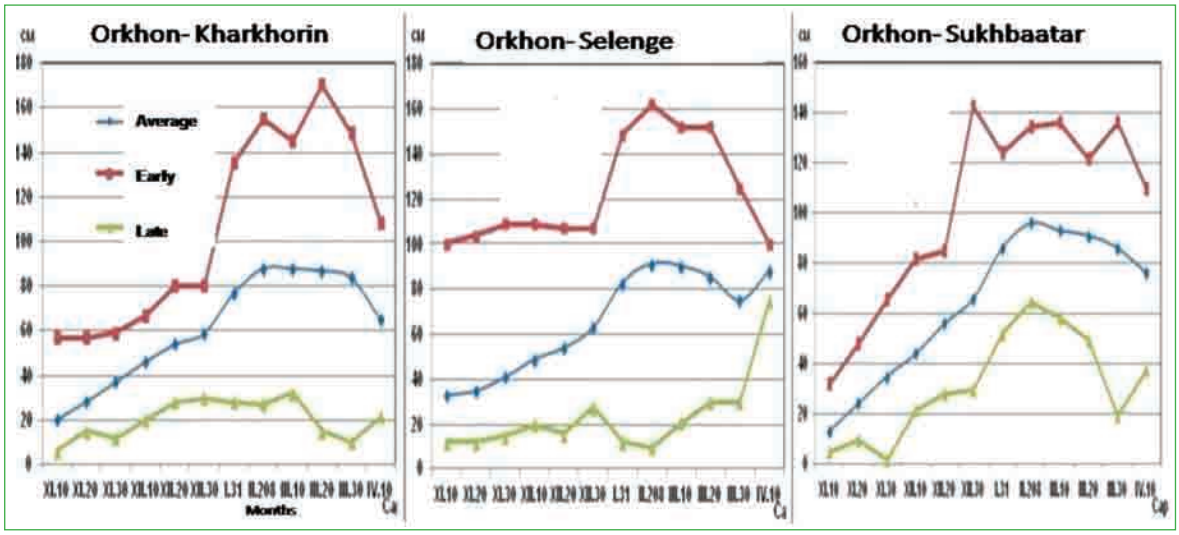


Figure 28. Average ice depth

Sediment: Sediments are a naturally occurring material that is broken down by processes of weathering and erosion, and is subsequently transported by the action of wind, water, ice or by the force of gravity. Rivers and streams carry sediment in their flows. This sediment can be divided as suspended load, bed load and wash load depending on the balance between the upwards velocity on the particle. Overland flow can erode soil particles and transport them down the slope. The erosion associated with overland flow may occur through different methods depending on meteorological and flow conditions. Available information about particle size of suspended load in Orkhon River is shown in Table 17.

Table 17. Mechanical composition of suspended sediment

River and stations	Loss of HCL,% during the processing	Diameter of particles, grains /mm/,								
		1-0.25	0.25-0.10	0.10-0.05	0.05-0.01	0.01-0.005	0.005-0.001	0.001	Sum of grain particles	
									>0.01	<0.01
Orkhon-Kharkhorin	3.20	3.20	31.13	25.19	2.48	1.40	4.40	11.00	80.00	16.80
Tuul-Ulaanbaatar	2.96	6.37	34.27	25.2	15.48	2.32	3.92	9.48	81.32	15.72
Tuul-Terelj	2.87	5.80	33.19	23.34	14.91	1.12	3.76	8.45	76.32	14.47
Terelj-Terelj	1.83	2.49	9.48	19.34	2.4	0.95	0.85	5.48	59.41	12.17

2.1.5. Quality and chemical composition of surface water

Orkhon river upstream part: The upstream part covers Tsenkher soum, Arkhangai aimag where the Orkhon River originates. It includes tributaries of the upper part of the rivers Orkhon, Urd and Khoid Tamir, Tsenkher and Tsetserleg. They have clear, soft, mountainous fresh water which originate from branch mountains of Khangai Mountain.

Table 18. Tributaries of Tamir River (Bulgan and Ikh Tamir soum, upper part)

Tributaries	Composition	Mineralization, *mg/l*	Hardness, *mg-equiv/l*
Urd Tamir	C^{Ca}_{I}	96-137.6	0.85-0.90
Tributaries*: Urd and Khoid rivers, Tsenkher, Tsetserleg, Mogoi, Teel, Jargalant, Bugat, Khoshigt, Nariin, Chandmani, Khavtgai Modot, Khokh Davaa- these rivers have very soft and fresh water.*			
Khoid Tamir	C^{Ca}_{I}	100.0	1.00
Khoid river and its tributaries*: Khujirt, Ikh Shivert, Emt, Dood, Deed, Nariin, Jargalant, Delgereh Bulag, Dood Khavchig, Shar Bulag, Ust Tag, Khokh Nuuriin Gol, Maraan Tag, Ekhen Khavchig, Khatuu, Angarkhai, Davaanii Gol- these rivers have very soft and fresh water.*			
Urd river: The following rivers are integrated as Urd river: *Zamt (CCaNaI, mineralization 88.4 mg/l, hardness 0.75 mg-equiv/l,), Uliastai (C^{CaNa}_{I}, mineralization 95.4 mg/l, hardness 0.75 mg-equiv/l,). Tributaries: Duganiin Shivert (C^{Ca}_{I}, mineralization 65.3 mg/l, hardness 0.50 mg-equiv/l)*			

Urd Tamir, Khoid Tamir and its tributaries have not been affected by negative human activities. They keep their natural conditions. The water is fresh and clear. In the last years, gold mines increased in the Uult river valley in the upstream part of the Orkhon River. There is a negative impact on the river water quality. Ikh Teel and its tributary, Uult and Uult's tributaries, Ulziit Teel and Bodonch are very fresh (mineralization 122-164 mg/l), water is very soft (hardness 1.4-1.6 mg-equiv/l). But they have been polluted and have turbidity. The gold mining activity runs in the valley (Budant Teel, Khargui, Shiirt, Zuun Sodot, Baruun Sodot and Guut rivers) and soil, pasture and environmental ecosystem have been degraded.

Figure 29. Ikh Teel river

Figure 30. Ult river pollution

Figure 31. Ulziit Teeliin river

Orkhon River upstream and Uult river valley's small rivers have dried up and there is no flow. The polluted and turbid water caused by negative human activities and floods, flows through Uult river channel and it has been polluting the Orkhon River upstream. Orkhon

river is very fresh (mineralization 148.7 mg/l), very soft (hardness 1.00 mg-equiv/l), no turbidity and pollution before joining Ulaan river in the territory of Bat-Ulzii soum of Uvurkhangai aimag. In this part, small rivers with fresh, clear and soft water flow in from the west side of Orkhon River. Their water body (environment) is not affected.

Table 19. Tributaries of Orkhon river upstream (Bat-Ulzii soum)

Tributaries	Composition	Mineralization, mg/l	Hardness, mg-equiv/l
Gorkhin river	C^{Na}_{II}	189.4	1.50
Tributaries: Khurvuulgu	C^{Na}_{II}	141.0	1.10
Jimger, Khoshigt, Tongorog	C^{X}_{II}	170.0	1.60
Uliastai	C^{Ca}_{II}	198.8	1.85
Ulaan	C^{Na}_{I}	87.4	0.55
Tributaries: Khurmen, Biluut	C^{Ca}_{I}	135.0	1.15
Khonog	C^{Ca}_{II}	115.6	1.20
Tsagaan	C^{Na}_{II}	90.0	0.80
Tributaries: Khamart	C^{Na}_{I}	100.0	0.50
Moilt	C^{Ca}_{I}	127.0	0.70
Uvt*	C^{Na}_{I}	196.0	0.90
Adag Turuu **	C^{Ca}_{II}	256.6	2.20
Khujirt **	C^{Na}_{I}	460.9	3.00

Remarks: * little bit polluted
** polluted (river water is polluted after waste water discharged from Khujirt camp flows into Khujirt river)

Further downstream the Orkhon River, according to research at the irrigation system headwork near Kharkhorin soum, the mineralization is raised to 167.3 mg/l, hardness to 1.75 mg-eqv/l, respectively. As mud and pollution is largely found here, it is subject to the "largely polluted" class according to the NCPLSW.

Figure 32. Orkhon River (Bat-Ulzii soum)

Figure 33. Near headwork of irrigation system, Orkhon River in Kharkhorin soum

The below result was made by Central Laboratory for Environmental Measurement based on the data received from the Orkhon-Kharkhorin river station.

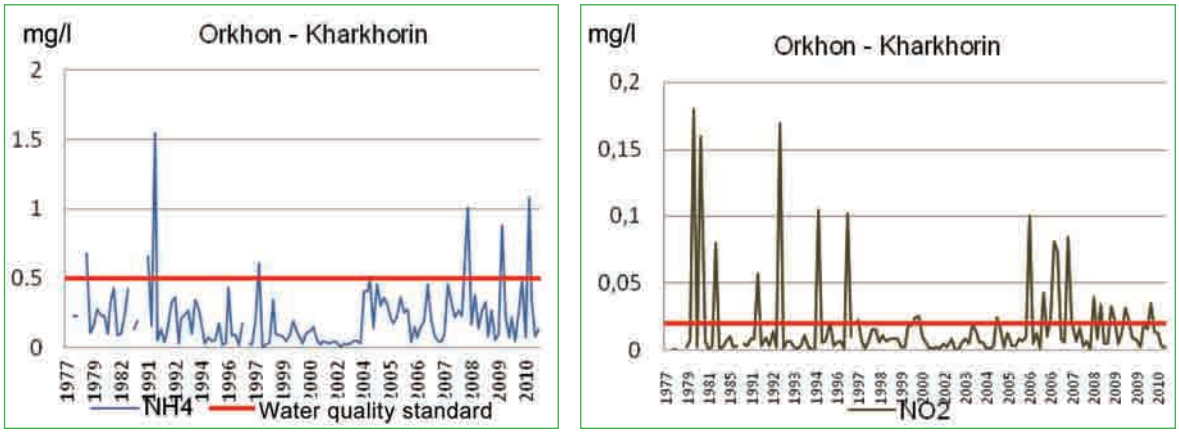


Figure 34. Ammonium and nitrite ion contained in water of the Orkhon River at Kharkhorin station (1977-2010)

As we can see from above, water pollution in the Orkhon River in the vicinity of Kharkhorin soum is substantial and it corresponds to the result from previous research. Especially the ammonium ion component indicating a new pollution tends to increase in recent years.

Orkhon river midstream part: The midstream Orkhon River covers the South Tamir River from Tsetserleg, the North Tamir River from Ikhtamir soum center, the Khaluun Usnii gol from Tsenkher hot spa and the Orkhon River from the Hujirt tributary. Of all the tributaries which flow into this midstream part, Tsagaan soum and Khukh soum rivers, which firstly flow into the Orkhon River from its left side via southern soums of Arkhangai aimag, are subject to hydrocarbonate class, Ca group, type 1, and for quality, its mineralization 366-372 mg/l or fresh, hardness 3.45 mg-eqv/l or very soft water. These rivers are in "polluted" class in summer time due to local herdsmen summer camps in valleys of these small rivers.

The most mineralized, polluted and hardest river amongst the tributaries which flow into midstream of the Orkhon River is the Khugshin Orkhon River and its hardness near Kharkhorin soum is 3.70 mg-eqv/l and considered the hardest compared to other rivers around. The Khugshin Orkhon River is alternatively called Nariinii River after passing through west part of the Ugii Lake. But its pollution is almost the same however there is a reduction in hardness /2.50 mg-eqv/l/.

Figure 35. Khugshin Orkhon River (Kharkhorin soum)

The Urd and Khoid Tamir rivers have not been affected by human activities and still keep their original form. By joining each other and flowing into the Orkhon River, they positively affect the river water quality and runoff.

While the Orkhon River passes through the territory of Saikhan soum, Bulgan aimag and Baruunburen soum, Selenge aimag, some tributaries flow into it from its left side such as Ugalz River (C^{Na}_{I}, mineralization 309 mg/l, hardness 2.65 mg-eqv/l, "very largely polluted"), Khuremt River (C^{Na}_{I}, mineralization 601 mg/l, hardness 4.3 mg-eqv/l, "polluted"), Dundat River (C^{Ca}_{I}, mineralization 500 mg/l, hardness 4.65mg-eqv/l, "slightly polluted"), Burgaltai River (C^{Ca}_{I}, mineralization 322 mg/l, hardness 2.9 mg-eqv/l, "slightly polluted").

The water of small rivers which flow in from the west side of Burgaltai River near the central road bridge and the west side of Baruunburen soum center, Selenge aimag, is very turbid. Mining activities impact on this rivers.

Figure 36. Burgaltai River as of Aug 2010

Khangal River is included in a list of rivers which significantly affect water quality and chemical composition of the Orkhon River. Quality and component in the Khangal River have been changed and increasingly polluted year by year. The Orkhon River was polluted due to influence by the Khangal River, there have been several cases in some months such as change in its chemical composition and sulphate ion was dominant. Under most events, all macro, micro and bioactive elements' volume contained in water have been increased and consequently, the Orkhon River has been polluted. Hydrochemist A.Munguntsetseg, D, approved that rivers' water mineralization is being changed due to seasons.

According to the research, water mineralization has been changed depending on a seasonal condition. Between 1970 and 1980, Erdenet River water mineralization was 519-829 mg/l, hardness 6.96-7.20 mg-eqv/l, Govil River's average mineralization was 503 mg/l, hardness 7.89 mg-eqv/l, Zunii River's mineralization was 372 mg/l, hardness 4.60 mg-eqv/l and Khangal River's mineralization was 585 mg/l, hardness 5.44 mg-eqv/l. As we can see from above, these rivers' mineralization and hardness were high, generally. This region's water is slightly alkaline (pH 7.3-8.3), organic substance permanganate oxidation 0.5-8.7 mgO/l, dissolved oxygen (DO) 9.46-11.71 mg/l, solute carbonic gas 13.8-14.5 mg/l, non-organic phosphor 0.014-0.070 mg/l from bioactive elements, ammonium ion 0.01-0.07 mg/l, silicon oxide 1.08-1.89 mg/l, total iron 0.12-1.26 mg/l, fluoride ion 0.9-

1.0 mg/l, copper 0.002-0.082 mg/l from microelements and molybdenum 0.2-0.33 mg/l, respectively.

In 1975, before the Erdenet's mining operation, the Khangal River water was fresh (average mineralization 480 mg/l), slightly hard (average hardness 5.02 mg-eqv/l), and for a chemical component, hydrocarbonate ion was dominant, anion ratio HCO_3^- >Cl^- >SO_4^{2-}, cation ratio Ca^{2+}>Na^++K^+ >Mg^{2+}.

After waste water, which percolates down through the dam of the Erdenet mining plant, reaches the Khangal River, its manganese 0.41 mg/l, copper 0.32 mg/l, zinc 0.066 mg/l, molybdenum 0.2 mg/l and solute oxygen volume decreased. In reverse, contained bioactive elements, nitrogenous composition, micro and macro elements have been increased. The Khangal River joins the Orkhon River without purification. However, solute elements tend to decrease along the river in downstream direction.

According to research by the Geo-ecological Institute, the Erdenet River water is subject to relatively high mineralization (average mineralization 730 mg/l), hardness (average hardness 7.20 mg-eqv/l), polluted (NO2- 0.3 mg/l), and for a chemical composition, sulphate ion is dominant, anion ratio SO42- >HCO3- > Cl-, cation ratio Ca2+ > Mg2+ > Na++K+ by ions structure. Compare to the NCPLSW, the Erdenet River water is subject to "largely polluted" class. Zunii River is usually disappeared and it percolates through the Erdenet plant's dam by joining waste water from the Erdenet plant and flows into the Orkhon River. According to recent research, the Khangal River water mineralization is constantly high or 600-800 mg/l, hardness 6.50-7.50 mg-eqv/l, and it is polluted by nitrogenous composition and heavy metals such as copper and nickel, etc. For a chemical composition, sulphate ion is prevailed, and anion ratio SO42->HCO3->Cl- and cation ratio Ca2+>Mg2+>Na++K+ by ion's structure. The Khangal River is the only river subject to type 3 amid tributaries which flow into the Orkhon River.

In the framework of Mongolian-Russian joint biological expedition, research team of US, Russia and Mongolia carried out research on water quality, river bed materials, as well as water animals in the Selenge river basin. According to research carried out on water quality in the Khangal River on Aug 29, 2010, the river water was slightly polluted / NH_4^+ 0.3 mg/l/, brownish colored. But next morning the river's colour has been changed into auburn colour and there were some white bubble along the river bank. So, we decided to take sample again and pollution indicators were increased, for example, ammonium ion was sharply increased /NH_4^+ 6.0 mg/l/.

Figure 37. Khangal River (2010.08.29)

Figure 38. Khangal River (2010.08.30)

This change of river water shows that waste water is discharged to Khangal River from any pollution/waste source during night time. If this continues, there is a risk that it will not be treated for 70 km and will join Orkhon River. According to data of hydrological monitoring station of Orkhon river midstream, the result from Environmental measurement central laboratory is presented in the figures below.

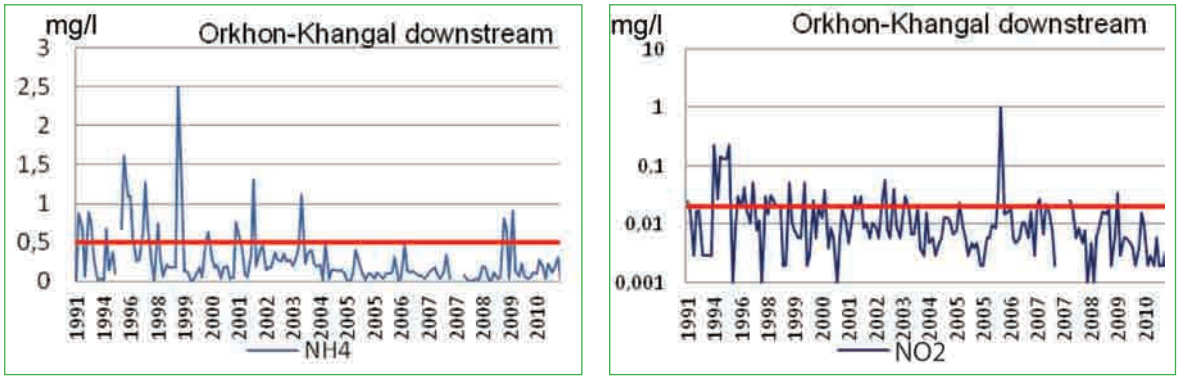


Figure 39. Ammonium and nitrite ion contained in water of the Orkhon River at Orkhon-Khangal downstream monitoring station, 1991-2010/

For water quality, its mineralization 240.7mg/l, hardness 2.45mg-eqv/l and "slightly polluted" class by ammonium volume (NH_4^+ 0.1 mg/l) according to the NCPLSW. Indeed, its water was fresh here. But after joining the Tuul River, there is a change in water of the Orkhon River and main ions' volume and turbid were increased /mineralization 283.1mg/l, hardness 2.60mg-eqv/l, suspended solid volume 78 mg/l/ and included in the "polluted" class according to the NCPLSW. This pollution is due to strong impact by the gold mining activities in the Tuul River and its water has been largely become turbid.

Figure 40. Orkhon River before joining the Khangal River

Figure 41. Orkhon River after joining Tuul River

Whereas, the Tamir River with very pure, very soft and fresh water shows the most positive impact on the Orkhon River's water quality amid overall tributaries which flow into its midstream, the Khangal and Tuul Rivers show the negative impact on it with an ecological change.

Orkhon river downstream part: The downstream part of the Orkhon Basin stretches from Erdenet to the junction of the Orkhon and Selenge rivers. Of the tributaries subject to this part, some rivers such as Kharaa, Shariin Gol, Eroo and Buur were undergone the related research. The chemical composition of the Eroo River water is very fresh, very soft water and other rivers have fresh and soft water. But heavy metals have been accumulated in the river water and in the river bed material, and it affects ecosystem of the river water. This is due to long year's gold mining activities in the valleys of the Eroo River and its tributaries such as Yalbag, Mogoi, Tsamkhag, Ikh Kharganat, Ikh Ajir, Baga Ajir, Bugant, Nariin and Tolgoit, etc.

Some elements such as arsenic, zinc, aluminium, iron, etc have entered in the turbid water in a colloidal manner due to gold mining activities. These elements have been penetrated into sediments on the bottom along the river. That's why these elements are substantially contained and very largely polluted. Therefore, relatively large number of elements found in the sediment and mud on the bottom of the Kharaa and Shariin Gol rivers. Besides, heavy elements which contained in sediments on the bottom the Orkhon River along the downstream direction is high.

The last tributary of the Orkhon River is Buur River which flows through Sukhbaatar soum, Selenge aimag. While the Buur River flows through households live in ger area, it is polluted by organic and domestic pollution and it is subject to "Very polluted" class. Except that, it has relatively high mineralization and hardness (mineralization 600-800 mg/l, hardness 6.50-7.50 mg-eqv/l).

In 2001, some fuel and lubricant material were leaked from the Oil supply base of Ulaanbaatar Railway in Sukhbaatar city, Selenge aimag and consequently, it was percolated into the soil and then entered into the Buur River which flows into the Orkhon River. The river was polluted by organic substance. On the other hand, Khiagt River which flows through Altan Bulag soum centre is largely polluted while it flows through Mongolian border from Russian and this might substantially affect water quality of the Buur River.

According to research, there hasn't yet been change in water quality and chemical composition of the Buur River and it was subject to still polluted, contained ammonium ion NH_4^+ 0.7 mg/l, permanganate oxidation which is an organic pollution 13.4 mg/l and "very largely polluted" class according to the NCPLSW, Ca and Mg ions and hardness have been increased (hardness 7.10 mg-eqv/l).

Figure 42. Buur River's pollution by oil leakage, 2001

Figure 43. Buur River's pollution, down from Ger area, 2010

Before joining the Selenge River, the Orkhon River water is subject to hydrocarbonate class, Ca group, type 1. For quality, mineralization 175.6mg/l, hardness 1.8 mg-eqv/l, "slightly polluted" class by volume of suspended solid according to NCPLSW.

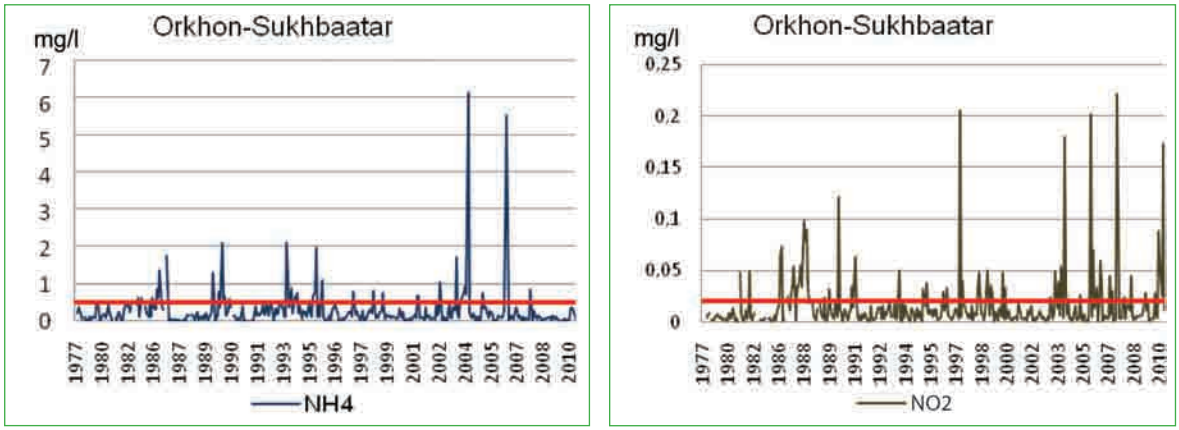


Figure 44. Ammonium and nitrite ion component in water of the Orkhon River at Sukhbaatar station (1977-2010)

As we can see from the above graph, ammonium nitrogenous component in water of the Orkhon River around Sukhbaatar river station ranges from 0.00-6.12 mg/l and 0.30 mgN/l on an average. There have been some cases that exceeded the MNS4586-98 water quality standard which were observed in 2004 and 2006. But there have been many cases which exceeded the standard even though contained nitrite ion ranged 0.000-0.222 mg/ and 0.018 mg/l on an average. And there were some five cases compared to the MNS4586-98 water quality standard that mineral phosphor contained in water ranged 0.000- 0.514 mg/l and average of 0.044 mg/l for long years, total contained iron ranged 0.00-0.77 mg/l and average of 0.11 mg/l for many years.

Table 20. Micro elements contained in the Orkhon River along its length, mg/l

Sampling points	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Cd	Pb	Ag	Mo
Result from the Natural Resource Institute, the Buriat, Russia, 2002												
Orkhon River / midstream/	0.0057			0	0	0.0843	0		0.0009	0.0125		
Orkhon River / downstream/	0.0044			0.0050	0.0002	0.0281	0		0.0016	0.0195		
Result from the Natural Resource Institute, the Republic of Korea, 2009												
Orkhon River / upstream/	0.0005	0.0051	0.0799	0.0001	0.0010	0.0015	0.0222	0.0074	у/м	0.0005		
Orkhon River / midstream/	0.0028	0.0236	0.427	0.0009	0.0042	0.0026	0.1131	0.0125	у/м	0.0004		
Orkhon River / downstream/	0.0005	0.0183	0.8802		0.0007	0.0006	0.0154	0.0014	у/м			
Geo-ecological Institute /USUG laboratory/, 2011												
Orkhon River / before joining Kharaa River/	0	0	0.0146	0.001	0.001	0.006	0	0.001	0	0	0.006	0.012
Orkhon River / after joining Eroo River/	0	0	0.1744	0	0.001	0.006	0.014	0	0	0.001	0.012	0.001

Figure below shows the result from tested micro elements contained in the samples taken from water and sediments in the Orkhon River and its tributaries in 2010.

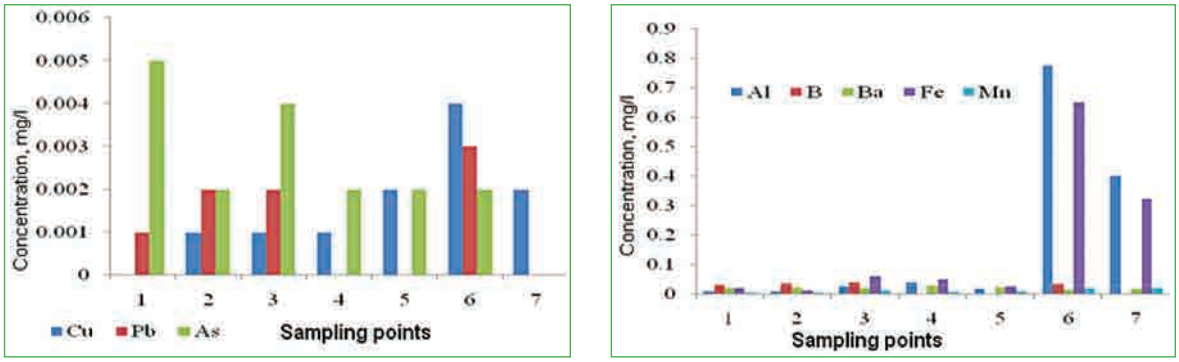


Figure 45. Heavy metals contained in water of the Orkhon River and its tributaries

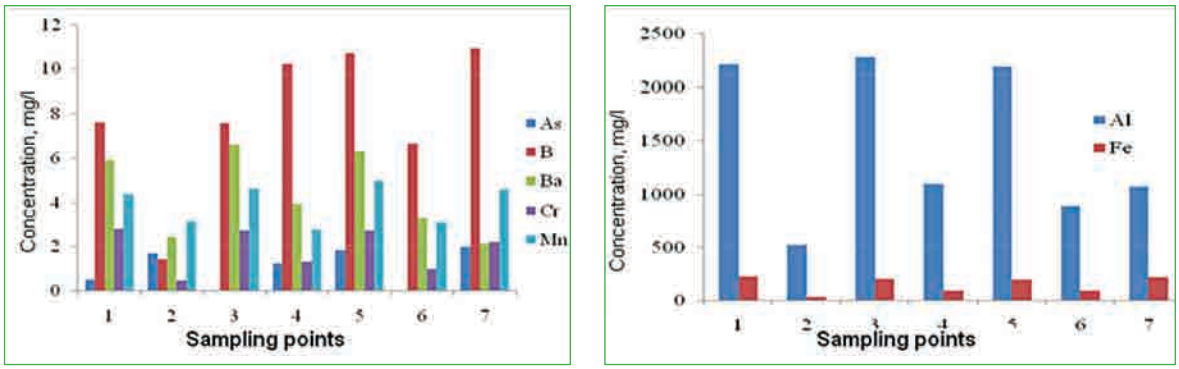


Figure 46. Heavy metals contained in sediments of the Orkhon River and its tributaries

/Sampling points: 1. Orkhon River before joining Kharaa River; 2. Kharaa River before joining Orkhon 3. Orkhon River after joining Kharaa River; 4. Shariin River before joining Orkhon 5. Orkhon River after joining Shariin River; 6. Eroo River before joining Orkhon 7. Orkhon River after joining Eroo River/

According to test result of microelements contained in water of the Orkhon River and its tributaries, aluminum and iron contained in water of the Eroo River high and it affects the Orkhon River water. These are main elements of ground layers and these elements typically enter into water from mining activities in turbid /colloid/ form and are accumulated in sediments on the bottom during downstream process.

Water pollution of the Orkhon River and its tributaries tends to increase year by year.

As we can see from the figure, some rivers such as Ulaan River in upstream part, Tamir River in midstream part and Eroo River in downstream part have the minimum mineralization. But Khugshin Orkhon and Khangal Rivers in midstream part and Buur River in downstream part have the maximum mineralization. The Khangal River water has the highest sulfate ion component. The Orkhon River water mineralization and hardness volume increases along its downstream direction. After joining the Eroo River which has very pure and large water (mineralization 70-110 mg/l, hardness 0.70-1.00 mg-eqv/l), its mineralization decreases below 200 mg/l and becomes very pure and soft water. Then it flows into the Selenge River.

Water quality of some lakes in the Orkhon River Basin

Upstream part lakes' water quality: Khukh Lake and Duut Lake have been chosen as an example amongst the lakes in the Orkhon river basin upstream.

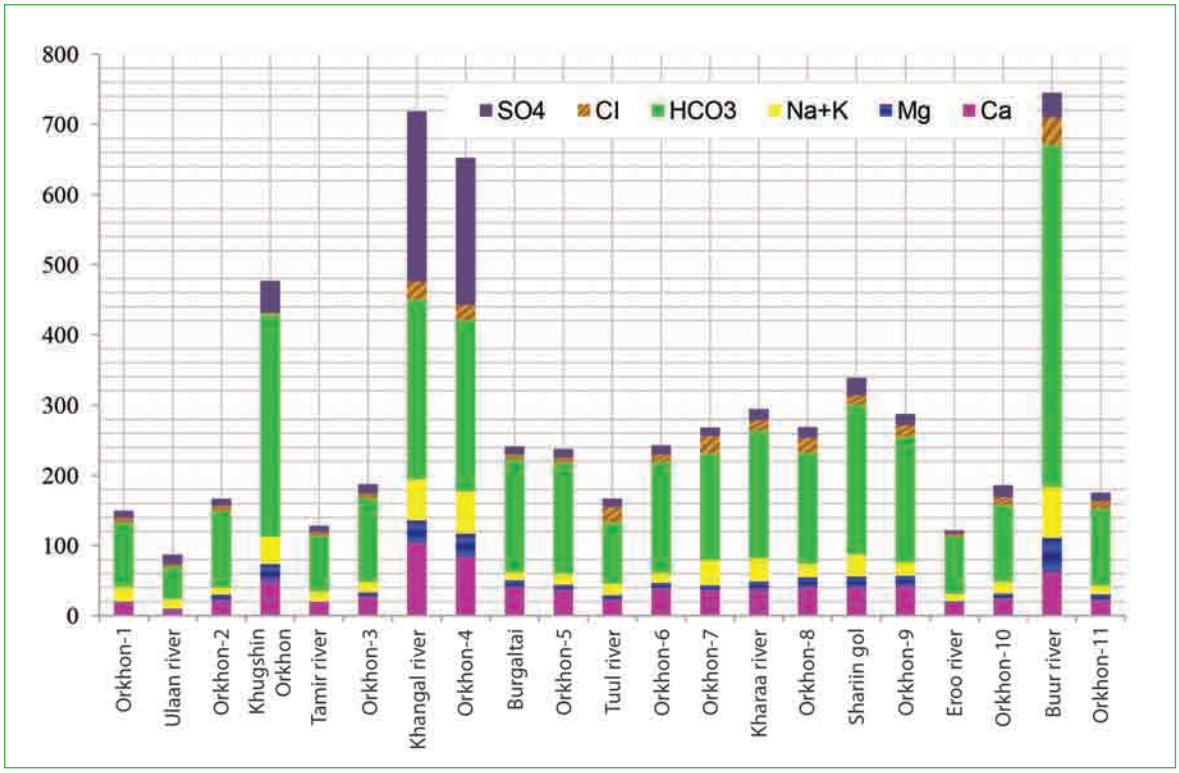


Figure 47. Water mineralization and main ions contained in the Orkhon River and its large tributaries

1. Orkhon-1. Before joining Ulaan River; 2. Ulaan River, before joining Orkhon; 3. Orkhon-2, Headwork of irrigation system in Kharkhorin; 4. Khugshin Orkhon River, Kharkhorin; 5. Tamir River; 6. Orkhon-3, Orkhon soum, upstream before joining Khangal River; 7. Khangal River, before joining Orkhon River; 8. Orkhon-4, 500 m after joining Khangal River; 9. Burgaltai River, Baruunburen; 10. Orkhon-5, before joining Tuul River, 11. Tuul River, before joining Orkhon River; 12. Orkhon-6, Orkhon bridge; 13. Orkhon-7, before joining Kharaa River; 14. Kharaa River, before joining Orkhon; 15. Orkhon-8, junction with Kharaa River; 16. Shariin River, before joining Orkhon River; 17. Orkhon-9, downstream after joining Shariin River; 18. Eroo River, from south of Dulaankhaan; 19. Orkhon-10, downstream after joining Eroo River; 20. Buur River, Sukhbaatar soum; 21. Orkhon-11, Orkhon River, before joining Selenge River.

Khukh Lake: This beautiful lake is elevated at 2660 m from sea level on a mountain peak as the river source, located in the territory of Ikh Tamir soum, Arkhangai aimag. Lake water is fed by rain/snow water. For quality, its mineralization 69.6 mg/l or fresh, hardness 0.50 mg-eqv/l or very soft and very fresh water according to the NCPLSW. This is due to far distance from influence by human and livestock.

Duut Lake: Compared to the Khukh Lake, it has relatively large mineralization, sand on the bottom and it's slightly warm. There are many water birds gather here and it‘s been substantially affected by human and livestock. For chemical composition, its water is subject to hydrocarbonate class, Na group, type 1, and for ion structure anion HCO_3^- >CO_3^{2-}>SO_4^{2-} or carbonate ion is dominant and cation ratio Na^++K^+>Ca^{2+}>Mg^{2+}. For quality, its mineralization 340.4 mg/l fresh, hardness 1.50 mg-eqv/l or soft, *polluted* class according to the NCPLSW and alkalinity pH-9.14.

As we see from above two lakes, the Khukh Lake, located on a high mountainous region, is not affected by human and livestock, and still keeps its original nature. While the Duut Lake is relatively polluted as there are many local families summer around here.

Figure 48. Khukh Lake (Arkhangai aimag)

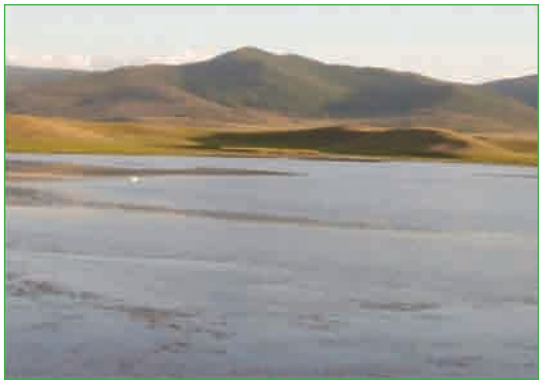


Figure 49. Duut Lake (Arkhangai aimag)

Midstream part lakes' water quality: Ugii Lake has been chosen as an example.

The midstream part locates at relatively lower altitude than the upstream part and mineralization in the Ugii Lake tends to increase. The Ugii Lake is the largest and ecologically important lake in this midstream part. It is located at 1337 m above sea level.

Due to the Ugii Lake has only one inflow (Nariinii River) and outflow (Ugiin Channel) in its west part at present time, water exchange process is relatively slow.

For the Ugii Lake, its mineralization ranges 210-274 mg/l and it is subject to "fresh" class according to classification. There are two small lakes on the east of the Ugii Lake, big one's mineralization is 312 mg/l and another one 620 mg/l. The Ugii Lake's water hardness ranges 2.70-3.20 mg-eqv/l and Mg ion is dominant in its hardness. And this is different from other lakes with fresh water.

Figure 50. Ugii Lake (Arkhangai aimag)

The river inflow is one of main sources to create/form the chemical water composition of the lake. But mineralization gradually decreases starting from the inflow part and a new classification was created in the lake's area in horizontal direction. And runoff with the same mineralization and composition flows not so far distance from the inflow. Therefore, it can be concluded that influence in the lake's hydro-chemistry and ecological balance by the inflow is unstable.

Downstream part lakes' water quality: Tsagaan Lake and Dardai Lake have been chosen as an example amongst the lakes in the Orkhon river basin downstream part. These salty lakes are located in the territory of Orkhon soum, Darkhan Uul aimag

(mineralization >11000 mg/l), slightly hard and polluted, and the chemical composition is subject to Chlorine class, Na group and very polluted class which means different from the lakes in the upstream and midstream.

Figure 51. Shargiin Tsagaan Lake (Darkhan-Uul)

Figure 52. Dardai Lake (Darkhan-Uul)

2.1.6. Conclusion on quality and chemical composition of surface water

The natural water quality and the chemical composition of surface water evolves and changes depending on factors such as geographical feature, condition, soil, vegetation, geology, animal and human activities, etc of the related region:

- The tributaries in the Orkhon River upstream area mostly originate in the Khangai Mountains, which are relatively not largely affected by human activities, keeping their original form, and having mountainous fresh, pure and soft water. That's why its impact on the Orkhon River water is positive.
- The Ikh Teel River is the Orkhon River source and still keeping its main natural composition. Due to gold mining activities in the Ult River valley, many small rivers have been blocked and consequently, runoff disappeared in the riverbed of the Ult River. There is a high risk of pollution in the Orkhon River upstream part if polluted and turbid water joins the river due to both intentional and sudden actions by humans, as well as by floods.
- The Tamir River and its tributaries in the Orkhon River midstream part, originating in the Khangai Mountains are not affected by human activities and these rivers keep their original form and have mountainous fresh, pure and soft water. The impact on the water quality in the Orkhon River is obviously positive.
- The Khangal River, a tributary flowing in the Orkhon River midstream part from the left side, has the most polluted water with the largest mineralization and hardness. There have been many cases in which mineral nitrogen components contained in water downstream of the junction of the Orkhon and Khangal River exceeded the standard. Moreover, water mineralization in the Orkhon River has increased and there have been some changes in hydro-chemical composition e.g. the anion ratio in water changed and the sulphate ion concentration has increased.
- Of the large tributaries in the Orkhon River midstream part, the Tuul River which originates from the Khentii Mountains has been largely affected by domestic pollution and there has been ecological change in its valley due to gold mining activities. Therefore, the Tuul River is negatively affecting the water quality in the Orkhon River. Of the small rivers in this part, the tributary of the Burgaltai River from its right side has been observed largely turbid.

- Tributaries in the Orkhon River's downstream part are Kharaa, Shariin Gol and Eroo rivers originating in the Khentii Mountains. These rivers are affected by gold mining activities and are turbid and polluted by heavy metals. The Buur River is affected by domestic pollution. And this pollution negatively affects the water quality in the Orkhon River.
- Even though Eroo River has the freshest and very soft water, it's been mostly polluted by heavy metals in connection with gold mining activities along its riverbed and in valleys of its tributaries.
- Water mineralization, hardness and main elements contained in the Orkhon River have not seriously changed for the period of long years. However, the river water is being polluted.
- According to research on water quality of lakes, mineralization tends to increase at lower elevation in the steppe region.

2.2. Groundwater

2.2.1. Geomorphology, geology and hydrogeology of the Orkhon river basin

The Orkhon river basin stretches from southwest to north in terms of geology and geomorphology. The formation of the basin's geomorphology and geology is very complex. The peak of Tarwagtai nuruu is 3540 m Angarkhai mountain; Erkhet khairkhan (3535 m) of Khangain nuruu; Suvarga khairkhan (3179 m) and Zuun khairkhan (2408 m).

Geomorphology: The basic geomorphological elements of the Orkhon river basin are mountains and river valleys. The southeast sources of the Orkhon River include Munkh bulgiin river, Sariin river and Zegst river which start from Zuun khairkhan mountain, Ulziit and Zuil soums of Uvurkhangai. The south and west source of the Orkhon river include the following rivers Dukh Chuluut, Khuush, Joroogiin sairuud, Kharznii gol, Tsuvria, Bunkhant, Khujirt, Khavtsgai, Tsagaan sum, Uliastai, Tongorog, Tamch, Urkhit, Ulaan, Shireet, Bukhiin shar, Ar aguit, Ar uwt, Mogoit, Moilt, Khamar and Khonog which flow from the mountains Baruun khairkhan, Angaliin tsagaan ovoo, Dukh ovoo, Dolgoon uul, Jargalant davaa, Jargalant uul, Tsetseg mod, Baruun dugnen, Khetsuu davaa, Jargalantiin davaa, Tavan ulaan chuluu, Ulaan chuluunii davaa, Urtiin davaa, Zaluurtiin shovkh, Emgediin davaa, Uvtiin davaa, Khamariin davaa, Ulaan nuruu, Khar hushtiin nuruu, Salhit uul, Erkhet khairkhanii baruun hyar, Angarhai uul, Khan undur davaa, Shar bulag davaa, Chingeltei uul, Rashaant uul, Saikhan uul, Bulgan nuruu, Khats hash uul, and Ikh zaluu uul.

The Khoid Tamir and Urd Tamir rivers are a big source at the west side of the Orkhon River. The geomorphological elements of the middle Orkhon river basin consist of the following mountains on the west hand side: Angarkhai uul, Khan Undur davaa, Shar bulag davaa, Chingeltei uul, Rashaant uul, Saikhan uul, Bulgan nuruu, Khats khash uul, Ikh zaluu uul and Burengiin nuruu.

The following geomorphological elements are found in the Orkhon river basin along the above mentioned mountains and the Orkhon River and its branch rivers and streams: flat and steep alluvial valleys; glaciations; holes and hills caused by frozen ground. Also there are small concentrations of sand dunes formed by erosion in the Orkhon valley.

Geology: The geological structure of the Orkhon river basin is very complex: Quaternary alluvial, proluvial, dilluvial sedimentary rock, terrestrial and lacustrine sedimentary rock of Neogene and lower Cretaceous age, Neogene-Quaternary valley rock, Permian and Triassic sediment, Paleozoic and Mesozoic effusive and intrusive rock.

These geological aquifers and formations constitute granular aquifers and fissured aquifers and possibility of unconfined and confined groundwater distribution.

Mines are active in the upstream and middle part of the Orkhon river. Gold mines are located in Tuvshruuleh soum of Arkhangai province, in Saikhan soum of Bulgan province and in Orkhontuul soum of Selenge province, etc. The big copper mine of Erdenet is located in Orkhon aimag.

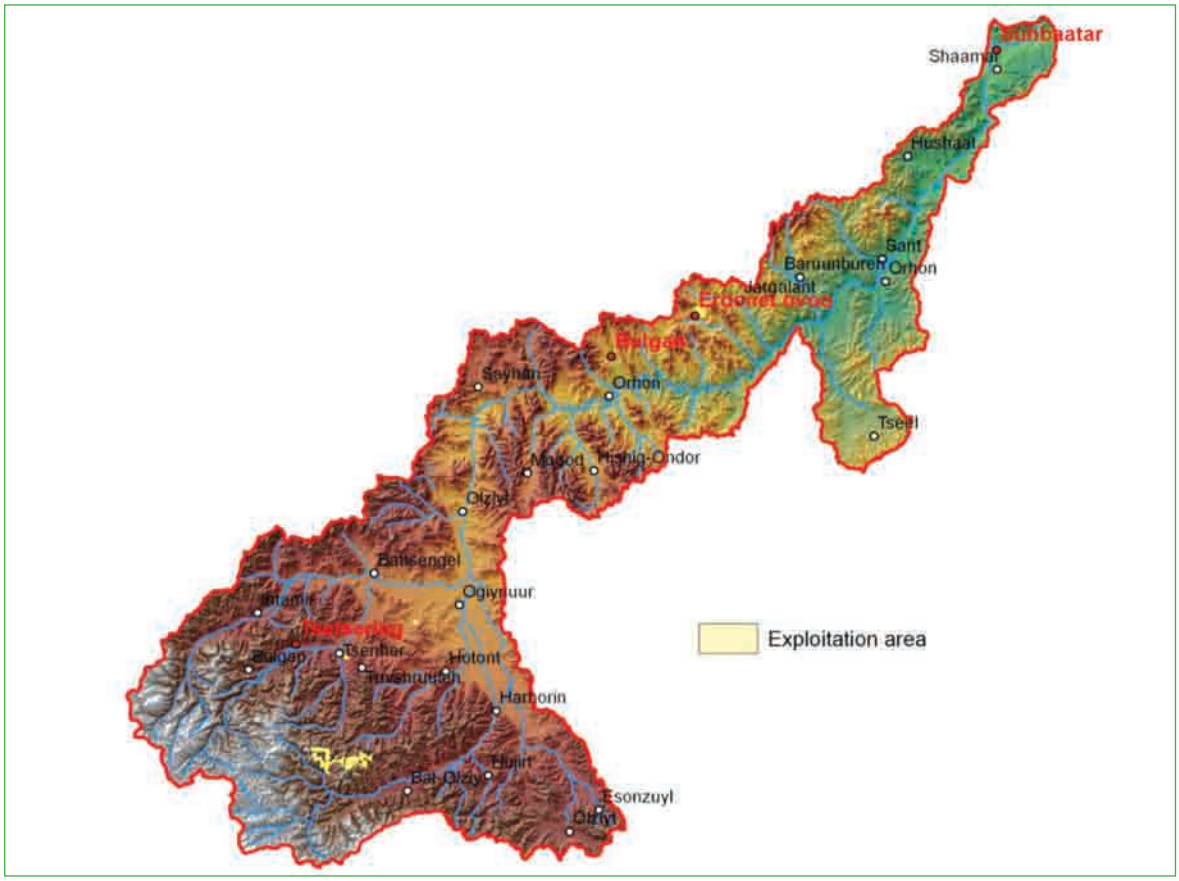


Figure 53. Location of mines in Orkhon river basin

Hydrogeology: There are 5 granular aquifers and 2 fissured aquifers in the Orkhon basin.

Granular aquifer formation in Holocene aged alluvial sediment: The granular alluvial aquifer is located along the whole length of the Orkhon River as shown on the 1:500,000 Mongolian hydrogeological map. The granular aquifer formation in Holocene aged alluvial sediment and metamorphic rock-fissured aquifer were found in the borehole number 43 which was drilled near Kharkhorin. The Holocene aged granular aquifer formation in alluvial sediment was found at a depth of 2.0 meters and the yield was 6.8 l/sec at a drawdown of 1.8 m.

The Holocene aged granular aquifer formation in alluvial sediment indicators were as follows in the boreholes of Khutul city water supply: groundwater yield was 11.9-33.4 l/sec; granular aquifer depth was 50-60 m in the field of Bajgar Ulaan where hydrogeological surveys were conducted; borehole yield was 0.3-6.8 l/sec; hydraulic conductivity is 4-26.4 m/day; aquifer transmissivity is 123-776.4 m^2/day. The groundwater composition was hydrocarbon-calcium-sodium-magnesium; chemical composition was 2.6-3.7 mg/l and *pH was 7.9-8.4*.

The Enkh-tal groundwater deposit found in the Orkhon river valley and the Sukhbaatar city water supply source has large resources with high yield. The alluvial aquifer located along the Orkhon valley is composed of gravel, sand, poor cemented conglomerate and rocks. The aquifer has a high storativity and transmissivity. In winter time, it does not freeze beyond 2.0 meters and has low risk of evaporation. The resources and yields are plentiful. The Holocene aged granular aquifer formation located in the Orkhon valley has much economical importance.

Granular aquifer formation in Pleistocene aged alluvial, proluvial, alluvial-proluvial sediment: The Pleistocene granular aquifer formation is located in separate areas and consists dominantly of debris. The aquifer may be 65-meter thick and comprises boulders, gravel, sand, sandy clay and clay.

Granular aquifer formation in alluvial, proluvial, proluvial-alluvial sediment of Holocene-Pleistocene age in side valleys: The survey is conducted for the purpose of using groundwater as a source for the cement-chalk factory water supply of Khutul city. According to the survey results, the aquifer is composed of Holocene-Pleistocene age alluvial, proluvial, proluvial-alluvial sediment. The groundwater was found at a depth of 5 m and pumping tests were done in 7 boreholes. The yield was estimated at 43.5-83.3 l/sec for a drawdown of 1.3-5.6 m. The water composition is hydrocarbon-calcium-magnesium.

The hydrogeological survey was conducted in 1980 on the granular aquifer formation in alluvial-proluvial sediment of Holocene-Pleistocene. During the survey, a groundwater aquifer was found in the Achuut river valley (a branch of Orkhon River) which can be used as water supply source of Bulgan aimag. The aquifer consisted of different types of sand, gravel with boulder and clay. The thickness of the aquifer was 14.9-54.9 m and the water level was 0.7-5.8 m. The hydraulic conductivity was 12.4-37.8 m/day and diffusivity was 46-120 thousand m^2/day.

Granular aquifer formation in Cretaceous age land-lake origin sedimentary aquifer: Its distribution is very limited in the Orkhon basin. This aquifer was surveyed in the coal mine of Saikhan ovoo. N.F. Chemodanova did a survey on mine hydrogeology and it was defined as Jurassic age. Ts. Khosbayar, J. Byamba and Ts. Maksbadar confirmed that Saikhan ovoo coal-containing sedimentary aquifer has lower Cretaceous age (geological figure at scale of 1:1,000,000, 1996). As for geomorphology, Saikhan ovoo mine is located in the basin of Khanui and Orkhon rivers. Most of the area is in the Orkhon basin. The mine came to light at the end of 1960s and beginning of 1970s due to geological researches.

Between 1971 and 1973, a survey to make geological mapping was conducted in the basin between Orkhon and Selenge rivers as well as Saikhan ovoo minefield. As B.Adyaa mentioned in his report on survey work results of Saikhan ovoo coal mine, main groundwater aquifer is Cretaceous age land-lake origin sedimentary aquifer (it is possible to have 0.01-0.3 l/sec yield from 1 square kilometer area).

In 1973, N.F. Chemodanova made an estimation on basic hydrogeological indicators and water amount to flow into the mine during the survey on western and eastern parts of Saikhan ovoo coal mine. She did short term pumping on boreholes number 122, 12 and 133. The yield was 0.02-0.2 l/sec and drawdown was 0.6-5.4 m.

The aquifer is composed of charcoal, sandstone, shell and compressed dun near Saikhan-Ovoo coal mine. Stable groundwater level is revealed at depth of 14.6-16.8 m. Based on hydrogeological conditions of Saikhan-Ovoo coal mine, lower cretaceous granular aquifer water is mixed and changeable. Generally water lacks. The groundwater is recharged by precipitation infiltration. There is continuous permafrost near Saikhan-Ovoo coal mine and it is unevenly distributed. The continuous permafrost is distributed in some

tributaries' valley of Orkhon river. Hydrogeological conditions should be studied in a more detailed way.

Fissured aquifer formation in Triassic – Jurassic aged sediments and Permian: It is located in following areas. They include: the upstream part of the Achuut river which flows through Bulgan aimag center; Toiloviin davaa; downstream of Teeg river and Bayanzurkh mountain (1851 m)-east part of Shuvuut river.

The free-surface water is revealed between the depth of 3 m and 28 m according to 45 boreholes data which revealed aquifers in Permian age layer. The yield of boreholes was 0.2-4.0 l/sec.

Fissured aquifers in sedimentary, sedimentary mafic, effusive, effusive-mafic, mafic rocks of Paleozoic age have broad distribution in the Orkhon basin, but water amount is basically low. The fissured aquifer water was found in 400 boreholes in this basin. It usually has hydraulic connections with Quaternary and other aquifer water.

Fissured aquifers in intrusive sediments: This type of aquifer is widely distributed in the Orkhon basin and the water quantity is not high. The water quality is good in most cases, so local people use it for water supply by drilling wells. According to Table 21, survey was conducted in 120 spots, groundwater level is between a depth of 0.7 m and 40 m. The yield fluctuates between 0.06 and 4.0 l/sec.

Table 21. Hydrogeological indicators of the Orkhon basin granular aquifers and fissured aquifers

No	Name	Number of boreholes used	Static level (m)	Yield (l/sec)
1	Holocene alluvial sediment	180	1-55.0	0.2-28.4
2	Granular aquifer formation in Pleistocene aged proluvial, alluvial-proluvial sediment	100	0.7-38	0.8-18
3	Granular aquifer formation in alluvial, proluvial sediment of Holocene-Pleistocene age in side valleys	80	2-40	0.5-11.0
4	Cretaceous aquifer	30	4-29	0.15-1.4
5	Fissured aquifer formation in Triassic – Jurassic aged sediments	45	3-28.0	0.3-4
6	Fissured aquifers in sedimentary, effusive, mafic rocks of Paleozoic age	280	0.4-96	0.02-11.7
7	Fissured aquifer in intrusive sediment	120	0.7-40	0.06-4

Hydrogeology-engineer-geological survey reports are used /which were conducted between 1933 and 2008/. The most important are: V.N.Popov (1932-1933), Z.A.Lebedeva (1933), K.A.Gomaniko, I.A.Anpipov (1944-1946), U.S.Jelubovski (1948), U.Mukhin, A.Botcharov (1956-1957), R.A.Kriger (1959-1960), V.A.Zaitsev, L.N.Kazuiseva, Z.V.Davletshina, N.N.Tichomirova and others (1974-1975, 1981-1985), Z.Narangerel (1968-1970), N.Jadambaa (1974-1977), N.Jadambaa, Z.Tserendorj, L.Enkhkhishig (1978-1980) and JICA (1992-1995) research report.

2.2.2. Groundwater resources

Natural renewable groundwater resources: The renewable groundwater resources are the groundwater resources which are replenished on average every year by infiltration of precipitation, by infiltration of surface water or by flow from adjacent groundwater aquifers or reservoirs.

The maximum of the renewable groundwater resources in the whole Orkhon river basin is 190 mm/year/km^2 in the upper part of Tamir river valley and near Ugii lake. The renewable groundwater resources are 110 mm/year/km^2 near the confluence of the Orkhon river and the Selenge river; 100 mm/year/km^2 near Khishig-undur; 10-50 mm/year/km^2 near the northeastern part of Burengiin ridge and Bayan-undur mountain near Erdenet city and 5 mm/year/km^2 in alluvial, proluvial sediment granular aquifers

and fissured aquifer which located near the mountains on the left and right sides of the Orkhon river valley. The renewable resources per 1 square kilometer are estimated as follows and it is focused on 6 different types of area.

- 50-100 mm/year or 75000 m^3/year/km^2 on average
- 20-50 mm/year or 35000 m^3/year/km^2 on average
- 10-20 mm/year or 15000 m^3/year/km^2 on average
- 5-10 mm/year or 7500 m^3/year/km^2
- 0-5 mm/year or 5000 m^3/year/km^2
- Mixed or 10-190 mm/year/km^2

It is presented in Table 22 and Figure 54.

Table 22. Estimate of Orkhon river basin renewable groundwater resources

Classification of renewable resources *(mm/year/km²)*	Area *(km²)*	Average flow *(mm/year)*	Renewable resources *(mln m³/year)*
Extremely low (0-5)	21,809.0	5.0	109.0
Low (5-10)	10,072.0	7.5	76.0
Low to average (10-20)	8,544.0	15.0	128.0
Average (20-50)	5,625.0	35.0	197.0
Average to high (50-100)	1,591.0	75.0	119.0
Mixed (10-190)	6,145.0	10.0-190.0	819.0
Total	53,786.0		1,448.0

From this table, it is 5 mm/year or 5000 m^3/year per 1 km^2, it is clear that extremely low renewable resources cover an area of 21,809 km^2 or 40.1% of the total area of the Orkhon river basin containing 7.5 percent of the total renewable groundwater resources. An area of 6,145 km^2 or 11.4% of the total basin area with mixed renewable resources of 10-190 mm/year contains 56.5 percent of the renewable groundwater resources. The most renewable groundwater resources are formed and recharged in the granular alluvial deposits of the river valley.

Potential exploitable groundwater resources: The potential exploitable groundwater resources are the groundwater resources which may be abstracted from renewable groundwater resources taking into account the dimension (area, saturated thickness) and the properties (granular, fissured) of the aquifer, the recharge to the aquifer and the estimated capacity of the proposed wells. The potential exploitable groundwater resources are derived from the Hydrogeological Map of Mongolia at scale 1:1,000,000. The potential exploitable groundwater resources per 1 km^2 are divided into the following 7 classifications:

- 10 l/sec/km^2
- 3-10 l/sec/km^2
- 1.0-3.0 l/sec/km^2
- 0.3-1.0 l/sec/km^2
- 0.03-0.3 l/sec/km^2
- 0.003-0.03 l/sec/km^2
- <0.0003 l/sec/km^2

It is presented in Figure 55.

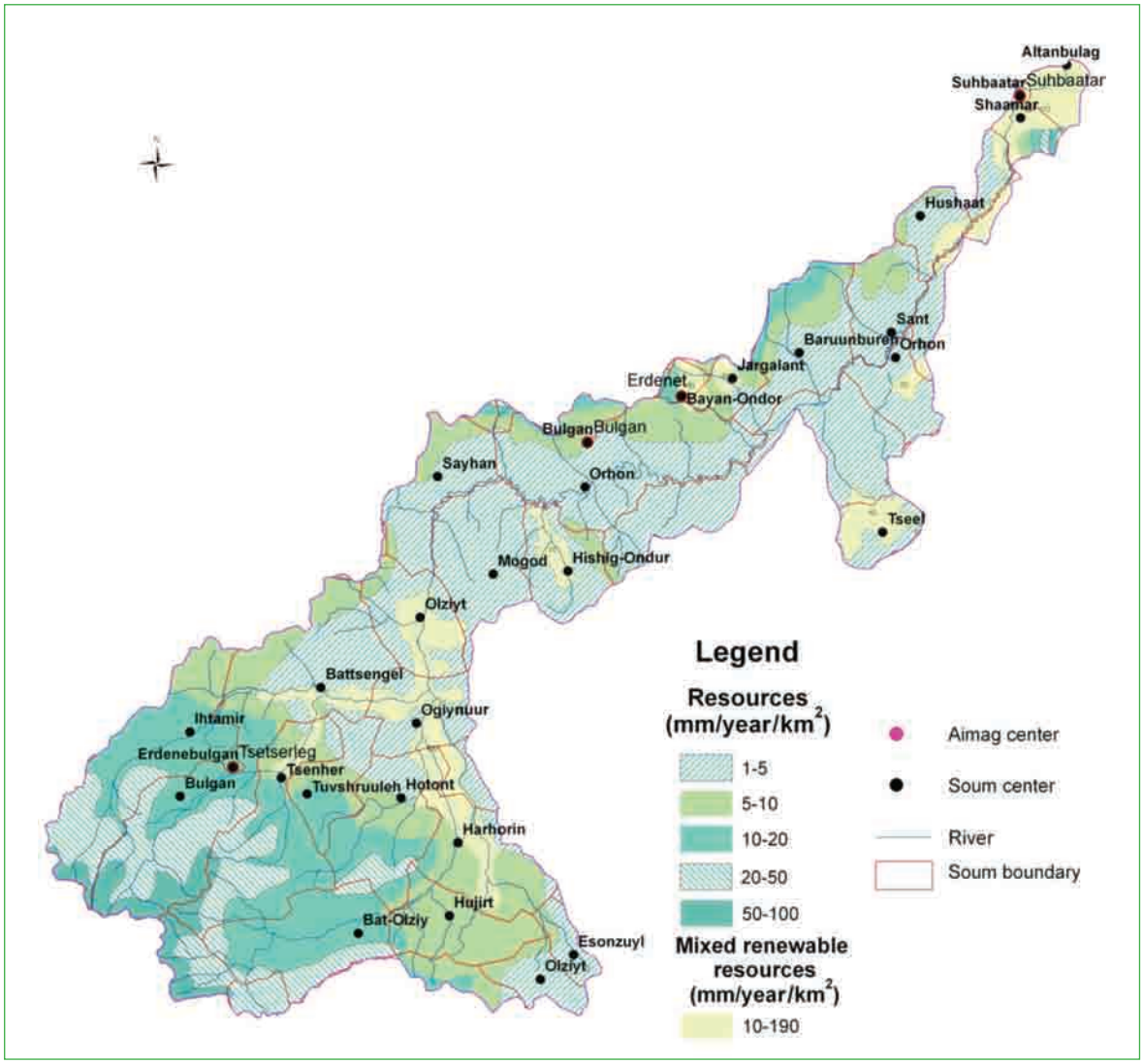


Figure 54. Renewable groundwater resources map of the Orkhon river basin

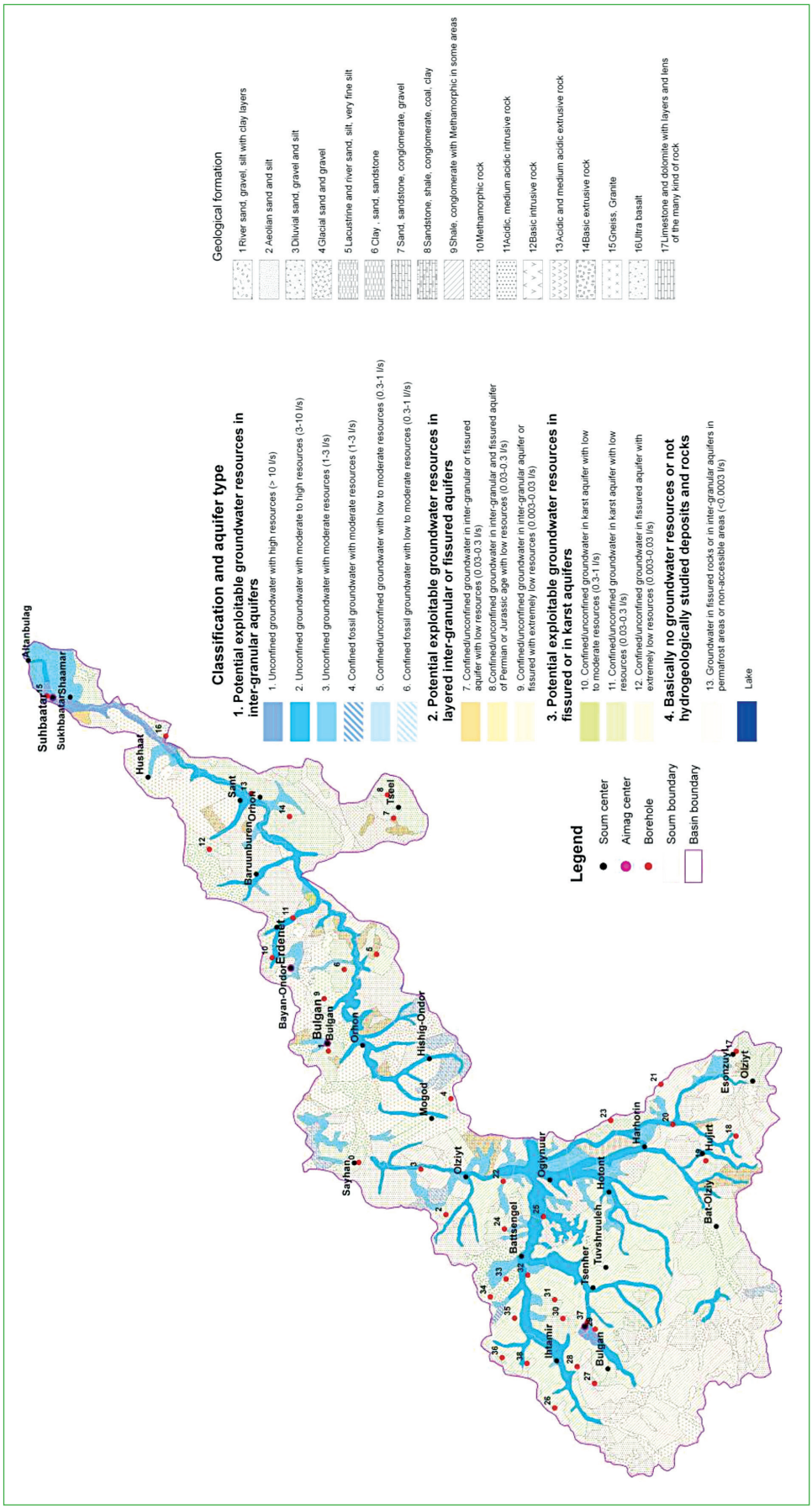


Figure 55. Potential exploitable groundwater resources map of the Orkhon River Basin

There are 842 million m^3/year potential exploitable groundwater resources in the total area of 53,786 km^2 in the Orkhon river basin. It is possible to extract 10 l/sec groundwater from 1 km^2 from the area where Orkhon River (downstream) meets Selenge River. The possibility is that 3-10 l/sec yield water can be extracted from 1 km^2 area where granular alluvial aquifers are distributed in the valley of Orkhon, Khoid and Urd Tamir, Tsenkher and Khugshin Orkhon rivers.

Exploitable groundwater resources: Some 25 soum centers of 6 aimags and Sukhbaatar, Bulgan, Tsetserleg and Orkhon aimag centers are located in the Orkhon basin. Hydrogeological surveys were conducted to estimate the groundwater resources of the Sukhbaatar, Bulgan and Tsetserleg centralized water supply sources.

Orkhon aimag center takes its drinking water demand from the Selenge basin. No specific groundwater surveys were done for the soum centers water supply. 10 soum centers are located in or near the flood plain of the Orkhon River and the soum center population uses surface water and groundwater. The other 15 soum centers do not have rivers, springs, ponds nearby and they use groundwater only. Each soum center has 2-3 boreholes. Some 67 boreholes are used for the water supply of these 25 soum centers (Table 23).

Table 23. Water sources used for Orkhon river basin-soum center population water supply

№	Aimag	Soum center	Water source	Number of boreholes	Yield (l/sec)
1	Arkhangai	Ikh Tamir	Khoid Tamir river and boreholes	4	0.7
2		Ugiinuur	Orkhon river, boreholes	3	3.6
3		Battsengel	Khoid Tamir river and boreholes	3	5
4		Bulgan	Zuunmod river, boreholes	3	2
5		Ulziit	Orkhon river, boreholes	2	4
6		Khotont	Jarantain river, boreholes	3	3.1, 1.3
7		Tsenkher	Urd Tamir, boreholes	2	2.5, 8
8		Tuvshruulekh	Boreholes	3	1, 1.5
9	Bulgan	Khishig Undur		2	3
10		Saikhan	Boreholes	2	0.45, 1.5
11		Orkhon	Orkhon river, boreholes	2	2
12		Mogod	Boreholes	2	
13	Orkhon	Jargalant	Boreholes	6	3
14	Uvurkhangai	Yusunzuil	Springs, borehole	1	3.5
15		Ulziit	Khuisiin river, boreholes	2	2.2
16		Bat Ulzii	Boreholes	3	1, 5, 4
17		Khujirt	Khujirt river, boreholes	3	5.5, 2.4, 2.7
18		Kharkhorin	Orkhon river, boreholes	6	5
19	Selenge	Altanbulag	Springs, boreholes	3	0.7
20		Khushaat	Orkhon river, boreholes	2	
21		Baruunburen		3	3.3
22		Orkhon	Orkhon river, boreholes	1	0.7, 3
23		Sant	Boreholes	3	1, 3.3
24		Shaamar	Orkhon river, borehole	1	1.5
25	Tuv	Tseel	Boreholes	2	5
	Total			67	

Groundwater aquifer of Sukhbaatar city: The city of Sukhbaatar has much surface water and groundwater resources, especially along the Orkhon and Selenge rivers. Alluvial and alluvial-proluvial sediment aquifers have much water in a large area. The boreholes can be drilled and used without doing any pre-hydrogeological surveys.

In 1983, R.Byambadorj did a survey on centralized sources of Sukhbaatar city. He revealed that there are sufficient resources that can supply Sukhbaatar city water demand for many years in terms of hydrogeology. He did it with the aid of only 2 boreholes. According to the survey of Sukhbaatar city centralized water supply sources, boreholes number 3 and 4 were drilled with a small diameter.

The yield of the boreholes was 38.4-48.2 l/sec; drawdown was 2.45-3.73 m; hydraulic conductivity was 42.5 m/day; diffusivity was $1x10^4$ m^2/day and aquifer thickness was over 100 m. It has been 25-26 years since preparing the aquifer for the extraction. The groundwater exploitable resources at Sukhbaatar city were recalculated in 2008 at 17,280 m^3/day. It was done by "Tuv-Us" LLC.

Groundwater aquifer of Tsetserleg city: N.Munkhbaatar estimated that the alluvial sediment aquifer in the Urd Tamir river valley gives 19.9-31.2 l/sec yield and groundwater exploitable resource is 10,082.8 m^3/day. The groundwater exploitable resources at Tsetserleg were recalculated in 2012 at 5,702.4 m^3/day. It was done by "Ar Chandmani" LLC. The source is being used in aimag center water supply.

Groundwater aquifer of Bulgan city: D.Khatanbaatar conducted groundwater research between 1983 and 1984. The groundwater use resource was 4907.6 m^3/day.

Erdenet city water supply sources: Erdenet city water supply source is located 61 km from the city. It is in the Selenge river valley and relevant data is put into the National groundwater report. The deposit's exploitable groundwater resources are total 247500 m^3/day, divided in A category 112000 m^3/year and C_2 category 135500 m^3/year as calculated by PNIIS institute.

Groundwater aquifer of Khutul: Khutul is one of the Mongolian important cement producing areas. The main water supply sources are located in the downstream part of the Nelge river which flows into Orkhon river.

The groundwater aquifer was first explored by a Russian hydrogeological expedition in 1980. They drilled 7 exploratory boreholes and the yield was 42.5-83.3 l/sec for a drawdown of 1.3-5.6 m (pumping). The groundwater exploitable resources of Nelge were estimated at 7,000 m^3/day [Borovikova, 1981].

Groundwater aquifer of Barjgar Ulaan: This aquifer is located on the east bank of the Orkhon River in Selenge aimag and it is 2-2.2 km from the river bed. It is an alluvial granular aquifer composed of gravels and sand. The thickness is 30-60 m; permeability is 4-26.4 m/day or 19.6 m/day on average; transmissivity is 123-776.4 m^2/day or 388.4 m^2/day on average and diffusivity is $7.6x10^3$ m^2/day. The groundwater is found at a depth of 1.5-4.5 m in the boreholes. The yield is 2.5-15 l/sec for a drawdown of 4.0-8.9 m. The specific yield is 0.6-3.8 l/sec. The mineralization is 0.3 g/l and the water composition is hydrocarbon-calcium-sodium-magnesium. The water hardness is 2.6-3.7 mg-equiv/l. The groundwater exploitable resource is 1.98 thousand m^3/day (Nyatdari, 1989). The level is $A+C_1$.

Groundwater aquifer of Enkh Tal: Enkh Tal is the source of Orkhon aimag's fruit and vegetable farms and Gombosuren conducted aquifer survey works (1985). The borehole's yield was 28 l/sec and permeability was 57 m/day. The water composition is hydrocarbon-calcium-sodium. The mineralization is 0.2-0.3 g/l and hardness is 3.1-5.9 mg-equiv/l.

The potential exploitable resource of Enkh Tal's groundwater aquifer is 5,500 m^3/day. The hydrogeological research was conducted in Orkhon river basin. The deposits, whose groundwater use resources are approved, are presented in the table below.

Table 24. List of approved groundwater deposits

No	Aimag	Soum	Name of aquifer	Resource, m^3/day	Location	
					X	Y
1	Uvurkhangai	Kharkhorin	Orkhon	10,800.0	102.796278	47.155389
2	Arkhangai	Battsengel	Shivert	432.0	101.5	47.6
3	Arkhangai	Bulgan	Urd Tamir river	10,545.3	101.366667	47.416667
4	Arkhangai	Bulgan	Urd Tamir-Taruu river	5,702.4		
5	Arkhangai	Tuvshruulekh	Del bag	910.87	102.241667	47.625
6	Bulgan	Orkhon	Maidar river	4,907.5	103.55	48.841667
7	Bulgan	Bugat	Maidar river	4,907.5	103.425	48.783333
8	Bulgan	Orkhon	Upper part of Chingel river	2,073.6	104.006944	48.935
9	Bulgan	Orkhon	Middle part-1 of Chingel river	1,028.16	104.001944	48.877222
10	Bulgan	Orkhon	Middle part-2 of Chingel river	2,021.76	104.127778	48.968056
11	Bulgan	Orkhon	Down part of Chingel river	2,073.6	104.168056	48.936111
12	Orkhon	Bayan-Undur	Govil river valley	1,696.8	104.088056	49.076111
13	Orkhon	Bayan-Undur	Erdenet river	2,109.5	104.0075	49.0075
14	Selenge	Khushaat	Orkhon /Enkhtal/	5,500.0	106.033333	49.716667
15	Selenge	Zuunburen	Orkhon	17,280.0	106.187083	50.22175
16	Selenge	Saikhan	Narstiin khudag	501.0	105.602222	49.109444
17	Selenge	Orkhon	Nelge	7,000.0		

2.2.3. Groundwater quality and chemical composition

Groundwater resources in Mongolia are not equally distributed and their quality is relatively different from one another. For the territory, there has been observed that mineralization tends to increase from west to east and from north to south. This is related to climate change such as precipitation volume, air temperature and evaporation increase, as well as basic property /or main feature/ of aquifer rock which contains the water. Shallow groundwater which is being used for the purpose of water supply in any region is affected by extreme continental climate especially, hot and cold air, quarterly changes in precipitation. In the result, its water resource, quality and composition have been changed not only regionally, but there is a constant change within the same geographical region. This climate condition leads to erosion, absorption and salt accumulation of soil and stone/rock, and it becomes main factor which affects the formation of chemical composition of natural water in the related region.

Although there are not few materials about research in the field of identifying groundwater quality and chemical composition, some drawbacks/disadvantages have been commonly observed such as water sample was taken at random; water quality and composition were not closely related to geographic formation, soil, rock/stone and climate feature in the related region; chemical analysis was limited by only identifying main element and pollution indicators; research on microelement and bacteriology were put aside, etc.

Water mineralization in total water/irrigation point in Arkhangai, Uvurkhangai, Bulgan, Darkhan Uul and Selenge aimags included in the Orkhon river basin in Central and Khangai region is less than 1.0 g/l and compared to Gobi region, it shows relatively fresh water.

In northern Mongolia, fresh water subject to hydrocarbonate class, Na and Ca group, /HCO_3^->SO_4^{2-}>Cl, Ca^{2+}>Mg^{2+}>Na^+/ is dominantly distributed.

***Groundwater quality and chemical composition of the Orkhon river basin upstream part*:** The upstream part covers some 6 south and south-west soums of Arkhangai aimag such as Bulgan, Ikh Tamir, Erdenebulgan /Tsetserleg/, Tsenkher, Tuvshruulekh and Khotont; some 3 soums of Uvurkhangai aimag in full such as Bat Ulzii, Khujirt and Kharkhorin, as well as north part of Ulziit soum, west and north-west part of Yusun Zuil soum, north-east part of Zuunbayan Ulaan soum, respectively.

The chemical composition of the water in the wells in the region included in the Orkhon river basin upstream part, hydrocarbonate ion solely prevails, calcium ion is mostly dominant rather than cation, water type 1-2, Na group is 5.8% or in few cases, mixed group is 3.5%, and there hasn't been any water in which Mg ion solely prevails.

Table 25. Mineralization in well water located in the Orkhon river basin upstream part

Total water points	Mineralization level and classification, mg/l					
	I	II	III	IV	V	VI
	<200	201-500	501-1000	1001-3000	3001-7000	>7001
86	20	59	4	2	1	-

Considering mineralization in well water in the upstream part, 96.5% meets the quality standard and remaining 3.5% is subject to more mineralization than the standard. There were some water/irrigation points with larger mineralization /1820 mg/l/ than the standard in the territory of Kharkhorin soum, Uvurkhangai aimag. Besides, water drawn from the well with a tube in the Musun zoorit channel in the territory of Bat Ulzii soum in 1979 was subject to salty /mineralization 4040 mg/l/, very hard /hardness 29.2 mg-eqv/l/, and for a chemical composition, it was subject to chlorine-sulphate class, Na group and type 3. It's different from other wells in this part and this well water is not suitable for any water use.

Table 26. Hardness in water well in the Orkhon river basin upstream part

Total water points	Hardness level and classification, *mg-eqv/l*					
	I	II	III	IV	V	VI
	<1.5	1.51-3.0	3.01-5.00	5.01-7.00	7.01-9.00	>9.01
86	7	32	43	1	2	1

Water drawn from the well which was deeply drilled in the north-west part of Khotont soum centre, Arkhangai aimag was hard and therefore, water softening equipment has been installed. One water point in the territory of Kharkhorin soum has hardness that exceeded the related standard.

Nitrogenous compounds which are mostly originated by disintegration of nutritious substance (NH_4^+, NO_2^-, NO_3^-) have been substantially detected in the regional water point. But ammonium (NH_4^+) and nitrite (NO_2^-) are dominant. These ions have been not slightly detected in the water points in Khangai region. Consequently, plant cover makes nitrogenous compounds as nutrition and this might be associated with small damage and percolation in soil cover. This property is also seen from volume of permanganate oxidation.

Oxidation: In this region, some 95.8% of water/irrigation points have an oxidation ranging from 1.5-5.6 mg/l which is an indicator of organic pollution and meets the standard. But some 6 water points with exceeded oxidation /oxidation 12-30 mg/l/ are in the territory of Bat Ulzii, Kharkhorin and Khujirt soums of Uvurkhangai aimag. The pH of water points in this part ranges (pH 6.4-8.2) from weak acidity to weak alkalinity environment.

Iron ion, one of biological active compound, has been not slightly detected in total regions. Iron contained in mountain stone/rock is different from one another, but most

one is muddy/clay aquifer (5.5-8.5%). Therefore, iron content may be associated with stone/rock which contains water in the related region. In view of iron, zinc and oxide, etc which have been identified in relatively few water points in the region, SiO2 6.0-16.0 mg/l and some 6 water points /0.5-1.2 mg/l/ exceeded the standard have been detected by iron content and free carbonic gas content.

***Groundwater quality and chemical composition of the Orkhon river basin midstream part*:** In this part, we have made analysis and processing of the results from researches on 160 wells in the territory of Ugii Nuur, Battsengel and Ulziit soums of Arkhangai aimag; south part of Mogod, Saikhan, Khishig Undur, Orkhon, Bulgan and Bugat soum of Bulgan aimag; Erdenet, Jargalant and Bayan Undur soums of Orkhon aimag; Tseel soum of Tuv aimag; half east part of Baruunburen and Orkhontuul soums, and Orkhon soum of Selenge aimag.

Water mineralization and hardness towards south direction in the region tends to increase if it is considered at level of total territory.

If considering total well water in the midstream by their *mineralization,* 95% have fresh water which meets the required standard and 5% or some 8 water points have water with large mineralization. And its 6 points are located in the territory of Mogod soum, Bulgan aimag /mineralization 1004-1746mg/l/, one is located in Orkhon soum / mineralization 2101mg/l/, and last one is in Erdenet /mineralization 1450 mg/l/.

Table 27. Mineralization in well water in the Orkhon river basin midstream part

Total number of water points	Mineralization level and classification, mg/l					
	I	II	III	IV	V	VI
	<200	201-500	501-1000	1001-3000	3001-7000	>7001
160	15	105	32	8	-	-

For mineralization, 9.4% of water/irrigation points is subject to very fresh or level I, 65.6% is subject to fresh or level II, 20% is subject to slightly fresh or level III, 5% is subject to slightly salty or level IV and there is no water point which is subject to salty level.

If considering total well water in the midstream part by their *hardness,* 82.5% is subject to fresh water which meets the standard, 10% is in the accepted maximum level however, more than the appropriate level, and 6.9% is subject to hardness more than the standard.

Table 28. Hardness in well water in the Orkhon river basin midstream part

Total number of Water points	Hardness level and classification, mg-eqv/l					
	I	II	III	IV	V	VI
	<1.5	1.51-3.0	3.01-5.00	5.01-7.00	7.01-9.00	>9.01
160	5	26	101	17	8	3
	3.1%	16.2%	63.1%	10.6%	5.0%	1.9%

Hard water has been found in some 3 wells in Mogod soum, 2 wells in Orkhon soum and 2 wells in Khishig Undur soum of Bulgan aimag. Moreover, almost all the wells in the vicinity of Erdenet soum, Orkhon aimag have very hard water /hardness 6.85-14.80 mg-eqv/l/, Mg ion is dominant in its hardness and mineralization 628.7-1459.6 mg/l or relatively high. But water in the boreholes which were drilled in valley of the Chingeltei River is slightly less than the wells around Erdenet /hardness 1.45-5.75 mg-eqv/l/, Mg ion is dominant in its hardness and mineralization is 227-751 mg/l or high.

The chemical composition of the groundwater in the midstream part is mostly subject to hydrocarbonate class but in few events, chlorine and mixed classes in the region

of Bulgan and Erdenet. For cation, percent of Na ion is increased, Ca and Na ion is dominant, and water type 1-2 compared to the upstream part. There were some 2 water points in which Mg ion is dominant in Mogod soum. Besides, 2 water points in which Ca and Mg ion is dominant, and some 4 water points with mixed class in Erdenet.

For water environment, it ranges in standard level or between pH 6.6-8.0. According to pollution indicator, pollution of ammonium ion has been detected in few water points. For instance, there are some wells which exceeded the standard such as one well in Saikhan soum, one in Mogod soum, one in Bugat soum, one in Orkhon soum of Bulgan aimag and two wells in Tseel soum of Tuv aimag, respectively. There have been some 8 water points which were subject to organic pollution.

Groundwater quality and chemical composition of the Orkhon river basin downstream part: In this part, we have made analysis and processing on the results from researches on approx. 60 wells water by covering most part of Sant soum, south part of Khushaat and Zuunburen soums, and Shaamar and Altanbulag soum of Selenge aimag.

If considering total well water in the downstream part by their *mineralization,* there is no water point in which mineralization is exceeded the standard.

Table 29. Mineralization in well water in the Orkhon river basin downstream part

Total number of water points	Mineralization level and classification, mg/l					
	I	II	III	IV	V	VI
	<200	201-500	501-1000	1001-3000	3001-7000	>7001
55	-	34	21	-	-	-
%	-	61.8	38.2	-	-	-

Table 30. Hardness in well water in the Orkhon river basin downstream part

Total number of water points	Hardness level and classification, mg-eqv/l					
	I	II	III	IV	V	VI
	<1.5	1.51-3.0	3.01-5.00	5.01-7.00	7.01-9.00	>9.01
55	1	17	23	9	3	2
	1.8%	30.9%	41.8%	16.4%	5.5%	3.6%

All 5 water points with hardness exceeding the standard were found in Altanbulag free zone. There have been some 4 points with slightly hard water in Altanbulag soum, 3 in Sukhbaatar soum, 1 in Khushaat soum and 1 in Shaamar soum, respectively.

For chemical composition, its water is subject to hydrocarbonate class. In Altanbulag region, there were 2 water points subject to sulphate and hydrocarbonate-sulphate classes. For cation, mostly subject to Ca class and type 1-3. Also there were 11 water points in which Na ion is dominant, 6 points with mixed class, 2 points in which Mg ion is dominant, 7 points in which Mg ion is dominant in its hardness and its 5 points exceeded the standard. Compared to the upstream and midstream parts, some water points with water type 3 have been detected substantially in this part.

Water environment pH relatively ranges 6.4-8.8 and there has been one case in which less than the standard in one water point /pH 6.4/ in Sukhbaatar soum and more than the standard in one water point /pH 8.8/ in Altanbulag soum, and others were in the standard level. According to pollution indicator, pollution of ammonium ion exceeded the standard in 2 water points in Sukhbaatar soum and 1 well in Altanbulag soum. Permanganate oxidation which is an organic pollution exceeded the standard in one well in Zuunburen soum and other points in the standard level.

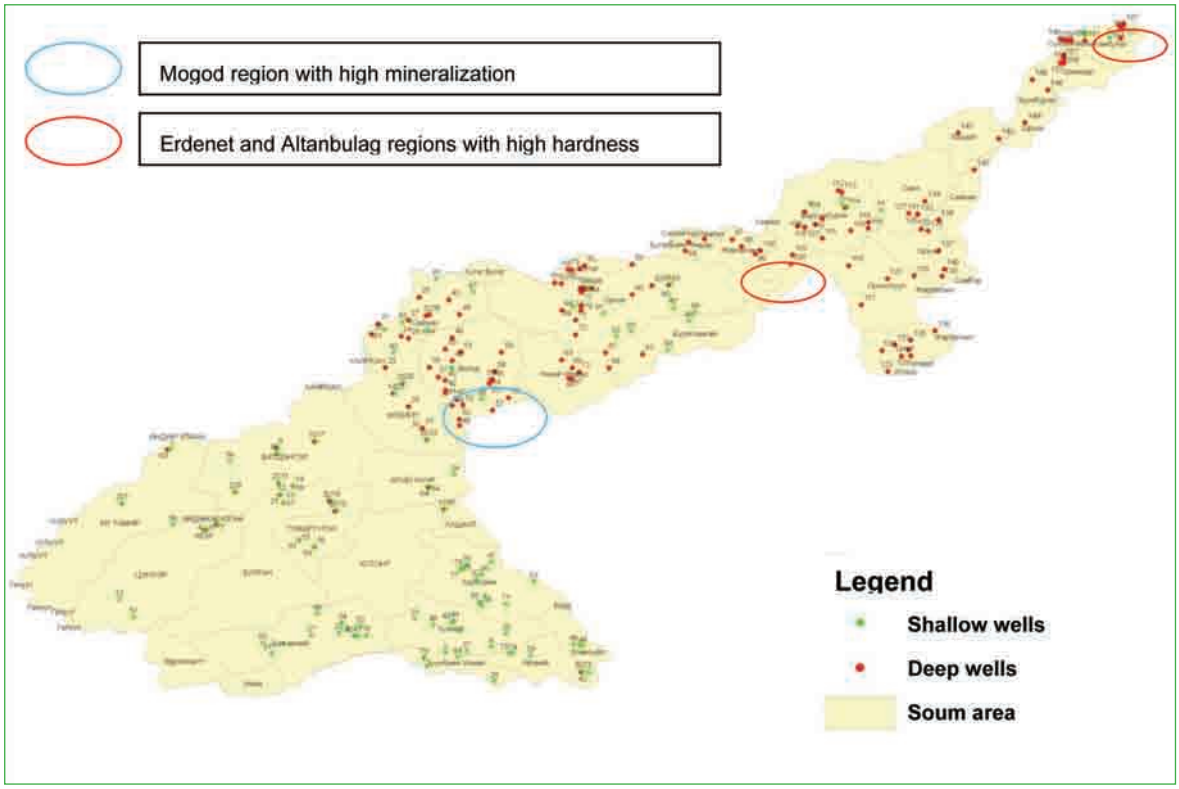


Figure 56. Location of boreholes included in Orkhon river basin survey, regions with mineralization and hardness which exceeded the standard

2.2.4. Groundwater monitoring

Within the framework of "Strengthening Integrated Water Resources Management in Mongolia" project, 11 groundwater monitoring boreholes are equipped and observed in the Orkhon river basin. Data loggers are installed in these boreholes and measuring data is collected at intervals of 3-6 months. Both groundwater quality and groundwater level monitoring will be conducted in these monitoring boreholes.

NAMHEM conducts monitoring in one groundwater monitoring borehole in Tsetserleg city. But measurement is not continuous, in some years the measurement is not done. The groundwater level is measured by hand in the borehole.

2.2.5. Some springs in the basin and their quality and chemical composition

Springs in the upstream part of the basin and their quality and chemical composition: The parts of Arkhangai and Uvurkhangai aimags, which are included in the Orkhon river basin, have much surface water. There are plenty of mineral springs. Many hot springs are concentrated in this area. It is located in Khangai sub zone of the hot springs 3rd zone. Like groundwater, the following parts are included in this part: Bulgan, Ikh Tamir, Erdenebulgan (Tsetserleg), Tsenkher, Tuvshruulekh and Khotont soums of Arkhangai aimag; Bat-Ulzii, Khujirt and Kharkhorin soums of Uvurkhangai aimag; northern part of Ulziit soum of Uvurkhangai aimag; west and northwestern part of Yusunzuil soum of Uvurkhangai aimag; northeastern part of Zuunbayan Ulaan soum of Uvurkhangai aimag.

Figure 57. Location of monitoring boreholes in the Orkhon river basin

Table 31. General indicators of chemical analyses in the mineral springs in the Orkhon river basin upstream part

No	Name of spring/spa	Location	Research year and researcher	Main ion index	Mineralization g/l	Hardness mg-eqv/l	pH	T °C	H_2S mg/l	Remarks
0	1	2	3	4	5	6	7	8	9	10
1	Tsenkher hot spa	47°19′00.4″ 101°39′08.2″	1955, Sh.Tseren	C^{Na}_{I}	0.24	0.20		90	11.6	Spa resort, sanatorium and entity
			1985, Genscheme	C^{Na}_{I}	0.33		8.8	86	10.0	Q-10.0 litre/second
			2005, Geoecology	CO^{X}_{II}	0.32	0.30	7.9-8.5	80-85		Q-3.8 l/s /main yield not included/
			2009, Geoecology	CO^{Na}_{I}	0.24	0.10	8.89	86.2	3.7	4 tourist camps
2	Bor Tal hot spa	47°11′19.7″ 101°35′35″	1957, Sh.Tseren	C^{Na}_{I}	0.26	0.25	8.0	42	4.6	
			1985, Genscheme	CCO^{Na}_{I}	0.26		9.0	46	12.0	Q-4.5 l/s
			2005, Geoecology	CCO^{X}_{II}	0.28	0.35	8.9	41-43	Used for daily wash by locals	
			2009, Geoecology	CO^{Na}_{I}	0.19	0.05	8.95	45-50		

No	Name of spring/spa	Location	Research year and researcher	Main ion index	Mineralization g/l	Hardness mg-eqv/l	pH	T °C	H_2S mg/l	Remarks
0	1	2	3	4	5	6	7	8	9	10
3	Gyalgar (Gyalaan) hot spa	47°12′07″ 101°30′16″	1957, Sh.Tseren	CO^{Na}_{I}	0.21	0.15	8.1	50		
			1985, Genscheme	CCO^{Na}_{I}	0.35		9.0	52	12.0	Q-1.0 l/s
			2005, Geoecology	C^{X}_{II}	0.34	0.25	8.9	40-52	Many hot and warm yields	
			2009, Geoecology	CO^{Na}_{I}	0.19	0.05	8.7	44-54	Borehole near the spa and tourist camp is being built	
4	Tsagaan Sum (Jarantai) hot spa	47°04′01.7″ 102°05′56″	1957, Sh.Tseren	X^{Na}_{I}	0.18	0.20	7.6	59-69	9.2	It has 5-6 yields and each yield has different algae
			1985, Genscheme	CCO^{Na}_{I}	0.29		8.8	69	18.0	Q-8.0 l/s
			2005, Geoecology	C^{Ca}_{I}	0.25	0.30	8.1	65		There are 3 tourist camps
			2009, Geoecology	CCO^{Na}_{I}	0.21	0.15	8.38	56-71		
5	Khukh Sum (Bor Burgas) spring	47°15′ 101°58′05″	1957, Sh.Tseren	C^{Ca}_{I}	0.21	2.0	7.8	8		Stomach and internal disease
			2005, Geoecology	C^{Ca}_{I}	0.37	3.45	7.1	12	Main Q	
			2005, Geoecology	C^{Na}_{I}	0.21	1.0	7.4	6.4		Wooden houses for guests
6	Shart spring	47°01′41.8″ 101°39′21″	1960, Sh.Tseren	C^{Ca}_{I}	0.26	3.2	6.8	4		Variety of stomach and internal disease
			2009, Geoecology	C^{Ca}_{I}	0.20	2.25	7.82	2.1		Not used for gall bladder disease
7	Jamgan spring	47°29′18.4″ 101°27′16″	1960, Sh.Tseren	C^{X}_{I}	0.12	1.10	6.8	1		
			2005, Geoecology	C^{CaMg}_{I}	0.14	0.90	6.8	1-2		Internal disease
			2009, Geoecology	C^{Ca}_{I}	0.10	1.05	6.86	4.0		Source is protected
8	Gants Mod spring	47°28′57″ 101°25′25″	2005, Geoecology	C^{CaMg}_{I}	0.14	0.80	7.2	1-2		Internal disease
			2009, Geoecology	C^{Ca}_{I}	0.09	1.00	7.4	4.7		Source is protected
9	Altan Ovoo spring	47°24′01″ 101°45′	1957, Sh.Tseren	C^{Ca}_{I}	0.37	2.6	6.8	3		Variety of stomach and internal disease
10	Ulziit Tolgoi spring	47°37′ 102°00′	1957, Sh.Tseren	C^{Na}_{I}	0.23	1.56	6.6	7		Variety of stomach and internal disease
11	Ikh Teel spring	47°16′ 101°39′30″	1960, Sh.Tseren	C^{X}_{I}	0.22	2.11	6.6	6		Stomach acid increase or decrease, headache and rheumatic
12	Baishin Bulag spring	47°13′30″ 102°34′	1960, Sh.Tseren	C^{Ca}_{I}	0.30	2.57	6.8	3	Internal disease	

No	Name of spring/spa	Location	Research year and researcher	Main ion index	Mineralization g/l	Hardness mg-eqv/l	pH	T °C	H_2S mg/l	Remarks
0	1	2	3	4	5	6	7	8	9	10
13	Khujirt hot spa	46°54′04.8″ 102°46′22.1″	1927, V.A.Smirnov	CO^{Na}_{I}	256.6	0.74	9.4	39	9.37	H_2SiO_3-105.9 mg/l
			1934, expedition of Health Ministry	C^{Na}_{I}	256.3	0.42	7.9			H_2SiO_3-17.8 mg/l
			1944, V.N.Popov	CO^{Na}_{I}	209.5	0.15	8.4	45	3.9	H_2SiO_3-48.8 mg/l
			1945, V.N.Popov	X^{Na}_{I}	205.5	0.16	8.4	52	5.2	H_2SiO_3-98.8 mg/l
			1957, Sh.Tseren	CO^{Na}_{I}	163.3	0.26	8.0	40	4.4	H_2SiO_3-58.8 mg/l
			1957, Sh.Tseren	CO^{Na}_{I}	249.2	0.30	8.2	53	8.2	H_2SiO_3-100 mg/l
			1985, Genscheme	CO^{Na}_{I}	290.0		8.6	55	12.0	It has a therapeutic mud. Elma Khujirt camp's borehole T-56.2°C, pH-9.056
			2005, Geoecology	CO^{Na}_{I}	260.0	0.20	9.1	42-53	+	
			2009, Geoecology	C^{Na}_{I}	239.8	0.65	8.7	52	+	
14	Mogoit hot spa	46°44′50.7″ 102°13′56.3″	1957, Sh.Tseren	CO^{Na}_{I}	320.0		8.4	50	16 yields for each human organ	
			2009, Geoecology	CO^{Na}_{I}	207.3	0.05	8.5	45-73	It's owned by "Ombo" LLC. There are 10 yields	
15	Khamar hot spa	46°44′35.1″ 102°08′18.4″	2009, Geoecology	C^{Na}_{I}	199.3	0.35	8.7	24	T-5.4°C, pH-7.47, C^{CaNa}_{I}, mineralization 72 mg/l	
16	Gyatruun hot spa	46°38′41.8″ 101°56′49.7″	1957, Sh.Tseren	CO^{Na}_{I}	210.6	0.15	8.2	50	6.1	H_2SiO_3-54.1 mg/l
			2009, Geoecology	C^{Na}_{I}	126.3	0.30	8.5	30-38	10 yields for each human organ	
17	Gyatruun cold spring	46°38′47.5″ 101°56′51.1″	2009, Geoecology	C^{Ca}_{I}	32.1	0.30	6.6	1.4	Chemical composition is similar to rain water	
18	Khust spring	46°53′34.5″ 102°19′28.6″	2009, Geoecology	C^{Na}_{I}	134.0	0.60	7.5	3.8	Number of yields for each human organ	
19	Uurtiin Tokhoi spring	46°53′31.1″ 102°22′43.6″	2009, Geoecology	C^{Na}_{I}	2665	9.90	6.1	8.6	CO_2-1100 mg/l, yield resource is small and difficult to use	
20	Uvur Gyatruun spring	46°33′32.4″ 102°03′00.9″	2009, Geoecology	C^{Ca}_{I}	136.0	1.00	7.8	17.0	There are 6-8 yields for each human organ	
21	Bituut spring	46°32′27.4″ 102°03′34.2″	2009, Geoecology	C^{Ca}_{I}	135.2	1.15	7.5	15	Stomach and internal disease	
22	Orkhonii Saikhan Bulgan spring	46°56′ 102°30′					7.4		Fresh and cold spring flows 500 m and joins the Orkhon River	
23	Tavan Salaa spring	46°53'52.5" 102°21'34.6"	2005, Geoecology	C^{Ca}_{I}					Fresh and cold 5 springs flow into Orkhon River in a very short distance	
24	Moilt spring	47°12′11.8″ 102°47′38.5″	1957, Sh.Tseren	C^{Ca}_{I}	492.2	4.87	6.8	6.0	Internal disease	
			2009, Geoecology	C^{Ca}_{I}	395.4	4.70	7.5	7.2	Water is drawn manually from well as its yield reduced	
25	1st spring	46°42′22.0″ 102°46′33.2″	2009, Geoecology	C^{Ca}_{I}	301.2	2.75	7.15	0.8	Yield is very small and unprotected	
26	Seruun bulag spring	46°41′58.2″ 103°42′03.1″	2009, Geoecology	C^{Ca}_{I}	330.6	3.65	6.9	3.3	Yield is small and it flows into the Dulguun spring immediately after blowing out. Unprotected	

Mineral springs in the Orkhon river basin midstream part: This part covers Ugii Nuur, Battsengel and Ulziit soums of Arkhangai aimag; Mogod, Saikhan, Khishig Undur, Orkhon, Bulgan soums, south part of Bugat soums of Bulgan aimag; Erdenet, Jargalant and Bayan Undur soums of Orkhon aimag; Tseel soum of Tuv aimag; Baruunburen, Orkhon soum and half east part of Orkhontuul soum of Selenge aimag.

Table 32. General indicators of chemical analyses in the mineral springs in the Orkhon river basin midstream part

No	Name of spring/spa	Location	Research date/ Researcher	Main ion index	Mineralization g/l	Hardness mg-eq/l	pH	T ^{0}C	H_2S mg/l	Remarks
1	Ulziit Tolgoi spring	47^{0}37/ 102^{0}00/	1957, Sh.Tseren	C^{Na}_{I}	0.23	1.56	6.6	7		Stomach and internal disease
2	Ikh Teel spring	47^{0}16/ 101^{0}39/30//	1960, Sh.Tseren	C^{X}_{I}	0.22	2.11	6.6	6		Stomach acid increase and decrease, headache and rheumatic
3	Shivert hot spa	47^{0}38/30// 101^{0}31/15//	1957, Sh.Tseren	COS^{Na}_{I} S^{Na}_{I}	0.23	0.20	8.2	80	6.8	Spring with a sulfuric gas and mud is used
			1985, Genscheme	COS^{Na}_{I}	0.33		8.8	47		Q-0.1l/s
4	Khuree Nutag spring	47^{0}37/ 101^{0}31/	1985, Genscheme	C^{Ca}_{I}	0.13		7.8	2.0	-	Internal disease
5	Baishin Bulag spring	47^{0}13/30// 102^{0}34/	1960, Sh.Tseren	C^{Ca}_{I}	0.30	2.57	6.8	3	Internal disease	
6	Sarlag spring	47^{0}37/ 102^{0}34/	1960, Sh.Tseren	C^{NaCa}_{I}	0.52	3.77	6.6	8	Digestive organ, against slimming and dizziness, etc	
7	Tamiriin Ulaan Khosuu spring	47^{0}44/ 102^{0}29/	1960, Sh.Tseren	C^{X}_{I}	0.31	2.48	6.8	4	Stomach and internal disease	
8	Tsats Tolgoi spring	47^{0}48/ 102^{0}37/	1960, Sh.Tseren	C^{Ca}_{I}	0.38	3.40	6.8	6	Digestive organ and internal disease	
9	Tsaidam Lake	47^{0}52/30// 102^{0}37/30//	1960, Sh.Tseren	CO^{Na}_{I}	2.41	5.43	7.8	20	Skin disease, rheumatic, scurvy, 4 joints, kidney and spine disease	
10	Saikhan Khulij hot spa	48^{0}16/ 102^{0}58/	1960, Sh.Tseren	S^{Na}_{II}	0.74	2.32	7.8	38	7.6	Sulfuric-tasted, Disease in kidney, spine, rheumatic and venereal disease
			1985, Genscheme	S^{Na}_{II}	0.77		8.7	52	6.0	Q-1.3 /s
11	Khulijiin Khar Lake	In the foot of spring	1960, Sh.Tseren	S^{Na}_{II}	1.09	3.23	7.8	24	Articulation, rheumatic kidney, spine and venereal disease	
12	Khunt spring and lake	48^{0}28/ 102^{0}32/	1960, Sh.Tseren	The lake's temperature is 17^{0}C and its mud is used for articulation therapy, and spring (T- 3^{0}C) which flows out of the lake is used for stomach and internal disease						
13	Asgat spring	48^{0}39/ 102^{0}38/	1960, Sh.Tseren	C^{Na}_{I}	0.56	3.60	6.8	1	It consists of a slight CO_2 and iron. Mg is dominant in its hardness	
14	Dalain Bulag spring	48^{0}56/ 102^{0}27/	1960, Sh.Tseren	C^{X}_{I}	0.33	3.03	6.8	5	Stomach and internal disease	
15	Khugnu Khaan small spring	47^{0}25/ 103^{0}41/	1960, Sh.Tseren	CS^{Na}_{I}	0.13	0.55	Digestive organ, internal disease and good at eyes as it is leaked almost drop by drop			
16	Khundlun spring	48^{0}19/ 104^{0}00/	1956, Sh.Tseren	C^{Na}_{I}	0.49	2.72		0-5	8.8	All kinds of disease

No	Name of spring/spa	Location	Research date/ Researcher	Main ion index	Mineralization g/l	Hardness mg-eqv/l	pH	T °C	H_2S mg/l	Remarks
17	Nomiin Bulag spring	48°12′ 103°40′	1955, Sh.Tseren	C^{Ca}_{I}	0.31	2.58	6.8	0.4		CO_2 88 mg/l. Stomach and internal disease
18	Orkhon spring	48°40′ 103°37′30″	1960, Sh.Tseren	C^{Mg}_{I}	0.34	3.13	6.8	5		Stomach and internal disease
19	Baishin spring	48°47′ 103°23′	1960, Sh.Tseren							Stomach and internal disease
20	Khuis Lake spring	48°47′30″ 103°11′	1960, Sh.Tseren	ClC^{Na}_{I}	0.40	1.94	6.8	4		Stomach and internal disease
21	Zuun Turuun spring	48°52′ 103°32′	1960, Sh.Tseren	C^{Na}_{I}	0.54	3.20	6.8	4		Stomach and internal disease
22	Khuuvur spring and lake	48°58′ 104°10′	1960, Sh.Tseren	C^{Na}_{I}	0.76	2.57	7.2	4		Articulation, venereal disease, rheumatic, kidney and spine disease
23	Erdenet spring	49°02′ 104°07′30″	1960, Sh.Tseren	C^{Ca}_{II}	0.27	2.92	6.4	3		Articulation, venereal disease, rheumatic, kidney and spine disease
24	Bayan Undur spring		2003, Geoecology	Cl^{Na}_{IY}	3.75	11.35	3.52			This spring with a very specific quality and composition, as well as iron needs to be researched

Mineral springs in the Orkhon river basin downstream part: Dulaankhaan spring in Shaamar soum, Selenge aimag and Dalt spring in Zuunburen soum have been selected as representative in this part.

Table 33. Compared results of chemical analyses in the Dalt spring

No.	Analysed indicators, mg/l	1960.09.30			1969.06.21			2011.11.22		
		mg/l	mg-eqv/l	mg-eqv%	mg/l	mg-eqv/l	mg/eqv %	mg/l	mg-eqv/l	mg/eqv %
1	Natrium+Kali	44,8	1,95	37,4	4	0,17	3	15.3	0.66	13.47
2	Calcium	53,6	2,68	51,3	68	3,4	61	58.1	2.9	58.89
3	Magnesium	7,2	0,59	11,3	24	2,0	36	16.4	1.35	27.41
4	Ammonium	Unidentified			Undetected			0.2	0.01	0.23
5	Chloride	36,5	0,1	1,9	7	0,2	4	3.6	0.1	2.03
6	Sulphate	25,0	0,52	10,0	20	0,52	9	10.0	0.21	4.23
7	Hydrocarbonate	280,6	4,6	88,1	299	4,8	86	280.6	4.6	93.41
8	Nitrite	Unidentified			Undetected			0.0	0.0	0.0
9	Nitrate	Unidentified			3	0,85	1	1.0	0.02	0.33
10	Carbonate	Undetected			Undetected			0.0	0.0	0.0
11	Mineralization	447,7			420			385.1		
12	pH	6,4			7,1			7.41		
13	Permanganate oxidation	Unidentified			3,52			1.92		
14	Dry remains	Unidentified			Unidentified			232.4		
15	Hardness, mg-eqv/l	3,27			5,4			4.25		
16	Carbonic gas	231,4			-			0.44		

There has been almost no change in water mineralization in the Dalt spring for last 50 years. But sharp decline in carbonic gas, slight increase in water environment pH and converted from weak acidity into weak alkalinity. Temperature is stable.

Table 34. Chemical composition of the Dulaankhaan spring

No.	Analysed indicator	1969.05.21*			2011.11.22**		
		mg/l	mg-eqv/l	mg-eqv %	mg/l	mg-eqv/l	mg-eqv %
1	Na+Ka	27	1,16	33	8.1	0.35	15.04
2	Calcium	34	1,7	48	32.1	1.6	67.96
3	Magnesium	9	0,7	20	4.9	0.4	16.99
4	Ammonium	Undetected			0.0	0.0	0.0
5	Chloride	14	0,4	11	5.3	0.15	6.37
6	Sulphate	25	0,52	15	5.0	0.1	4.42
7	Hydrocarbonate	159	2,6	73	128.1	2.1	89.2
8	Nitrite	Undetected			0.0	0.0	0.0
9	Nitrate	2	0,04	1	0.0	0.0	0.0
10	Carbonate	Undetected			0.0	0.0	0.0
11	Mineralization, mg/l	260			183.5		
12	pH	6.9			6.95		
13	Permanganate oxidation, mg/l	1.92			2.24		
14	Dry remains	Undefined			110.5		
15	Hardness, mg-eqv/l	2.4			2.0		
16	Carbonic gas, mg/ls	-			-		

Remark: ** Result by the Hydrochemical Laboratory, Scientific Institute for Water Exploration*
***Result by the Geoecological Institute of the Academy of Science*

The Dulaan Khaan spring still has fresh, soft, weak acidity, pure and cold water which can be considered that there has been basically no change in water quality and chemical composition of the spring for last 40 years. For the yield resource, it is relatively small and merely 241.2 l/hour (0.067 l/s) compared to other springs with a good yield. However, this volume is three times as much than the Dalt spring's yield.

2.2.5. Conclusions on groundwater, mineral springs, their quality and chemical composition

- Groundwater resources are unevenly distributed in the Orkhon river basin. The most favorable condition is groundwater accumulated in the sedimentary aquifer along the river valley. The resources are plentiful. But mountains and hills around the river valley have little resource.
- As for this basin, it is possible to use deposits' exploitable resources in the water use balance. It is important to determine potential exploitable resources of areas whose exploitable resources are not estimated, based on the map of “Groundwater potential exploitable resources distribution”.
- It is possible to learn about the area with exploitable resource from the potential exploitable groundwater resource distribution map. The exploitable resources should be estimated within the framework of detailed research and survey if groundwater is used in certain objects, industries and entities.
- When making integrated water resources management plan the continuous permafrost issue should be taken into account.
- Water samples have been mostly taken at the level of microelements and pollution indicators. However, there are some materials of researches which were carried out in the field of identifying the groundwater quality and chemical composition
- Water mineralization in water points in Arkhangai, Uvurkhangai, Bulgan, Darkhan Uul and Selenge aimags included in the Orkhon river basin is less than 1.0 g/l.

It shows that water in this basin is relatively fresh compared to the Gobi-desert region.

- Fresh water subject to hydrocarbonate class, Ca and Na group /HCO3->SO42->Cl, Ca2+>Mg2+>Na+/ is dominantly distributed in northern Mongolia and there are some water points with salty and hard water in few cases. By identifying the quality and composition of water points at regional level in such way, it enables us to pre-determine the guidelines on identifying water point in the future and how to use the existing water points.
- Wells and water points in the upstream part are mostly subject to fresh and soft water. But water softening equipment has been installed in some water points subject to relatively high hardness, e.g. in one well in soum centre of Khotont, Arkhangai aimag.
- There are relatively large numbers of water points which do not satisfy the requirements in the midstream part. E.g. water points subject to high mineralization and hardness are (relatively) commonly found in Mogod soum, Bulgan aimag and Erdenet city, Orkhon aimag.
- There are many water points which do not satisfy the quality requirements within the boundary of the Altanbulag free zone in the downstream part.
- There are many hot and cold springs in the Orkhon River Basin. In view of spring use, most springs are being used locally especially hot spa is used by locals for washing and bathing. This can lead to a high risk of pollution in water quality and environmental ecological deterioration as well. Such as; Bor Tal, Jarantai and Gyalaan hot springs.
- Resorts are established based on big hot springs. The positive thing is that people are cured and they relax at resorts. But waste water discharged from resorts pollutes mineral springs and environment. This condition is observed in hot springs of Tsenkher and Khujirt.
- Mineral springs' yield is decreased and polluted due to access by livestock to the mineral spring source which is not fenced and protected. The following mineral springs are being polluted as above mentioned: Moilt, Most, Khamar and Dalt.
- Boreholes are drilled near mineral spring source at will and it has negative influence in the resources. For example: Gyalaan mineral springs.
- In order to prevent pollution and scarcity of water resource as well as change in water quality, the related professional authority determines the limitation and configuration of spring protection zones by considering the sanitarian condition of a particular part in which water source and soil water aquifer exist, geological formation, hydrogeological nature, soil structure, runoff direction in groundwater, prevailed wind direction and pollution source, etc. By now, successfully implemented work is rarely found.

2.3. Pollution and scarcity of water resources and actions for prevention and protection

Sections 2.1.5 and 6.2 describe the Orkhon river basin surface water resource pollution, its amount and sources. The researchers estimated that surface water in Orkhon river basin and mountainous regions of Mongolia is usually fresh and soft. The water belongs to hydrocarbonate classification. For the last few years, small rivers are drying up due to warming and negative human activities. Rivers are polluted due to gold mining. The

pollution has a negative impact on the water quality and the water body environment. The fresh water resources will be scarce. The gold mining is concentrated in the river valleys of Ulziit Teel, Budant Teel, Khargui, Shiirt, Zuun Sodot, Baruun Sodot and Guut, tributaries of Uult River, and tributary of Ikh Teel near Orkhon River upstream.

These rivers almost do not have runoff. Kharaa River, a tributary of Orkhon, is polluted by mercury due to gold mining. The amount of waste discharged from Erdenet industry caused Zunii River to disappear. The water percolating from the dam pollutes the Khangal River. Many fresh water rivers in Orkhon river basin are polluted and become turbid due to gold mining. There is a negative change in underwater insect group. The fish which live in fresh water, is not able to live in turbid water.

The number of fish which was infected by parasites, increased and the ecosystem of the river is changed. In the warm season, Kharkhorin channel water joins Khugshin Orkhon River and there is a change in water chemical composition and quality. For example: in July, water mineralization of Khugshin Orkhon river is decreased twice due to water from the channel; water cation proportion is changed. The amount of turbidity and suspended solids in water is increased. There are blue and green algae in heavily polluted water in Orkhon river basin (pH>9), these can act as indicators for determining water quality. The research work to determine water resources pollution and scarcity, should be organized without wasting time. The water pollution and scarcity sources need to be limited. The required measures to prevent water resource scarcity and water body ecosystem imbalance should be implemented.

The main issues in Orkhon river basin for which measures taken are not enough are described below. The ecological degradation of the basin is likely to increase. The measures to be taken are:

- Inspection will be carried out in water supply source of Erdenet, Bulgan, Tsetserleg and Sukhbaatar. These sources' hygienic zones and recharge areas will be newly set.
- To determine location and extent of activities which have negative impact on water in the hygienic zones and recharge areas of water supply sources of Darkhan, Erdenet, Bulgan, Tsetserleg and Sukhbaatar cities. To develop measures to limit further negative impacts and implement the measures.
- The degradation caused by gold mining in the Uult river valley in the upstream part of Orkhon river basin has a high risk of polluting the Orkhon river water via soil washout. Measures need to be organized to restore river channels of the Uult River and the Ikh Teel River.
- Installing modern water treatment facility in sanatoriums and monitoring needs to be improved. The standard requirement of “Treated waste water to be discharged into environment MNS: 4943:2011” must be met.
- Installing monitoring equipment on Khangal River, measuring pollution and taking relevant measures without wasting time.
- Limit mining activities in the tributaries' valley of Orkhon river downstream. Ecological monitoring will be improved and rehabilitation will be conducted according to the standard.
- When conducting river water quality research, heavy metal content in river water and sediments will be determined; to study in a more detailed way how it affects on fish, aquatic animals, plants, livestock and humans. To develop basis of measures to be implemented for the purpose of decreasing already-formed heavy metal accumulation.

- Strengthening river basin authority and council; surface water and groundwater quality monitoring research will be regularly conducted. Assessment will be given.
- Improving quality of regional urban areas' borehole water which has high mineralization and hardness by using new technology.
- In order not to pollute and change springs quality, composition, especially basic property of absorbed gas and variable components, landscaping needs to be improved. Hygienic and protection zones will be determined and their regimes will be complied.
- Improving and expanding complex water quality research networks; constructing branch laboratory in rural areas.
- In the scope of Orkhon river basin, water resources, regime and ecosystem research will be conducted; possibility should be created to give actual assessment and conclusion based on managing basic roles of training and research center near Ugii Lake.

Along with climate change and warming, negative human activities including land use, mining, road network concentration increase and they cause a change of land cover. The aridity is increased in the river basin and number of surface water sources is decreasing, including small rivers and springs. The water resources are decreasing. The basin's forest area decreases and degradation of soil and plant cover decrease the chance of surface runoff forming. The erosion and degradation are increased.

A total of 82 plant species of Orkhon river and Ugii lake basins belong to low land plant species. It means that this area is having some sort of pasture degradation.

The following measures should be included when planning measures to protect water resources or to improve surface runoff/flow forming conditions in upstream part of Orkhon River:

- Soil removing activities will not be conducted within runoff forming zones and areas where water protection zones are established.
- Support management to protect and use forest (forest insects, fighting forest fire, to stop illegal logging, tree planting in areas where trees are cut)
- Registering small rivers and springs, collecting data on their numbers, water resources and regime change; installed and mobile remote monitoring.

Taking measures to restore surface water natural resources and regime and to balance water resources and demand in midstream part of Orkhon river basin:

- Conducting runoff regulation and constructing reservoirs and ponds for the purpose of accumulating and using water resources.
- Preventing soil and plant degradation in Ugii Lake, other lakes and rivers' flood plain and river bank areas.
- Determining locations of water bodies where migratory birds and fish and rare animals reside; protection boundary will be made clear.
- Taking measures to rehabilitate soil and plant cover by developing possible scenario of pastoral management.
- The followings will be put into integrated registration: water supply sources in the basin; entities operating in river channel and flood plain; points which take water from rivers and discharge waste water and dump sites. Database will be made and monitoring points will be increased.

- Auto road networks will be improved; taking measures to decrease aridity and dust of the basin.
- In order to protect land cover in arid land, plants will be planted and soil will be strengthened. Reuse activity will be organized and forest zone will be established.

Measures to protect populated areas and objects from floods in Orkhon river basin downstream and midstream part:

- Determining areas which can be affected by floods near urban areas; improving and constructing new flood protection.
- Improving basin's soil and plant cover by conducting good pastoral and land use management (to control and manage livestock number)
- Determining possible areas where tourism, fishing and water sport can be developed; conducting research on their impacts on ecosystem and water body/ environment; taking protection measures during usage process.

3. SOCIO–ECONOMIC CONDITION AND FUTURE TREND OF THE ORKHON RIVER BASIN

3.1. Importance and function of the Orkhon river basin in the socio-economic development of Mongolia

The Orkhon river basin covers 3.4% of the total territory of the country and it spreads through the economic regions of Ulaanbaatar, Tuv and Khangai. Please see the location and administrative structure of the basin from Figure 58.

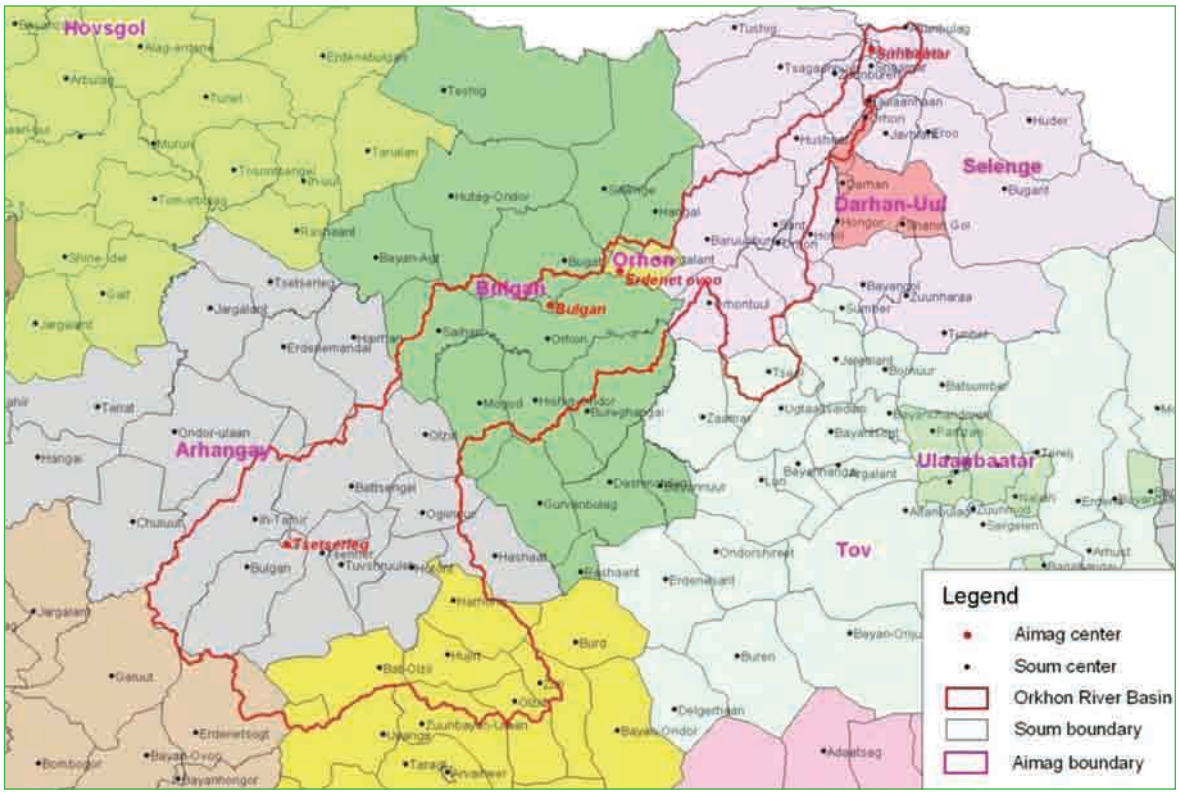


Figure 58. Location and administrative boundaries of the Orkhon river basin

Some 8 aimags including Arkhangai, Bayankhongor, Bulgan, Darkhan-Uul, Orkhon, Uvurkhangai, Selenge and Tuv partly belong to the Orkhon river basin. Of the river basin territory Arkhangai aimag covers 38.2% of the basin, Bulgan 22.1%, Selenge 18.4%, Uvurkhangai 15.9% and the 4 other aimags 0.4-1.9%. The territory of some 8 soums is 100% covered in the basin, 32 soums 5.0%-99.9% and 13 soums up to 5%, respectively. And 4 aimag centers and 25 soum centers, including Khangai region pillar cities Erdenet and Kharkhorin are located in the basin.

In 2010, 8.6% of the Mongolian population lived in the basin and produced 17% of the GDP of Mongolia. The aimags, which are located in the Orkhon River Basin, generate about 75% of the Khangai region GDP and 27% of the Central region GDP. The Erdenet mining company located in the Orkhon aimag produces some 30% of the total export of Mongolia. In 2010, the aimags located in the Orkhon River Basin produced

in total MNT1456.1 billion of which some 66.9% was made in the industrial sector. The composition of the GDP of the aimags located in the Orkhon River Basin is presented in Table 35.

Table 35. GDP produced in the Orkhon River Basin, at current prices, 2010

Aimag	GDP, *in billion MNT*	Share of the sectors, %		
		Agriculture	Industry and construction	Services
Arkhangai	133.0	76.6	1.5	21.8
Bulgan	121.6	77.6	2.0	20.4
Orkhon	1 007.6	1.5	92.6	5.9
Selenge	193.9	62.2	19.1	18.7
Total	1 456.1	22.8	66.9	10.3

Some factors which may affect the future development of the Orkhon river basin:

Advantages:

- Located near the largest cities such as of Ulaanbaatar, Darkhan and Erdenet, and therefore good market conditions,
- Sufficient human resources,
- A relatively high education level,
- Convenient soil and climate to run intensified livestock husbandry and crop farming,
- Relatively high developed infrastructure,
- Good conditions for industrial development related to mining,
- Good quantities of mineral resources,
- Excellent conditions for tourism.

Disadvantages:

- Due to over grazing, there are some conditions deteriorating the ecological balance such as desertification and pasture degradation, etc.
- Due to influence by mining, pollution of water resource, etc.
- High level of poverty and unemployment.

3.2. Demography

In 2010, the Orkhon River Basin population was 235.6 thousand from which 51.1% were female. Of the total basin population 37.3% is living in Orkhon aimag, 21.0% in Arkhangai, 17.8% in Selenge, 12.6% in Uvurkhangai and the remainder in other aimags (see Table 36).

Table 36. Population of Orkhon River Basin in thousand persons

Aimag	2006		2007		2008		2009		2010	
	Total	Rural	Total	Rural	Total	Rural	Total	Rural	Total	Rural
Arkhangai	48.6	21.8	48.0	21.8	48.0	21.3	47.7	22.1	49.5	22.0
Bayankhongor	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Bulgan	23.6	8.0	23.5	7.9	23.5	8.5	24.7	9.6	23.6	8.0

Aimag	2006		2007		2008		2009		2010	
	Total	Rural	Total	Rural	Total	Rural	Total	Rural	Total	Rural
Darkhan-Uul	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Orkhon	86.3	4.0	88.2	4.0	89.9	4.3	91.2	1.3	87.9	1.8
Uvurkhangai	29.6	14.0	29.1	13.2	29.5	13.2	29.6	13.3	29.8	12.3
Selenge	36.5	5.1	38.8	8.4	37.9	6.4	41.8	8.0	42.1	7.2
Tuv	2.2	0.3	2.1	0.5	2.1	0.6	1.8	1.1	1.8	1.2
Total	227.7	54.1	230.6	56.7	231.8	55.2	237.8	56.3	235.6	53.5

In the basin, there are 4.4 persons per km^2 which is 2.5 times more than the country's average (1.75). Whereas, the Orkhon aimag is the most densely populated with 106.3 people per km^2 and the least populated is Bayankhongor aimag with 0.9 person per km^2. Of the aimag and soum centers, Sukhbaatar city of Selenge aimag is the most densely populated with 484.3 people per km^2 and the least populated is Buregkhangai soum of Bulgan aimag with 0.4 person per km^2. The population density map is presented in Figure 59. [1]

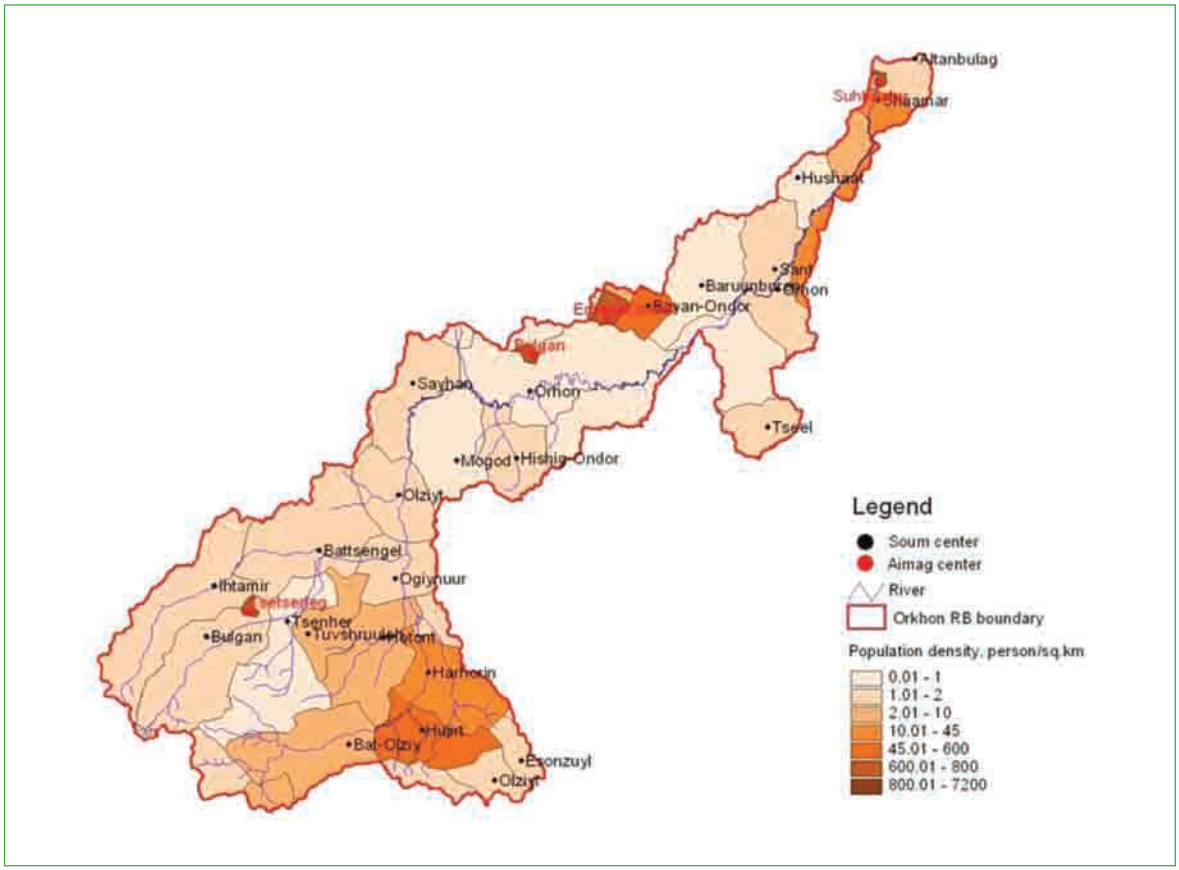


Figure 59. Population density

In 2006-2010 the average annual growth of the Orkhon River Basin population was 0.9%, which was lower than the country average. According to the statistical data, the population growth was higher in the Selenge aimag and lower in the Arkhangai aimag. Although some big urban areas are located in the basin, population growth is low due to migration to the Capital.

[1] Only population included in the basin has been used in the calculation.

According to the age groups, some 70 thousand persons were less than 15 years old, 151.5 thousand persons have working age and 13.9 thousand are elderly people. The demographic burden on 100 working age people was 55, from which some 46 are children and 9 are elderly people. As about 83% of the people outside the working age group are children under 14 years old, it can be concluded that the labour force resource is high.

Population growth is an essential indicator to calculate drinking water demand of the population in the future. In forecasting the population growth on a national scale the "Population prospect of Mongolia 2010-2040" issued by NSO used three scenarios: high, medium and low. Table 37 shows the medium scenario of calculating the population growth of urban areas. The total population of the Orkhon river basin is forecasted to reach 262.4 thousand by 2021 an increase by 13.2% compared to 2008. Figure 60 shows the population prospect of the Orkhon River Basin by low, medium and high scenarios.

Table 37. Population growth projection in thousand persons

Aimag	2008	2010	2015	2020	2021
Arkhangai	48.0	49.4	48.6	49.6	50.0
Bayankhongor	0.7	0.7	0.7	0.7	0.7
Bulgan	23.5	23.6	23.2	23.7	23.8
Darkhan-Uul	0.3	0.3	0.3	0.4	0.4
Orkhon	89.9	87.9	98.5	109.0	111.6
Uvurkhangai	29.5	29.8	29.5	30.2	30.4
Selenge	37.9	42.1	42.1	43.4	43.7
Tuv	2.1	1.8	1.8	1.9	2.0
Total of the basin	**231.8**	**235.6**	**244.7**	**258.9**	**262.4**

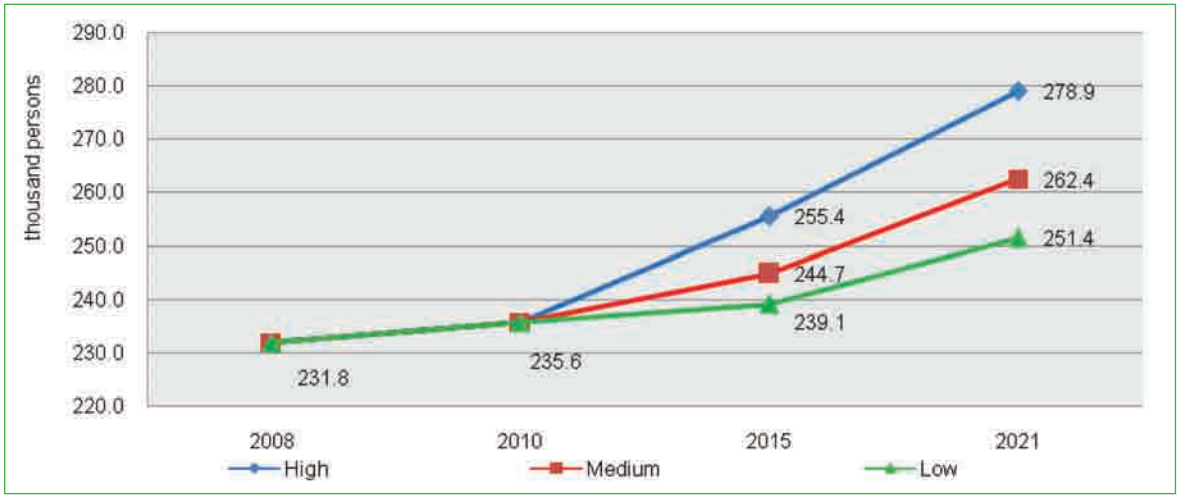


Figure 60. Population prospect of the Orkhon River Basin

Households in the Orkhon River Basin: In 2010, there were 64.7 thousand households in the basin which is some 8.7% of the total households of the country. Of the basin households, 75.7% live in urban areas and soum centre, and 24.3% live in rural areas (Table 38).

Table 38. Number of households, 2010

Aimag	Households in the basin, *thous. households*		Average number of family members per household
	Total	of which, rural	
Arkhangai	13.8	6.1	3.6
Bayankhongor	0.1	0.1	3.7
Bulgan	6.6	2.5	3.6
Darkhan-Uul	0.1	0.1	3.0
Orkhon	23.2	1.1	3.8
Uvurkhangai	8.6	3.9	3.4
Selenge	11.8	1.9	3.6
Tuv	0.5	0.2	3.6
Total of the basin	**64.7**	**15.7**	**3.6**

3.3. Aimag centers and urban development

In 2010, some 147.6 thousand persons were living in the cities and 34.2 thousand in soum centers (Figure 61). Erdenet (Bayan-Undur) city has 85.0 thousand people, Tsetserleg (Erdenebulgan) 20.1 thousand, Bulgan 11.6 thousand, Sukhbaatar 21.9 thousand and Kharkhorin city 9.0 thousand people.

Adopted by the 1st resolution of the State Great Khural of Mongolia from 2003, Erdenet of Orkhon aimag and Kharkhorin of Uvurkhangai aimag became Pillar cities of the Khangai region. Currently, Kharkhorin city has about 9 thousand people.

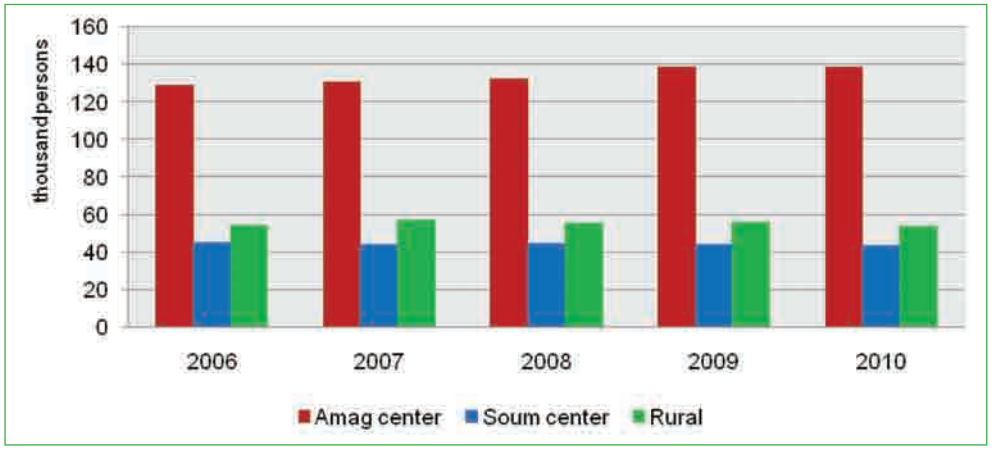


Figure 61. Population of Orkhon river basin, by settlement

Of 25 soum centers, 44% or 11 soum centers have 500-1000 persons, 36% or 9 soum centers have 1000-2000 persons and 20% or 5 soum centers have over 2000 persons. From these the most high population are in Bat-Ulzii soum center of Uvurkhangai aimag (4091 people), Altanbulag soum center (4067 people) and Shaamar soum center (3827 people) of Selenge aimag. And the lowest populations are in Ulziit soum center (560 people) of Uvurkhangai, Mogod soum center (579 people) of Bulgan and Tseel soum center (630 people) of Tuv aimag. The population number and projection by settlement area of the Orkhon River Basin is presented in Table 39.

Table 39. Urban and soum center population of the ORB in thousand persons

Aimag, soum, city name	2006	2007	2008	2009	2010	2015	2021	2021/2008 %
Arkhangai	**26.8**	**26.2**	**26.7**	**26.0**	**27.4**	**27.0**	**27.8**	**103.9**
Tsetserleg city	*17.9*	*18.0*	*18.0*	*17.8*	*20.1*	*19.8*	*20.3*	*112.6*
Battsengel	1.1	1.1	1.1	1.1	1.1	1.0	1.1	97.2
Bulgan	0.8	0.7	0.9	1.0	1.0	1.0	1.0	108.2
Ikhtamir	1.2	1.4	1.2	1.1	1.1	1.0	1.1	88.9
Ugiinuur	0.6	0.6	0.6	0.6	0.6	0.6	0.6	114.3
Ulziit	0.8	0.8	0.8	0.8	0.8	0.8	0.8	99.8
Tuvshruulekh	1.9	1.9	1.9	1.9	1.1	1.1	1.1	59.0
Khotont	1.2	0.9	1.3	0.8	0.8	0.8	0.8	62.0
Tsenkher	1.3	1.0	1.0	1.0	1.0	1.0	1.0	102.0
Bulgan	**15.6**	**15.5**	**15.0**	**15.1**	**15.6**	**15.3**	**15.8**	**105.0**
Bulgan city	*11.0*	*11.6*	*11.2*	*11.0*	*11.6*	*11.4*	*11.7*	*104.6*
Mogod	0.7	0.7	0.6	0.6	0.6	0.6	0.6	92.4
Orkhon	1.0	1.0	1.0	0.9	1.0	0.9	1.0	99.6
Saikhan	1.3	0.9	0.9	1.2	1.2	1.2	1.2	140.1
Khishig-Undur	1.6	1.4	1.3	1.3	1.3	1.2	1.3	95.6
Orkhon	**82.3**	**84.1**	**85.6**	**90.0**	**86.1**	**96.4**	**109.3**	**127.7**
Erdenet city	*79.9*	*81.8*	*83.3*	*88.1*	*85.0*	*95.2*	*107.9*	*129.5*
Jargalant	2.4	2.3	2.3	1.9	1.1	1.2	1.4	62.2
Ovorkhangai	**15.6**	**15.9**	**16.3**	**16.4**	**17.5**	**17.4**	**17.8**	**109.4**
Bat-Ulzii	2.1	2.2	2.2	3.7	4.1	4.1	4.2	186.8
Yesunzuil	0.8	0.9	0.9	0.9	0.9	0.8	0.9	100.3
Ulziit	0.6	0.9	0.9	0.7	0.6	0.6	0.6	66.7
Kharkhorin city	*9.3*	*8.8*	*9.2*	*8.3*	*9.0*	*9.0*	*9.2*	*100.3*
Khujirt	2.8	3.1	3.1	2.8	2.9	2.9	2.9	94.9
Selenge	**31.3**	**30.5**	**31.5**	**33.7**	**34.7**	**34.7**	**36.0**	**114.3**
Sukhbaatar city	*19.7*	*18.8*	*19.4*	*21.3*	*21.9*	*21.9*	*22.8*	*117.4*
Altanbulag	3.4	3.5	3.6	3.8	4.1	4.1	4.2	117.4
Baruunburen	1.2	1.2	1.3	1.3	1.3	1.3	1.3	101.4
Orkhon	1.1	1.0	1.1	1.0	1.0	1.0	1.1	99.3
Sant	1.4	1.6	1.4	1.5	1.6	1.6	1.6	120.0
Khushaat	1.1	1.0	0.9	1.0	1.0	1.0	1.0	110.6
Shaamar	3.4	3.4	3.9	3.8	3.8	3.8	4.0	102.9
Tuv	1.8	1.6	1.5	0.7	0.6	0.6	0.6	40.2
Цээл	1.8	1.6	1.5	0.7	0.6	0.6	0.6	40.2
River basin total	**173.4**	**173.8**	**176.6**	**181.8**	**181.9**	**191.4**	**207.3**	**117.3**
City total	137.8	139.0	141.2	146.5	147.6	157.3	172.0	121.8
Soum center total	35.6	34.8	35.4	35.3	34.3	34.1	35.3	99.6

According to the medium scenario of the NSO projection of population, the population of urban and soum centers of the Orkhon River Basin will reach 191.4 thousand persons in 2015 and 207.3 thousand persons in 2021, an increase by 17.3% compared to 2008. From these in 2021, 172.0 thousand persons or 83.0% may live in the cities and 35.3 thousand persons or 17.0% may live in the soum centers. About 63% of the city's population will live in Erdenet.

The Khangai region development program aims to improve the living condition of the population by updating and implementing the regional pillar cities and urban development programs for the current market economy. Moreover based on population growth and apartment needs will increase apartment coverage and the percentage of apartment households will reach 70% in 2015.

The Orkhon aimag development program plans to improve land use in the urban area and to study the establishment of a new settlement between Erdenet and Bulgan. The development program of Uvurkhangai aimag aims to give more attention to creating work places and favorable living conditions for the residents, to update and implement Kharkhorin city's master plan, to prepare and implement general development programs for the micro-region centers and large soum centers based on "Soum center" project and to improve environmental condition around cities and protect water and soil from pollution.

According to the Bulgan and Arkhangai aimags' comprehensive development policy, the objectives are: to implement measures systematically to define general plan according to city general planning which is aimed at developing Tsetserleg and Bulgan cities based on approved general plan; to coordinate big soums' general development plan with regional development situation; to improve urban area land use; to improve citizens' apartment supply level in coherence with population growth and apartment demand. According to Selenge aimag development program, the following things will be implemented: to constitute appropriate systems of population settlement; to establish construction and urban development; improve population apartment supply dramatically; develop urban planning based on population settlement and appropriate system of the settlement; provide urban area residents with comfortable surroundings.

The development programs of the region and the aimags aim to support urban development and to improve the living condition of the population that will contribute to achieving the MDGs of Mongolia. Also, the development of other urban areas may decrease migration to Ulaanbaatar.

3.4. Education, cultural level, custom and religion

3.4.1. Education

The education index[2] of Mongolia is relatively high: 0.925 in 2010. The education system of Mongolia consists of pre-school education, primary and secondary education and higher education. Erdenet, the country's second largest city is located in the basin and it has created good opportunities to develop centralized educational institutes.

During the academic year 2010-2011, in total 11.5 thousand children have enrolled in approximately 80 kindergartens of aimags in the basin and they are receiving pre-school education. This is 23.0% of the country total. Food costs for children involved in state-owned kindergartens are fully covered by the government and this became a significant action towards improving the living standard of the population. At the same time, there are 47.3 thousand children studying at some 70 general education schools of which 38.2% in Orkhon aimag. Overall pupils studying at general education schools in the aimags and soums of the basin are 25.6% of the country total.

In Orkhon river basin, there are in total 5.4 thousand students who are now studying at 6 universities and 7 vocational training centres. This is 2.5% of the total number of students in the country.

3.4.2. Social and cultural status

The Orkhon river basin is a rich region, historically and culturally and it is essentially related to Mongolian history. By now, there have been two cultural objects registered in

[2] One component of HDI, that is measured by the adult literacy rate and the combined primary, secondary, and tertiary gross enrolment ratio. In 2009 the overall countries education indices were 0.280-0.993.

the world heritage of UNESCO and one of them is historic monuments based in Orkhon valley. It includes a number of historically significant places related to tradition culture and custom of nomadic Mongol nation.

Mongolians are one of the few nations in the world which still keep a traditional nomadic life and culture. And essential co-existence of nomadic life and nature has formed the tradition to preserve and respect our planet and local environment.

One demonstration of this tradition delivered hand to hand from ancient time is an inclusion of nature preserving procedures in its religion and traditional saga. Around the 18th century, a specific procedure for the protection of the nature and environment was released and it was prohibited to pollute environment/river or hunt during the season of breeding. Mongolians have a history in which they've been strictly following the procedure.

Figure 62. Luvaanjalbuu, the water god; Ulaantsutgalan waterfall

One sacred idol which has been kept so far related to fresh water is Luvaanjalbuu water god and whose image was created on a litho glyph located on a bank of the Orkhon River, Orkhon aimag. This place has become one of the favorite places for sightseeing and prayer as well. In 2007, Erdenezuu temple administration established a small temple on a ruin of an old temple in Kharkhorin soum for a chant by monks in order to praise the water god in Mongolia. Inside the temple, there is an icon of various animals headed by fish and instruction to preserve nature and environment in order to educate local community through their belief.

In Shamanism, the traditional religion has been keeping the precious tradition to respect the blue sky and preserve water, nature and environment. Both Shamanism and Buddhism are an obvious closely-knitted part of our tradition and culture, and the religion has been enriched by a hereditary commitment/intention to hand over to next generation a pure nature by preserving and not polluting our planet, keeping it clean.

So far, nomad-style livestock husbandry has prevailed in the agricultural sector and

herdsman families usually move by following rivers, lakeshores and good pastures. In conjunction with the nomad-style life, labor organization/schedule in a family has been already accustomed. Also there are many numbers of households who still live in a ger or house which is not connected to a water supply system, even when they are located in an urban area. There is much continued use of water directly from wells, rivers, springs, fountains, snow and ice depending on the related life and condition. However, centralized water supply and sewerage networks were launched in our country since 1960.

While women are mainly responsible for water use in a family, men dominantly participate in fetching water as this is considered a difficult labor. Also there is plenty of participation by children in fetching water in ger districts of urban areas. It's been clearly confirmed according to a questionnaire carried out amongst ger districts of Ulaanbaatar, that some 45% of adult male, 29% of adult female and 26% of children do fetch water.

Since 90s within the high urbanization a life style of the Mongolian people is changing. In the future, there will be continuing the trend of rapid growth of urbanization and high migration to the few big cities. It is due to weak infrastructure development of the aimag and soum centers; residents' needs are not provided; not establishing environment for industries and services to be developed.

Water supply and sewerage development plays an important role to establish environment for population to live and industries as well as services to be developed, in other words, aimag centers and urban areas will be developed to the level of modern cities and towns. One example is: Kharkhorin is called center of the region and it is suitable region to develop tourism. But water supply and sewerage development is weak, so supply level of apartment blocks is low and industries as well as service development is still low. The population number has been decreased for the last 5 years. Modern-technology water supply and sewerage system, which suitable for the usage in small and medium cities in cold season, needs to be introduced and developed.

Recently due to rapid urbanization the lifestyle of the population has been changing. Rivers and water sources around the cities and industries become polluted from human activities. Therefore there is a need to improve public participation for the environmental protection and evoke national traditions and customs related to protect environment and water resources.

3.4.3. Health

It is stated in the policy on population development which is implemented by the government that its purpose is to provide sustainable growth of the population and create a convenient condition for long, healthy and productive life and development of the population.

According to statistics, there have been about 2.3 thousand health institutes at national level as of 2010 and 50% or 1160 institutes are based in aimag and soums of the basin.

Maternal mortality which took place in aimag and soum of the basin consisted 10% of the total maternal mortality of the country in 2010 while infant mortality consisted some 9.4% of total infant mortality. Also number of patients suffered from infectious disease consisted 7.7% or 3.2 thousand of the country total. Of the patients in the basin, some 50% suffered from viral hepatitis, one of the infectious diseases caused by polluted water.

Aimag centers hospitals in the basin are mostly connected to the centralised water supply and sewerage system. However, only Erdenet and Sukhbaatar cities are supplied

with the centralized hot water. While water consumption by the other cities is supplied from wells and waste water is discharged into soil or pit latrine and covered clarifier are being used. It makes the hospitals unable to use sufficient water that meets the sanitation requirement. In improving water supply and sanitation availability, it's important to supply aimag centre hospitals with hot water and to launch a mini-size water supply and sanitation facilities which are suitable for soum centres. According to water consumption normative which is being complied in Mongolia, water consumption for outpatient is 15 l/day per day and inpatient is 250 l/day of hospitals equipped with bath tub and shower. These indicators closely approach to the international standard. Although most hospitals used less water than the normative amount according to data and information obtained from aimag centres and this shows that it needs to improve water supply and sewerage in the future.

3.5. Living standard and employment

3.5.1. Employment and Labour Resources

As of 2010, there were 151.6 thousand working age people in the basin that is 9.6% of the country's economically active population and 9.2% of the country's employed population, respectively (Table 40). Employment rate is lower than the country's average by 4 points due to the high level of unemployment in Orkhon aimag. However, labor force participation is higher than the country's average.

According to an employment study conducted in 2008 in Orkhon aimag, which is the most densely populated, some 67% of its population was of working age and 58.5% of its workforce resource were employees. There were 12.5 thousand unemployed and 59.2% is due to a lack of working premises. In view of the above, adherence to a policy of increasing job vacancies and encouraging small-and-medium businesses promises to be a significant influence to improve the living standard of the population.

Table 40. Employment of the Orkhon River Basin in thousand persons, 2010

Indicators	Arkhangai	Bayankhongor	Bulgan	Darkhan-Uul	Orkhon	Uvurkhangai	Selenge	Tuv	Total of the basin	Total of the country	Percent in the country's total
Total population	49.4	0.7	23.6	0.3	87.9	29.8	42.1	1.8	235.6	2,780.8	8.6
Working age population	32.2	0.4	15.9	0.2	54.7	18.4	28.6	1.2	151.6	1,863.4	8.1
Economically active population	26.6	0.3	11.7	0.1	38.6	13.8	18.6	0.9	110.6	1,147.1	9.6
Employees	24.8	0.3	9.9	0.1	28.0	13.1	18.2	0.8	95.2	1,033.7	9.2
Unemployed	1.9	0.0	1.8	0.0	10.0	0.7	0.4	0.1	14.8	113.4	13.0
Registered unemployed	1.2	0	0.7	0	1.7	0.6	0.4	0	4.6	38.3	12.0
Labor force participation, %	82.6	74.9	73.3	61.7	70.6	75.2	65.1	71.2	73.0	61.6	-
Employment rate, %	93.0	96.4	84.8	89.0	74.1	95.1	97.9	94.0	86.1	90.1	-
Unemployment rate, %	7.0	3.6	15.2	11.0	25.9	4.9	2.1	6.0	13.4	9.9	-

In 2010, some 44.3% of all employees worked in the agricultural sector, 8.4% in the service sector and 17.3% in the industrial sector (Table 41).

Table 41. Number of employees in thousand persons, 2010

Sectors	Arkhangai	Bayankhongor	Bulgan	Darkhan-Uul	Orkhon	Uvurkhangai	Selenge	Tuv	Total of the basin	Percent in the basin total, %
Agriculture, forestry, hunting and fishing	17.0	0.3	5.9	0.1	3.5	8.3	7.0	0.4	**42.5**	44.3
Mining	0.1	0.0	0.0	0.0	5.7	0.5	0.9	0.0	**7.2**	7.5
Processing plant	0.9	0.0	0.5	0.0	4.3	0.7	2.2	0.1	**8.6**	9.0
Water supply, sewage and waste management and treatment activities	0.1	0.0	0.1	0.0	0.3	0.0	0.2	0.0	**0.7**	0.8
Trade, maintenance, transport and communication	3.0	0.0	1.2	0.0	6.5	1.7	2.9	0.1	**15.5**	16.2
Activities to provide housing and food supply service	0.2	0.0	0.2	0.0	0.5	0.3	0.3	0.0	**1.6**	1.6
Finance, insurance and real estate	0.1	0.0	0.1	0.0	0.7	0.1	0.3	0.0	**1.3**	1.4
Public and administration service	1.3	0.0	0.8	0.0	1.3	0.8	1.7	0.1	**5.9**	6.1
Education	1.0	0.0	0.8	0.0	3.2	0.9	1.1	0.0	**6.9**	7.2
Population health and social welfare	0.9	0.0	0.3	0.0	1.0	0.4	0.9	0.0	**3.5**	3.6
Other activities	0.2	0.0	0.1	0.0	1.0	0.2	0.7	0.0	**2.2**	2.3

3.5.2. Living Standard

Human Development Index: The Human Development index (HDI) is one of the socio-economic indicators that measure country's development by combining indicators of life expectancy, educational attainment and income. Since 1997 Mongolia started to publish a Human Development Report supported by UNDP. The MDGs based Comprehensive National Development Strategy of Mongolia aims to reach a HDI of 0.83 in 2015.

In 2010, Mongolia's HDI was 0.622, which ranks the country at 100 out of 169 countries placing it in the Medium Human Development countries. This HDI is slightly below the World average of 0.624 and that of East Asia and the Pacific, which is 0.650. By UNDP's estimation Mongolia's life expectancy index was 0.748, the education index 0.674 and the GDP per capita index 0.477. According to the WB classification of Gross national income per capita by the Atlas methodology, Mongolia's GNI per capita reached 1630 USD categorizing it as a "Lower middle income country".

The estimation of the human development index is based on average life expectancy, education level and GDP per capita. The index is shown by aimags of the basin in Table 42.

Orkhon aimag has the highest HDI with 0.845 which is 0.082 higher than the country's average while Bayankhongor and Uvurkhangai aimags have 0.07 lower than the country's average. The higher than the country's average GDP per capita of Orkhon aimag is due to the location of Erdenet, the leading copper mining company.

Table 42. Human development index of aimags in the basin, 2010

Aimag	Life expectancy index	Education index	GDP per capita index	Human development index
Arkhangai	0.711	0.917	0.536	0.722
Bayankhongor	0.685	0.916	0.477	0.693
Bulgan	0.739	0.901	0.575	0.739
Darkhan-Uul	0.679	0.985	0.554	0.739

Orkhon	0.716	0.966	0.853	0.845
Uvurkhangai	0.715	0.902	0.467	0.694
Selenge	0.732	0.907	0.611	0.750
Tuv	0.747	0.887	0.584	0.739
Country's average	0.718	0.928	0.648	0.763

Source: Statistical book of Mongolia-2010

Household Income and Expenditures: The NSO started conducting researches on population, household income and expenditures since 1966. In 2010, average income per household in Mongolia reached MNT448.0 thousand, from which cash income was 86.4% or MNT387.1 thousand. The cash income was in the urban MNT476.7 thousand and in the rural MNT277.4 thousand. Figure 63 presents the average household income and expenditure for urban and rural population.

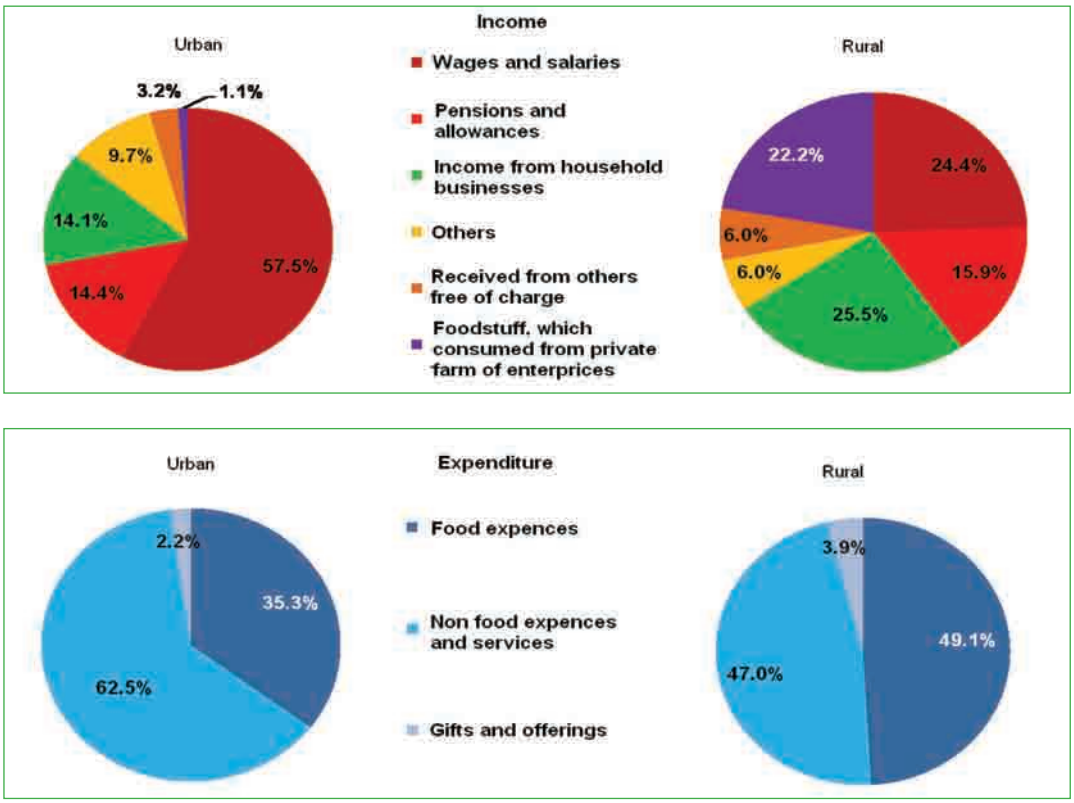


Figure 63. Composition of Household income and expenditure, 2010

In the "Survey on average wages and salaries of employees" of the Orkhon aimag were involved 9135 employees of 41 organizations like Erdmin, Stroi invest, Erdenet carpet, Medical clinic, Majaa hospital, Saving's bank and Khiimori CATV and Erdenet Khaan Suu LLC, etc. According to the survey, the average salary was MNT362.1 thousand which is MNT20.6 thousand more than the country's average salary.

In 2010, household expenditure at national level amounted to MNT450.6 thousand on average with MNT501.0 thousand in urban areas and MNT387.9 thousand in rural areas (Table 43). Of a total monthly expenditure per household, cash expenditure is 86.5%, food expenditure is 29.3% and other products and services are 54.3% compared to the national level.

Table 43. Monthly average income and expenditure per household, in MNT

Indicators		2006	2007	2008	2009	2010
Income	Country average	200,179	263,681	363,594	402,525	448,027
	Urban	181,165	269,472	406,667	454,854	498,172
	Rural	207,588	254,090	305,216	331,600	386,605
Expenditure	Country average	228,172	292,488	367,466	437,602	450,602
	Urban	232,188	308,016	421,924	471,336	501,042
	Rural	211,644	266,768	293,653	391,883	387,937

According to a Tuul River Basin survey, water and waste water expenses from the average monthly expenditure of a family of 4 persons in the ger area were estimated at MNT1.8 thousand, whereas households in apartments connected to the central water supply system without water meter pay MNT18.7 thousand (water 12.8 and waste water 5.9). This equals 0.3-4% of the monthly average household income.[3] However, for a low-income family it is 0.7% in the ger area and 7.3% in apartments. This shows us that when considering the water tariff situation more attention should be given to the low-income families in apartments. Furthermore, it is necessary to improve the water supply situation in the ger areas and to increase per capita water consumption. If the per capita water consumption increases 2 times and if the water tariff will not change then the expenditure for water will increase 2 times to reach 0.6-1.4% of the household income, which is acceptable. According to the survey in the ger area on willingness to pay, if the water supply condition will improve then people are willing to pay 1.5 times more for water.

Since 1998, according to the Law on Statistics and the Law on Defining Minimum Subsistence Level of Population (from 1998) the NSO has defined the minimum subsistence level of the population by region. Table 44 shows the minimum subsistence levels in 2006-2010.

Table 44. Minimum subsistence level of population

Region	Minimum Subsistence Level, *MNT/per month per person*					
	2006	2007	2008.II	2008.X	2009	2010
Central: Darkhan-Uul, Tuv, Selenge	39,000	56,700	73,100	90,800	91,200	91,700
Khangai: Arkhangai, Bayankhongor, Uvurkhangai, Bulgan and Orkhon	38,300	54,600	70,600	89,000	90,600	91,500

One of the indicators showing the living condition of the country is the poverty indicator. The poverty indicator includes poverty headcount, gap and severity. The poverty headcount index indicates the proportion of the population that lives below the poverty line.

The Millennium Development Goals (MDGs)-based Comprehensive National Development Strategy of Mongolia" aims to reduce the poverty headcount index by 2 times and to "create a regulatory mechanism to ensure full participation of all forms of enterprises and citizens in poverty reduction, and rapidly reduce poverty".

[3] By recommendation from EBRD water and waste water expense has to be less than 5% of household income.

Table 45. Poverty headcount index, by region

Indicator		2002-2003	2007-2008	2009	2010
Country average		36.1	35.2	38.7	39.2
Urban		30.3	26.9	30.6	32.2
Rural		43.4	46.6	49.6	47.8
Region	Khangai	38.7	46.6	55.2	51.9
	Central	34.4	30.7	29.3	29.3
Location	Aimag center	33.9	34.9	37.0	36.2
	Soum center	44.5	42.0	42.6	38.8
	Rural	42.7	49.7	53.2	54.2

The poverty of the population has certainly become an attention-drawing and crucial issue. However, there is an increase in Mongolia's economy and GDP per capita. Poverty level has reached 39.2% from 2006 to 2010 due to the dzud which took place in 2009 and 2010. Compared to 2007, the poverty level has increased by 4.5 points in rural area, 1.3 in aimag centers and 3.2 in soum centers, respectively.

*Water Poverty: w*ater is essential for human life. In 2002, for the purpose to express an interdisciplinary measure that links household welfare with water availability and water scarcity, C. Sullivan and a research group of the Economic Department of Keele University defined a Water Poverty Index. Applying this to 140 countries rates Mongolia at the 4th level with a low WPI. From the components that determine the WPI, Mongolia scored lowest on access to water and sanitation. This component will improve if the water supply and sanitation situation in ger and in rural areas is improved.

According to the water demand estimation, in 2010 33.4% of the Orkhon River Basin population was connected to a centralized water supply and sewerage system, 40.7% used other protected water sources and 25.9% used unprotected water sources (Table 46). In other words, 74.1% of the total population of the basin used improved water sources.

Table 46. Drinking water supply connections

Water source		2008		2010	
		thousand persons	share of the total, %	thousand persons	share of the total, %
Connection to the centralized system	Apartment	45.6	19.6	47.7	20.2
	Kiosks	23.2	10.0	31.1	13.2
Kiosks supplied by transport		73.3	31.6	63.8	27.1
Protected wells, springs		27.3	11.8	32.1	13.6
Other sources		62.4	27.0	60.9	25.9
Total		231.8	100.0	235.6	100.0

3.8. Infrastructure

Transport: In this basin, one of our industrial centers, Erdenet is located as well as 3 aimag centers. The infrastructure is well-developed. The railway lines which connect Mongolia with Russia pass through this region. The cities of Erdenet and Sukhbaatar are connected with Ulaanbaatar via railway lines.

The aimag centers are connected with Ulaanbaatar city by 1550 km paved road. Bulgan, Orkhon and Sukhbaatar cities are connected with each other by state and local roads. Orkhon aimag is 420 km from Ulaanbaatar and connected with neighboring aimags by paved road. Orkhon aimag has 190 km auto road and 54 km is paved road and 135 km is

pebbled road. Bulgan aimag has 1023 km improved pebbled road which connects aimags and soums. The black-top road is 27.5 km and state road is 477 km.

Energy: The aimags in the basin are connected to the central energy network. They have reliable energy sources. The central region energy systems occupy 90% of the energy networks. It consists of Ulaanbaatar's power plants number 2, 3, 4; Darkhan power plant; Erdenet power plant; Central region electricity transmitting network and electricity transmitting network agencies of Ulaanbaatar, Darkhan, Erdenet and Baganuur.

The total installed electricity capacity is 712 MW and total installed thermal capacity is 1786 Gcal/hour. It distributes electricity to Ulaanbaatar, Khangai and Central region aimags (except Umnugovi) and Khentii's 270 soums' consumers using 35-220 KW-1300 km-long electricity transmitting lines.

Water supply and sewerage system: Erdenet city is located in the basin and has centralized water and thermal supplies. 50% of the population lives in apartments. Erdenet city water supply is carried from 64 km using 4 pump stations and in the ger district 40 kiosks supply consumers with drinking water. Some 6.3% of the Tsetserleg city population, 9.2% of the Bulgan city population and 10% of the Sukhbaatar city population lives in apartments connected to engineering pipelines. Currently Kharkhorin city houses are not connected to the centralized system. For more specific information please see chapter 4.

The Water National Program approved in 2010 planned to improve drinking water supply in the urban area, intensify surveys and investigation for water sources for cities and soum centers, and to protect water supply sources. In the new mid-term development program it is planned to improve the urban development and local infrastructure, to create comfortable living condition in the local area and to provide engineering infrastructure to local area residents. As a result of implementing these programs aimag and soum centers will solve some problems related to the water supply and *waste water* of the cities and urban areas.

3.7. Agriculture

3.7.1. Livestock husbandry

In 2010, the agricultural production comprised some 22.8% of the GDP of the Orkhon River Basin. In 2010, agriculture sector of Orkhon aimag produced 1.5% and other aimags 62.2%-77.6%.

Structure and growth of livestock and influencing factors on livestock husbandry

Herders: In 2010, there were in total 160.3 herder families and 327.2 thousand herders in the country. Some 11% or 17.5 thousand families and 9.7% or 31.9 thousand herders are living in the Orkhon river basin.

Livestock: As of 2010, there were 2.9 mln livestock in the basin comprising 8.9% of the total livestock number of the country. As we see from Figure 64, Arkhangai aimag contained 35.7%, the highest percentage of the total livestock of the basin while Darkhan-Uul aimag contained a mere 0.5%, the least percentage.

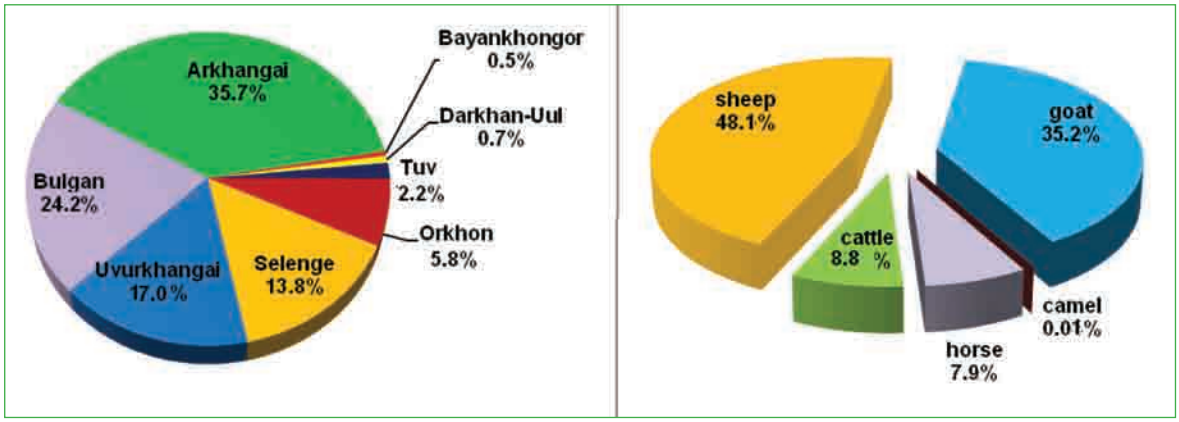


Figure 64. Livestock percentage of aimags and livestock structure in Orkhon River Basin

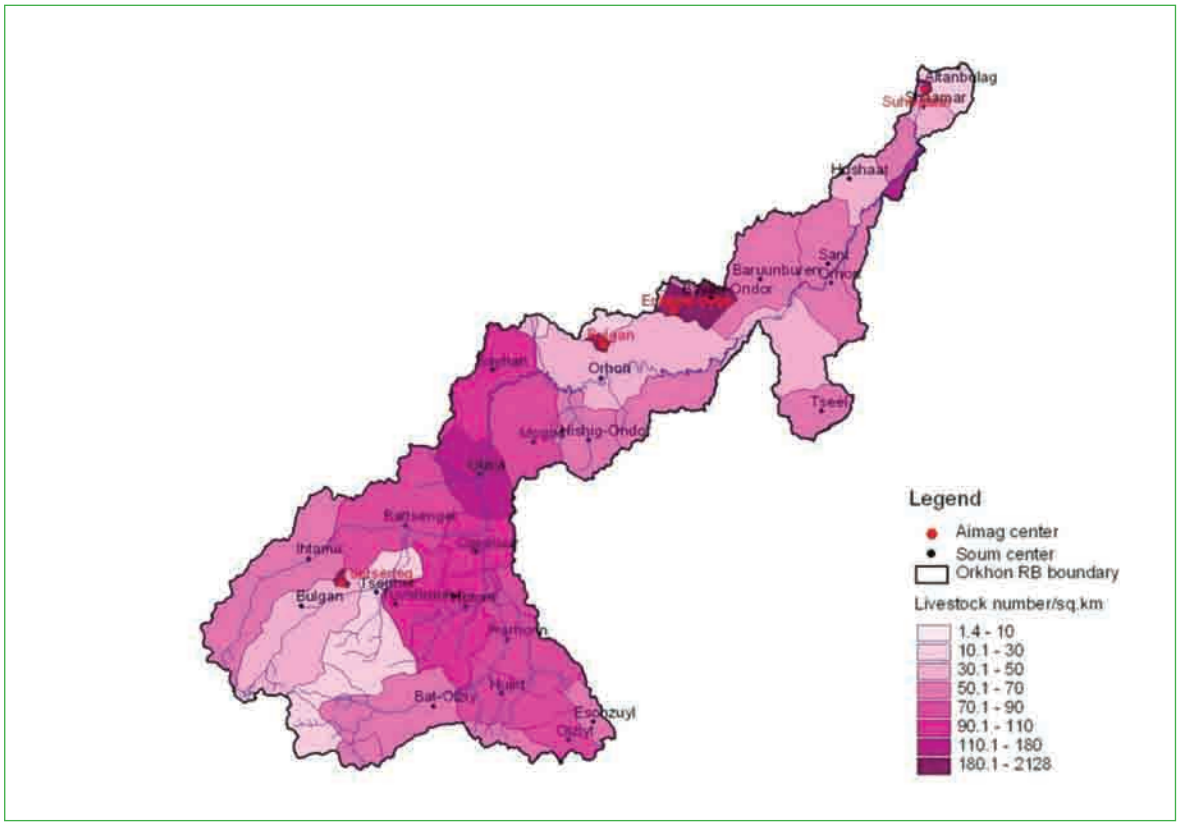


Figure 65. Livestock density

The livestock density by soum presented in Figure 65 shows livestock density in terms of location and the most densely populated soums include Bayan-Undur, Orkhon aimag and Ulziit soum, Uvurkhangai aimag while Tsenkher and Bulgan soums, Arkhangai aimag are included in the least densely populated.

Small cattle comprises 83.3% of the total livestock number and large cattle 16.7%. The decreased percentage of small cattle compared to 2008 is due to the dzud of 2009. The percentage of goat heads in small cattle has decreased from 45.6% to 42.3%. This is still considered as relatively high according to some scientists' definition. The livestock number in the Orkhon River Basin is presented in Table 47 and Table 48.

In 2008 the livestock number of Orkhon River Basin was about 7 million in terms of sheephead. Since 2004 the share of the cattle and horses decreased while the share of the small animals increased. Between 2004-2008 small animal numbers in terms of sheephead increased 2 times and cattle increased 1.7 times. As of 2010, the basin had 42.6 million km^2 pasture area and 5.5 million livestock in terms of sheephead. There are 129 sheephead per hectare which is 2.6 times more than the country's average and 1.4 times more than the average of the Tuul river basin (Table 49).

Table 47. Livestock numbers in the Orkhon river basin, 2010

thousand head

	Camel	Horse	Cow	Sheep	Goat	Total
Arkhangai	0.5	84.8	98.6	487.8	369.3	1041.0
Bayankhongor	0.0	1.1	5.1	7.7	7.5	21.4
Bulgan	0.2	69.0	52.0	366.8	218.8	706.8
Darkhan-Uul	0.1	0.6	3.1	7.8	4.4	16.0
Orkhon	0.2	10.7	17.8	73.1	67.4	169.2
Uvurkhangai	0.3	33.5	26.5	190.5	150.4	401.2
Selenge	0.4	25.3	50.3	237.0	182.4	495.5
Tuv	0.0	4.6	4.3	31.1	24.8	64.9
Total	**1.8**	**229.6**	**257.6**	**1402.0**	**1025.0**	**2915.9**

Table 48. Livestock numbers in the basin in terms of sheephead

Type of livestock	Livestock, *thousand sheephead*			
	2004	2006	2008	2010
Camel	5.7	7.0	8.0	9.2
Horse	1488.8	1662.6	1965.8	1607.1
Cow	1058.3	1354.6	1835.5	1545.4
Sheep	874.2	1222.1	1790.2	1402.0
Goat	656.2	921.4	1364.9	922.5
Total	**4083.2**	**5167.7**	**6964.4**	**5486.1**

Table 49. Grazing capacity of the Orkhon basin, 2010

Aimag	Pasture area, *km^2*	In terms of sheephead	
		Total, *thous. sheephead*	On per 100 ha
Arkhangai	16656.3	2007.6	121
Bayankhongor	822.3	52.7	64
Bulgan	9572.7	1359.6	142
Darkhan-Uul	216.4	35.2	163
Orkhon	431.7	316.3	771
Uvurkhangai	6981.4	720.8	103
Selenge	7128.7	882.2	124
Tuv	827.4	111.8	135
Total	**42636.9**	**5486.1**	**129**

As Erdenet, the densely populated city is in the basin and it is located closely to cities of Darkhan and Ulaanbaatar, the biggest marketplace, it would be more convenient to develop an intensive livestock husbandry.

The administration of land affairs, construction, geodesy and cartography conducts "State inspection and guarantee on land status and quality" in all types of land subject to the integrated fund once in five years and most recently this inspection has been carried out between 2008 and 2010.

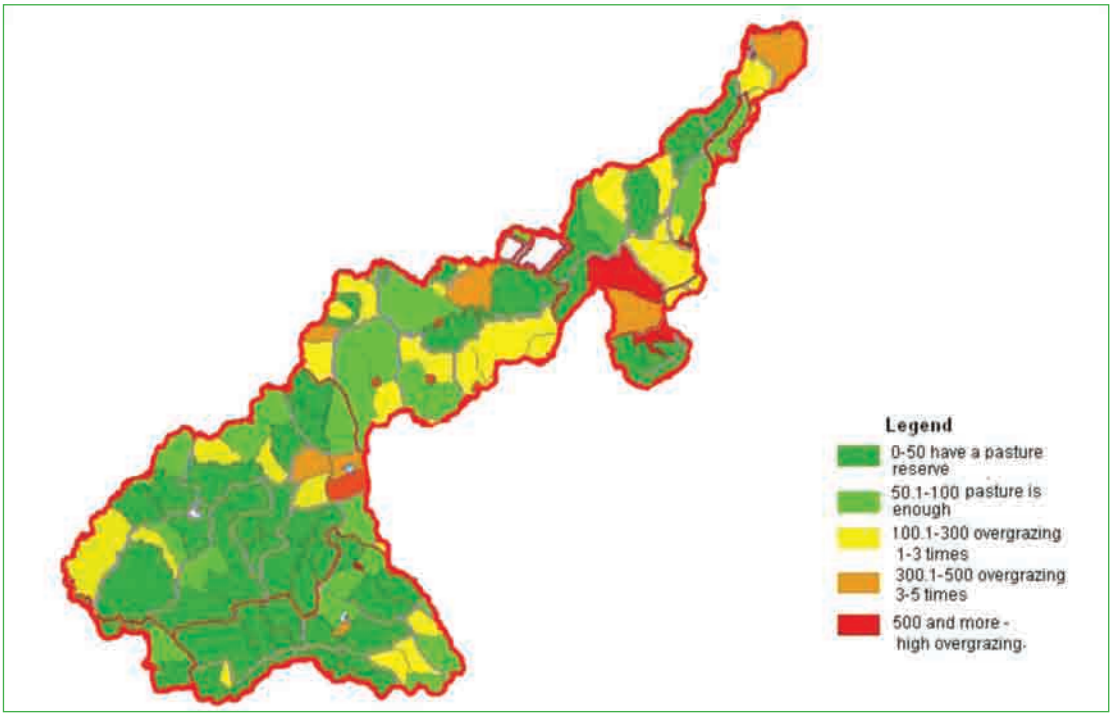


Figure 66. Grazing capacity in the Orkhon river basin, 2011

Also, the National Meteorological Institute conducts calculates the grazing capacity by the end of August every year. Figure 66 shows the grazing capacity of the basin as of 2011 and it can be seen that the grazing capacity in Orkhontuul soum, Selenge aimag has been exceeded strongly, while the grazing capacity was exceeded 3 to 5 times in Ugiinuur soum, Arkhangai aimag and Orkhon soum, Bulgan aimag. The way to overcome these difficulties is to plant some additional animal food, to receive it from other aimags, or to graze livestock for fattening, etc.

For the purpose to meet the food needs of the population it is necessary to develop intensive livestock herding. In 2010, there were 14 dairy farms with 330 cows in the Erdenet city and about 70 dairy farms with 1200 cows in the other aimags in the basin. Also, there were operating some 50 meat farms, about 50 pork and chicken farms and 8 bee farms. For the intensive livestock breeding water consumption will be higher than pastoral cattle breeding. However, currently, the water use of the livestock farming is based on the same water consumption norms. In the future the water consumption norms for intensive livestock farms need to be determined separately.

Production of livestock husbandry

Meat production: As of 2010, in total 8.4 million livestock were used for food at the national level, whereas 665.1 thousand were used for food at the level of the basin (Table 50). This is 7.9% of the country total with 92.1% small cattle and 7.9% large cattle.

Table 50. Number of livestock used for food by type and head as of 2010

Aimag	Camel	Horse	Cow	Sheep	Goat	Total
Arkhangai	0.1	12.7	23.2	133.8	78.5	248.3
Bayankhongor	-	0.2	1.2	1.9	1.7	5.0
Bulgan	-	16.1	14.6	137.4	85.5	253.6
Darkhan-Uul	-	0.1	0.9	4.5	3.4	8.9
Orkhon	0.1	2.3	5.8	30.0	17.1	55.1

Aimag	Camel	Horse	Cow	Sheep	Goat	Total
Uvurkhangai	-	2.3	4.5	32.9	16.5	56.2
Selenge	0.1	7.8	16.4	74.0	57.7	156.0
Tuv	-	0.7	1.2	9.4	5.5	16.9
Total of the basin	0.3	42.2	67.7	423.9	265.9	800.1
Share of country total, %	0.9	15.4	12.5	10.9	10.0	10.8

Remark: above figures calculated by aimag are subject to the Orkhon river basin only.

According to calculation in terms of live weight, 468.4 thousand ton of meat was supplied for meat production at national level. And 8.2% of total meat production was supplied by the basin with camel meat 0.1%, horse meat 15.1%, beef 23.1%, mutton 38.4% and goat meat 23.1%.

As of 2010, 338.4 million liter milk was produced at national level and 43.5 mil. liter or 12.9% was produced in the basin. In the basin it is very common to produce airag (fermented mare milk) and in total 7.1 million liter of airag was produced in the basin.

In 2010, 23.5 thousand ton of sheep wool and 6.3 thousand ton of cashmere were produced in the country. In the basin 2.1 thousand ton or 8.8% of total wool production and 6.5% or 407.1 ton of total cashmere production were produced. Also, in current year, some 16.8 million pieces of leather were manufactured at national level and 4.4% or 731.6 thousand were supplied from the basin.

Future development trend of livestock husbandry

In forecasting the growth of the livestock numbers, a proportion method has been used by comparing the projection by the Ministry of Food, Agriculture and Light Industry and the average livestock growth in the recent 5 years. This projection was calculated including changes in livestock numbers and the increase in food demand of the population of Mongolia.

According to the livestock growth projection of the Orkhon basin, livestock head is about to reach 3.8 million and sheephead to reach 3.5 million by 2021 (Table 51).

Table 51. Livestock growth projection of the Orkhon River Basin in thousand sheephead

Aimag	2008	2010	2015	2021
Arkhangai	1508.4	1041.0	1245.4	1271.3
Bayankhongor	18.6	21.4	27.1	29.8
Bulgan	801.2	706.8	848.6	865.1
Darkhan-Uul	631.1	401.2	447.9	468.8
Orkhon	29.8	16.0	20.0	21.7
Uvurkhangai	268.9	169.2	192.7	190.9
Selenge	576.7	495.5	584.6	590.7
Tuv	62.6	64.8	75.9	75.4
Total of the basin	**3897.3**	**2915.9**	**3464.5**	**3513.6**

In 2010, the "Mongolian Livestock" National program was adopted through the 23rd resolution of Parliament of Mongolia. The objective of the program is to develop a livestock sector that is adaptable to changing climatic and social conditions and create an environment where the sector is economically viable and competitive in the market economy, to provide a safe and healthy food supply to the population, to deliver quality raw materials to processing industries, and to increase exports.

Furthermore, the program is to ensure a sustainable development of the livestock sector and to create a legal environment that will promote economic turnover; to improve traditional livestock breeding and to develop cooperation between nomadic herding

and the intensive livestock keeping. It also aims to increase its the productivity and to improve the quality livestock products and to improve efficiency; to develop the livestock sector based on regions; to restore destroyed pastureland; to improve fodder production; and develop a market system of livestock products.

In the relation to the livestock water supply, the Livestock program aimed the following: based on herders' ideas and initiatives to implement exploration work to find appropriate sites for the new water wells, and to develop cost-sharing practices for the building and operating water sources. Also there were planning to develop ownership system and implement of the transfer responsibility for the use, protection and maintenance of new and repaired wells. The program projects the number of wells to be newly constructed in 2012 to reach 2400, in 2015 to reach 3600, and in 2021 to reach 2686 wells, while on the other hand the National Water program presents a construction target of 800-1000 wells per year.

Table 52 presents the main agriculture farming development guidelines of the aimags that are planned in the Development program of the aimags. According to the table below, in the aimags were planned to develop intensive livestock and crop farming.

Table 52. Main development guidelines of aimags in the Orkhon River Basin

Development direction	City, aimag, soum
Intensive livestock farming	Erdenet, Kharkhorin, Tsetserleg; Khutag-Undur, Bulgan, Bugat, Orkhon, Buregkhangai of Bulgan; Uyanga of Uvurkhangai
Core herd of cattle, raise the male parent of an animal	Khotont of Arkhangai, Uyanga of Uvurkhangai
Cattle farm of Selenge breed	Khutag-Undur of Bulgan, Arkhangai
Intensive, model farms of crop and livestock	Arkhangai, Bulgan
Livestock Research Institute of Mountain area	Ikhtamir of Arkhangai
Farm of fine-woolen sheep	Buregkhangai, Khishig-Undur of Bulgan; Orkhon; Selenge
Fodder farm	Rashaant, Khutag-Undur, Khishig-Undur of Bulgan; Orkhon; Selenge
Slaughter plant, a cellar	Mogod, Dashinchilen and Khishig-Undur of Bulgan

3.7.2. Crop farming

An essential sector of the agriculture is crop farming. As the basin is closely located to the main marketplaces, it is possible to develop crop farming in terms of economy and climate. Most parts of the basin are convenient for crop farming and it belongs to a region with an assessment of 60 points[4] according to the assessment on soil quality. Therefore, the following regions have been determined as major agricultural region[5] for Mongolia. Some 8 soums located in the forest steppe zone in the north of Tuv aimag, another 3 soums of Bulgan aimag, the Orkhon aimag, and the territory of Selenge aimag. Of the aimags included in the Orkhon river basin, Selenge aimag was dedicated in 1931 with a specifically given name of "crop farming" and developed as a birthplace of botanic, livestock husbandry and crop farming. As of 1990, Selenge aimag used to provide 23.7% of the total crop in the country. In 2010, it reached to some 47% of total sown area at national level. Of this, the Orkhon river basin contributed 35%. As of 2010, 24.7% of the irrigation fields of the country are located in the Selenge aimag.

Aimags included in the basin have planted seed/grain, potato and vegetables on crop fields with 79.6 thousand hectare as of 2010 and comprised some 25.2% of the total

[4] Mongolian National Map-2009, page 122.
[5] Development program of Selenge aimag, page 14.

crop field in the country. Some 28.6% of seed/grain, 16.6% of potato, 19.5% of other vegetables were planted in the basin. Please see figures of crops and harvests from Table 53.

Table 53. Size of crop field and crops in the Orkhon river basin

Aimag	Type of crop	2007		2008		2009		2010		
		Sown area, *ha*	Crop, *ton*	Sown area, *ha*	Crop, *ton*	Sown area, *ha*	Crop, *ton*	Sown area, *ha*	Crop, *ton*	Yield, c/ha
Arkhangai	Wheat	548.0	142.5	670.0	880.0	4000.0	2395.0	3515.0	2753.0	7.8
	Potato	401.8	2704.1	568.5	4234.8	551.7	1515.8	316.3	3861.6	122.1
	Vegetable	171.6	495.9	159.4	1037.6	162.9	1076.0	118.9	1218.8	102.5
	Fodder	-	-	-	-	39.0	95.0	1231.9	3208.7	26.0
Bulgan	Wheat	1271.0	1052.0	1781.0	3380.0	1121.0	1642.0	3166.0	3216.0	10.2
	Potato	158.2	1385.0	144.0	1494.0	154.0	1476.7	154.0	1635.5	106.2
	Vegetable	62.6	582.0	80.0	834.0	79.0	742.5	88.0	832.0	94.5
Orkhon	Wheat	2009.2	1349.8	2326.0	5134.9	4529.0	11322.0	4102.0	8491.2	20.7
	Potato	487.5	4465.2	561.0	5670.1	672.8	6519.4	479.1	5418.6	113.1
	Vegetable	323.6	3375.9	448.3	4220.8	436.7	4487.3	367.6	4517.9	122.9
	Technical plant	395.0	29.0	20.0	8.0			60.0	42.0	7.0
Uvurkhangai	Wheat	1145.0	4.4	570.0	150.3	980.0	702.0	1395.0	1088.0	7.8
	Potato	80.5	695.0	87.2	824.8	97.0	887.1	104.3	931.7	89.3
	Vegetable	72.0	435.4	45.8	511.7	60.3	457.0	55.3	406.8	73.6
Selenge	Wheat	14840.0	12284.9	26366.0	36020.5	44715.0	57743.0	49162.0	64526.0	13.1
	Potato	889.4	13498.5	1095.0	19071.0	1166.0	17814.0	1126.0	15771.0	140.1
	Vegetable	531.0	10685.3	596.0	10815.0	646.0	9789.0	724.0	10287.0	142.1
Tuv	Wheat	2183.0	2401.0	2861.0	2993.8	9907.0	20407.6	12885.0	26413.9	20.5
	Potato	110.0	550.0	115.0	575.0	110.3	880.0	113.5	1305.2	115.0
	Vegetable	13.6	54.4	10.0	45.0	14.0	92.1	15.8	208.5	132.0
	Fodder	-	-	-	-	-	-	150.0	265.6	17.7
	Technical plant	-	-	-	-	-	-	276.0	1337.6	48.5
Total of the basin	Wheat	21996.2	4949.7	34574.0	12539	65252.0	36468.6	74225.0	41962.1	14.3
	Potato	2127.4	9799.3	2570.7	12798.7	2751.8	11279	2293.2	13152.6	126.1
	Vegetable	1174.4	4943.6	1339.5	6649.1	1398.9	6854.9	1369.6	7184	127.6
	Fodder	0.0	0	0.0	39	39.0	1381.9	1381.9	43.7	25.1
	Technical plant	395.0	29	20.0	8	0.0	0	336.0	1379.6	41.1
	Total	25693.0	-	38504.2	-	69441.7	-	79605.7	-	-

Irrigation. As of 2010, there were some 20 irrigation systems in the basin with a capacity to irrigate of 4.8 thousand hectare of which 65% is located in Selenge aimag.

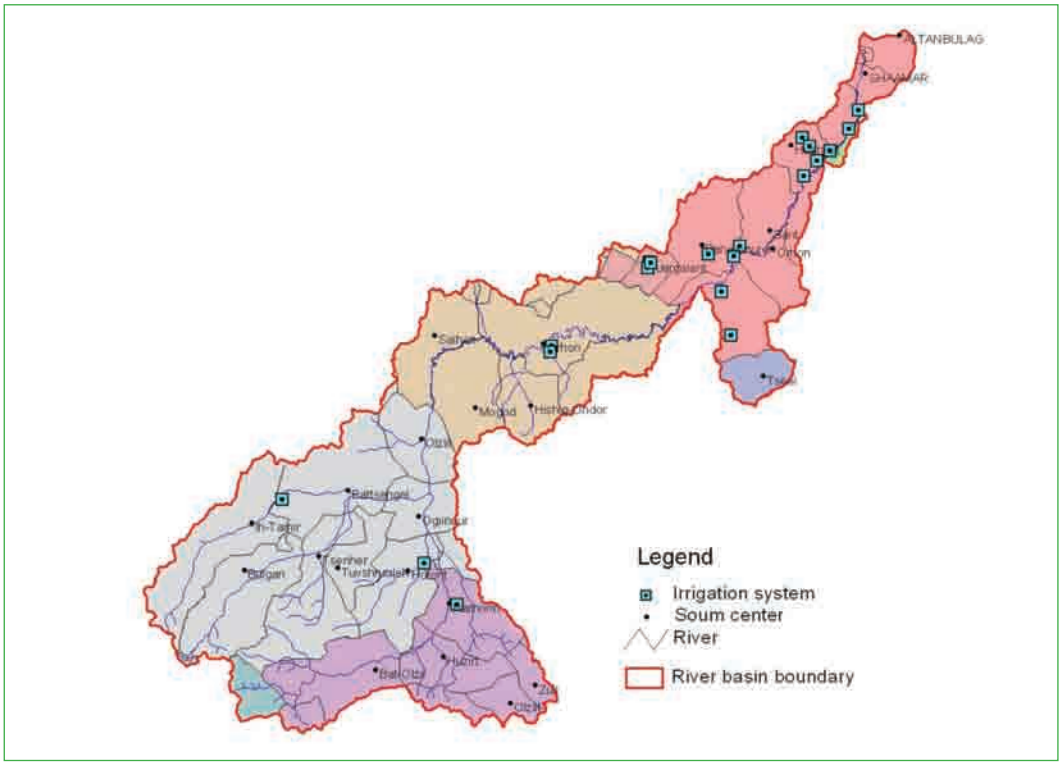


Figure 67. Irrigation systems in the Orkhon river basin

Potato and vegetables are mostly planted on irrigation fields. The harvest of the irrigation fields is 20-40% higher than the average harvest of non-irrigation fields. This indicator is still lower than international standards. This is due to non-compliance with relevant irrigation procedures and lack of sufficient use of other technologies such as fertilizers and pesticides used for plantation.

3.8. Industry

In the basin, the industrial sector contributes 66.9% of the GDP which is higher than the country's average. Orkhon aimag solely produces 70% of the GDP of which 92.6% is contributed by the industrial sector. The status of manufacturing was calculated approximately by aimag centre located in the basin. The GDP produced in the Orkhon River Basin is presented in Figure 68.

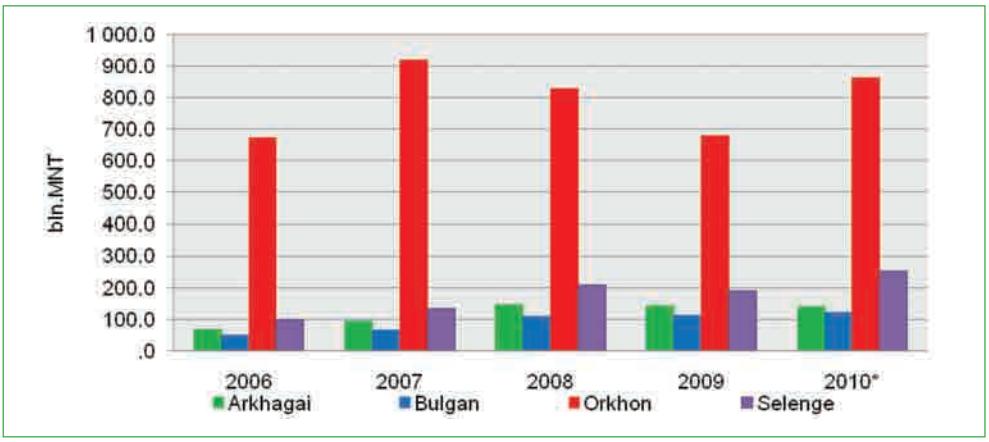


Figure 68. GDP produced in the Orkhon River Basin, at current prices

The Orkhon River basin is different from other basins as the industrial sector of its aimags contributes a relatively high percentage of the GDP. Compared to other basins, the percentage agriculture in the GDP of the basin is low. Orkhon aimag produced 69.2% of the total value added products produced by the aimags of the basin while 13.3% is produced by Selenge aimag, the largest agricultural region.

The production of the Orkhon aimag output of the industry reached to MNT1.2 trillion that increased by 10.7% compared to 2008 (which was MNT1.08 trillion). The mining sector produced 96.9% of the total production, the processing sector 2.1%, and the power and heating sector 0.9%, respectively. Of the processing sector, iron industry contributes 41.1%, wool and cashmere 33.6%, food product 8.7%, ironwork factory except machinery and equipment 5.2%, garment 3.9%, items/construction material made from non-metal substance 6.3%.[6] The production output of the mining sector increased by 45.2% in 2010, which is due to the increased price of copper and molybdenum in the world's commodity market.

In Selenge aimag, the manufacturing sector contributes 48.1% of the GDP. As of the end of 2010, the production output of manufacturing sector was measured at MNT342.2 trillion and its total sold products amounted to MNT376.3 trillion. The mining sector contributes 84.9% of the total manufacturing products, the food sector 6.9% and the construction material sector 6.8%.

For Bulgan aimag, the manufacturing sector contributes 2.5% of the GDP reaching MNT3356.6 million. In 2008, it was MNT2108 million.

Arkhangai aimag: According to current prices, the manufactured products of MNT4255.1 million in 2010 and MNT2476.3 million at constant prices of 2005. It has increased by 3.2% or MNT75.6 million than previous year.

3.8.1. Light and food Industries

In 2010, aimags of the Orkhon River Basin produced MNT48.4 billion products of light and food industries at current prices, from which MNT31.7 billion was produced in the food sector, MNT10.1 billion in the garment sector and MNT6.3 billion in the wood processing sector (Table 54).

Table 54. Production of the light and food industry in million MNT, at current prices

Sector	Orkhon		Arkhangai		Bulgan		Selenge		Uvurkhangai	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Food, beverage, and alcohol drinks	3,798.0	2,278.2	2,257.2	2,126.6	1,120.9	1,267.4	26,654.8	23,698.2	1,564.0	2,392.6
Garment	11,992.9	8,831.4	-	-	118.7	76.6	-	-	-	-
Fur and leather	779.8	1,013.8	56.4	61.7	-	-	-	-	97.4	116.8
Wood, wooden products	50.8	52.0	115.5	119.0	88.3	290.7	8,797.0	4,794.7	913.0	1,009.7
Book and printing	118.7	68.3	15.1	17.6	4.0	3.6	-	-	16.7	21.2
Other products	138.0	83.3	-	-	-	-	-	-	29.8	63.0

Orkhon aimag: Orkhon aimag's industries are located in Erdenet city. The processing industry sector of Orkhon aimag produced MNT26.3 billion of products in 2010. The breakdown is: MNT2.3 billion of products were produced by the food sector; the garment sector produced MNT8.8 billion of products and the knitting sector produced MNT1.0 billion of products. 8.7% of aimag's processing industry is food industry; 33.6% is wool and garment industry; 3.9% is sewing industry. Alcohol and beverage production

[6] Statistical report of Orkhon aimag-2010

occupies 4.7% of food production; 18.4% is dairy production; 11.3% is meat production; 27.5% is flour and fodder production and 38.1% is other production (Table 54).

The meat production of Erdenet city is decreased by 90% compared to that of 2008. The alcoholic beverage production is dropped by 59% compared to that of 2008. The production of cosmetics, oxygen and toilet paper is completely stopped. It is possible to renew the dairy and meat production. Erdenet city exports carpets and meat.

As of 2010, there were some 86 entities which operate in the food production sector. They include: 3 meat processing industries; 3 dairy processing industries; 3 grain processing industries; 3 beverage industries and 29 entities in food production. The other industries are: 6 garment industries; 26 sewing industries; 2 wooden material industries; 1 chemical industry and 3 plastic material industries. Other big industries are: Erdenet carpet company, "Erdenet progress" LLC and Shimtechnology LLC.

The following industries are developing in Erdenet city: waste processing; wooden materials of construction; construction; wooden materials; sewing; garments; tannery; fruits; beverage; meat products; dairy products and bakery. As for Jargalant soum, developing industries are: grain, vegetables, bricks, bakery and animal husbandry.

Arkhangai aimag: In the aimag MNT4255.1 million of products at current prices were manufactured in 2010. Some MNT2476.3 million of products at constant prices of 2005 manufactured, which increased by 3.2% or MNT75.6 million from previous year. There were 50% of the total production is food and beverage production; 2.8% is wooden material production; 0.4% is publishing production and 1.5% is clothes production and light industries. It is possible to develop dairy and felt material productions.

Bulgan aimag: Total industrial production of Bulgan aimag reached MNT3356.6 million at the end of 2010. It increased by 104.1% or MNT131.4 million compared to that of 2009. Flour-product production increased by 120.0%; food production by 108.5% and wooden material production increased 3.2 times. Garment and clothes production decreased by 35.5%; publishing production by 11.2% and alcoholic beverage production decreased by 73.2%.

Selenge aimag: In the aimag MNT342.2 billion of products were produced in the industrial sector as of 2010. MNT376.3 billion of sales were made. Total production increased by 8.2% and sales increased by 37.9%. The basic products increased when comparing to the previous year: milk production by 53.8%; ice cream production 5 times; beverage production 2 times; flour production by 6.7%; bakery by 12%; mill offal production by 11.5% and ready-made flour (noodle) by 38%.

Uvurkhangai aimag: Arvaikheer city of Uvurkhangai aimag does not belong to Orkhon river basin. But Kharkhorin does and it is a center of the Khangai region. There are 923 entities in the aimag and 231 of them are located in soums that belong to the basin. As of 2010, MNT5973.5 million of products were manufactured in Uvurkhangai aimag industrial sector. MNT5619.2 million of sales were made as of current prices. Comparing to previous year, production was increased by 28.5% and sales were increased by 29%. The food sector produced 40.1% of total production; 23.1% wooden material production; 5.8% other small and medium industries. As for food production, 13.4% is alcohol, 5.4% is flour, 5.3% is dairy product and 3.2% is beverage, water and ice cream production. Also 1592.8 tons of flour and flour products were produced and it was 15.0% of aimag's food demand. Uvurkhangai aimag has a possibility to increase flour, potatoes and vegetables productions.

As of 2010, light and food industries of Orkhon river basin aimags used 263.4 thousand cubic meter water. The calculation was based on manufactured products' amount and water use norm. The sector's production will increase by 6.9% a year on average. It will

be 367.8 thousand cubic meter water in 2015 and 548.8 thousand cubic meter water in 2021.

Development perspective

The Ministry of Food, Agriculture and Light Industry announced that the following measures should be taken in local areas: construction of raw material processing industry, flour and fodder industry, cement industry, iron and glass processing industry, nanotechnology, fuel (smokeless) industry, planting seabuckthorn and producing vegetable oil.

The Government of Mongolia approved the "Industry Development Trend in Local Areas" by the resolution number 178 in June, 2009. In the framework of the program, the following small and medium industries will be developed in aimags which belong to the Orkhon River Basin ().

Table 55. Planned small and medium industries

Industries	Arkhangai	Bulgan	Orkhon	Uvurkhangai	Selenge
Livestock feeding farm		+			+
High breeding livestock farm	+	+			
Milk processing	+				
Milk processing plant (one of soums)	+	+	+	+	+
Milk cooling center and units	+	+	+	+	++
Farm with 50 cow	+	+	+	+	+
Fodder factory				+	
Greenhouses (for every soums)	+	+	+	+	+
Vegetable processing plant			+		+
Fruits and berries processing plant	+		+		+
Starch plant					+
Fish farming	+				
Poultry farm (construct and expand)	+	+	+	+	+
Service center (aimag, soum center)	+	+	+	+	+
Wool washing and felt plant	+	+	+	+	+
Textile factory	+	+	+	+	+
Wood work plant (construct and expand)	+	+			+
Stone work plant			+		
Patent fuel plant			+		
Small, metal work plant(construct and expand)			+		
Small and medium enterprises for export products			+		

Erdenet city has possibilities to develop the following industries: milk powder industry; greenhouse husbandry; fodder industry; animal husbandry of milk and meat and waste processing industry.

Orkhon aimag included following things in its development strategy policy till 2021: Increasing processing industries on the basis of raw material resources; establish cooperation with big industries like "Erdenet"; develop small spare-part producing industries; support export-available production; and sector's GDP will be reached at 18% of industrial sector GDP by 2021.

As for Arkhangai aimag, the following things are included in the development program: develop light and food industries; planting trees; constructing woodworking industry;

constructing garment and knitting industries in soums; constructing brick industry; greenhouses; establishing vegetables-packing workshops; building waste recycling workshops; building modern industry for processing butter and dairy products and building waste recycling plant in Erdenebulgan soum.

Bulgan aimag will increase its processing production growth by 11.9% a year on average and building or strengthening following industries.

Table 56. Development of small and medium industries in soums of Bulgan aimag

Soum	New small and medium industries
Khishig-Undur	Milk and dairy production plant, patent fuel, water bottling plant
Saikhan	Airag processing plant
Mogod	Airag processing plant, patent fuel, carpet plant
Orkhon	Flour plant, wood work, water bottling plant
Bulgan	Flour plant, meat processing plant, Milk and dairy production plant, fruits and berries processing plant, waste processing plant, vvegetable processing and chips plant, sea-buckthorn processing plant

As for Selenge aimag, the following is included in its development program: developing sub program to develop small and medium industries; constructing meat, milk and vegetables processing small industries in soums; increase competing capacity of knitted and woven products.

Uvurkhangai aimag has included following measures in its development program: develop small and medium industries on the basis of agricultural raw material and natural resources. Table 57 shows planned small and medium industries in Uvurkhangai aimag's soums which belong to the Orkhon River Basin.

Table 57. Development of small and medium industries in Uvurkhangai aimag's soums

Soum	New small and medium industries
Kharkhorin	Sausage and can industry, Milk and dairy production plant, pastry plant, fish and vegetable processing plant
Bat-Ulzii	Milk and dairy production plant, pastry plant, fish and vegetable processing plant
Khujirt	Milk and dairy production plant, pastry plant, fish and vegetable processing plant, yak wool processing plant

In the future, it is possible to establish plants in Orkhon aimag including the centralized fresh water and sewage system for Erdenet city, manufacturing based on industrial and technological park Erdenet, production output to replace import products of Erdenet LLC, iron design production, milk-powder plant, green-house farm, nutritional plant, intensive livestock husbandry for milk and meat products and waste processing plant. In Jargalant soum in the future, it is possible to establish a vegetable processing plant, green-house, vegetable, seed/grain, warehousing farm, agrotechnical vegetable park, tare/bag plant and flour plant. Water supply will increase due to development of light and food industry sectors.

3.8.2. Metal Processing Industry

In Mongolia, mining is rapidly developing. There are very few heavy industries except processing industries. The metal processing industry of the basin is located in Erdenet city. Iron industry started functioning in Sukhbaatar city since 2008.

The first part of Erdenet industry started working in 1978 and its capacity was as follows: ore-dressing of 25-25.6 million tons a year on average; 530.0 thousand tons of copper concentrate with 23.5% copper; 3.0 thousand tons of molybdenum concentrate

(49-51% Molybdenum). Also other companies operate there. They are: Erdmin company (Mongolian-American joint), Copper cable industry, Khokhgan LLC, Ora metal LLC, "Metal Industrial" LLC, "Orkhon Khiits" LLC and "Mongema" LLC.

The Beren group LLC has constructed an iron industry in Erdenet city. As of 2010, followings have been produced in Erdenet city: 5522.0 thousand tons of copper concentrate and 4.3 thousand tons of molybdenum concentrate (*Table 58*).

Table 58. Main products of metal processing industry of Erdenet and Sukhbaatar

Commodity	Unit	2006	2007	2008	2009	2010	2010/2008, %
Copper concentrate	*Thous. ton*	537.7	543.2	525.3	531.3	522.0	99.4
Molybdenum concentrate	*ton*	3022.0	3978.0	3795.0	4769.1	4348.0	114.6
Metal cast product	*ton*	107.8	49.4	133.3	149.2	83.1	55.7
Metal products	*ton*	661.2	724.8	550.9	490.8	295.3	60.2
Steel construction	*ton*	13934.6	24705.6	3245.4	3482.8	3162.8	90.8
Cathode copper, 99%	*ton*	2618.4	3006.5	2594.7	2470.1	2746.2	111.2
Armature	*ton*	0	0	745	450.0	602.0	133.8

Erdenet industry plays a key role in our country's economy. For example: the industry produces 30% of Mongolia's export alone. As of 2010, Orkhon aimag exported MNT1135.7 billion of products (Table 59). Orkhon aimag imported MNT183.3 million of products.

Table 59. Exported products of Erdenet city by volume, at current prices

Indicator	Unit	2008	2009	2010
Total export	*Mil MNT*	1121.6	811.0	1135.7
	Mil USD,	-	-	844.6
Copper concentrate	*Thous. ton*	582.9	580.3	563.2
Molybdenum concentrate	*Thous. ton*	3.0	5.8	4.5
Cathode copper	*Thous. ton*	2.4	2.3	2.8
Carpet	*Thous. m2*	122.5	54.2	61.5
Meat	*ton*	2482.5	3674.4	2541.7
Bio fuel	*ton*	120.0	-	40.0
Other	*ton*	1.76	18.3	-
Calcium molibdate	*Thous. ton*	1.06	-	-
Molybdenum oxide	*Thous. ton*	0.6	-	-
Molybdenum concentrate not processed in torrefaction method	*Thous. ton*	0.1	-	-

Source: Statistical report of Orkhon aimag-2010

The technical and technological reforms of Erdenet industry need to be made step by step; producing pure copper and separating other elements; increasing capacity to process ore with small amount of copper; increasing cathode copper production; establishing metallurgic complex on the basis of iron-ore mines of Darkhan and Selenge regions where infrastructure is well-developed.

3.8.3. Mining and Quarrying

The mining production sector manufactured 22.7% of GDP, 66.7% of total industrial products and 81% of export products. It constitutes 40% of the local budget income and 34.1 thousand people work here. The mining sector benefits to the Mongolian economy are constantly increasing. This is presented in Table 60.

Table 60. Mining sector percentage in Mongolia's economy, %

Production	2006	2007	2008	2009	2010
GDP	30.0	27.4	20.6	19.8	22.7
Industrial output	69.9	63.4	56.4	62.7	66.7
Export	67.9	66.8	60.3	66.4	81.0

This basin has a lot of gold, iron-ore, copper and molybdenum resources. At the moment, there is 6198.9 square km area with mining exploration and exploitation licenses. This is 11.9% of the total area of the basin. Erdenet industry operates in the basin and it is strategically important. There are some 20 entities operating in areas near Orkhon River and they are mining gold. For example: "Altandornod Mongol" LLC, "Altan yondoi" LLC, "Mongol Gazar" LLC and "Gatsuurt" LLC etc. Also there is a mine in Saikhan soum of Bulgan aimag.

Gold is being extracted in places of Tsenkher soum of Arkhangai aimag, they are: Bavgariin am, Kharguitiin baruun salaa, Olt and Ulaan chuluut as well as Zuun sodot of Bat-Ulzii soum of Uvurkhangai aimag. The mining sector is very vital for our country's economy, but we should regularly monitor impact on the environment. Orkhon River is being polluted heavily every year during the active gold-mining season. Also the surrounding ecosystem is damaged a lot. It is very vital to implement the "Law on Prohibition of Mineral Prospecting Exploration in Water Basin Areas and Forest Areas" in order to secure the stability of the ecosystem.

The government of Mongolia is focusing on developing mining and copper production on the basis of the Erdenet ore-processing facilities. The aimags in the basin will develop mining and processing industries within the framework of the development program. Most mining industries of the basin use water from the Orkhon River and its branch rivers. As for Erdenet industry, it is supplied from Selenge river basin. The mining water use of the basin was 3284.4 thousand cubic meter a year in 2008. In 2010, it was decreased to 927.1 thousand cubic meters a year.

This is due to the implementation of the Law on Prohibition of Mineral Prospecting Exploration in Water Basin and Forest Areas. According to the demand calculation, water use will be 1527.3 thousand cubic meter a year in 2015 and 2780.3 thousand cubic meter a year in 2021.

3.8.4. Energy

Orkhon river basin belongs to the Central energy region. Erdenet's thermal power station is located in the basin. The capacity is 36 MW of electricity. At the moment, it is producing 28.8 MW of electro energy and 193.5 Gcal/h of thermal energy annually on average. In 2010, the thermal power station produced 103.2 million KWh of electricity and 541.1 thousand Gcal of thermal energy. According to the water use norm calculation, it used some 1 million cubic meter water (Table 61).

Table 61. Erdenet's thermal power station production

Energy	Unit	2006	2007	2008	2009	2010
Electricity	*Mln. KWh*	108.4	110.0	113.6	113.2	103.2
Thermal energy	*Thous. Gcal*	581.4	648.3	618.6	640.5	541.4

Water is used for producing thermal energy in the aimag centers of the basin. Their water use calculation was done on the basis of thermal energy amount and water use norm. At the moment, basin energy demand is fully supplied. Due to the increasing

number of population and production, energy and thermal demand will increase in the future.

Orkhon river basin has many renewable energy and water energy resources. Kharkhorin hydro power station was constructed in 1959 but it is not working at the moment due to breakdown. A 100 MW capacity hydro power station will be built on Orkhon River as described in "National Program on Renewable Energy", approved in 2005.

3.8.5. Construction and Construction Material

Mongolia's construction sector was established in 1921 and it has played an important role in the country's economy. Erdenet and Kharkhorin cities are located in the basin and this is one of the factors why the construction sector is developing rapidly.

There are 45 construction entities in Orkhon aimag and their construction works and maintenance were worth MNT22.5 billion. 33.9% or MNT7.6 billion was from the maintenance works. The investment was increased by 50.4% compared to the previous year and maintenance work was increased by 52.4%. Some 50% of Erdenet's population lives in apartments and this figure will be increased in the future. There are 7 companies in Erdenet city which operate in the field of construction material. As of 2010, 2.5 million bricks and 3.9 thousand cubic meter concrete mixture were produced (Table 62).

Table 62. Orkhon aimag's construction material production, by volume

Production	unit	2008	2009	2010	2010/2009, %
Door and window	m^2	729.5	338.1	480.7	142.2
Vacuum door and window	m^2	4461.5	2347.9	1337.7	57.0
Concrete mixture	m^3	4712.0	2198.0	3879.0	176.5
Plaster mixture	m^3	480.0	269.0	217.0	80.7
Red brick	Thous.pc	5641.9	0.0	2485.0	
Concrete	m^3	2557.7	770.5	1179.0	153.0
Metal concrete construction	Thous. m^3	7.3	2.5	4.8	192.0
Cast construction	t	133.3	149.2	83.1	55.7

As of 2010, MNT4691.4 million of construction and maintenance works were done in Arkhangai aimag; MNT12901.3 million in Uvurkhangai aimag and 4127.7 million tugrugs in Kharkhorin city.

3.9. Services

3.9.1. Public urban services

The following organizations are operating in the field of water supply and sewerage in the basin cities. They are: "Erdenet UDTS" LLC (Erdenet city); "Undarga" LLC (Tsetserleg); "Bulgan Meej" LLC (Bulgan city); "Ursgal-Us" LLC (Sukhbaatar).

As for **Erdenet city**, "Erdenet UBU", "Erdenet UDTS" LLC and "Erdenet-Amidral" LLC companies are supplying the city population and organizations with drinking water and sewerage services. Some 39.5 thousand people are living in 212 apartment buildings with 1010.4 thousand square meter area. As of 2010, "Erdenet UDTS" LLC made a profit and "Erdenet-Amidral" LLC was at a loss of 758.9 million tugrugs. "Erdenet UDTS" LLC and 22 Apartment owners' associations are in the service of apartments and public utilities service. There are 47 kiosks and 8 water trucks operating in ger districts of Orkhon aimag.

Erdenet city supplies its water use from a distance of 64 km and the water price is high due to this. Some organizations are not interested in the centralized water supply due to the high water price. For example: the following companies drilled boreholes. They are: "Ochir tuv" LLC, "Selenge-Erdenet" LLC, "Otgontenger-Orgil" LLC, "Uils construction" LLC and "Orkhon khiits" LLC.

Attention needs to be paid to reduce the water supply system loss and water cost. The project "Urban development sector MON-2301" is being implemented with an Asian Development Bank loan. The following measures are planned to be taken: Construction of 4 boreholes, pumping stations, 2x1000 m^3 and 1x100m^3 reservoirs, 34 km drinking water pipelines and 26 kiosks. Some 24 kiosks will be maintained and connected to the centralized system.

The "Improving public utilities of local cities-II project" was implemented in **Tsetserleg** city in Arkhangai aimag in 2008. This project was financed with an Asian Development Bank grant. The following things were done within the framework of the project: 3 borehole pumps were renovated; 1 borehole was drilled; 2.5 km pipelines with 250 mm diameter and 11.8 km pipelines in ger districts. Some 2.9 thousand people are living in 45 apartment buildings. Some 19 apartment buildings are connected to the centralized water supply, heating and sewerage services. The ger district households are supplied from 22 kiosks and 4 water trucks.

The "Improving public utilities of local cities-II project" was implemented in **Bulgan** city in 2007. This project was financed with an Asian Development Bank grant. The following things were done within the framework of the project: 2 boreholes were drilled; 10.4 km drinking water pipelines; 2x150m3 reservoirs and one of water disinfection equipment were installed.

Some 2 thousand people are living in 692 apartment buildings as of 2010 and public utility services and "Khantulga" AOA are operating. 18 apartment buildings are connected to the centralized water supply, heating and sewerage services. The ger district households are supplied from 15 kiosks and 2 water trucks.

In **Sukhbaatar**, "Ursgal-Us" LLC and 9 apartment owners' associations are responsible for public utility services in 55 apartment buildings with 55.2 thousand square meter area. Some 5 thousand people are living in those apartment buildings. The following measure will be implemented between 2013 and 2014 by state investment. The measure is called "Equipment renovation of water source constructions". The ger district population is supplied from 23 kiosks and 9 water trucks.

In 2010 PUSO's of the Orkhon river basin supplied 8.7 million m3 of drinking water to the population and organisations which is a decrease of 7.6% in comparison with the previous year. This is due to measures taken in Erdenet and Sukhbaatar cities to reduce water losses and to improve water use efficiency by installing water meters.

3.9.2. Other Services

In the Orkhon river basin some 200 entities are operating in the field of utilities and 1.2 thousand people are employed. According to a 2007 survey, the total number of people in Mongolia working in the field of utilities is estimated at 60 thousand. An estiamted 98% of the sector's activities belong to the unofficial sector.

Public bathhouses. As of 2010, there were over 40 bathhouses with a capacity of 230 people in one session in aimags and soums of the basin.

According to the Ulaanbaatar health agency survey, 20% of the participants in the questionnaires take a shower every week; 12% takes a shower every 2 weeks. 81% of the total households participating in the survey take a shower in more than 7 days. On the

basis of the survey, a ger district resident takes a shower in 2 weeks on average. The bathhouse capacity of aimags and soums of the basin supplies only 40% of the demand.

According to the some surveys, per person uses 27-99 liter water at one time when taking a shower. This is 60-180 liter water according to other surveys. The "Water use temporary norm in the public utility services" needs to be renewed due to the introduction of new technologies which decrease water loss.

Laundry and dry cleaning: As for our country, there are not many laundry places. People do the laundry at home. In the warm season, people wash their clothes and cars in the river water. There is a laundry service called "Metro Express" in Ulaanbaatar where people can do their laundry. It has not become that popular due to location and tariff.

Dry cleaning is more popular. There were 2 dry cleaning services in Orkhon aimag which have been registered officially. The laundry services and dry cleaning places are connected to the centralized water supply and sewerage networks. The water use calculation is done together with organization and service water use.

Beauty and hairdressing services: Beauty services occupy most of the service sector. There are some 361 public utility services in Orkhon aimag and 42 of them are in the hair-dressing services. The hair-dressing service water use calculation in aimag and soum center of the basin is done together with organization and service water use. As described in the development program of the basin aimags, utility centers will be constructed in aimag centers and some soum centers.

Car wash: Car wash uses much water and pollutes water heavily. The number of cars is increasing along with the increasing living standard. There were 254.5 thousand cars in Mongolia in 2010. Some 6.9 thousand cars are in Orkhon aimag. There are 39 car maintenance and service centers in Orkhon aimag. At the moment, there is not any registered car washing center. But car maintenance centers do car washing as well. The registered car washing centers are generally connected to the centralized systems and have water meters.

It is difficult to define the water volume for car washing. There is no water use norm. It was defined as follows based on surveys. If the car is washed at home, some 5-15 liter water is used. As for car washing center, 25-40 liter water is used for a small size car. Some 80-100 liter water is used for a big car. According to a survey conducted in Texas, United States in 2002, 28-38 liter water is used for a small size car; 57-76 liter for medium size cars and 95-114 liter water for big cars. In the warm season, cars are washed 2-4 times a month on average and in winter 1-2 times. Some 7.5 thousand cubic meter water was used in the basin in 2010 if the calculation is as follows: 40 liter water is used for 1 car on average and it is washed 2 times a month. Although the water use is low, water polluting level is high.

Shop, hotel and restaurant services: Some 370 thousand people are employed. It is one of the important economic sectors. As of 2010, there were 746 shops and 163 hotels and restaurants in Orkhon aimag. Total sales were 27.4 billion tugrugs. As for other aimags of the basin, there were 350 shops, 50 hotels and restaurants. The hotels and restaurants in aimag centers are connected to the centralized networks. The hotels and restaurants in soum centers are supplied from boreholes. Some 95.9 thousand cubic meter water is used for basin shop, hotel and restaurant services in 2010. As described in the aimags' development programs, the service sector production will increase by 6.9% a year on average. The water use will be 138.3 thousand cubic meter water in 2015 and 214.7 thousand cubic meter water in 2021.

Green areas. There is no separate water source to water parks and lawn areas. There is 68.7 hectares green areas according to data received from the aimag centers' Environmental and tourism agencies and soum governments. Some organizations water surrounding lawn and green areas from their own water source.

Table 63. Area of irrigated aimag center parks and green areas

№	Aimag	City	Green area, ha
1	Arkhangai	Tsetserleg	4.3
2	Bulgan	Bulgan	6.7
3	Orkhon	Erdenet	56.8
4	Selenge	Sukhbaatar	0.9
-	TOTAL	-	68.7

3.10. Tourism

The Orkhon river basin is a specific region rich with historic and cultural heritage and in which the tourist industry is being intensively developed. Besides monuments of ancient Turkic tribes, there is Kharkhorum, the ancient capital city of Great Mongol in the basin.

The Orkhon river basin includes Khangai mountain, Orkhon valley, Bulgan mountain and Ugiinuur lake which are registered national parks, as well as Kharkhorum and Erdenezuu, historically important places. And it creates a convenient condition to develop tourism industry.

Figure 69. Erdenezuu temple, Ulaantsutgalan, Kharkhorum museum and Ugii Lake

Kharkhorum was the capital city of Great Mongol in times of Uguudei and Guyeg kings, the next generation of Chingis Khaan and it was firstly included as protected area in 1961. Erdenezuu, the first Buddhist temple was established in 1486 in Kharkhorum

city according to the order by then-Avtaisan king. Also the Kharkhorum museum was established in 2010 in order to store, protect, research and advertise valuable findings from historic memorial places in Orkhon valley which are registered as World Heritage.

Tourism: There are some registered 40 tourist camps which run tourism activities of which 34.1% in Arkhangai aimag, 31.7% in Selenge aimag and 26.8% in Uvurkhangai aimag.

According to a study carried out by the Ministry of Nature, Environment and Tourism in 2009, some 10% of overall tourists visit Arkhangai aimag in which the highest number of tourist camps is located. The main visiting period is from June 15 until Sep 15 with a length of 90 days. The majority of the tourists come from China, Russia, South Korea, Japan, USA, German Democratic Republic, France, Kazakhstan and Australia, etc.

Selenge aimag is famous for its Hunnu-era statues and tombs, Buur heeriin tal and Amarbayasgalant monastery. In Bulgan aimag there are some 10 tourist camps, 2 hunting camps and 10 resorts. There are mostly 2-star hotels in the basin. It is important to introduce small size water supply and sewerage facilities to these small hotels in order to develop the tourism sector in the basin.

Spa resort: There are many springs in the basin and some 10 spa resorts are operating. In our country, there are many springs which are good for human health. There are 100 spa resorts in Mongolia. As of 2010, only 27 of them were authorized. They include in the basin: "Elima Hujirt" in Uvurkhangai; "Erdenet" spa resort in Orkhon aimag; "Bujinkhen" children's spa resort in Selenge; Suvd and Khasu Mandal spa resorts in Arkhangai aimag.

As for the basin, it is possible to establish spa resorts on the basis of the following spas and springs. They include: in Arkhangai aimag: Bor tal, Gyalgar and Tsenkher of Tsenkher soum, Tsagaan sum of Khotont soum, Shivert of Erdenebulgan soum; in Bulgan aimag: Saikhan hulij of Mogod soum; in Uvurkhangai aimag: Gyatruun, Mogoit and Hujirt Uurt of Bat-Ulzii soum.

The sector's water demand was 10.9 thousand cubic meter water in 2010. The calculation was based on tourist camp capacity, service time, tourist number and water use norm. The average annual growth will be 6.9% as described in the aimags' development programs. The water use will be 15.1 thousand cubic meter water in 2015 and 22.5 thousand cubic meter water in 2021.

Tourism development perspective: The Ministry of Environment and Tourism developed the program "Tourism" in 2011 in order to develop tourism and make it a leading economic sector. According to the program, tourism will develop in 6 different tourism regions depending on traditional methods and features. One of them is "Kharkhorin region to develop history; culture; spa cure and archeological research trips".

A specific program for tourism development in the aimags of the Orkhon river basin has been proposed and is being implemented. Arkhangai aimag included in its development program: develop tourism and agricultural sectors as leading economic sectors of the aimag. In order to achieve it, the following measures will be taken: develop tourism infrastructure; construct tourism complex in Tsetserleg soum; construct international-standard hotels, tourist camps and motels to receive hunters and implement sub-program of winter tourism.

Bulgan aimag will develop tourism as leading economic sector of the aimag and following measures will be taken: implement sub-program to develop tourism; build tourism complex in Bulgan city; establish chain of hotels, tourist camps and motels; establish chain hotels to receive tourists in Khutag-Undur soum.

Uvurkhangai aimag is paying much attention to the development of tourism and spa resorts. The aimag developed a master plan to develop the aimag tourism sector and the following measures will be taken: develop micro regions of Kharkhorin, Khujirt, Bat-Ulzii and Yusunzuil; renovate Erdenezuu monastery and build centers to serve tourists; connect the "Murguliin zam" route to regional and international routes; construct new tourist camps; improve tourist camp services and material base; develop spa resort on the basis of Khujirt spa and springs; build spa-bottling factories; rehabilitate hot spa areas which attract Japanese and Korean tourists.

Selenge aimag developed an "Aimag's candor program" in order to develop tourism in the aimag. It is being implemented in 2 phases. The 1st phase is to improve the capacity to transport and receive tourists; to register historical areas and beautiful landscapes in state and local area tourism networks; to establish tourism centers in regional centers and to develop different kinds of tourism types.

3.11. Conclusions

1. Some 9 percent of our country's population lives in Orkhon river basin. The industries are well developed and 30 percent of our country's export is constituted here. This region has high economic importance. According to the economic assessment of water, it is required to pay attention mostly to mining and industrial water supply issues in the basin.
2. In the regional and local area development policy, there are objectives to support urban area development and improve living environment of population. It is vital for developing Mongolian people and improving living standard. The vital importance is to neutralize the population migration headed to Ulaanbaatar which continued last 10 years.
3. Urbanization was intensified since 1990's and along with it, some living habits of the residents have been changed. In the long run, urban population growth will be high and there will be migration headed to capital city and other big cities. The reasons are: weak infrastructure development of aimag and soum centers, residents' demand is not provided, no environment for developing industries and services.
4. Some 0.3 percent of the average income of an urban area ger district household monthly income goes to water fees. Some 4.0 percent of apartment household's monthly income and 0.7-7.3 percent of poor household's monthly income goes to water fees. It is close to the recommendation: "Fresh water fee will be 3 percent of the household income, together with waste water fee, it will be under 5 percent" released by the European Development and Innovation Bank. In other words, it means that water fee is in good condition.
5. In the basin, the following cities are located. They include: Kharkhorin, Khangai region main center; Erdenet city; Bulgan; Sukhbaatar and Tsetserleg. Attention needs to be paid for the improvement of these cities' water supply and sewerage facilities.
6. Erdenet city is supplied from the Selenge flood plain through 65 km pipes. The pipes are old and water loss is 4000 thousand m^3 a year on average or 18 percent water loss. It is due to the unwise use of water and bad economic calculation. It causes a high water fee. Some organizations use own boreholes instead of the central water supply. Attention needs to be paid to decrease the water supply system loss of Erdenet city and to decrease water expenses.

7. Water supply and sewerage development plays a key role to develop aimag and soum centers as modern urban areas. The comfortable environment will be established for people to live and for industries to develop. For example: Kharkhorin city is a center of the region and it is a place where tourism is developed. But water supply and sewerage development is weak. Apartment availability is bad and development of industries and services is low. The number of population decreased for the last 5 years. Modern water supply and sewerage systems need to be introduced and developed suitable in cold season for small and average-sized cities.
8. There are rivers which maintain a pure condition. But there are river sections near big cities polluted due to human activities. It means that people should take care of the environment and keep it clean.
9. The basin's aimag center hospitals have a connection to a central water supply and sewerage network. Erdenet and Sukhbaatar cities have central hot water supply and other cities and soums use borehole water. They discharge waste water to the soil and they use pit latrines and septic tanks. Hospitals use insufficient quantities of water which do not meet the sanitary requirements. The following is vital to improve the availability of water supply and sanitation facilities: to provide aimag center hospitals with hot water and to introduce small-size water supply and sanitation facilities in soum centers.
10. According to the norm in our country, one patient uses 15 l/day water at hospitals and one patient uses 250 l/day water at hospitals with bath and shower when staying there and receiving treatment. This indication is close to international standard. According to the data received from aimag centers, most hospitals use amounts of water below the standard level. It means that water supply and sewerage need to be improved.
11. If we assume that the urban area ger district resident's water demand is doubled, then the water fee percentage in household income will be 0.6 percent. This amount is fine. If water supply is improved, people are ready to pay 1.5 times higher per 1 liter water. It means that price condition has not much impact. Required improvements are for example: sanitation facility related issues, possibilities to carry and store water.
12. Much water is used in intensified livestock rather than mobile/migratory livestock. But we do not have special norm so far. So water demand for both is defined the same and it is not enough. The water demand norm related to this kind of livestock farming needs to be re-established.
13. On country's average, irrigation field crop yields are 20-40 percent higher than that of non irrigation fields. This indicator is low compared to other countries' standards. It is due to the following reasons: irrigation regime and norm are not followed, irrigation field agro-technical requirements are not fully provided.
14. New irrigation systems needs to be built, renovated in the basin and their usage needs to be improved. This basin has a suitable environment for irrigation field development in terms of environment and climate.
15. The mining sector growth is one of the country's economic development factors. But its impact on environment is too much. So there needs to be constant monitoring and rehabilitation needs to be conducted on a regular basis. It is one of the ways to provide sustainable development and keep ecological balance. Orkhon river water is polluted a lot in the warm season due to gold mining activities and there is much damage on environmental ecosystems. Much attention needs to be

paid to the implementation of the law with the long name as it is called. It is important for the safety of the basin ecosystems.

16. There is no water norm for car washing services in our country. According to the survey, people use 5-15 l water for car wash at home and some 25-40 l water is used for the average-sized car wash at car washing center. If the car is large, 80-100 l water is used. This kind of survey was conducted in 2002 in Texas, USA and 28-38 l water is used for small sized car, 57-76 l water for average sized car and 95-114 l water for large sized car. This amount can be used for establishing this sector's water demand norm. Car washing centers' water polluting level is high and it needs to be considered in waste water fee.

17. According to MDG-based Comprehensive National Development Policy, tourism will be developed intensively. The Orkhon river basin has many historical and cultural places as well as beautiful landscapes including Orkhon valley which was registered in world cultural heritage. The environment is right to develop tourism. It is required to pay attention to develop tourism infrastructures and introduce new technologies of small size water supply and waste water treatment and discharge facilities in tourist camps.

18. There is much potential for hydropower. The construction and use of hydropower plants has a high importance to the economy and ecology.

19. In the basin, especially in Orkhon and Selenge aimags, livestock numbers per 100 ha pasture are too high. It shows that livestock quality needs to be improved, not livestock numbers.

4. ORKHON RIVER BASIN WATER CONSUMPTION, WATER USE AND WATER DEMAND

The water consumption-water use and water demand for the Orkhon River Basin has been calculated of 5 urban areas (4 aimag centers and 1 soum center-Kharkhorin), 25 soum centers (including Khutul village or Saikhan soum center of Selenge aimag) and 38 soums which have more than 5.6% of their territories included in the basin (Table 64).

Table 64. Aimags and soums included in the basin and size/percentage of their territories in the basin

№	Aimag	№	Soum/city	Total soum area, km²	Within the basin, soum area	
					area, km²	percent, %
1	2	3	4	5	6	7
1	Arkhangai	1	Battsengel**	3,519.29	3,378.52	96.0
		2	Bulgan**	3,218.81	3,218.81	100.0
		3	Ikhtamir**	4,873.57	3,591.82	73.7
		4	Ugiinuur**	1,681.94	1,385.92	82.4
		5	Ulziit**	1,717.54	1,717.54	100.0
		6	Undur-Ulaan***	4,394.00	0.05	0.0
		7	Tuvshruulekh**	1,185.41	1,185.41	100.0
		8	Khairkhan***	2,512.07	72.85	2.9
		9	Khashaat***	2,591.04	424.93	16.4
		10	Khotont**	2,343.07	2,343.07	100.0
		11	Chuluut***	3,435.00	6.87	0.2
		12	Tsenkher**	3,147.09	3,147.09	100.0
		13	Erdenebulgan (Tsetserleg)*	62.68	62.68	100.0
		14	Erdenemandal***	3,363.30	0.45	0.0
2	Bayankhongor	15	Galuut***	6,330.00	6.33	0.1
		16	Erdenetsogt	4,061.89	836.75	20.6
3	Bulgan	17	Bugat***	3,200.13	476.82	14.9
		18	Bulgan (Bulgan)*	88.76	88.76	100.0
		19	Burenkhangai	3,487.77	1,468.35	42.1
		20	Gurvanbulag***	2,686.10	0.06	0.0
		21	Mogod**	2,819.56	2,199.26	78.0
		22	Orkhon**	4,092.36	4,080.08	99.7
		23	Saikhan**	2,759.99	1,849.19	67.0
		24	Selenge***	4,650.00	18.60	0.4
		25	Khangal***	1,640.54	91.87	5.6
		26	Khishig-Undur**	2,436.82	1,476.71	60.6
		27	Khutag-Undur***	5,669.50	113.39	2.0
4	Darkhan-Uul	28	Orkhon	461.92	214.33	46.4
5	Orkhon	29	Bayan-Undur (Erdenet)*	567.48	562.94	99.2
		30	Jargalant**	273.00	273.00	100.0
6	Uvurkhangai	31	Bat-Ulzii**	2,586.90	2,579.14	99.7
		32	Burd***	2,707.78	24.37	0.9
		33	Yesunzuil**	1,961.04	566.74	28.9
		34	Zuunbayan-Ulaan	2,512.42	540.17	21.5
		35	Ulziit**	1,967.05	733.71	37.3
		36	Uyanga	3,047.14	405.27	13.3
		37	Kharkhorin (Kharkhorin)*	2,301.26	2,043.52	88.8
		38	Khujirt**	1,661.41	1,661.41	100.0

№	Aimag	№	Soum/city	Total soum area, km²	Within the basin, soum area	
					area, km²	percent, %
1	2	3	4	5	6	7
7	Selenge	39	Altanbulag**	2,435.34	674.59	27.7
		40	Baruunburen**	2,805.70	2,334.34	83.2
		41	Zuunburen	1,191.88	609.05	51.1
		42	Orkhon**	1,264.73	1,040.87	82.3
		43	Orkhontuul	2,935.07	2,001.72	68.2
		44	Saikhan (Khutul)****	1,306.87	546.27	41.8
		45	Sant**	1,350.99	1,337.48	99.0
		46	Sukhbaatar (Sukhbaatar)*	46.89	46.47	99.1
		47	Khushaat**	2,002.06	856.88	42.8
		48	Shaamar**	617.88	474.53	76.8
8	Tuv	49	Jargalant***	1,840.00	7.36	0.4
		50	Zaamar***	1,900.00	1.90	0.1
		51	Sumber***	527.50	4.22	0.8
		52	Ugtaal***	1,680.00	1.68	0.1
		53	Tseel**	1,641.16	1,002.75	61.1
Total					53,786.89	

Remarks: *1. * Cities or aimag and soum centers included in the basin*
*2. ** Soum centers included in the basin*
*3.*** Not included in water consumption-use calculation because soum territory included in the basin is less than 5.6%*
*4.**** Khutul or Saikhan soum center of Selenge aimag is a large village. The town abstracts water from the Orkhon River floodplain, however included in the Kharaa River Basin. Therefore, it is subject to soum center according to the calculation.*

4.1. Population water supply, sewerage, sanitation, water consumption and water demand

The Joint Programme for Improving Water Supply and Sanitation Service is being implemented by UNDP, UNICEF, WHO and UNFPA in Mongolia in collaboration with the Government of Mongolia. Within the framework of this programme, drinking water supply sources have been divided into improved and unimproved sources. An improved source is characterized by three main indicators: water quality, access to water and water availability.

In a joint water supply and sanitation monitoring programme by UNICEF and WHO, water sources have been described as follows (Table 65).

Table 65. Difference between improved and unimproved drinking water sources

Improved water supply source	Unimproved water supply source
• Central water supply	• Unprotected well and spring
• Water kiosk	• River and spring
• Borehole	• Bottled water*
• Protected hand well and spring	• Water distribution by water truck**
• Rain water harvesting construction	

Remarks: *1. * Because the amount of bottled water is small (insufficient) it is not included as improved source.*
*2. ** Water truck tanks are considered unimproved because sometimes hygienic requirements are not met.*

In determining the water demand of aimag and soum centers' people in the Orkhon River Basin, their water consumption norm is differentiated depending on what source is used for their water supply. In each phase of the IWM plan, a policy has been adhered to which aims to reduce water consumption by urban consumers connected to the central water supply system to the level of water consumption in the world's biggest cities, to reduce the number of water consumers that are supplied from unimproved sources and to increase the water availability. The water consumption by urban and rural people in the basin has been calculated within the framework of the IWM plan according to the following norm.

Table 66. Water consumption norm for people in aimag centers, soum centers and cities

Type of water supply source	Coverage	Water consumption norm, l/day			
		2008	2010	2015	2021
Improved source	Resident of apartment connected to central water supply (with hot and cold water)	230	230	200	160
	Resident of apartment connected to central water supply (with cold water)	175*	175*	170	160
	Resident of ger area supplied from water kiosk connected to the central water supply	8*	10*	25	30
	Resident of ger area supplied from water kiosk not connected to the central water supply	6*	8*	15	20
Unimproved source	Resident who fetches water from open water such as springs and rivers	6*	8*	10	15

* *The water consumption in 2008 and 2010 was calculated using the actual water use in l/day per person*

There are in total 16 waste water treatment plants /WWTP/ in the Orkhon River Basin. Of these, there is 1 WWTP in Arkhangai aimag, 1 in Bulgan aimag, 1 in Darkhan-Uul aimag, 3 in Orkhon aimag, 5 in Selenge aimag and 5 in Uvurkhangai aimag (Table 67, Figure 70)

Table 67. Number of WWTPs in the Orkhon River Basin

Aimag	Soum	Number of WWTP
Arkhangai	Erdenebulgan (Tsetserleg)	1
Bulgan	Bulgan	1
Darkhan-Uul	Orkhon	1
Orkhon	Bayan-Undur (Erdenet)	2
	Jargalant	1
Selenge	Altanbulag	1
	Baruunburen	1
	Shaamar	1
	Sant	1
	Sukhbaatar	1
Uvurkhangai	Ulziit	1
	Khujirt	2
	Bat-Ulzii	1
	Kharkhorin	1
Total		**16**

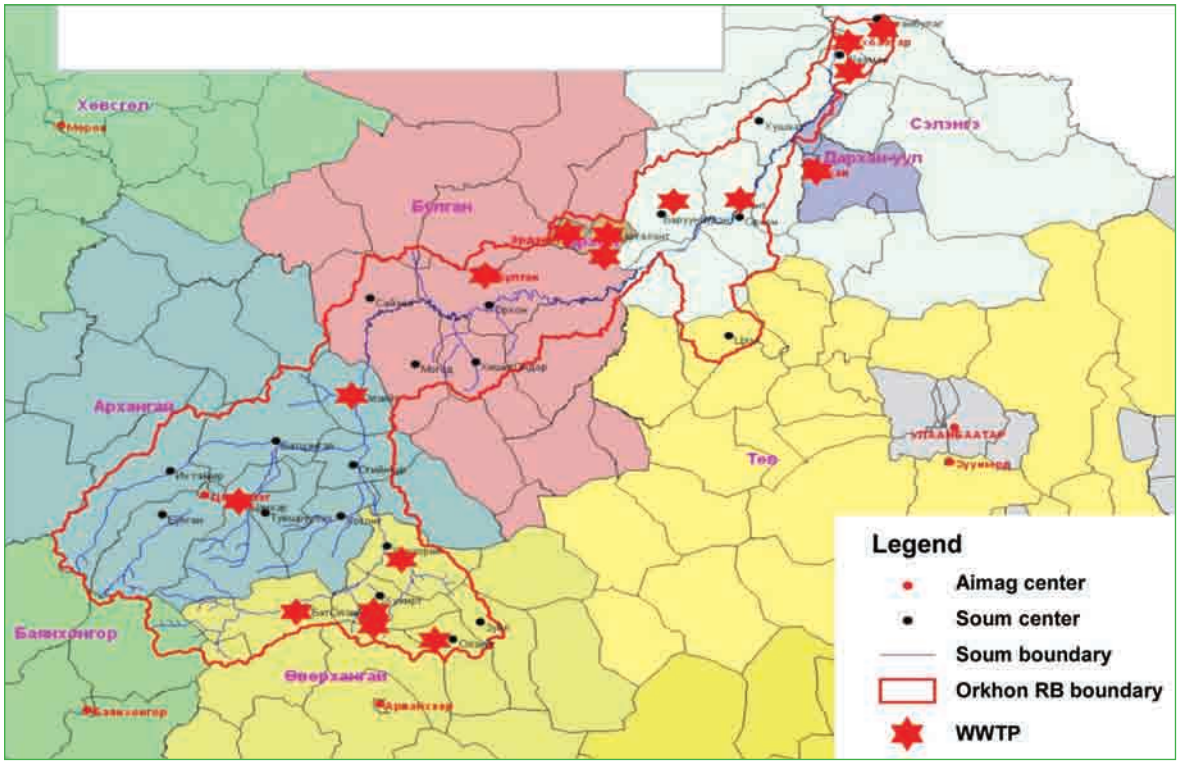


Figure 70. Location of WWTPs in the Orkhon River Basin, 2010

4.1.1. Urban population water supply, sewerage, water consumption and water demand

Tsetserleg city (Erdenebulgan soum) of Arkhangai aimag, Bulgan city (Bulgan soum) of Bulgan aimag, Erdenet city (Bayan-Undur soum) of Orkhon aimag, Sukhbaatar city (Sukhbaatar soum) of Selenge aimag and Kharkhorin city (Kharkhorin soum center) of Uvurkhangai aimag are included in the Orkhon River Basin. Water supply, sewerage and water consumption have been considered for each city as follows.

Tsetserleg city, center of Arkhangai aimag

Water supply facilities: Tsetserleg city is elevated at 1695 m and located in front side of Bulgan Mountain beautiful protected area of Khangai Mountain Range, between the north and south Tamir Rivers, 480 km to the west of Ulaanbaatar city. The city, during its development, was called Tsetserleg in 1961 according to administrative restructuring. Undarga Public Utility Service Shareholding Company is responsible for water supply in Tsetserleg city.

Tsetserleg city's main water supply sources are 6 boreholes: 3 in floodplain of Tarvuu River located 4 km in the south-west of the city, 2 at the general education school and 1 in the west district's ger area. There is a ferro-concrete water tank with a capacity of 10,000 m^3.

Figure 71. Location of Tsetserleg city water supply source

As of 2010, some 6.0% of the Tsetserleg population live in apartments connected to the piped network and 94.0% live in ger areas. Chlorination is not used at this moment. However it was built in 2000 for the purpose of disinfection and purification of waste water used in the city's water supply. The city's central water supply source was established and put into operation between 1988 and 1990. The total length of the fresh water distribution and transmission pipeline is 39 km.

The drinking and domestic water for the ger area people is supplied from 13 water kiosks. Also many households in the 1st and 2nd bag (sub-soum) of Erdenebulgan soum fetch water from protected and improved Gants Modnii Bulag spring located in front side of Tsagaan mountain pass. Citizens and economic entities have established and are using 23 boreholes in ger areas of the aimag center for their own demand. Public administration and service organizations, and communal apartments in aimag center are supplied by cold water only.

Table 68. Water consumption and water demand by Tsetserleg city population

№	Water supply source and its coverage		Population, *thous. people*				Water consumption, *thous. m³/year*			
			2008	2010	2015	2021	2008	2010	2015	2021
1	Central water supply	Apartment with hot and cold water	-	-	-	-	-	-	-	-
		Apartment with only cold water	1.2	1.2	2.1	2.6	74.2	78.2	128.5	152.4
		Water kiosk	5.5	8.4	11.1	10.1	16.0	30.6	101.5	155.1
2	Non-central water supply	Water kiosk	7.5	6.5	2.8	3.5	25.0	30.6	36.0	25.7
3	Protected source		-	-	-	-	-	-	-	-
4	Unprotected source		-	-	-	-	-	-	-	-
5	Other sources		-	-	-	-	-	-	-	-
Total			**18.1**	**20.1**	**19.8**	**20.3**	**115.1**	**139.3**	**266.0**	**333.2**

The water consumption payment is conducted using water meters to reduce water losses and improve efficient consumption by water consuming economic entities and apartment residents.

In total 60% of fresh water pipelines or 11.3 km new pipelines have been installed from 2003 to 2009 by 'MON-1907 to Support Utility Service Development' project implemented with financial support from the Asian Development Bank /ADB/.

***WWTP*:** a plant with a capacity to treat 1200 m³ waste water by mechanical method was established in Tsetserleg city in 1987. The plant used to treat and disinfect 900 m³ waste water per day by method of soil percolation. In 2003 the WWTP old technology was renovated within the framework of the MON-1907 project. New bio-ponds with 8 areas were established and 75% of the total waste water was started to be treated through the WWTP.

Figure 72. Waste water treatment bio-pond in Tsetserleg city

The Arkhangai Aimag Strategic Development Plan for 2016-2021 includes some measures including improvement of the Tsetserleg WWTP technology, increase of the capacity, reuse of waste water, connection of some part of ger area to the central water supply system, creation of a model apartment block, etc.

Bulgan city, center of Bulgan aimag

***Water supply facility*:** as of 2010, some 13.8% of Bulgan population live in apartment

buildings connected to the central water supply and 86.2% of the population live in ger areas not connected to the central system. Bulgan-Meej LLC holds a special license to run the public commercial service and is responsible for the water supply of Bulgan city.

The Bulgan city water supply source comprises 9 boreholes: 2 along the Achuut River floodplain located 4 km to the north-west of the city and 7 in the city previously used. Water is distributed to offices and apartments from a pressure tower with a capacity of 50 m^3 through fresh water pipelines.

Offices and apartments in Bulgan city are connected to the central water supply pipelines with cold water only.

Figure 73. Location of Bulgan city water supply source

Table 69. Water consumption and water demand by Bulgan city population

№	Water supply source and its coverage		Population, *thous. people*				Water consumption, *thous. m^3/year*			
			2008	2010	2015	2021	2008	2010	2015	2021
1	Central water supply	Apartment with hot and cold water	-	-	-	-	-	-	-	-
		Apartment with only cold water	1.5	1.6	2.7	3.4	97.1	102.4	168.2	199.6
		Water kiosk	3.5	5.4	7.2	8.3	10.3	19.8	65.8	90.8
2	Non-central water supply	Water kiosk	6.1	4.6	1.5	0.0	13.4	13.5	8.2	0.0
3	Protected source		-	-	-	-	-	-	-	-
4	Unprotected source		-	-	-	-	-	-	-	-
5	Other sources		-	-	-	-	-	-	-	-
Total			**11.1**	**11.6**	**11.4**	**11.7**	120.9	135.7	**242.2**	**290.4**

WWTP: the WWTP with a capacity of 1400 m^3 waste water per day by mechanical treatment and disinfection started its operation in 1989. At present time, the plant treats 200 m^3 waste water at 45% treatment level per day using mechanical treatment and the

treated waste water is directly infiltrated to the soil from the bio-pond. Due to damage in the bio-pond dam, it creates a bad condition which doesn't meet the sanitation requirements and the waste water pollutes the surrounding environment. Therefore, it is necessary to precisely determine sanitation and protection zones.

The objective to develop Bulgan as a city with industries, services and intensified agriculture based on its infrastructure and as a city which is influential for the regional economy has been formulated in the Aimag Strategic Development Plan. Within this framework, the central water supply system has been planned to be expanded.

Erdenet city, center of Orkhon aimag

Water supply facility: The energy workshop of Erdenet copper mining factory is responsible for the city's water supply and sewerage activities. It provides hot and cold water supply and waste water drainage and treatment service to people, factories and economic entities through Erdenet-Us heat transmission network shareholding company and Erdenet-Amidral locally owned company. Also it supplies water for technological demand of the mining factory.

Erdenet-Us heat transmission network company abstracts water from 3 boreholes located in the 6th sub-district and delivers it to 45 water kiosks by water trucks for water supply of ger area households. Around 100 boreholes have been established and are being used by individuals, industry and service providers in suburban sub-districts for water supply purposes. The main water supply source is a groundwater resource in the Selenge River floodplain located 63 km from the factory. Water is abstracted from 14 boreholes in 'Akhai Gun' fresh water deposit along the Selenge River in the territory of Khangal soum, Bulgan aimag and the water is delivered to the city through pipelines with the support of 4 pumping stations. On average 60-70 thousand m^3 water is abstracted from the Akhai Gun groundwater deposit per day.

Steel pipelines with a length of 180 km are used in the Erdenet mining factory and the central water supply system of Erdenet city.

Table 70. Water consumption and water demand by Erdenet city

№	Water supply source and its coverage		Population, *thous. people*				Water consumption, *thous. m^3/year*			
			2008	2010	2015	2021	2008	2010	2015	2021
1	Central water supply	Apartment with hot and cold water	38.4	40.0	67.7	85.3	3223.7	3359.1	4938.7	4980.5
		Apartment with only cold water	-	-	-	-	-	-	-	-
		Water kiosk	5.5	8.4	11.2	14.3	16.1	30.7	102.2	156.1
2	Non-central water supply	Water kiosk	39.4	36.5	16.3	8.4	86.4	106.6	89.5	61.2
3	Protected source		-	-	-	-	-	-	-	-
4	Unprotected source		-	-	-	-	-	-	-	-
5	Other sources		-	-	-	-	-	-	-	-
Total			**83.3**	**84.9**	**95.2**	**108.0**	3326.1	3496.4	5130.4	**5197.8**

For the purpose of efficient use of fresh water, the Erdenet mining factory has launched a SCADA system in its industry for monitoring water consumption and installed water meters in pipelines of the water supply system. By doing so, water loss has been reduced by 10%.

WWTP: was established in 1978 with a treatment capacity of 24000 m^3 waste water per day and is still in use. Erdenet city WWTP underwent expansion: deep treatment plant established in 1991 and a sludge bed in 2003, respectively. Recently, the plant treats

31.4 thousand m^3 waste water per day on average, which exceeds its normal capacity by 7.4 thousand m^3 waste water. The treated waste water from the WWTP is disinfected through chlorination.

a. Clarifier *b. Deep treatment section*

Figure 74. Erdenet city WWTP

A design for expanding the Erdenet city WWTP was made in 2009 with support from France and the related equipment supply has just started. The expected result is to increase the WWTP capacity by as much as twice the existing capacity, to treat waste water up to 48,000 m^3 per day, to save some material cost by 40% by launching a new disinfection and treatment technology and to bring the waste water treatment level up to 98%.

According to analyses /2001-2003/ carried out by the Geoecological Institute of the Academy of Science of Mongolia on treated waste water from the Erdenet city WWTP and Khangal River water, pollution level of the Khangal River water was higher than the treated water from the WWTP and bacteriological pollution was found in the river water. In other words, the treated waste water was cleaner than the Khangal River water or its treatment level was more than 90%. This indicator reveals that the Erdenet WWTP treats waste water well according to technology.

As the Erdenet city WWTP has an advanced waste water treatment technology, its treatment level is high. Previously, the plant used to discharge its treated waste water into the Khangal River. But later it came up with a solution to reuse the waste water. Since 2004 the treated waste water is collected in a pond and water leaking through the pond dam was started to be used for some technological demand of the factory.

In the Aimag Strategic Development Plan for 2009-2021, it was planned to provide ger area households with houses and connect them to the central pipeline network, to reduce air pollution and to connect domestic and industrial waste water from people, economic entities and organizations to the sewerage pipelines.

Sukhbaatar city, center of Selenge aimag

Water supply facility: as of 2010, some 21.9% of Sukhbaatar city population live in apartments connected to the central water supply system and 78.1% of the population live in ger areas. The water supply source is groundwater in the Orkhon River floodplain. Fresh water is supplied to consumers from 4 boreholes established in 1991 located 2 km to the south of Sukhbaatar city through pipelines with a length of 45 km.

Table 71. Water consumption and water demand by Sukhbaatar city population

№	Water supply source and its coverage		Population, *thous. people*				Water consumption, *thous. m³/year*			
			2008	2010	2015	2021	2008	2010	2015	2021
1	Central water supply	Apartment with hot and cold water	4.5	4.8	8.2	10.3	286.0	309.2	507.8	602.5
		Apartment with only cold water	-	-	-	-	-	-	-	-
		Water kiosk	5.8	8.9	11.9	12.5	17.0	32.6	108.3	136.7
2	Non-central water supply	Water kiosk	9.1	8.2	1.9	0.0	19.9	23.9	10.4	0.0
3	Protected source		-	-	-	-	-	-	-	-
4	Unprotected source		-	-	-	-	-	-	-	-
5	Other sources		-	-	-	-	-	-	-	-
Total			**19.4**	**21.9**	**22.0**	**22.8**	322.9	365.6	**626.5**	**739.2**

The 1st and 2nd pumping stations, double reservoirs with a capacity of 500 m³ located in front of the 2nd station, double reservoirs with a capacity of 1400 m³ located at the end of the pipeline network and 4 main ring pipes with a length of 32 km are used in hot and cold water supply for apartments, economic entities and organizations in Sukhbaatar city. Ger area residents are supplied from 7 water kiosks connected to the pipelines and 13 not connected water kiosks.

There are many hand wells on private grounds of ger area residents located on the south embankment of Buur River 7 km from Sukhbaatar city and the well water is consumed for drinking and domestic purposes as well as for other uses.

WWTP: was established with a treatment capacity of 12,000 m³ waste water by biological method in 1990. During its operation, 9000 m³ waste water was treated and disinfected at 90% treatment level per day on average. A minor part of the waste water percolates down to the soil and the majority is discharged into the Orkhon River.

Figure 75. Sukhbaatar city WWTP

In recent years the water supply and sewerage organisation receives waste water through the central sewerage, carries out mechanical treatment only and discharges its treated waste water into the Orkhon River directly. This WWTP is planned to undergo maintenance and renovation.

Kharkhorin city, center of Kharkhorin soum of Uvurkhangai aimag

Kharkhorin is the ancient capital city of Mongolia and is now considered as one of the largest tourism centers combined with irrigated area, flour and animal feed factories. In the Regional Development Concept approved by the State Great Khural /Parliament/ in 2011, the goal has been set to develop Kharkhorin city as the main Khangai regional

center and to develop pastoral farming, crop farming, tourism, sanatorium/spa resorts, small and medium sized enterprise, mining and processing, and wood processing industry.

Water supply facility: the Kharkhorin city water supply source are 6 boreholes established in the Orkhon River floodplain. Water is abstracted from these sources and delivered to the city's public administrative organisations, factories, economic entities, apartment buildings and people. The city has a central water supply and 5.1 km fresh water pipelines were renovated in 2011. Over 40 wells have been established and are used by factories, economic entities and citizens on their own cost for the purpose of increasing the water supply availability.

Figure 76. Renovation of Kharkhorin city water supply source

A locally owned shareholding company in charge of water supply and sewerage is planned to be established in Kharkhorin soum.

Table 72. Water consumption and water demand by Kharkhorin city population

№	Water supply source and its coverage		Population, *thous. people*				Water consumption, *thous. m³/year*			
			2008	2010	2015	2021	2008	2010	2015	2021
1	Central water supply	Apartment with hot and cold water	-	-	-	-	-	-	-	-
		Apartment with only cold water	-	-	-	-	-	-	-	-
		Water kiosk	-	-	-	-	-	-	-	-
2	Non-central water supply	Water kiosk	0.7	0.8	0.9	1.1	1.5	2.2	4.8	8.0
3	Protected source		2.3	2.8	3.4	4.2	5.1	8.3	12.5	23.1
4	Unprotected source		6.2	5.4	4.7	3.9	10.3	15.9	17.0	21.4
5	Other sources			-	-	-	3.3	-	-	-
Total			**9.2**	**9.0**	**9.0**	**9.2**	**20.2**	**26.4**	**34.3**	**52.5**

WWTP: was established in 1979 with a capacity to treat 1000 m³ waste water by mechanical method. Currently, few organisations deliver their waste water to this plant and 20 m³ waste water is being treated per day on average. Expansion and renovation work for pipelines, water supply system and WWTP has been started since 2011.

Figure 77. Under-construction new WWTP in Kharkhorin city

For Kharkhorin city, it is necessary to establish an independent organisation for water supply and sewerage use, to provide normal operation of pipeline network, to improve its use and to determine water resources.

4.1.2. Rural population water supply, sanitation, water consumption and water demand

Soum center population

In total 26 soum centers, 8 soum centers of Arkhangai aimag, 5 of Uvurkhangai aimag, 4 of Bulgan aimag, 1 of Tuv aimag, 1 of Orkhon aimag and 7 of Selenge aimag are included in the Orkhon River Basin and 10 of them are located along the river floodplain.

Water supply facility: the main water supply source for soum center people is groundwater. In some soums located along the river floodplain, open water such as rivers and springs, etc is used during the warm season.

Figure 78. Borehole used in soum center water supply

Khutul city or Saikhan soum center of Selenge aimag is included in the Kharaa River Basin. But its water consumption is from 4 boreholes established in the Orkhon River floodplain through 2 pumping stations and pipelines with a length of 23 km. Therefore, this water consumption is included in the soum center calculation.

Soum center people are supplied from boreholes established for water supply. Some soums have only two boreholes while others have 16 boreholes. Water is collected in a reservoir with a capacity of 2-4 m^3 which is located inside the water kiosk building and distributed to consumers. When consumers fetch water, they use a variety of buckets carried on a cart, but mostly by hand.

Water truck and horse carts deliver water to some service centers in soum centers, but not on a regular basis throughout the year. Some soum center people fetch water from the river by using their own transport and small carts. Also water consumers who live along the large river floodplain carry ice by breaking it and use it for drinking

and domestic water purpose during winter time. Water softener equipment has been installed in a borehole with high mineralization in Ugiinuur and Khotont soum centers of Arkhangai aimag and Ulziit soum center of Uvurkhangai aimag between 2008 and 2010. But the equipments have been damaged and the wells are no longer available for use.

According to definition by the National Statistics Committee, soum center and rural people are both included in rural population. Depending on different water consumption norms, these people have been divided into soum center consumers and rural consumers, and their water consumption and water demand have been calculated as follows.

Table 73. Water consumption and water demand by soum center people

№	Aimag	Soum	Population, *thous. person*				Water consumption, *thous. m³/year*			
			2008	2010	2015	2021	2008	2010	2015	2021
1	Arkhangai	Battsengel	1.1	1.1	1.0	1.1	2.4	3.1	4.5	6.8
2		Bulgan	0.9	1.0	1.0	1.0	2.0	2.8	0.0	0.0
3		Ikhtamir	1.2	1.1	1.0	1.1	2.6	3.1	4.5	6.9
4		Ugiinuur	0.6	0.6	0.6	0.6	1.2	1.8	2.7	4.1
5		Ulziit	0.8	0.8	0.8	0.8	1.8	2.3	3.4	5.2
6		Tuvshruulekh	1.9	1.1	1.1	1.1	4.1	3.2	4.7	7.1
7		Khotont	1.3	0.8	0.8	0.8	2.8	2.3	3.4	5.1
8		Tsenkher	1.0	1.0	1.0	1.0	2.1	2.8	4.1	6.3
Total of Arkhangai			8.7	7.3	7.2	7.4	19.0	21.5	27.3	41.5
1	Bulgan	Mogod	0.6	0.6	0.6	0.6	1.4	1.7	2.5	3.7
2		Orkhon	1.0	1.0	0.9	1.0	2.1	2.8	4.1	6.2
3		Saikhan	0.9	1.2	1.2	1.2	1.9	3.5	5.2	7.8
4		Khishig-Undur	1.3	1.3	1.2	1.3	2.9	3.7	5.4	8.1
Total of Bulgan			3.8	4.0	3.9	4.0	8.3	11.7	17.1	25.9
1	Orkhon	Jargalant	2.3	1.1	1.2	1.4	4.9	3.2	5.4	9.1
Total of Orkhon			2.3	1.1	1.2	1.4	4.9	3.2	5.4	9.1
1	Uvurkhangai	Bat-Ulzii	2.2	4.1	4.1	4.2	4.9	11.9	17.6	26.9
2		Yesunzuil	0.9	0.9	0.8	0.9	1.9	2.5	3.7	5.6
3		Ulziit	0.9	0.6	0.6	0.6	1.9	1.6	2.4	3.7
4		Uyanga	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5		Khujirt	3.1	2.9	2.9	2.9	6.8	8.4	12.4	18.9
Total of Uvurkhangai			7.1	8.4	8.3	8.6	15.5	24.5	36.1	55.1
1	Selenge	Altanbulag	3.6	4.1	4.1	4.2	7.9	11.9	17.7	27.2
2		Baruunburen	1.3	1.3	1.3	1.3	2.9	3.7	5.6	8.6
3		Orkhon	1.1	1.0	1.0	1.1	2.3	3.0	4.4	6.8
5		Saikhan*	7.4	6.7	6.7	7.0	384.8	348.6	348.7	362.2
6		Sant	1.4	1.6	1.6	1.6	3.0	4.6	6.9	10.5
7		Khushaat	0.9	1.0	1.0	1.0	2.0	2.9	4.3	6.6
8		Shaamar	3.9	3.8	3.8	4.0	8.5	11.2	16.7	25.6
Total of Selenge			19.6	19.5	19.5	20.3	411.4	385.8	404.2	447.5
1	Tuv	Tseel	1.5	0.6	0.6	0.6	3.4	1.8	2.7	4.1
Total of Tuv			1.5	0.6	0.6	0.6	3.4	1.8	2.7	4.1
1	Darkhan-Uul	Orkhon*	2.5	2.6	2.7	2.9	30.0	31.3	33.1	35.2
Total of Tuv			2.5	2.6	2.7	2.9	30.0	31.3	33.1	35.2
Grand total			45.5	43.5	43.4	45.2	492.5	479.9	526.7	619.5

Remarks: ** Saikhan soum of Selenge aimag or Khutul city and Orkhon soum center of Darkhan aimag are included in the Kharaa River Basin, but water is abstracted from the Orkhon River floodplain. Therefore, its water consumption is included in soum center calculation. Demand is high due to apartments with private connections.*

Some boreholes used in the soum center water supply are being used for other activities such as industry, vegetable irrigation, etc, and not for drinking or domestic purposes.

Local administrative organisations have released and are enforcing the resolution which sets the sanitation zone and build fences 25 m around the wells/boreholes used in water supply and to prohibit building apartment blocks and buildings for industrial and service purposes.

Soum center inhabitants are consuming in total 250-300 m^3 water per day on an average. The distance to fetch water from the soum center water kiosk to the consumer's destination is different and 400 m on average. Water source resource investigations have not been carried out in most soum centers which are supplied from groundwater.

WWTP: there are soum center WWTPs in the basin with a treatment capacity of 100-1400 m^3 waste water per day in Khairkhan soum center of Arkhangai aimag and in Orkhon and Mogod soum centers of Bulgan aimag. These WWTPs are non-operational at this moment due to damages and vandalization.

There is a sewerage network in Jargalant soum of Orkhon aimag and a WWTP was established in 1989 with a capacity to carry out mechanical treatment at 400 m^3 waste water per day.

A WWTP with a capacity to carry out biological treatment at 450 m^3 waste water per day was established in Altanbulag soum of Selenge aimag in 1970 and a WWTP with a capacity to carry out biological treatment of 200 m^3 waste water in Baruun soum in 1990, respectively. But these WWTPs are not operating and only function to receive and drain waste water without any treatment.

A WWTP with a capacity to carry out mechanical treatment at 200 m^3 waste water per day was established in Sant soum of Selenge aimag in 1980 and the plant discharges its treated waste water into Yeven River. At the time the plant used to receive and treat 190 m^3 waste water per day. But currently, this plant is out of service and vandalized. In recent years waste water is discharged into the Yeven River without any treatment. However, there is a water supply and sewerage network in the soum.

A WWTP was established in Shaamar soum of Selenge aimag in 1973 with a capacity to carry out mechanical treatment of 200 m^3 waste water per day and to percolate down to soil. The plant has been vandalized as it hasn't been used for a while.

Figure 79. Soum center WWTP and bio pond

Saikhan soum of Selenge aimag (Khutul city) is a large settled area with a sewerage network and WWTP. The plant was established in 1985 with a capacity to carry out biological treatment of 3000 m^3 waste water per day and to percolate down to soil. Now the plant receives and treats 2600 m^3 waste water from economic entities, organisations and apartment buildings a day. Since it was established, routine maintenance has been carried out on a regular basis. Consequently, the plant now operates normally, treats and

disinfects waste water with more than 85% treatment level, and drains treated waste water by percolating down to soil and evaporation.

A WWTP with a capacity to carry out mechanical treatment of 100 m^3 waste water was built in Ulziit soum of Uvurkhangai aimag in 1976, but the plant is not operating at this moment. A waste water borehole with internal layer and a capacity of 30 m^3 is being used in a kindergarten in Bat-Ulzii soum and a hospital in Khujirt soum, respectively.

Khujirt sanatorium WWTP nearby Khujirt soum of Uvurkhangai aimag treats 90 m^3 waste water up to 60% treatment level per day and percolates its treated waste water down to soil. Elma Khujirt sanatorium WWTP has a capacity to carry out biological treatment of 20 m^3 waste water per day. At this moment, the plant treats 12 m^3 waste water per day. The WWTPs of Khujirt, Elma Khujirt, Bu-Ba-Se sanatoriums and Gem Khujirt spa bottling factory are no longer able to meet the sanitation and technical requirements. Therefore, new WWTPs with modern technology, high productivity and high treatment indicator are urgently needed to be established in the near future.

A sewerage network and WWTP operated normally in Orkhon soum of Darkhan-Uul aimag prior to 1990 or during operation period of vegetable processing factory that was established with support of People's Republic of Bulgaria (former). This WWTP was established in 1981 with a capacity to carry biological treatment of 200 m^3 waste water per day and used to treat 140 m^3 waste water per day and discharge its treated waste water into the Orkhon River. The water supply and sewerage network is completely available to be restored and used.

Within the framework of the MoMo project which is being implemented in Mongolia by Germany, a mini-biological WWTP with treatment capacity of 10 m^3 waste water per day has been established near the school in Orkhon soum and it is achieving a good result.

Water supply of rural people (herdsmen and farmers)

Rural people include herdsmen and farmers who run agricultural businesses in the basin. Water demand by herdsmen who run pastoral farming are supplied from the wells that are established for livestock watering as well as open water such as rivers, springs and streams. In other words, water supply for both herdsmen families and livestock is from the same water source.

Figure 80. Water sources for rural people and livestock

In recent years herdsmen have been changing to a settled form of livestock herding from traditional pastoral farming by starting farms and intensified farms. Farmers who run intensified livestock farms and grow crops established boreholes in their dwellings.

The Orkhon River Basin boundary is determined by the watershed of the Orkhon River and its tributaries. Data and information related to water consumers and water users is released by soum which is a territorial administrative unit. In the event of the basin

boundary partially dividing the soum territory, the rural population in the basin has been determined by the pastoral area included in the basin.

Table 74. Water consumption and water demand by soums' rural people included in the Orkhon River Basin

№	Aimag	Soum	Population, *thous. person*				Water consumption, *thous. m³/year*			
			2008	2010	2015	2021	2008	2010	2015	2021
1	Arkhangai	Battsengel	2.8	2.7	2.7	2.7	6.0	7.9	9.7	14.9
2		Bulgan	1.5	1.5	1.4	1.5	3.2	4.3	5.3	8.1
3		Ikhtamir	2.9	3.1	3.1	3.1	6.4	9.1	11.2	17.2
4		Ugiinuur	2.0	2.0	1.9	2.0	4.5	5.7	7.1	10.9
5		Ulziit	2.2	2.2	2.2	2.3	4.9	6.5	8.1	12.4
6		Tuvshruulekh	1.5	2.2	2.2	2.2	3.4	6.4	7.9	12.1
7		Khashaat	0.4	0.4	0.4	0.4	0.9	1.1	1.3	2.0
8		Khotont	3.5	3.5	3.5	3.6	7.7	10.3	12.7	19.6
9		Tsenkher	4.4	4.4	4.4	4.5	9.7	13.0	16.0	24.6
Total of Arkhangai			21.3	22.0	21.7	22.3	46.7	64.3	79.1	121.9
10	Bayankhongor	Erdenetsogt	0.7	0.7	0.7	0.7	1.5	2.0	2.4	3.7
Total of Bayankhongor			0.7	0.7	0.7	0.7	1.5	2.0	2.4	3.7
11	Bulgan	Bugat	0.3	0.3	0.3	0.3	0.6	0.8	1.0	1.5
		Bulgan	1.1	0.8	0.8	0.8	2.5	2.2	2.8	4.2
12		Buregkhangai	0.6	0.6	0.6	0.6	1.2	1.8	2.2	3.4
13		Mogod	1.5	1.6	1.5	1.6	3.3	4.5	5.6	8.6
14		Orkhon	2.0	2.0	1.9	2.0	4.3	5.7	7.0	10.8
15		Saikhan	1.9	1.7	1.7	1.7	4.2	4.9	6.0	9.3
16		Khangal	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.5
17		Khishig-Undur	1.0	1.0	1.0	1.0	2.3	3.0	3.7	5.7
Total of Bulgan			8.5	8.0	7.8	8.0	18.6	23.3	28.6	44.0
18	Darkhan-Uul	Orkhon	0.3	0.3	0.3	0.4	0.6	1.0	1.3	2.0
Total of Darkhan-Uul			0.3	0.3	0.3	0.4	0.6	1.0	1.3	2.0
19	Orkhon	Bayan-Undur	3.5	0.0	0.0	0.0	7.7	0.0	0.0	0.0
20		Jargalant	0.8	1.8	2.0	2.3	1.7	5.3	7.4	12.6
Total of Orkhon			4.3	1.8	2.0	2.3	9.4	5.3	7.4	12.6
21	Uvurkhangai	Bat-Ulzii	4.0	2.3	2.3	2.3	8.7	6.7	8.3	12.8
22		Yesunzuil	0.6	0.6	0.6	0.6	1.4	1.7	2.1	3.3
23		Zuunbayan-Ulaan	0.6	0.7	0.7	0.7	1.2	2.0	2.5	3.8
24		Ulziit	0.7	0.8	0.8	0.8	1.5	2.3	2.9	4.4
25		Uyanga	0.6	0.7	0.7	0.7	1.3	2.0	2.5	3.8
26		Kharkhorin	3.2	3.4	3.3	3.4	7.0	9.8	12.2	18.9
27		Khujirt	3.5	3.9	3.9	4.0	7.8	11.5	14.2	22.0
Total of Uvurkhangai			13.2	12.3	12.2	12.6	28.9	36.0	44.6	69.0
28	Selenge	Altanbulag	0.3	0.4	0.4	0.4	0.8	1.0	1.3	2.0
29		Baruunburen	1.4	1.6	1.6	1.6	3.0	4.6	5.7	8.9
30		Zuunburen	0.4	0.5	0.5	0.5	0.9	1.4	1.7	2.7
31		Orkhon	0.9	1.1	1.1	1.1	2.0	3.1	3.9	6.1
32		Orkhontuul	1.4	1.7	1.7	1.7	3.2	4.8	6.1	9.4
33		Saikhan	0.4	1.0	1.0	1.0	0.9	2.9	3.6	5.6
34		Sant	0.7	0.7	0.7	0.7	1.5	1.9	2.4	3.7
35		Sukhbaatar	0.2	0.1	0.1	0.1	0.5	0.4	0.4	0.7
36		Khushaat	0.4	0.4	0.4	0.4	0.8	1.2	1.5	2.4
37		Shaamar	0.2	0.1	0.1	0.1	0.5	0.3	0.4	0.6
Total of Selenge			6.4	7.4	7.4	7.7	14.0	21.6	27.0	42.1
38	Tuv	Tseel	0.6	1.2	1.2	1.2	1.2	3.5	4.3	6.6
Total of Tuv			0.6	1.2	1.2	1.2	1.2	3.5	4.3	6.6
Grand total			55.2	53.7	53.4	55.2	120.9	156.9	194.7	302.0

Compared to 2008, the rural population in 2010 did not increase, but decreased by 3.5%.

4.1.3. Conclusion on water supply, waste water treatment and water consumption for people

- Most people in aimag and soum centers are supplied from non-central water supplies and systems need to be expanded to connect them to a central water supply in the future.
- measures should be taken to improve efficient water consumption by installing tap devices, shower sprinklers and tanks in toilets of public utility service establishments connected to the central water supply e.g. apartment blocks, hotels, schools and hospitals.
- There is experience e.g. in China and Germany, to treat waste water from domestic consumption (water consumed for body washing and clothes) by collecting it in the basement or the 1st floor of a building and reuse it in toilets. This is called 'grey water'. Measures need to be taken to include this good experience in the design of new buildings.
- Improve water supply required for population, aimag and soum center industries and services; determining waste water compositions and pollution level; constructing nature-friendly biological WWTP.
- There is no measure of chlorination and filtering in soum center drinking water; chemical research is conducted in boreholes' water when it is newly received to be used, since then, there is no regular water quality and composition research. The research should be stabilized.
- Technological regime is irregular, because soum center WWTP's use service was not stable. Now waste water is just transmitted through it. It should be maintained and its operation needs to be equalized.
- There is no regular control in rural population drinking water quality. The government is implementing many projects and programs on livestock water supply. But, there is no certain policy on herders' water supply. Consider that population and livestock water supply has one water source.
- Rural people who run pastoral farming and their livestock use the same water source. It is necessary to provide mini-portable water treatment equipment to nomadic herdsmen in areas where the mineral content and hardness of water is high and surface water is scarce, and to help them to become accustomed to filtration of drinking water before use.
- Orkhon River and its tributaries originate from branches of the Khangai Mountain and they have plenty streams and springs which contain a variety of minerals and chemical elements that are used in water and mud therapies. Therefore, it is necessary to carry out study on their resources, quality and composition, to set their protection zones and to improve their use.
- It is important to make planning for urban area and mining processing factory which will be newly established and to implement the plan within the framework of the Water National Programme approved by the State Great Khural (Parliament) in 2010 on the ground of e.g. carrying out monitoring on the current status of water supply sources for cities and urban areas, newly setting their sanitation zone and recharge area, bringing them under local protection and determining regime to be enforced.

4.2. Industrial water use and water demand

The manufacturing industry consists of light industry, food industry, mining industry, energy industry and construction and building material industry.

4.2.1. Food industry

Every year the number of large and small food factories is increasing in all the aimag centers and soums located in the Orkhon River Basin. Most of these factories have been established for the purpose of supplying the local demand of the main food products. E.g. small bread and bakery factories are in operation based at each aimag and soum center, and supply not only local demand, but also supply lunch demand of school children and food demand of kindergarten children. Everyday bread and pastry production is different in each factory. However the water use is calculated depending on type and quantity of above products. But it's not possible to calculate the actual water consumption as the output is different according to factory capacity, consumers' purchase power, demand and supply.

Bulgan aimag flour factory has a capacity to produce 11500 ton flour and 18000 ton mixed fodder and fodder in granules on an annual basis. Its water demand is supplied from a borehole.

There have been factories of food, flour, spirit, asphalt and concrete, and elevator for grain storage, and thermo-power plant in Kharkhorin soum of Uvurkhangai aimag. But these factories are currently not operating.

There are some factories of food, flour, bread and pastry operating in Sukhbaatar city of Selenge aimag.

Water use and water demand in 2015 and 2021 have been calculated according to the average annual output growth 6.9% in the Regional Development Programme.

Table 75. Water use and water demand by food industry

Year	2008	2010	2015	2021
Water use, thous. m^3/year	242.3	127.0	177.3	264.6

Some equipment designed to screen and clarify solid wastes have been installed in large food factories prior to delivering their waste water to the WWTP.

4.2.2. Light industry

There are some factories of carpet, knitting, felt and felt footwear in Erdenet city and these factories use water from the central water supply for their technological demand. In other cities and soum centers, some knitting and felt craft products are manufactured with support from the Small and Medium Enterprise Development Fund. But there is no data and information on their output at the basin level. Therefore, it's not possible to calculate its water consumption.

Water use and water demand by light industry in 2015 and 2021 have been calculated according to the average annual output growth 6.9% in the Aimags' Regional Development Programme of Khangai Region.

Table 76. Water use and water demand by light industry

Year	2008	2010	2015	2021
Water use, *thous. m^3/year*	176.4	136.4	190.4	284.2

Aimag and soum center small factories mostly don't have water supply and sewerage network and have transported water or a borehole water supply. Waste water is discharged without treatment.

4.2.3. Mining industry

Strategically important large deposits are located in the Orkhon River Basin. These are the Erdenet copper mining factory and over 20 gold mining companies e.g. Altandornod Mongolia LLC, Altan Yondoi LLC, Mongol Gazar LLC, Gatsuurt LLC i.e. that run gold mining activities in the basin. Also coal mining is being carried out in Ereen coal deposit in Saikhan soum of Bulgan aimag.

Mongol Gazar LLC holds some licenses to run gold exploration and mining activities in river valleys of Ul, Shiirt, Ulaan Chuluut, Ulziit Teel Rivers in Tsenkher soum of Arkhangai aimag where the Orkhon River runoff is originated as well as in Zuun Sudut area in Bat-Ulzii soum of Uvurkhangai aimag. Also ethyl mining activity is being run in Shiirtiin Salaa and Kharguit areas, etc in the territory of Tsenkher soum of Arkhangai aimag. All above areas are included in the Orkhon River Basin.

Figure 81. Gold mining in the territory of Tsenkher soum, Arkhangai aimag

Water use for 11 large mining companies that run mining activities in the basin has been calculated as of 2008 and 2010 (Table 77 and Table 78).

Table 77. Water use by mining industry in 2008

№	Aimag	Soum	№	Deposit	Water use, *thous. m³/year*
1	Arkhangai	Tsenkher	1	Ulziit Teel	7.0
			2	Kharguitiin Baruun Salaa	538.0
		Tuvshruulekh	3	Beren	543.9
2	Selenge	Orkhontuul	4	Tsagaan Gozgor	86.7
	Uvurkhangai	Uyanga	5	Asgatiin Darkhad	46.6
		Bat-Ulzii	6	Khongilt	23.3
			7	Zuunsudut	336.3
3	Orkhon	Bayan-Undur	8	Erdenetiin Ovoo	14300.0
Total					**15881.8**
Total water use in Orkhon River Basin					**1581.8**

Table 78. Water use by mining industry in 2010

№	Aimag	Soum	№	Deposit	Water use, thous. m3/year
1	Arkhangai	Tsenkher	1	Bavgariin Am	142.8
			2	Kharguitiin Baruun Salaa	300.1
			3	Ult and Ulaan Chuluut	21.9
			4	Ulaan Chuluut	14.7
			5	Shiirtiin Salaa. Yastiin Am	22.2
			6	Uliin	22.2
			7	Khar Chuluut	8.7
			8	Shiirtiin Salaa	21.2
		Tuvshruulekh	9	Beren	576.7
2	Orkhon	Bayan-Undur	10	Erdenet	15118.0
3	Uvurkhangai	Bat Ulzii	11	Zuun sudut	212.8
4	Selenge	Orkhontuul	12	Tsagaan Gozgor	79.1
Total					**16540.4**
Total water use in Orkhon River Basin					**1422.4**

Compared to 2008, water use by mining industry increased by 3% in 2010. Water demand by mining industries has been calculated to be increased by 1.5% considering the industrial growth and water demand by factories which will be newly established or expanded every year (Table 79).

Table 79. Water use and water demand by mining industry

Year	2008	2010	2015	2021
Water use excluding Erdenet mine, *thous. m³/year*	1581.8	1422.4	1843.3	2355.7
Total water use, *thous. m³/year*	15881.8	16540.4	17343.3	18355.7

The government of Mongolia is adhering to a policy on developing a copper industry based on the Erdenet copper mining factory. It's been also included in Aimag Development Programmes to develop mining and processing factories. Water use by Erdenet mining factory is expected to increase by 1% every year. But water use by Erdenet carpet factory, steel mill in Beren, spirit and flour factories in Bulgan, thermo-power plant in Erdenet, cement and lime factory in Khutul and thermo-power plant in Sukhbaatar city are likely to increase by 3% every year as a goal has been set to improve the capacity of these factories.

4.2.4. Energy industry

Aimag centers, soum centers and large settled areas in the Orkhon River Basin are connected to the mains of the Central Region. There is a thermo-power plant in Erdenet city of Orkhon aimag, thermo plant in Sukhbaatar city of Selenge aimag and solid-fuel-burning heating stove in Arkhangai and Bulgan aimags for energy and heating supply of apartment buildings, offices and factories in the cities.

In 1960 Chinese experts established a hydropower plant with a capacity of 528 kW on the main channel of the irrigation system in Kharkhorin of Uvurkhangai aimag. The plant used to supply energy to Kharkhorin soum center until it was connected to the / high voltage/ power line and supplied energy to sprinkling machines of the irrigation system. As the generators have been damaged, they are now unused.

The water use and water demand has been calculated by water use norm by obtaining data and information on annual water use from Erdenet thermo-power plant and Sukhbaatar thermo plant producers, and by obtaining data and information on heat produced by Tsetserleg and Bulgan cities from the statistics information, respectively.

Table 80. Water use and water demand by energy and heating industry

Aimag	Product name, quantity, water use and water demand											
	2008			2010			2015			2021		
	Energy, *mil.kW.hour*	Heat, *Thous. gkal*	Water use, *Thous. m³/year*	Energy, *mil.kW.hour*	Heat, *Thous. gkal*	Water use, *Thous. m³/year*	Energy, *mil.kW.hour*	Heat, *Thous. gkal*	Water use, *Thous. m³/year*	Energy, *mil.kW.hour*	Heat, *Thous. gkal*	Water use, *Thous. m³/year*
Arkhangai	-	12.6	12.6	-	20.0	20.0	-	26.8	26.7	-	38.0	37.9
Bulgan	-	16.4	16.4	-	24.3	24.3	-	32.5	32.5	-	46.1	46.1
Orkhon	114.0	619.0	1200.0	103.0	541.0	1500.0	138.1	724.5	2007.3	195.9	1027.7	2847.4
Selenge	-	143.0	226.0	-	160.0	160.0	-	214.2	214.1	-	303.9	303.7
Total	**114.0**	**790.7**	**1454.6**	**103.0**	**745.8**	**1704.3**	**138.1**	**998.0**	**2280.6**	**195.9**	**1415.8**	**3235.1**

The annual growth of the energy consumption is 5.0% at national level in recent years and it has been calculated to be 6.0% according to the IWM plan.

Energy supply tends to become insufficient due to the rapid increase of energy and heat consumption by energy system from year to year.

4.2.5. Recommendations on industrial sector water use

- Most of the light and food industries in aimag centers are connected to water supply and sewerage networks. Small industries in soum centers do not have a water supply and sewerage network, they use transported water and discharge their waste water into sewerage pits.
- Mining companies operating (Erdenet mining industry not included) in Orkhon river basin discharge waste water into soil without conducting pre-treatment and disinfection. Also waste water used for mining is discharged into rivers without treatment. Surface water and groundwater is polluted in a direct and indirect way. It has effects on population health and ecology.
- Mining companies should obey the law on environmental protection related to providing ecosystem balance.
- Mining sector is developing rapidly. This sector's water demand is increasing a lot. Water reuse technology needs to be introduced in mining.
- Mongolia needs to supply an increasing energy demand; solve issues on mining-related infrastructure; implement energy saving activities. In order to achieve these objectives, the following things need to be started: extend electricity lines, renovate and extend thermal power plants of Darkhan and Erdenet (possible in terms of fuel and water resources), construct new thermal power plants in some areas and solve their water demand.

4.3. Agricultural water consumption-use and water demand

4.3.1. Pastoral farming

Pasture use is directly associated with water supply for livestock. The way of running pastoral farming is apparently changing in recent years depending on the necessity of socio-economic development and climate change. As of 2010, over 500 rivers, 600 springs and 3200 engineering designed and hand wells have been used in the Orkhon River Basin.

Cattle which is a marketable product comprises merely 5.2%-5.9% of all livestock at the basin level.

Figure 82. Water sources used for watering livestock in pasture area

Livestock number and average annual water consumption in the basin's soums have been calculated based on the result of the state census on livestock in 2008 and 2010 by the National Statistics Committee of Mongolia; the livestock growth projection for 2015 and 2021; and the researchers' conclusions which determined the water consumption norms for livestock per day on seasonal basis.

Table 81. Water consumption and water demand of livestock in the basin (by aimag)

№	Aimag	Livestock number, *thous. head*				Water consumption, *thous. m³/year*			
		2008	2010	2015	2021	2008	2010	2015	2021
1	Arkhangai	1508.4	1041	1226.3	1202.7	3782.6	2676.0	3876.6	4734.4
2	Bayankhongor	18.6	21.4	25.5	24.2	61.2	71.8	111.6	146.9
3	Bulgan	801.2	706.8	884.9	917.8	1919.8	1793.3	2586.1	3119.8
4	Darkhan-Uul	29.5	16	23.8	28.4	72.9	49.5	74.8	96.9
5	Orkhon	268.9	169.2	213.5	224.7	581.9	426.3	545.3	642.9
6	Uvurkhangai	632.4	401.2	447.9	420	1498.0	957.5	1337.0	1584.4
7	Selenge	575.7	495.5	719.5	855.4	1239.6	1188.6	1682.9	2048.2
8	Tuv	62.6	64.9	107.7	156	134.6	148.9	208.5	247.0
Total		**3897.3**	**2916.0**	**3649.1**	**3829.2**	9290.6	7311.9	**10422.8**	**12620.6**

Some initiatives are being carried out aimed at improving pasture use e.g. establishing herdsmen's groups, having winter and spring camps areas owned by herdsmen, joint pasture use by them, establishing new boreholes based on their demand and ownership of such wells.

It is stated in the state policy on food and agriculture that it is necessary to increase engineering and ordinary wells and water points, to improve their ownership and use, and to improve water supply for pasture to use water resources efficiently. Accordingly, the related framework for livestock water supply has been organized in two phases. At first phase, some 2.9 thousand wells have been restored financed from the state budget at MNT7.1 billion in 1998-2008. At second phase, 2.5 thousand new wells were established by financing from the state budget at MNT26.8 billion in 2004-2010. At this moment, there is no artificial lake or pond which is established for the purpose of

water supply for people and agriculture in the basin. But study and design to establish ponds for livestock watering and crop irrigation have been started in some soums from 2010. Also the required investment has just been provided by the Ministry of Nature, Environment and Tourism.

Also water investigation has been carried out in some 5 aimags financed from the state budget at MNT300 million in 2008 in order to identify water points to establish new wells in pasture area of soums included in the basin. As a result, some 438 water points have been identified. 9 aimags have undergone water investigation with state budget of MNT 500 million in 2010.

Between 2000 and 2008, within the framework of projects and programmes implemented by foreign countries and international financial organisations (ADB, IFAD, WB, UNDP, JICA and KOICA), they have supported and contributed herdsmen by spending MNT4.9 billion for restoration of 1.6 thousand old wells and MNT860 million for establishing 96 new wells.

4.3.2. Irrigation

The Orkhon River Basin belongs to the Khangai and Central Regions of economic development and is located close to marketplaces. It is an area with favorable natural and climate conditions for agricultural development. Most parts of the basin are suitable for crop farming according to assessment on soil quality. Traditionally, locals used to do crop farming. Irrigation systems currently used in the basin are shown in Table 82.

Figure 83. Sprinkler machine and reservoir used in irrigated areas

Table 82. Irrigation systems used in the Orkhon River Basin (as of 2010)

№	Aimag	Soum	№	Irrigation system name	Capacity, *ha*
1	Arkhangai	Battsengel	1	Suultolgoi	136.0
		Khotont	2	Tsagaan Sumiin Gol	122.0
2	Bulgan	Orkhon	3	Kheltgii Nuga	52.0
			4	Shuvuut River	76.0
3	Orkhon	Jargalant	5	Ulaan Tolgoi	137.0
			6	Khangal River	70.0
			7	Jargalantiin Khundii /valley	136.0
4	Uvurkhangai	Kharkhorin	8	Kharkhorin	540.0

№	Aimag	Soum	№	Irrigation system name	Capacity, *ha*
5	Selenge	Zuunburen	9	Zurkhangai	45.0
			10	Erkhetiin Nuga	100.0
		Khushaat	11	Orkhon Khushaat	249.0
			12	Mandaliin Bulan	83.0
			13	Rashaant	162.0
			14	Zeenegeriin Khotgor	388.0
			15	Khuduu Kharaat	40.0
		Orkhon	16	Gurvan Sertengiin Khundii	100.0
		Orkhontuul	17	Shar Usnii Khooloi	129.0
			18	Salkhit	80.0
		Baruunburen	19	Iveelt	213.0
			20	Khundiin Amnii Adag	190.0
			21	Zuunmod	210.0
		Sant	22	Tsagaan Tolgoi	1,265.8
			23	Mukhar Buduun	158.7
Total					**4,682.5**

Most economic entities using irrigation systems don't completely use their area and don't comply with rotation, fertilizer and irrigation norms but depend on their own initiative, knowledge and experience. Over 60% of currently used irrigation systems are located in the Selenge aimag. Irrigation water use depends on crop growth, air temperature and humidity. In the event of irrigation comes from groundwater, water consumption for irrigated area has been calculated by irrigation norm minimum indicator considering that it can't reach norm amount depending on high energy cost.

The aim to harvest 25-30% of grains and fodders from irrigated area is stated in the State Policy on Food and Agriculture and the Water National Programme. Accordingly, it has been planned in the IWM plan to increase the irrigated area size by 4% every year in this basin starting from the 2010 level which is the most potential area for crop irrigation.

Table 83. Water use and water demand of irrigated areas

Irrigated area, *ha*				Water consumption, *thous. m³/year*			
2008	2010	2015	2021	2008	2010	2015	2021
3,728.2	4,666.0	7,452.3	11,426.7	10,374.5	12,259.2	21,092.6	32,389.2

Within the framework of the programme to support the 'Third Campaign for Cultivation of Arid Land' by the government of Mongolia, crop industry has been rehabilitated, unused irrigation systems have been restored and significant amounts of investment have been spent for this campaign. As a result, 3 old irrigation systems covering 193 ha area have been restored and 7 new irrigation systems covering 1145 ha area have been established in the Orkhon River Basin from 2008 to 2010.

As the crop industry is intensively developed in the basin, groundwater as water source of irrigated area is likely to increase. But the use of groundwater violates the National Security Concept that 'limits groundwater consumption in crop irrigation and limits drinking water consumption in non-food industry sector...'. Groundwater is used in irrigation systems at Ulaan Tolgoi area in Jargalant soum of Orkhon aimag and at Mandaliin Bulan and Khuduu Kharaat areas in Khushaat soum of Selenge aimag.

Main crops planted in irrigated areas are grains, vegetables, sea-buckthorn and fruit bushes. The size of irrigation areas in Orkhon river basin is presented by each aimag and soum in the table below.

Table 84. Size of irrigation areas where irrigation is conducted

№	Aimag name	Soum name	Used		Possible to be used	
			Area name	Area size, *ha*	Area name	Area size, *ha*
1	Bayankhongor	Erdenetsogt			Khushuugiin Am	114
2	Arkhangai	Khotont			Taliin Balgas	6600
		Khashaat			Tarniin Gol	100
		Tuvshruulekh			Arnuur	1100
					Khokh Sumiin Gol	300
		Ugiinuur			Toglohiin Tal	1000
		Ulziit			Khar Hyaraan Gol	1000
		Bulgan	Arbel	258	Urumdul Khudag	16
		Erdenemandal			Dun tsur	200
					Baga Halzan	50
					Tenuun Tal	100
					Khaanii Balgas	1500
					Tsorgiin Am	700
		Battsengel	Suul Togoi	70	Erdene Tolgoi	800
					Urd Tamiriin Adag	50
		Ikh Tamir			Ulunt	50
		Tsenkher	Shirguu	408		
3	Bulgan	Mogod			Orkhon valley	400
		Orkhon	Seeriin Gol	48	Mogoin Gol	100
			Shuvuutiin Gol	85		
		Khishig-Undur			Sharhain Gol	150
					Bayangol	100
					Shivert	100
		Buregkhangai			Angirt	5.0
					Yamaat	80
		Gurvanbulag			Tahilt	160
					Tarnain Gol	200
		Dashinchilen			Shardow	450
					Milan Gol	60
		Rashaant			Tarniin gol	21.0
		Bayannuur	Daliin Bulag	57.0	Zaankhoshuu	2000
					Shar tal	3000
		Saikhan			Buuraliin Gol	100
		Khutag			Buur Nuur	200
		Bugat			Khujirt	100
		Khangal			Deed Evert	200
					Ar Khushuu	300
					Tsulhar	150
4	Orkhon	Bayanundur				
		Jargalant	Ulaantolgoi	547		

№	Aimag name	Soum name	Used		Possible to be used	
			Area name	Area size, *ha*	Area name	Area size, *ha*
5	Uvurkhangai	Batulzii			Khuiten Bulag	10
					Ongotsot	30
		Khujirt	Tsuurain Gol	219	Khaakhai Bulag	30
					Shawar Turuu	100
		Kharkhorin	Kharkhorin	3285	Bayangol	60
					Orkhonii zuun ereg	1200
		Zuunbayanulaan			Emt Bulag	2.0
					Hungui Muhar	300
		Ulziit			Huisiin Gol	65.0
		Uyanga			Baraan Gol	100
		Burd			Tarian Tolgoi	100
					Baga Barigdai	20
					Khar Biluut	90
		Yusunzuil	Sarankhundii	74	Ulaan Ereg	150
		Bayanundur			Bor Hujir	20
					Kharztain Gol	70
6	Tuv	Bayan-Unjuul			Bayanbulag	3.0
		Undurshireet			Maikhan Denj	100
					Berkhiin Khundii	50
					Taliin Bayan	100
		Lun			Burkhant Khundii	10
					Yatuut Khundii	100
		Zaamar	Ar Urt	125	Khadan Hushuu	200
		Altanbulag			Tuuliin Gol	50
					Buhugiin Gol	70
					Sumiin tuv	50
		Jargalant	Jargalant	850	Mendiin Uzuur	60
					Bor Hujir	120
		Mungunmorit			Udegiin Denj	300
					Hongoriin tal	2300
		Ugtaal			Tuutiin Adag	200
					Bor Hujir	5.0
		Bayankhangai			Buduun Dugar	3.0
		Bayanchandmani	Bayanchandmani	72	Zuun Muhar	30
			Shariin Am	60		
		Tseel			Teeliin Gol	200
					Bor Gol	20
		Bayantsogt	Guna	70		
			Dund Urt	57		
		Bornuur	Bornuur	966		
			Arangat	280		
		Batsumber	Batsumber	802	Dugan Davaa	300
			Bayantolgoi	250	Jargalantiin Ar	150
			Bayangol	34	Sugnugur Gol	40
		Erdenesant			Urtiin Gol	5.0
		Bayan-Unjuul			Bayanbulag	3.0
		Sergelen			Bayanbulag	2.0
		Erdene	Uu Bulan	36		

№	Aimag name	Soum name	Used		Possible to be used	
			Area name	Area size, *ha*	Area name	Area size, *ha*
7	Ulaanbaatar	Gachuurt	Khar Usan Tohoi	95		
			Uvurbayan	74		
			Uliastain Am	240		
		Jargalant	Ayushiin Am	150	Shuvuun Fabrik	200
			Arshand	83		
		Khan-Uul	Buhug-1	150		
			Buhug-2	189		
8	Selenge	Orkhontuul			Tsagaan Ereg	400
					Burgaltai	80
					Chuluut Gol	20
		Orkhon			Khudgiin Khundii	500
					Shiir	30
					Mangirt	180
					Chuluun Khoroot	210
		Sant	Tsagaantolgoi	3300	Mukhariin Am	200
		Saikhan			Nogoo Barigad	30
					Khushuu Chuluu	20
					Kharaa Orkhonii belchir	1000
		Javkhlant			Khuitnii Gol	60
					Shariin Gol	100
					Khongor Ovoo	200
		Shaamar	Shar Tohoi	61	Yapon Tohoi	500
					Manjiin Dotor	300
		Khuder			Shorgoolj	500
					Khudriin Khundii	300
					Tumurtui	500
		Mandal	Zuunkharaa-1	400	Tsagaan Khutul	300
			Zuunkharaa-2	144	Tukhumiin Bulag	60
			Boroo gol	30	Boroo Hundii	1400
					Bayanbulag	100
		Bayangol	Zagdliin Gol	76	Bayangol	80
			Bayanii Uvur	214	Tariatiin Am	50
			Dorgont	20	Erkhet	100
					Zagdal	30
					Tumurtui	70
		Baruunburen	Zuunmod	666	Zuunmod	333
		Khushaat			Artoilbo	400
					Khashaat	200
					Naadamiin Denj	500
					Tashir Erkhet	400
		Altanbulag	Khyaraan gol	216	Baruun Gol	13
			Tukhum	50	Bor Bulan	800
					Nariin Mogoit	20
		Sukhbaatar city				
		Zuunburen	Bongiin Tohoi	1000	Orkhon-Selenge belchir	3000
		Euruu			Enkh Tal	1500
					Karnakov	200
					Khar Ereg	100
					Tsagaan Tohoi	200

№	Aimag name	Soum name	Used		Possible to be used	
			Area name	Area size, *ha*	Area name	Area size, *ha*
9	Darkhan Uul	Khongor	Khongoriin Gol	90	Serten	100
			Uujim Bulag	20		
		Orkhon	Shariin Gol	436	Shariin gol	186
			Burentolgoi	380	79-Tohoi	42
			79-Tohoi	58		
		Shariin Gol	Buurt	130		
Basin Total				**16925**		**43774**

4.3.3. Farming

Due to the necessity of a sustainable safe food supply for people in urban areas, intensive livestock farming development is now becoming an important goal in increasing food industry. In order to enforce the state policy on herdsmen approved by the State Great Khural (Parliament) and the related clauses of the Mongolian Law on Small and Medium sized Enterprise, some measures are being taken such as turning herdsmen families into small and medium enterprisers and supporting their businesses by granting a loan from the government, etc.

Intensive farming is different from pastoral farming by breeding livestock with a high productivity and feeding them with water and fodder and keeping them in warm fences and shelters in manner of a fully-settled or semi-settled farming. In other words, more products can be produced by ensuring a good living condition, water and fodder for livestock.

In recent years there is a trend that farmers and economic entities dominantly develop greenhouses in the Orkhon River Basin for the purpose of a sustainable harvest of some vegetables on a regular basis.

4.3.4. Recommendations on water supply for agriculture:

- Recently many wells and water points have been established with financial support from the state budget, foreign and national projects and special funds aimed at improving water supply for livestock. It is necessary to make conclusion on availability of pasture area for livestock which number is intensively increasing in recent years due to significant percentage of newly established wells and water points near damaged and vandalized old wells;
- To establish new wells for livestock water supply based on ownership by herdsmen group and organization of operation and maintenance;
- Depending on livestock water supply conditions, pasture use became limited and in warm seasons livestock resides near water in one area for a long time. It disrupts pasture plants' growth possibilities. Consider pasture degradation.
- According to the research conducted by relevant ministries' experts and scientists, it is possible to construct some 124 irrigation systems which are capable of irrigating 43.7 thousand ha area in the Orkhon-Tuul basin. If adding old irrigation system's 16925 ha area (now being used and possible to be used), some 60.6 thousand ha area can be used for farming with irrigation in the basin. It has advantages including supplying food in the basin and in Ulaanbaatar and supplying intensified livestock near cities with fodder, creating possibility to have quality and stable harvest.

- Drought and evaporation of soil water have increased and many rivers stopped flowing in recent years. Consequently, there is a lack of water sources of some irrigation systems which were established based on runoff of these rivers. It is necessary to study the benefits to establish hydro-technical construction with runoff regulation, dam and dyke on rivers with constant runoff;
- Fodder is required to be planted on irrigated area for more harvesting. In recent years, the number of farmers is increasing in the vicinity of urban areas. But intensive farmers are limited to plant their own fodder due to lack of sufficient area for plantation of such fodder and lack of technical supply. Therefore, they usually purchase fodder from the market which does not enable them to decrease their products' price.
- For herdsmen households in the Orkhon River Basin, they are enabled to develop farming or intensive farming by receiving financial assistance and by taking their advantages e.g. relatively good infrastructure and close location to large urban areas i.e.
- If there is an urgent need of groundwater use in irrigated area, it is necessary to carry out a complete hydrogeological investigation and study and to determine the groundwater recharge regime and groundwater water resource;
- It is necessary to widely use methods for sustainable harvest in Mongolia: to establish greenhouse made from synthetic film and glass to create warm and humid environment, and to plant vegetables by covering soil by synthetic film and making hole on the film. These methods are to protect soil moisture from evaporation loss and weeds, and to maintain heat.

4.4. Services water consumption and water demand

4.4.1. Education, culture and health organizations

There are 6 universities, 7 vocational training centers, 70 schools and 80 kindergartens in the cities located in the Orkhon River Basin involving over 90,000 students and children. Also there are 4 polyclinics and 37 household medical centers in the cities. Every year the number of people using social services is increasing. At the same time, expansion and construction works for these service organisations are being performed by finance from the state budget.

For these organisations, water is supplied from the central water supply in the aimag centers and supplied from transported water in soum centers.

At the basin level, 14.7 thousand people are working at public administrative organisations and other 200 companies and offices. Water consumption for these organisations has been calculated by obtaining data and information from aimags' statistics departments on number of students of university, vocational training center and general education schools, and inpatients and outpatients of the health centers and medical service centers for household.

Table 85. Water consumption by the cities' social service organisations and offices in the basin (as of 2010)

№	City	Education organisation, *thous. students*				Health organisation, *thous. people*			Organisations, *thous. person*	Water consumption, *thous. m³/year*			
		Kindergarten	General education school	University	Vocational training and industrial center	Employees	Outpatients	Inpatients		Education organisations	Health organisations	Offices	Total
1	Tsetserleg	3.2	19.6	1.6	1.3	1.2	23.2	23.2	3.9	67.3	28.8	18.9	115.0
2	Bulgan	2.3	10.4	0.7	0.6	0.8	30.6	12.8	3.3	38.9	17.9	16.0	72.8
3	Sukhbaatar	4.9	18.9	1.2	1.4	1.4	27.1	23.3	4.2	76.5	53.8	20.3	150.6
4	Erdenet	4.8	18.1	1.6	1.5	1.2	42.6	17.1	3.3	141.3	42.9	16.0	200.1
Total		**15.2**	**67.0**	**5.1**	**4.8**	**4.6**	**123.5**	**76.4**	**14.7**	**324.0**	**143.4**	**71.2**	**538.5**

Water consumption has been calculated based on the water consumption norm approved by the resolution No.153 of the Ministry of Nature and Environment in 1995 at 75 l/day per kindergarten child in Erdenet city with the central water supply and sewerage network, 37.5 l/day per kindergarten child in other cities and 20 l/day per general education school child. Duration of the academic year was assumed to be 180 days for general education schools and kindergartens. Duration of working day was assumed to be 242 for office employees and 365 days for inpatients, respectively.

4.4.2. Commercial services

Commercial service is one of Mongolia's oldest sectors that represent a valuable contribution to socio-economic development such as population employment, household revenue increase, poverty reduction and culture improvement, etc. The following services in which water is inevitably used in our daily work and service have been selected for water consumption. However, there are many types of commercial services.

There are approximately 270 commercial service points such as hairdressers/barbers, bathes, laundry and dry cleanings to serve people in aimag and soum centers included in the basin.

Table 86. Commercial service points, 2010

№	Aimag	Number of commercial service point *(as of 2010)*			
		Hairdresser	Beauty salon	Bathes	Dry cleaning
1	Arkhangai	44	4	7	2
2	Bulgan	23	3	5	1
3	Uvurkhangai	8	-	5	-
4	Orkhon	80	22	9	4
5	Tuv	2	-	1	-
6	Selenge	33	7	13	-
Total		**190**	**36**	**40**	**7**

For water supply, commercial service points in aimag centers are mostly connected to the central water supply. But some soum baths have their own wells and some are supplied by transported water.

Catering establishments: There are approximately 300 establishments such as restaurants and canteens in aimag, soum centers and other large settled areas.

Table 87. Catering establishments, 2010

№	Aimag	Public catering establishment *(as of 2010)*		
		Restaurant	Canteen	Total
1	Arkhangai	33	15	**48**
2	Bulgan	25	36	**61**
3	Selenge	56	18	**74**
4	Orkhon	61	26	**87**
5	Uvurkhangai	8	12	**20**
6	Tuv	1	4	**5**
Total		**184**	**111**	**295**

Water consumption by commercial services and catering establishments has been calculated by method of comparison with approximate number of their clients and price of sold products.

Table 88. Total water consumption by commercial services and catering establishments, 2010

№	Aimag	Water consumption (2010), *thous. m³/year*
1	Arkhangai	15,600
2	Bulgan	4,000
3	Selenge	45,000
4	Orkhon	31,300
Total		**95,900**

The number of those who are involved in the public service sector in the basin is to be 1.4% and annual growth of water consumption in commercial services sector is to be 7.6% based on the service sector GDP included in the Regional Economic Development Programmes, respectively.

Table 89. Water consumption and water demand of the cities service organisations in the basin

№	City	Water consumption, *thous. m³/year*			
		2008	2010	2015	2021
1	Tsetserleg	124.0	130.6	145.7	168.9
2	Bulgan	72.9	76.8	83.8	93.8
3	Sukhbaatar	185.8	195.6	226.4	276.2
4	Erdenet	219.9	231.4	259.7	303.3
Total		**602.6**	**634.4**	**715.6**	**842.2**

4.5. Construction and building material industry water use and water demand

This sector hasn't well developed in the Orkhon River Basin. There are small and medium enterprises such as cement and concrete factory, brick factory, wood and wooden product factory, straw-bale construction industry, etc in aimag center and some soums.

There are 14 construction and building material producing companies and one road maintenance company in Arkhangai aimag. These companies not only build new apartment buildings and roads, but carry out the related maintenance and expansion work. Building material factories supplied by sand, commonly spread material from

Elstei deposit in Ikh Tamir. Gunjiin Davaa red brick producing company is supplied by mud which is main raw material for producing bricks from Ulaan Baayu deposit in the vicinity of Tsetserleg city. It was planned to build 100 apartment blocks in Arkhangai aimag center within the framework of the Programme for 100,000 Apartment Blocks.

Construction and building material industry hasn't developed well in Bulgan city of Bulgan aimag, its construction area is a small and its general construction plan has been delayed for the years due to financial difficulty. But new buildings and apartment blocks still built by private companies or individuals. And 40% of investment, construction work and overhaul is being carried out in the city of Bulgan.

There are 3 companies that provide road maintenance and care service and 4 companies that produce construction and building material in Erdenet city, the center of Orkhon aimag.

Based on wood processing factory in Sukhbaatar city of Selenge aimag, it is planned to supply Sukhbaatar city thermo-plant demand by producing bio-fuel such as pellet and briquette using sawdust and excessive woods from own factory, dead and excessive woods collected from its region. Amount of supplying pellet and briquette is to reduce amount of coal-burning and greenhouse emission. There are Khutul cement and lime factory, steel mill and railway sleeper factory in Saikhan soum. The future water use of the Khutul cement and lime factory in 2015 and 2021 was estimated based on the existing factory development planning and included in the water demand calculation.

Industrial waste water from construction and building material industry is discharged into surrounding environment and percolated down to soil.

Water use and water demand of construction and building material industry has been calculated based on performance by construction companies that run activities in the Orkhon River Basin and data and information of aimags' statistics departments (Table 90).

Table 90. Water use and water demand by construction and building material industry in the basin

Year	2008	2010	2015	2021
Water use, *thous. m³/year*	430.9	498.4	1,067.2	1,779.6

4.6. Tourism, sanatorium and green areas water consumption and water demand

4.6.1. Tourism

There are many historical and cultural places in the basin. Based on these areas, over 40 tourist camps have been registered at the basin level. Of these, 34.1% is located in the territory of Arkhangai aimag, 31.7% is in Selenge aimag and 26.8% is in Uvurkhangai aimag. Of these camps, some 21 camps are being operated normally.

Table 91. Tourist camps operating in the Orkhon River Basin

№	Aimag	Soum	Number of tourist camp	Capacity, *person/day*	Water source
1	Arkhangai	Ikhtamir	4	380	Groundwater (4 boreholes)
2	Arkhangai	Erdenebulgan	1	85	Transported water
3	Arkhangai	Tsenkher	3	190	Tsenkheriin Bulag
4	Uvurkhangai	Bat-Ulzii	1	60	Orkhon River

№	Aimag	Soum	Number of tourist camp	Capacity, *person/day*	Water source
5	Uvurkhangai	Kharkhorin	6	400	Orkhon River (5 boreholes)
6	Bulgan	Bulgan	2	40	Groundwater (2 boreholes)
7	Selenge	Sukhbaatar	4	95	Orkhon River (2 boreholes)
Total			21	1250	

In 2009, 10% of foreign tourists visited Arkhangai aimag generally between June 15 and September 15 according to a study carried out by the Ministry of Nature, Environment and Tourism.

Now there are 10 tourist camps and 2 hunter's camps in Bulgan aimag.

Tourism has been well developed in Kharkhorin soum of Uvurkhangai aimag. And significant percentages of soum citizens solely run tourism activity in summer time as their income sources are generated from tourism.

Figure 84. Erdene-Zuu Monastery in Kharkhorin soum

Currently 5 tourist camps are operating in Baruunburen soum of Selenge aimag.

Drinking and domestic water consumption by most tourist camps is supplied from groundwater while there is a minority in which water consumption is supplied by water truck and cart. According to study, one tourist camp with a capacity of 50-60 beds consumes 5 ton of water for 3 days when it is full. Tourist camps have their own open fresh water pipeline and underground waste water pipeline network connected to kitchen and sanitation used during warm season.

Some camps established swimming pool and bathrooms in order to provide a convenient condition to their clients and tourists. Most of tourist camps collect their waste water in an underground waste water tank. The waste water is transported by sewerage truck and dumped into a particular landfill as permitted by the local competent authority.

According to the norm and procedure for 'Water Supply and Sewerage inside Construction' (BNbD 40-05-98), when tourist camps are full they produce 110 m^3 waste water per day based on 85 l/day per person. Some tourist camps cause pollution of nature, soil and water environment by directly discharging their waste water into the river or percolating down to soil. Most camps have an improved toilet, shower, sink and flush toilet while some camps have only pit latrines.

In developing tourism sector in the future, it's important to launch mini water supply and sewerage facilities for tourist camps, to protect nature and environment and to provide amenities to tourists.

The total water consumption has been calculated based on capacity and operating period of tourist camps, number of received tourists and the water consumption norm. As of 2010, water consumption by all the tourist camps in the Orkhon River Basin amounted to 10.9 thousand m^3. If the sector annual water consumption is growing by 6.9% according to regional development programmes, water consumption is expected to reach 15.1 thousand m^3/year in 2015 and 18.6 thousand m^3/year in 2021, respectively.

4.6.2. Sanatorium and spa resorts

There are totally 100 sanatorium and spa resorts at national level based on spas, springs and mud as there are plenty of them in Mongolia used for spa, water and mud therapy. As of 2010, only 27 of them have been accredited.

Figure 85. Sanatorium and spa resorts

Accredited large sanatorium and spa resorts located in the Orkhon River Basin include Khujirt and Elma Khujirt spa resorts in Khujirt soum of Uvurkhangai aimag, Erdenet spa resorts in Orkhon aimag, Bujinkhen children's spa resort in Selenge aimag, Khudulmur, Suvd and Khasu Mandal spa resorts in Battsengel soum of Arkhangai aimag and Shivert spa resort in Erdenebulgan soum of Arkhangai aimag.

There are 11 spa resorts with a capacity of receiving 1100 clients at the same time in Erdenet city, the center of Orkhon aimag and some 3 spa resorts in Jargalant soum of Orkhon aimag. And there are few small camps which serve airag (fermented mare's milk) and saam (mare's fresh milk) on a temporary basis.

There are 10 sanatoriums and spa resorts that operate on a regular basis in Bulgan aimag.

In the future, a new sanatorium and spa resort can be established based on the following springs and spas in the Orkhon River Basin: Bor Tal, Gyalgar and Tsenkher springs in Tsenkher soum of Arkhangai aimag, Tsagaan Sum spring in Khotont soum of Arkhangai aimag, Saikhan Khulij spring in Mogod soum of Bulgan aimag, Gyatruun, Mogoit, Khujirt and Uurtiin Tokhoi springs in Bat-Ulzii soum of Uvurkhangai aimag, etc.

It is considered unnecessary to calculate water consumption for clients of these sanatoriums and spa resorts as they are already included in the calculation of the population water consumption in the related basin in which they reside.

4.6.3. Green areas

There is in total 75.3 ha green area in the cities according to the Nature, Environment and Tourism Departments and Governor Offices in aimags that are included in the basin. Water source for parks and lawn area irrigation is groundwater. Some organisations irrigate their surrounding lawn and green areas by the same water which is consumed for domestic purposes.

In some aimag centers, wells are established for the purpose of irrigating parks/ gardens and the irrigation is made by mini-portable sprinkler machine or sometimes mechanically by hand. In recent years, two fountains were established in Erdenet city center for the purpose of creating a convenient and humid environment for people to spend their leisure time and to feel comfortable.

There are 1-2 green parks in each aimag center. And offices, factories and economic entities and service organisations provide gardening and ministrations service such as planting lawn, larch, spruce and bushes in their surrounding area. But the cities' landscaping companies are responsible for maintenance, expansion and renovation of publicly owned green areas. Amount of green areas as of 2010 is shown in the table below.

Table 92. The cities' irrigated lawn and green areas' size

№	City or aimag center	Green area size, *ha*	Water source
1	Tsetserleg	4.3	Groundwater /borehole/
2	Bulgan	6.7	Groundwater /borehole/
3	Erdenet	56.8	Groundwater /borehole/
4	Sukhbaatar	7.5	Groundwater /borehole/
Total		**75.3**	-

In recent years when landscaping the publicly owned parks, not only trees and lawn has been planted, but a complete landscaping and architectural solution including statue, sculpture, illumination and fountain, etc has been carried out and a significant amount of cost is being spent for landscaping works. Cost amount for landscaping and gardening work is approved by local Citizens' Representative's Meeting and the green areas' size has been calculated to increase by 2% every year than the current amount according to the plan.

Figure 86. Green area landscape

Table 93. Water consumption and water demand by the cities' green area

Green area, *ha*				Water consumption, *thous. m³/year*			
2008	2010	2015	2021	2008	2010	2015	2021
72.3	75.3	82.8	91.8	144.6	150.6	165.6	182.8

4.7. Flood protection constructions

Dykes and channel constructions were built in some 4 aimag centers and Khangal soum center of Bulgan aimag to protect from spring flood, heavy showers and flash floods (Table 94).

Table 94. Flood protection constructions in the basin

№	Aimag	Aimag and soum center	Type of flood protection		Location	Length of dyke and channel, *km*
1	Selenge	Sukhbaatar	Dyke		In the north of the city along the Orkhon River	3.4
2	Bulgan	Bulgan		Channel	In the middle of ger area	3.0
3	Bulgan	Khangal	Dyke		In the east of soum	3.0
4	Arkhangai	Tsetserleg	Dyke		In the south-west of the center	3.5
5	Orkhon	Erdenet		Channel	In the north-west of the center	6.0
Total						**18.9**

The Tsetserleg city flood protection channel was built in 2007 in the north of a hill beside the Khalzan mountain pass in the south-west of aimag center. But the aimag governor considered that this is not a rational solution and didn't accept it. Because there is a high risk of flood through Tsagaan Davaa mountain pass and Arslantai Tsokhio valley located in the north of the aimag center. In 2010 a flood protection channel with a concrete and stone lining was built in Bulgan city for the purpose of protecting the city center and ger area from flood disaster. At this moment, expansion work is being carried out.

Figure 87. Tsetserleg city flood protection channel

Figure 88. Bulgan city flood protection channel

Sukhbaatar city flood protection dyke and channel were established in the north and north-west of the city as well as along the railway. The dyke along the railway was renovated by foreign investment and additionally equipped with a concrete lining in 2000-2002. But the channel with a length of 3428 m in the north of city hasn't undergone maintenance last 15 years and became unable to pass flood water. Therefore, it is necessary to make a new design and provide maintenance and renovation.

4.8. Total water consumption-use and water demand in the Orkhon river basin

Compared to 2010 or the initial year of the IWM plan for the Orkhon River Basin, water consumption-use in 2021 or the final year of the IWM plan increases by 57%.

The total water consumption-use and water demand of the basin has been included in Table 95 and Figure 89.

Table 95. Total water consumption-use and water demand in the Orkhon River Basin

№	Water consumer and user	Water consumption-use and water demand							
		2008		2010		2015		2021	
		thous. m^3/ year	*%*	*thous. m^3/ year*	*%*	*thous. m^3/ year*	*%*	*thous. m^3/ year*	*%*
1	Domestic water for the cities population	3,905.2	9.1	4,163.4	9.4	6,299.4	10.4	6,613.1	8.5
2	Domestic water for soum center population	492.5	1.1	479.9	1.1	526.7	0.9	619.5	0.8
3	Domestic water for rural population	120.9	0.3	156.9	0.4	194.7	0.3	302.0	0.4
4	Food industry	242.3	0.6	127.0	0.3	177.3	0.3	264.6	0.3
5	Light industry	176.4	0.4	136.4	0.3	190.4	0.3	284.2	0.4
6	Mining*	15,881.8	36.8	16,540.4	37.4	17,343.3	28.7	18,355.7	23.7
7	Energy and Heating	1,454.6	3.4	1,704.3	3.9	2,280.6	3.8	3,235.1	4.2
8	Livestock	9,290.6	21.5	7,311.9	16.6	10,422.8	17.2	12,620.6	16.3
9	Irrigation	10,374.5	24.1	12,259.2	27.8	21,092.6	34.9	32,389.2	41.8
10	Services and public utilities	602.6	1.4	634.4	1.4	715.6	1.2	842.2	1.1
11	Tourism	0.0	0.0	10.9	0.0	15.1	0.0	18.6	0.0
12	Green area	144.6	0.3	150.6	0.3	165.6	0.3	182.8	0.2
13	Construction	430.9	1.0	498.4	1.1	1,067.2	1.8	1,779.6	2.3
Total		43,116.9	100.0	44,173.7	100.0	60,491.3	100.0	77,507.2	100.0

Remark: ** Erdenet mine is included in calculation of water use and water demand but the mine uses water from the Selenge River Basin.*

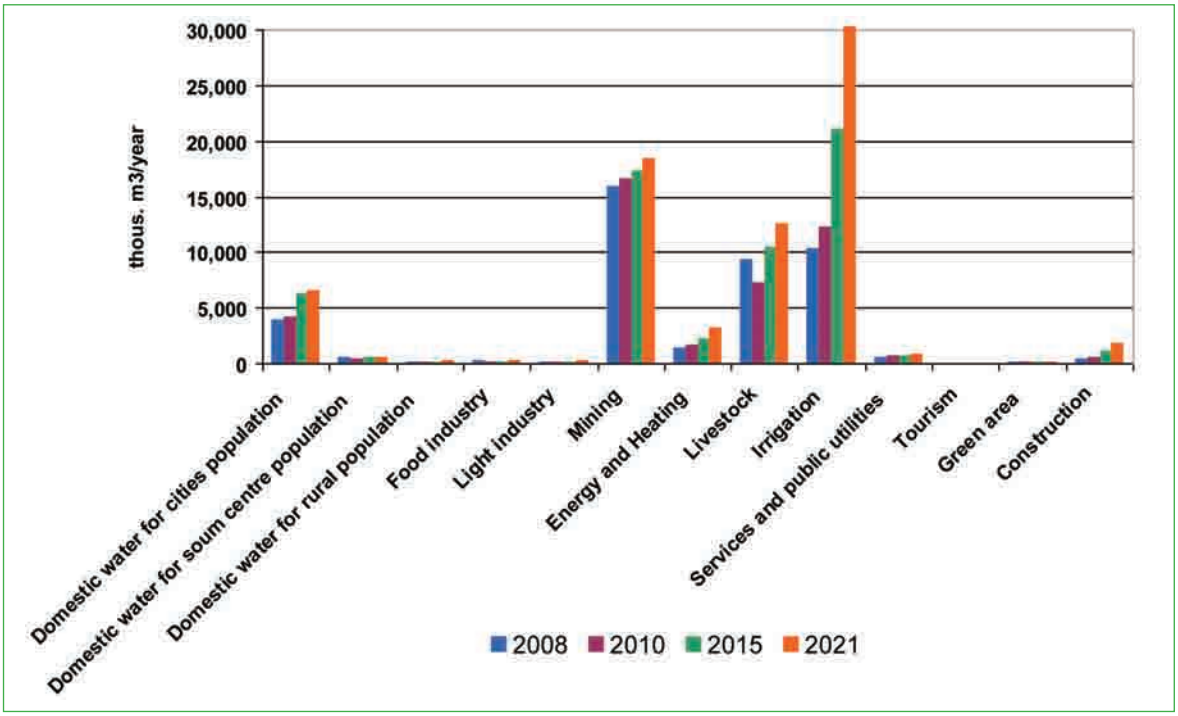


Figure 89. Total water consumption-use and water demand of the sectors in the Orkhon River Basin

Recently, a feasibility study was started under a WorldBank program for implementing the Orkhon-Gobi project for the purpose of transferring Orkhon River water to the South Gobi. Flood water will be collected in a reservoir and diverted. A decision on implementation will be made after completion of the feasibility study.

5. WATER USE BALANCE OF THE ORKHON RIVER BASIN

The **Orkhon River** is the longest river in Mongolia originating in the Suvraga Khairkhan Mountain of the Khangai Mountains and joining the Selenge River near Sukhbaatar city of Selenge aimag. The Orkhon River is the largest tributary of the Selenge River.

The upstream part of the Orkhon River is included in the Khangai Mountains national park. The Orkhon River Valley located in the river midstream part is included in the list of World Heritage sites according to the 28th Assembly of UNESCO which took place in 2004 as it comprises extraordinary and rare monuments that show how Central Asian nomadic civilizations evolved from generation to generation for 2000 years.

In calculating the Orkhon River Basin "water sector balance" or water use balance, the basin is divided into three parts. Water resources, water consumption, water use, water demand and the water use balance are calculated by aimag and soum in each part on an annual basis (Figure 90).

Upstream part: includes the river runoff-forming 17,634.1 km^2 watershed area that needs protection in soums of Arkhangai, Bayankhongor, Uvurkhangai and Uvurkhangai aimags;

Midstream part: includes the 23,592.5 km^2 watershed area in soums of Arkhangai, Uvurkhangai, Bulgan and Selenge aimags which boundaries are determined by considering socio-economic importance, development perspective, water consumption, water use, hydrological monitoring locations, etc;

Downstream part: includes the 12,560.3 km^2 watershed area in soums of Bulgan, Orkhon, Selenge and Tuv aimags which boundaries are determined by considering water consumption, water use, water pollution, flood risks, hydrological monitoring location, etc.

There is no large aimag or soum centre in the upstream part of the basin. Kharkhorin city of Uvurkhangai aimag, Tsetserleg city of Arkhangai aimag and Bulgan city of Bulgan aimag, the main centres of the Khangai region are located in the midstream part. Erdenet city and Sukhbaatar city of Selenge aimag, which are also main centres of Khangai region, are included in the downstream part.

The basin includes the territories of 53 soum of 8 aimags: Arkhangai, Bayankhongor, Bulgan, Darkhan-Uul, Orkhon, Uvurkhangai, Selenge and Tuv. Many soum territories are located partly only in the upstream, midstream or downstream parts. The water use balance calculation does not include soum territories which area inside the basin is less than 5.6% (Table 96).

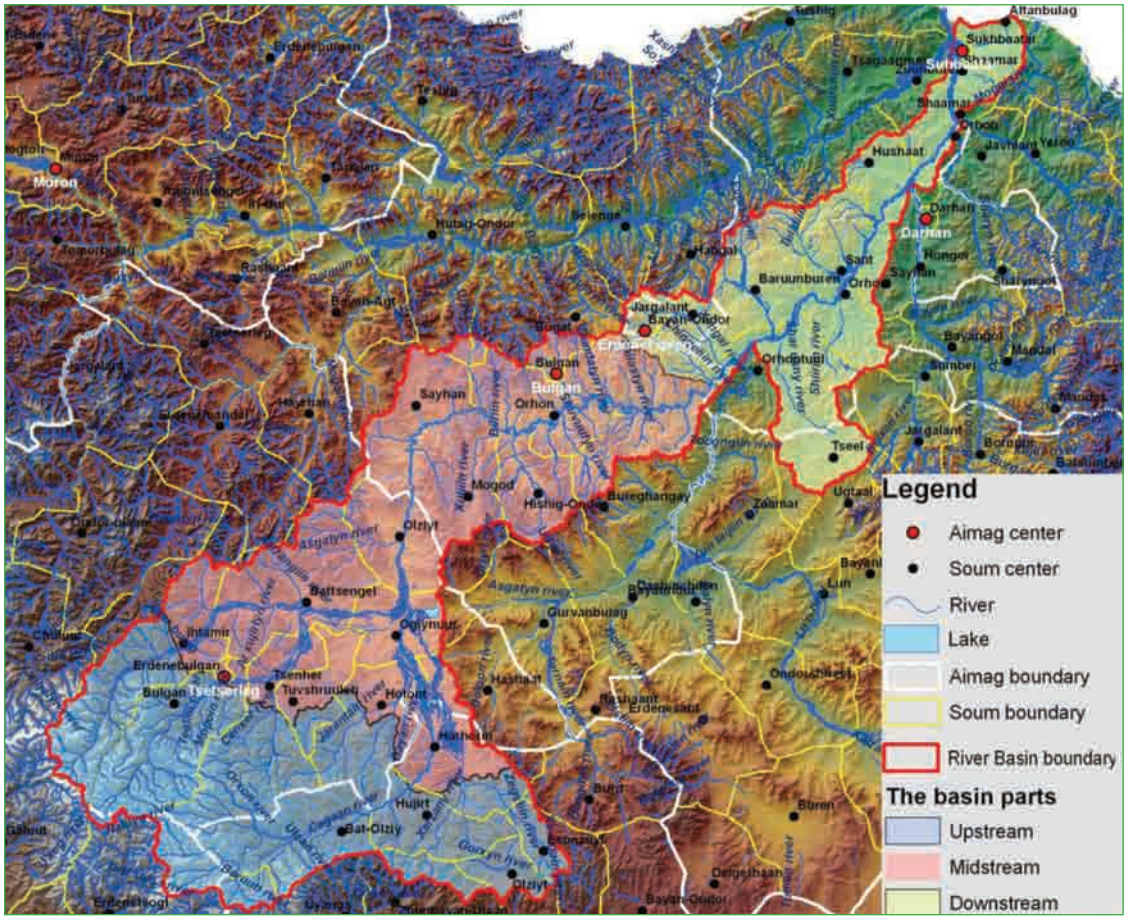


Figure 90. Orkhon River Basin water use balance parts

Table 96. The Orkhon River Basin water use balance parts and its area

The basin parts	Aimag	№	Soum	Soum or district area in the basin part (km²)	Percentage of area inside the basin part (%)
Upstream part	Arkhangai	1	Chuluut*	6.87	0.20
		2	Ikhtamir***	2,440.64	50.08
		3	Bulgan*** SC	3,089.74	95.99
		4	Tsenkher***	2,352.45	74.75
		5	Tuvshruulekh***	312.95	26.40
		6	Khotont	1,424.82	60.81
	Bayankhongor	7	Galuut*	6.33	0.10
		8	Erdenetsogt	836.75	20.60
	Uvurkhangai	9	Uyanga	405.27	13.30
		10	Bat-Ulzii SC	2,579.14	99.70
		11	Zuunbayan-Ulaan	540.17	21.50
		12	Khurjirt SC	1,661.41	100.00
		13	Ulziit SC	733.71	37.30
		14	Yesunzuil SC	566.74	28.90
		15	Burd*	24.37	0.90
		16	Kharkhorin***	652.70	28.36
Total of upstream part				17,634.06	

The basin parts	Aimag	№	Soum	Soum or district area in the basin part (km²)	Percentage of area inside the basin part (%)
Midstream part	Arkhangai	1	Undur-Ulaan	0.05	0.00
		2	Ikhtamir*** SC	1,151.18	23.62
		3	Erdenebulgan** *(Tsetserleg)*	62.68	100.00
		4	Bulgan*; ***	129.07	4.01
		5	Tsenkher*** SC	794.64	25.25
		6	Tuvshruulekh*** SC	872.46	73.60
		7	Khotont SC	918.25	39.19
		8	Khashaat	424.93	16.40
		9	Battsengel SC	3,378.52	96.00
		10	Ugiinuur SC	1,385.92	82.40
		11	Erdenemandal	0.45	0.01
		12	Khairkhan	72.85	2.90
		13	Ulziit SC	1,717.54	100.00
	Uvurkhangai	14	Kharkhorin*** SC	1,390.82	60.44
	Bulgan	15	Gurvanbulag*	0.06	0.00
		16	Mogod SC	2,199.26	78.00
		17	Khishig-Undur SC	1,476.71	60.60
		18	Saikhan SC	1,849.19	67.00
		19	Buregkhangai	1,468.35	42.10
		20	Orkhon*** SC	3,623.11	88.53
		21	Khutag-Undur	113.39	2.00
		22	Bulgan** *(Bulgan)*	88.76	100.00
		23	Bugat***	441.30	13.79
	Selenge	24	Orkhontuul*; ***	33.03	1.13
Total of midstream part				**23,592.52**	
Downstream part	Bulgan	1	Orkhon***	456.97	11.17
		2	Bugat	35.52	1.11
		3	Selenge*	18.60	0.40
		4	Khangal	91.87	5.60
	Orkhon	5	Bayan-Undur** *(Erdenet)*	562.94	99.20
		6	Jargalant SC	273.00	100.00
	Tuv	7	Zaamar*	1.90	0.10
		8	Ugtaaltsaidam*	1.68	0.10
		9	Tseel SC	1,002.75	61.10
		10	Jargalant*	7.36	0.40
		11	Sumber*	4.22	0.80
	Selenge	12	Orkhontuul***	1,968.69	67.07
		13	Baruunburen SC	2,334.34	83.20
		14	Orkhon SC	1,040.87	82.30
		15	Sant SC	1,337.48	99.00
		16	Saikhan	546.27	41.80
		17	Khushaat SC	856.88	42.80
		18	Shaamar SC	474.53	76.80
		19	Zuunburen	609.05	51.10
		20	Sukhbaatar** *(Sukhbaatar)* SC	46.47	99.10
		21	Altanbulag SC	674.59	27.70
	Darkhan-Uul	22	Orkhon	214.33	46.40
Total of downstream part				**12,560.31**	
Total				**53,786.89**	

Remarks: *1. * Soum that crosses the boundary of the basin and which is not included in the balance calculation because of the small area inside the basin;*
*2. ** Soums of aimag centre;*
*3. *** Soums which are divided into two parts;* *4. SC Soum centre;*
5. Soums divided by the boundaries of the upstream, midstream and downstream parts are shown in the same colour.

5.1. Water resources

5.1.1. Surface water resources

According to the state inventory carried out by the Water Authority in 2010, there were 1016 rivers with a permanent runoff, 112 river with a temporary runoff, 214 dried rivers and springs, 259 lakes and ponds, 1450 springs and streams and 45 hot and cold spas and springs in the Orkhon River Basin.

There are many tributaries in the upstream part: Uliastai River, Tsagaan Guut River, Tongorog River, Tsagaan River, Ulaan River, Urd River, Khoid /north/ Tamir River, Nariin River (Khugshin Orkhon), etc., which originate in the Khangai Mountains. Large rivers including Tuul River, Kharaa River, Eroo River and Shariin Gol River flow into the Orkhon River in its downstream part.

The water sources which form the Orkhon River runoff are 25% from groundwater, 10% from ice and snow and 60% from precipitation during summer and autumn. The Orkhon River is a river with a rain flood regime in summer. The volume of the spring flood is always less than the volume of the rain flood in summer and autumn.

The calculation of the 50% and 90% mean annual surface water resources runoff probabilities was made by S.Tumurchudur, hydrologist of the IWRM project, using the specific runoff map of the Orkhon River Basin (Figure 19, G.Davaa et al. IMH 2012) and observed river runoff in soums inside each part of the basin.

The resources represent the surface water generated within the aimag and soum respectively. This means that in soums (and aimags also) the total available surface water may include surface water generated in upstream areas which is not already used. However adding resources from upstream soums was not included in the water use balance.

The surface water resources derived from the specific runoff map correspond with the 50% probability runoff. The 90% probability runoff was calculated also based on a comparison with observed runoff.

The usable surface water resources in the upstream, midstream and downstream parts are calculated by subtracting the environmental flow from the mean runoff. According to the Surface Water in Mongolia Monograph (edited by G.Davaa and B.Myagmarjav in 1999), the environmental flow which should be reserved to maintain a healthy ecosystem balance is estimated at 94-96% of the runoff in the upstream part, 88-90% in the midstream part and 85-88% in the downstream part, respectively. Using the average of these percentages the environmental flow is expected to amount to 1063.1 million m^3/year in the upstream part, 831.6 million m^3/year in the midstream part and 228.7 million m^3/year in the downstream part according to the 50% probability annual mean surface resource runoff.

The calculation of the 50% probability mean annual surface water resources in the basin indicate a total amount of 2,345.0 million m^3/year and a usable amount of 221.6 million m^3/year. According to the 90% probability, the surface water resources amount to 1,063.0 million m^3/year and a usable amount of 99.7 million m^3/year (Table 98).

The territories of Tsetserleg city of Arkhangai aimag, Bulgan city of Bulgan aimag and Sukhbaatar city of Selenge aimag are less than 100 km^2. The surface water resources are not calculated here because it is difficult to calculate these for such small areas.

5.1.2. Groundwater resources

The Orkhon River Basin has many mountain ranges. These mountains are runoff forming areas recharging groundwater resources on hillsides and valley bottoms of the mountains and accumulating groundwater deposits in the low lying valleys of the Orkhon River and its tributaries. The groundwater is recharged by river water and precipitation during spring, summer and autumn.

The total renewable groundwater resources in the basin have been calculated at 1448 million m^3 per year (the project consultant N.Jadambaa and the project groundwater expert D.Batjargal, 2012). The renewable groundwater resources are 10-20 mm/year km^2 in Erdenebulgan, Bulgan, Ikhtamir, Tuvshruulekh soums of Arkhangai aimag and Bat-Ulzii soum centre of Uvurkhangai aimag; 5-10 mm/year km^2 in Tsenkher soum of Arkhangai aimag, Kharkhorin and Khujirt soums of Uvurkhangai aimag; 0-5 mm/year km^2 in Battsengel, Ugiinuur and Khotont soums of Arkhangai aimag, Orkhon, Mogod and Saikhan soums of Bulgan aimag, Baruunburen, Orkhon, Khushaat and Sant soums of Selenge aimag and Yesunzuil and Ulziit soums of Uvurkhangai aimag; and Khishig-Undur soum centre of Bulgan aimag, Ulziit soum centre of Arkhangai aimag, Bayan-Undur and 10-190 mm/year km^2 in Jargalant soum of Orkhon aimag, Bulgan soum of Bulgan aimag, Tseel soum of Tuv aimag, and Sukhbaatar, Altanbulag and Shaamar soums of Selenge aimag (Figure 54).

The potential exploitable groundwater resources are derived from the estimate of the renewable groundwater resources by taking into account the groundwater recharge, the groundwater storage volume and the abstraction rates of boreholes. According to the calculation of the potential exploitable groundwater resources at the basin level, it amounts to 838.1 million m^3/year (the project consultant N.Jadambaa and the project groundwater expert D.Batjargal, 2012) of which 142.1 million m^3/year in the upstream part, 448.0 million m^3/year in the midstream part and 248.0 million m^3/year in the downstream part, respectively (Table 98).

In order to determine the groundwater resources of central water supply sources, hydrogeological investigations were carried out since 1970's. According to these investigations, the groundwater resources of Tsetserleg city of Arkhangai aimag were determined at 2081.4 million m^3/year or 5702.4 m^3/day in the alluvial aquifer of the Taruugiin River – Urd Tamir River valley that is located 4 km to the south-west of the city, the groundwater resources of Bulgan city of Bulgan aimag were determined at 1791.2 million m^3/year or 4907.6 m^3/day in the Achuut River valley which flows through the city, the groundwater resources of Sukhbaatar city of Selenge aimag were determined at 6307.2 million m^3/year or 17280 m^3/day in the Orkhon River floodplain located to the south-west of the city, and the groundwater resources of Khutul city were determined at 2555.0 million m^3/year or 7000.0 m^3/day at Nelge located in the territory of Orkhon soum of Selenge aimag (the project consultant N.Jadambaa and the project groundwater expert D.Batjargal, 2012).

To solve the water supply for Erdenet city of Orkhon aimag, a hydrogeological investigation was carried out and the exploitable resources were determined in Orkhon soum of Bulgan aimag and Bayan-Undur soum of Orkhon aimag located near Erdenet city. But this resource was unable to completely supply the water demand of the city people and industries. Therefore, pipelines were constructed and water abstraction was started from a groundwater source at Akhai Gun in the Selenge River floodplain located 63 km to the north-east of the city (exploitable groundwater resource amounts to 247.5 thousand m^3/day).

The water supply for Saikhan soum of Selenge aimag or Khutul city is abstracted from the Nelge source with exploitable groundwater resource of 7,000 m^3/day located in the

territory of Orkhon soum of Selenge aimag, and the water supply for Orkhon soum (fruit and vegetables) of Darkhan-Uul aimag is abstracted from Enkhtal source with exploitable resource of 5.5 thousand m^3/day located 2-2.2 km from the Orkhon River. These cities are not included in the territory of the Orkhon River Basin.

The groundwater resources of 6 deposits (total exploitable resources amount to 40,821.9 m^3/day) which had undergone investigation are being used at the basin level. In addition groundwater resources (total exploitable resources amount to 38,668.1 m^3/day) were determined in 11 areas but these have not been put into operation as yet (Table 97).

Table 97. Exploitable groundwater resources in the basin

No	Aimag	Soum	Source	Exploitable resource, m^3/day	Source purpose of use
1	Arkhangai	Bulgan	Urd Tamir- Taruugiin River	5,702.4	*Used in Tsetserleg city water supply*
2	Arkhangai	Battsengel	Shivert	432.0	*Used in Shivert tourist camp water supply*
3	Bulgan	Bulgan	Maidariin River (Achuutiin River)	4,907.5	*Used in Bulgan city water supply*
4	Selenge	Zuunburen	Orkhon	17,280.0	*Used in Sukhbaatar city water supply*
5	Selenge	Khushaat	Orkhon /Enkhtal/	5,500.0	*Used in water supply of Orkhon soum of Darkhan-Uul aimag*
6	Selenge	Orkhon	Nelge	7,000.0	*Used in water supply of Khutul city or Saikhan soum centre of Selenge aimag*
Exploitable groundwater resources currently used				40,821.9	
1	Uvurkhangai	Kharkhorin	Orkhon	10,800.0	*Under construction for use in Kharkhorin city water supply*
2	Arkhangai	Bulgan	Urd Tamir River	10,545.3	*Used in Tsetserleg city water supply and but currently, flooded and not used.*
3	Arkhangai	Tuvshruulekh	Del bag /sub-soum/	910.87	*Used in crop water supply*
4	Bulgan	Bulgan	Maidariin River (Zuunturuun River)	4,907.5	*Resource determined for use in Bulgan city water supply*
5	Bulgan	Orkhon	Chingeliin River upstream part	2,073.6	*Hydrogeological investigation was carried out for use in Erdenet city water supply. But it was not enough to supply the water demand of the Erdenet city population and Erdenet mining factory. Therefore, these sources are needed to put into operation based on detailed calculation and study.*
6	Bulgan	Orkhon	Chingeliin River midstream part-1	1,028.16	
7	Bulgan	Orkhon	Chingeliin River midstream part-2	2,021.76	
8	Bulgan	Orkhon	Chingeliin River downstream part	2,073.6	
9	Orkhon	Bayan-Undur	Govil River valley	1,696.8	
10	Orkhon	Bayan-Undur	Erdenetiin River	2,109.5	
11	Selenge	Saikhan	Narstiin Khudag/ well	501.0	*Purpose of use is unclear*
12	Selenge	Altanbulag	Buur River	6,005.5	
Exploitable groundwater resources to be used				44,673.6	

There were no specific investigations carried out for water supplies of soum centres other than aimag centres inside the basin except for Khutul city and Orkhon soum centre of Darkhan-Uul aimag. But investigations for water points were carried out for drilling boreholes in soum centres and rural areas.

Of 25 soum centres included in the basin, 10 soum centres are located along the floodplain of the Orkhon River and its tributaries, and people in these soum centres consume both surface water and groundwater for their domestic and drinking purpose. As there is no river, spring and streams near 15 other soum centres, groundwater is consumed for domestic and drinking purpose with the support of 2-3 drilled boreholes (section 2.2.2).

Table 98 shows the calculated potential exploitable resource and exploitable resource in the upstream, midstream and downstream parts on an annual basis.

Table 98. Surface water and groundwater resources of the Orkhon River Basin

(thousand m^3/year)

Part of the basin	Aimag	№	Soum	Surface water						Groundwater	
				Surface water resource		Ecological resource		Possible usable resource		Potential exploitable resource	Exploitable resource
				Probability P=50%	Probability P=90%	Probability P=50%	Probability P=90%	Probability P=50%	Probability P=90%		
1	2	3	4	5	6	7	8	9	10	11	12
Upstream part	Arkhangai	1	Chuluut								
		2	Ihktamir	180,000.0	84,600.0	169,200.0	79,524.0	10,800.0	5,076.0	13,000.0	
		3	Bulgan SC	210,000.0	98,700.0	197,400.0	92,778.0	12,600.0	5,922.0	32,000.0	
		4	Tsenkher	180,000.0	84,600.0	169,200.0	79,524.0	10,800.0	5,076.0	20,000.0	
		5	Tuvshruulekh	30,000.0	14,100.0	28,200.0	13,254.0	1,800.0	846.0	3,000.0	
		6	Khotont	160,000.0	75,200.0	150,400.0	70,688.0	9,600.0	4,512.0	18,000.0	
	Bayan-khongor	7	Galuut								
		8	Erdenetsogt	40,000.0	18,800.0	37,600.0	17,672.0	2,400.0	1,128.0	,70.0	
	Uvurkhangai	9	Uyanga	20,000.0	9,400.0	18,800.0	8,836.0	1,200.0	564.0	1,000.0	
		10	Bat-Ulzii SC	160,000.0	75,200.0	150,400.0	70,688.0	9,600.0	4,512.0	8,000.0	
		11	Zuunbayan-Ulaan	21,000.0	9,870.0	19,740.0	9,277.8	1,260.0	592.2	4,000.0	
		12	Khujirt SC	80,000.0	37,600.0	75,200.0	35,344.0	4,800.0	2,256.0	26,000.0	
		13	Ulziit SC	20,000.0	9,400.0	18,800.0	8,836.0	1,200.0	564.0	3,000.0	
		14	Yesunzuil SC	10,000.0	4,700.0	9,400.0	4,418.0	600.0	282.0	6,000.0	
		15	Burd								
		16	Kharkhorin	20,000.0	9,400.0	18,800.0	8,836.0	1,200.0	564.0	8,000.0	
Total of the upstream part				**1,131,000.0**	**53,1570.0**	**1,063,140.0**	**499,675.8**	**67,860.0**	**31,894.2**	**142,070.0**	**0.0**
Midstream part	Arkhangai	1	Undur-Ulaan								
		2	Ikhtamir SC	60,000.0	25,200.0	52,800.0	22,176.0	7,200.0	3,024.0	22,000.0	
		3	Erdenebulgan *(Tsetserleg)*	-	-	-	-	-	-	8,000.0	2,081.4
		4	Bulgan							6,000.0	
		5	Tsenkher SC	45,000.0	18,900.0	39,600.0	16,632.0	5,400.0	2,268.0	24,000.0	
		6	Tuvshruulekh SC	45,000.0	18,900.0	39,600.0	16,632.0	5,400.0	2,268.0	19,000.0	
		7	Khotont SC	35,000.0	14,700.0	30,800.0	12,936.0	4,200.0	1,764.0	29,000.0	
		8	Khashaat	25,000.0	10,500.0	22,000.0	9,240.0	3,000.0	1,260.0	12,000.0	
		9	Battsengel SC	160,000.0	67,200.0	140,800.0	59,136.0	19,200.0	8,064.0	66,000.0	
		10	Ugiinuur SC	55,000.0	23,100.0	48,400.0	20,328.0	6,600.0	2,772.0	61,000.0	
		11	Erdenemandal								
		12	Khairkhan								
		13	Ulziit SC	55,000.0	23,100.0	48,400.0	20,328.0	6,600.0	2,772.0	34,000.0	
	Uvurkhangai	14	Kharkhorin SC	55,000.0	23,100.0	48,400.0	20,328.0	6,600.0	2,772.0	33,000.0	3,942.0

1	2	3	4	5	6	7	8	9	10	11	12
		15	Gurvanbulag								
		16	Mogod sc	75,000.0	31,500.0	66,000.0	27,720.0	9,000.0	3,780.0	18,000.0	
		17	Khishig-Undur sc	65,000.0	27,300.0	57,200.0	24,024.0	7,800.0	3,276.0	26,000.0	
		18	Saikhan sc	65,000.0	27,300.0	57,200.0	24,024.0	7,800.0	3,276.0	17,000.0	
	Bulgan	19	Buregkhangai	55,000.0	23,100.0	48,400.0	20,328.0	6,600.0	2,772.0	12,000.0	
		20	Orkhon sc	130,000.0	54,600.0	114,400.0	48,048.0	15,600.0	6,552.0	58,000.0	
		21	Khutag-Undur							2,000.0	
		22	Bulgan *(Bulgan)*	-	-	-	-	-	-	1,000.0	1,791.2
		23	Bugat	20,000.0	8,400.0	17,600.0	7,392.0	2,400.0	1,008.0	2,000.0	
	Selenge	24	Orkhontuul							400.0	
	Total of the midstream part			**945,000.0**	**396,900.0**	**831,600.0**	**349,272.0**	**113,400.0**	**47,628.0**	**448,000.0**	**7,814.6**

1	2	3	4	5	6	7	8	9	10	11	12
Downstream part		1	Orkhon	17,000.0	8,500.0	14,450.0	7,225.0	2,550.0	1,275.0	6,000.0	
	Bulgan	2	Bugat								
		3	Selenge								
		4	Khangal								
	Orkhon	5	Bayan-Undur *(Erdenet)*	18,000.0	9,000.0	15,300.0	7,650.0	2,700.0	1,350.0	9,000.0	Selenge, 90,337.5
		6	Jargalant sc	10,000.0	5,000.0	8,500.0	4,250.0	1,500.0	750.0	4,000.0	
	Tuv	7	Zaamar								
		8	Ugtaaltsaidam								
		9	Tseel sc	11,000.0	5,500.0	9,350.0	4,675.0	1,650.0	825.0	1,000.0	
		10	Jargalant								
		11	Sumber								
	Selenge	12	Orkhontuul	46,000.0	23,000.0	39,100.0	19,550.0	6,900.0	3,450.0	19,000.0	
		13	Baruunburen sc	60,000.0	30,000.0	51,000.0	25,500.0	9,000.0	4,500.0	22,000.0	
		14	Orkhon sc *	31,000.0	15,500.0	26,350.0	13,175.0	4,650.0	2,325.0	15,000.0	2,555.0
		15	Saikhan + sc	11,000.0	5,500.0	9,350.0	4,675.0	1,650.0	825.0	9,000.0	
		16	Sant sc	25,000.0	12,500.0	21,250.0	10,625.0	3,750.0	1,875.0	19,000.0	
		17	Shaamar sc	4,000.0	2,000.0	3,400.0	1,700.0	600.0	300.0	35,000.0	
		18	Zuunburen	4,000.0	2,000.0	3,400.0	1,700.0	,600.0	300.0	42 000.0	6 307.2
		19	Sukhbaatar sc *(Sukhbaatar)*	-	-	-	-	-	-	12 000.0	
		20	Altanbulag sc	20,000.0	10,000.0	17,000.0	8,500.0	3,000.0	1 500.0	25 000.0	
		21	Khushaat sc	10,000.0	5,000.0	8,500.0	4,250.0	1,500.0	750.0	20 000.0	2007.5
	Darkhan-uul	22	Orkhon + sc	2,000.0	1,000.0	1,700.0	850.0	300.0	150.0	10 000.0	
	Total of the downstream part			**269,000.0**	**134,500.0**	**228,650.0**	**114,325.0**	**40,350.0**	**20,175.0**	**248,000.0**	**10,869.7**
	Total			**2,345,000.0**	**1,062,970.0**	**2,123,390.0**	**963,272.8**	**221,610.0**	**99,697.2**	**838,070.0**	**18,684.3**

Remarks: 1. *Evaporation and infiltration loss included in surface water resources calculation.*
2. *sc Soum centre is located inside this part of the basin.*
3. * *The exploitable resources in the Selenge River floodplain used for the Erdenet city water supply are not included in the groundwater resources of the basin downstream part.*

5.2. The Orkhon River Basin water use balance

The water use balance of the basin is an important indicator to determine whether the basin water resources are sufficient to supply the existing water consumption-use and future water demand of population, industries and economic entities. The water use balance of the basin is calculated by soum for 2010 and by upstream, midstream and

downstream parts for 2015 and 2021.

The balance uses the annual water resources generated within the soum area. Use of water from upstream soums for surface water or from neighbouring soums for groundwater is not considered in the water balance unless water shortages exist. Also seasonal changes in resources and water use are not considered unless water shortages are expected.

The following water use balance indicators are used:

1). By comparing the potential exploitable groundwater use resources to the total groundwater consumption-use,

2). By comparing the exploitable groundwater use resources to the total groundwater consumption-use in supply of drinking water, domestic water, water for services and water for industries (light, food, heavy, energy, heat, construction, building material, road and transport),

3). By comparing the possible usable surface water resources generated within the area calculated by 50% probability to the total surface water consumption-use,

4). By comparing the possible usable surface water resources generated within the area calculated by 90% probability to the total surface water consumption-use,

5). Finally, by comparing the potential exploitable groundwater resources and the possible usable surface water resources (p=50%) generated within the area to the total water consumption-use.

Table 99 shows the water use balance calculation as of 2010 in the upstream, midstream and downstream parts of the basin by aimag and soum. Table 100 shows the 2015 and 2021 water use balances by aimag.

5.2.1. Water use balance of the basin upstream part

Almost one third of the Orkhon River Basin upstream part is located inside the Khangai Mountain Range National Park area (5995.7 km^2). Gold mining companies including Mongol Gazar LLC and Altan Dornod LLC and individuals mine gold in the territory of Orkhon bag of Tsenkher soum of Arkhangai aimag. However, natural resources in the upstream part are under protection and mining is prohibited in this part according to the relevant law and regulations. Consequently, the river water is significantly polluted.

Bulgan soum of Arkhangai aimag, Bat-Ulzii, Khujirt, Ulziit and Yesunzuil soum centres of Uvurkhangai aimag are included in the upstream part and there is no hydrogeological investigation or study carried out for water supply of these soums. There are enough resources in these soums according to the calculation of the 2010 water use balance for both the potential exploitable groundwater resources and the surface water resources (p=90%). The water resources in the upstream part are expected to be enough also in 2015 and 2021. But a critical issue remains the water pollution due to the gold mines.

5.2.2. Water use balance of the basin midstream part

Kharkhorin city of Uvurkhangai aimag and Bulgan city of Bulgan aimag are located near the Orkhon River and Tsetserleg city of Arkhangai aimag is located near the Urd Tamir River. But the river is not directly used for drinking, domestic and industrial purposes. The cities use groundwater for their water supply which has sufficient resources to supply the water demand now and in the future.

At Kharkhorin city the exploitable groundwater resources are determined at 3942.0 thousand m^3/year compared to the 2010 water consumption-use for people, services and industries of 33.1 thousand m^3/year. At Bulgan city the exploitable groundwater

resources are determined at 1791.2 thousand m^3/year compared to the 2010 water consumption-use for people, services and industries of 242.8 thousand m^3/year. At Tsetserleg city the exploitable groundwater resources are determined at 2081.4 thousand m^3/year compared to the 2010 water consumption-use for people, services and industries of 291.0 thousand m^3/year.

According to data and information, individuals and economic entities constructed a number of privately drilled boreholes in Tsetserleg, Bulgan and Kharkhorin cities. The water consumption-use from these boreholes is included in the calculated water consumption-use. The available groundwater resources are considered to be sufficient to cover this water consumption-use as well.

The surface water resource consumed for livestock watering and used for crop irrigation in 2010 in the midstream part was respectively, 1681.3 thousand m^3/year and 2678.6 thousand m^3/year. This is a relatively small volume compared to the volume of the surface water resources in this part.

There are no mines in this part of the basin. Gold mines in the territory of Buregkhangai soum of Bulgan aimag are located inside the Tuul River Basin.

5.2.3. Water use balance of the basin downstream part

The exploitable groundwater resources available to supply Sukhbaatar city of Selenge aimag which is located in the downstream part are determined at 6307.2 thousand m^3/year. The water resources are enough if compared to the total 2010 water consumption-use for people, services and industries of 826.7 thousand m^3/year.

Some hydrogeological investigations and studies were carried out nearby Erdenet City and the groundwater resources were determined as 7197.1 m^3/day or 2626.9 thousand m^3/year in four areas of the Chingel River floodplain located in the territory of Orkhon soum of Bulgan aimag; 1696.8 m^3/day or 619.3 thousand m^3/year in the Govil River valley located in the territory of Bayan-Undur soum of Orkhon aimag; and 2109.5 m^3/day or 770.0 thousand m^3/year in the Erdenet River valley. These water resources can't supply the total water consumption-use of Erdenet city therefore water will have to continue to be abstracted from the Selenge River floodplain.

Erdenet city of Orkhon aimag is supplied from groundwater resources with a capacity of 247.5 thousand m^3/day or 90337.5 thousand m^3/year located at Akhai Gun in the Selenge River floodplain, 63 km to the north-east of the city. The total water consumption-use by people, services, Erdenet mine, other industries and green areas is 20536.6 thousand m^3/year indicating that the water resources are expected to be enough in the future.

As of 2010, 991.3 thousand m^3/year water was consumed in irrigated areas in Jargalant soum of Orkhon aimag and 3661.5 thousand m^3/year in irrigated areas in Sant soum of Selenge aimag. Compared to the surface water resources generated within the soum with 90% probability, this shows a negative balance. And the surface water resources with 50% probability are barely enough. This indicates that water will have to be used generated in soums located upstream, which means for Jargalant from Bayan-Undur soum and for Sant soum from soums located upstream along the Orkhon River.

5.3. The basin water resource use model

The IWRM Water Balance Viewer (Figure 91) allows viewing the water consumption/use and demand, the water resources and the water balance by soum, aimag, or part of the river basin. The viewer presents the data in graphs and tables and on a geographical

map. Data is shown for the years 2008, 2010, 2015 and 2021 using three scenarios: High, Medium and Low. The data may be exported to Excel for further processing.

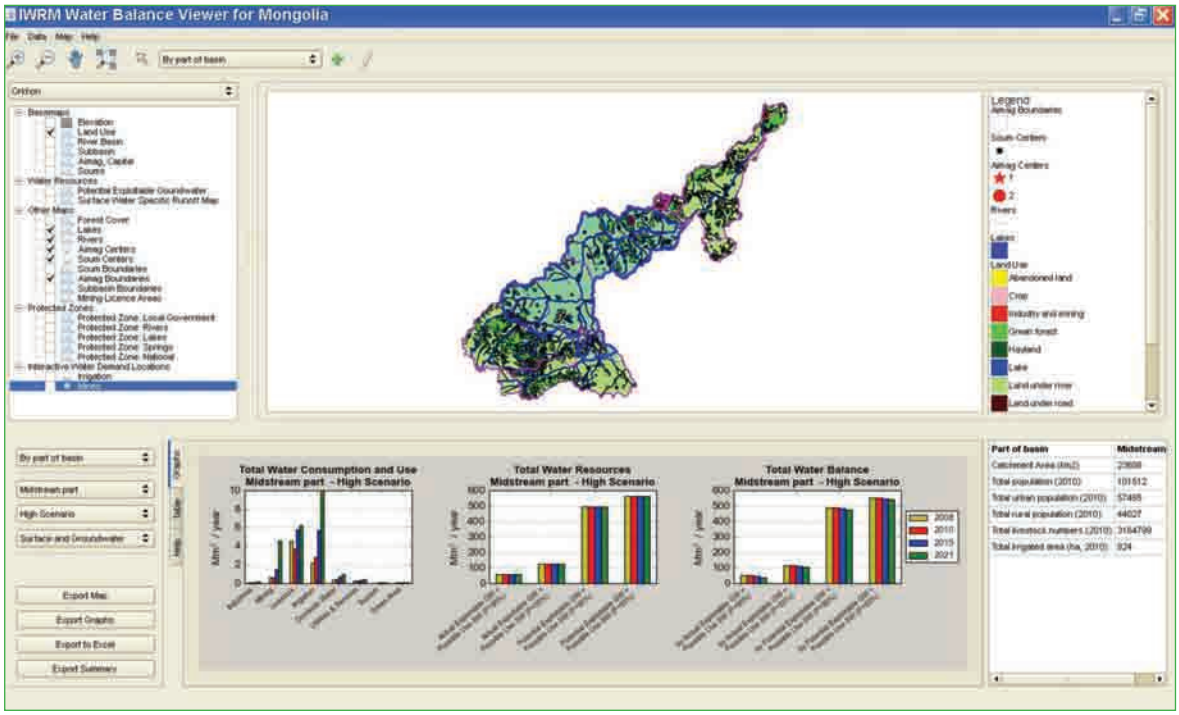


Figure 91. Appearance of the Orkhon River Basin water balance viewer

The viewer enables to have a look at graphics and quantitative indicators of the surface water and groundwater resources, water consumption, water use, water demand and water use balance of the basin by soum, aimag or basin part in both English and Mongolian.

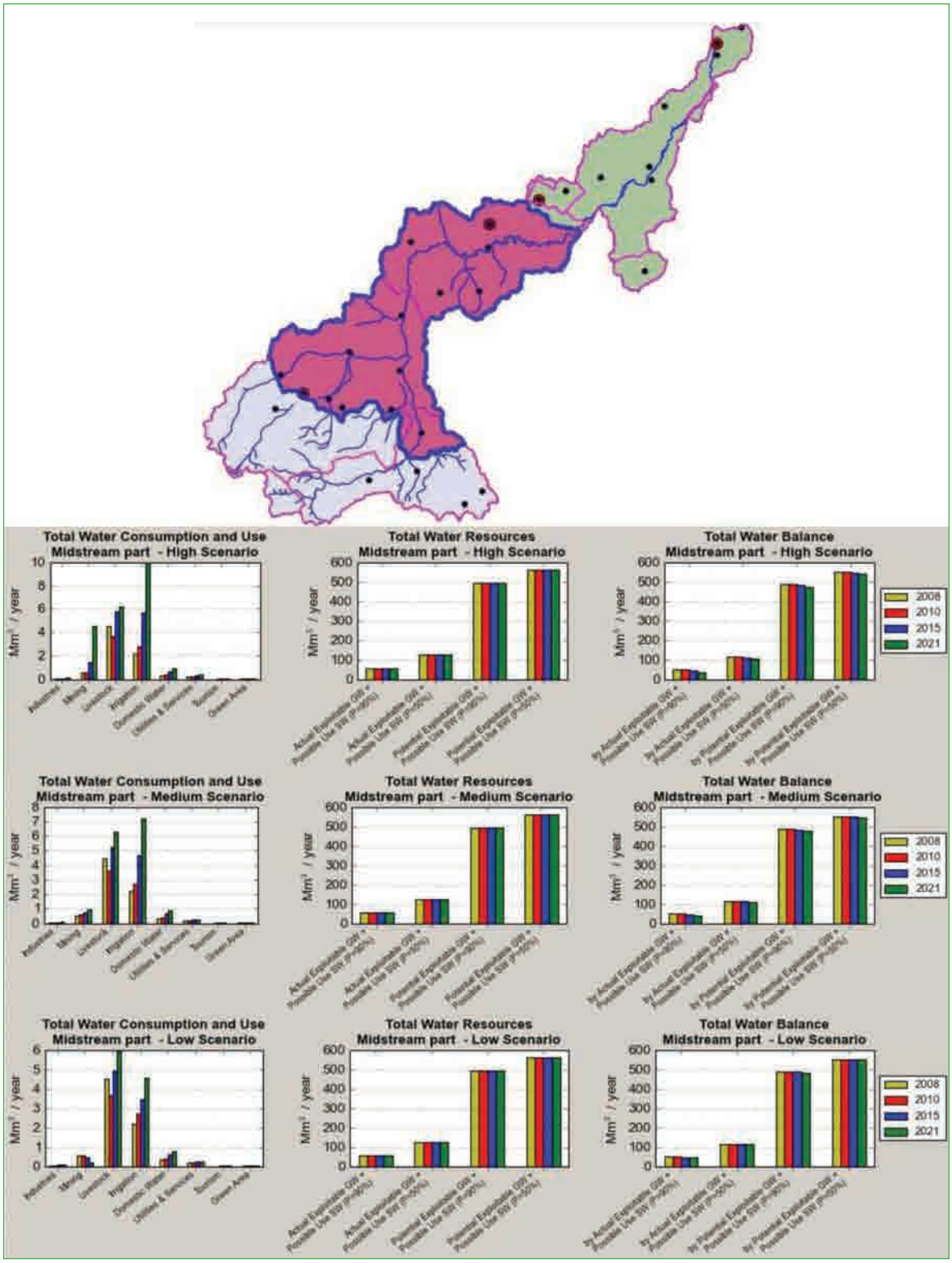


Figure 92. Example of output of the Orkhon River Basin water balance viewer

Table 99. The Orkhon River Basin water use balance as of 2010

Year of 2010 [thousand m3/year]

Parts of basin	Name of aimag	№	Name of soum	Catchment area (km2)	Catchment area percent of soum territory	Water resource: Surface water: Surface water resource P=50%	Surface water resource P=90%	Ecological resource P=50%	Ecological resource P=90%	Possible use of resource P=50%	Possible use of resource P=90%	Groundwater: Potential exploitable resource for use	Groundwater: Exploitable resource for use	Water consumption and use in 2010 (thousand m3/year): from Surface water: Drinking and domestic water for population: Urban settlement, town and aimag centre	Soum centre	Rural area	Total	Municipal service (hospital, school, offices) and commercial services	Industries: Food industry	Light industry	Energy	Construction and its material industry	Road and transport	Total	Mining (mine and processing)	Livestock (pastoral and farming)	Irrigated area	Tourism	Green area	Grand total	from Groundwater: Drinking and domestic water for population: Urban settlement, town and aimag centre	Soum centre	Rural area	Total	Municipal service (hospital, school, offices) and commercial services	Industries: Food industry	Light industries	Energy	Construction and its material industry	Road and transport	Total	Mining (mine and processing)	Livestock (pastoral and farming)	Irrigated area	Tourism	Green area	Grand total	Total water consumption and use	Balance difference: According to calculation of balance by potential exploitable groundwater resource	According to calculation of balance by exploitable groundwater resource and water use for drinking and industries	According to calculation of balance by surface water (50%)	According to calculation of balance by surface water (90%)	According to calculation of balance by surface (50%) and groundwater
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB
Calculation																																															AE+AV	M-AV	N-AI-AJ-AP	K-AE	L-AE	M+K-AW
Upstream part		1	Chuluut	6.87	0.2	-	-	-	-	-	-	-		-	-	-	-						-	-	-	-		-	-	-	-	-	-	-						-	-				-	-				
	Arkhangai	2	Ikhtamir	2,440.64	50.1	180,000	84,600	169,200	79,524	10,800	5,076	13,000		-	-	4.3	4.3						-	-	226.9		-	-	231.2	-	-	1.8	**1.8**							-	-		56.7		-	-	**58.6**	**290**	**12,941**	**-**	**10,569**	**4,845**	**23,510**
		3	Bulgan * SC	3,089.74	96.0	210,000	98,700	197,400	92,778	12,600	5,922	32,000		-	1.4	2.2	3.7						-	-	130.2		-	-	133.9	-	1.4	1.0	**2.4**							-	-		32.6		-	-	**34.9**	**169**	**31,965**	**-**	**12,466**	**5,788**	**44,431**
		4	Tsenkher	2,352.45	74.8	180,000	84,600	169,200	79,524	10,800	5,076	20,000		-	-	8.7	8.7						-	-	553.8	256.4	-	-	818.9	-	-	3.7	**3.7**							-	-		64.1		-	-	**67.8**	**887**	**19,932**	**-**	**9,981**	**4,257**	**29,913**
		5	Tuvshruulekh*	312.95	26.4	30,000	14,100	28,200	13,254	1,800	846	3,000		-	-	0.5	0.5						-	-	14.4		-	-	14.9	-	-	1.2	**1.2**							-	-		14.4		-	-	**15.6**	**31**	**2,984**	**-**	**1,785**	**831**	**4,769**
		6	Khotont	1,424.82	60.8	160,000	75,200	150,400	70,688	9,600	4,512	18,000		-	-	2.5	2.5						-	-	103.3		-	-	105.8	-	-	3.8	**3.8**							-	-		44.3		-	-	**48.0**	**154**	**17,952**	**-**	**9,494**	**4,406**	**27,446**
		7	Galuut	6.33	0.1	-	-	-	-	-	-	-		-	-	-	-						-	-	-		-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
	Bayankhongo	8	Erdenetsogt	836.75	20.6	40,000	18,800	37,600	17,672	2,400	1,128	70		-	-	1.4	1.4						-	-	50.2		-	-	51.6	-	-	0.6	**0.6**							-	-		21.5		-	-	**22.1**	**74**	**48**	**-**	**2,348**	**1,076**	**2,396**
		9	Uyanga	405.27	13.3	20,000	9,400	18,800	8,836	1,200	564	1,000		-	-	1.2	1.2						-	-	24.7		-	-	25.9	-	-	0.8	**0.8**							-	-		10.6		-	-	**11.4**	**37**	**989**	**-**	**1,174**	**538**	**2,163**
		10	Bat-Ulzii * SC	2,579.14	99.7	160,000	75,200	150,400	70,688	9,600	4,512	8,000		-	4.8	3.3	8.1						-	-	212.8	149.9	-	-	370.9	-	7.2	3.3	**10.5**							-	-		99.9		-	-	**110.4**	**481**	**7,890**	**-**	**9,229**	**4,141**	**17,119**
		11	Zuunbayan-Ulaan	540.17	21.5	21,000	9,870	19,740	9,278	1,260	592	4,000		-	-	0.8	0.8						-	-		17.0	-	-	17.8	-	-	1.2	**1.2**							-	-		11.3		-	-	**12.5**	**30**	**3,987**	**-**	**1,242**	**574**	**5,230**
	Uvurkhangai	12	Khujirt * SC	1,661.41	100.0	80,000	37,600	75,200	35,344	4,800	2,256	26,000		-	0.8	5.7	6.6						-	-		119.6	-	-	126.2	-	7.6	5.7	**13.3**							-	-		119.6		-	-	**132.9**	**259**	**25,867**	**-**	**4,674**	**2,130**	**30,541**
		13	Ulziit * SC	733.71	37.3	20,000	9,400	18,800	8,836	1,200	564	3,000		-	0.2	1.2	1.3						-	-		33.4	-	-	34.7	-	1.5	1.2	**2.6**							-	-		33.4		-	-	**36.0**	**71**	**2,964**	**-**	**1,165**	**529**	**4,129**
		14	Yusunzuil * SC	566.74	28.9	10,000	4,700	9,400	4,418	600	282	6,000		-	0.5	0.8	1.4						-	-		22.6	-	-	24.0	-	2.0	0.8	**2.9**							-	-		22.6		-	-	**25.5**	**49**	**5,975**	**-**	**576**	**258**	**6,551**
		15	Burd	24.37	0.9	-	-	-	-	-	-	-		-	-	-	-						-	-	-		-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
		16	Kharkhorin	652.70	28.4	20,000	9,400	18,800	8,836	1,200	564	8,000		-	-	1.3	1.3						-	-		46.8	-	-	48.0	-	-	1.9	**1.9**							-	-		46.8		-	-	**48.7**	**97**	**7,951**	**-**	**1,152**	**516**	**9,103**
	Total			17,634.06		1,131,000	531,570	1,063,140	499,676	67,860	31,894	142,070	-	-	7.7	34.0	41.7	-	#	#	#	-	-	-	766.6	1,195.4	-	-	2,003.7	-	19.6	27.1	**46.7**	-	-	-	-	-	-	-	-	-	577.8	-	-	-	**624.5**	**2,628**	**141,445**	**-**	**65,856**	**29,890**	**207,302**
Midsteam part		1	Undur-Ulaan	0.05	-	-	-	-	-	-	-	-		-	-	-	-						-	-	-	-	-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
	Arkhangai	2	Ikhtamir * SC	1,151.18	23.6	60,000	25,200	52,800	22,176	7,200	3,024	22,000		-	0.9	1.2	2.1						-	-		80.3	-	-	82.4	-	2.2	1.7	**3.9**							-	-		53.5		-	-	**57.4**	**140**	**21,943**	**-**	**7,118**	**2,942**	**29,060**
		3	Erdenebulgan *AC	62.68	100.0	-	-	-	-	-	-	8,000	2,081	13.9	-	-	13.9						-	-		141.1	-	-	155.0	125.4	-	-	**125.4**	130.6	1.1	0.0	20.0	0.0	-	**21.1**			8.6	**346.2**	**501**	**7,654**	**1,804**	**-**	**-**	**7,499**
		4	Bulgan	129.07	4.0	-	-	-	-	-	-	6,000		-	-	0.5	0.5						-	-		44.0	-	-	44.5	-	-	0.5	**0.5**							-	-		11.0		-	-	**11.5**	**56**	**5,988**	**-**	**-**	**-**	**5,944**
		5	Tsenkher * SC	794.64	25.3	45,000	18,900	39,600	16,632	5,400	2,268	24,000		-	0.3	0.4	0.6						-	-		10.7	-	-	11.4	-	2.5	0.2	**2.7**							-	-		2.7		-	-	**5.4**	**17**	**23,995**	**-**	**5,389**	**2,257**	**29,383**
		6	Tuvshruulekh * SC	872.46	73.6	45,000	18,900	39,600	16,632	5,400	2,268	19,000		-	0.3	0.5	0.8						-	-		40.2	-	-	41.0	-	2.9	4.2	**7.1**							-	-		40.2		-	-	**47.3**	**665**	**18,376**	**-**	**5,359**	**2,227**	**23,735**
		7	Khotont * SC	918.25	39.2	35,000	14,700	30,800	12,936	4,200	1,764	29,000		-	0.5	1.6	2.1						-	-		47.5	352.9	-	402.5	-	1.8	2.4	**4.3**							-	-		47.5	-	-	-	**51.8**	**454**	**28,948**	**-**	**3,797**	**1,361**	**32,746**
		8	Khashaat	424.93	16.4	25,000	10,500	22,000	9,240	3,000	1,260	12,000		-	-	0.4	0.4						-	-		29.6	-	-	30.1	-	-	0.6	**0.6**							-	-		44.5		-	-	**45.1**	**75**	**11,955**	**-**	**2,970**	**1,230**	**14,925**
		9	Battsengel * SC	3,378.52	96.0	160,000	67,200	140,800	59,136	19,200	8,064	66,000		-	0.6	3.1	3.8						-	-		287.7	393.4	-	684.8	-	2.5	4.7	**7.2**							-	-		191.8	-	-	-	**199.0**	**884**	**65,801**	**-**	**18,515**	**7,379**	**84,316**
		10	Ugiinuur * SC	1,385.92	82.4	55,000	23,100	48,400	20,328	6,600	2,772	61,000		-	0.4	2.9	3.2						-	-		161.7	-	-	164.9	-	1.5	2.9	**4.3**							-	-		107.8		-	-	**112.1**	**277**	**60,888**	**-**	**6,435**	**2,607**	**67,323**
		11	Erdenemandal	0.45	0.0	-	-	-	-	-	-	-		-	-	-	-						-	-		-	-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
		12	Khairkhan	72.85	2.9	-	-	-	-	-	-	-		-	-	-	-						-	-		-	-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
	Uvurkhangai	13	Ulziit * SC	1,717.54	100.0	55,000	23,100	48,400	20,328	6,600	2,772	34,000		-	0.2	2.6	2.8						-	-		165.2		-	168.1	-	2.1	3.9	**6.0**							-	-		165.2		-	-	**171.2**	**339**	**33,829**	**-**	**6,432**	**2,604**	**40,261**
		14	Kharkhorin * SC	1,390.82	60.4	55,000	23,100	48,400	20,328	6,600	2,772	33,000	3,942	5.3	-	2.7	8.0						-	-		99.7	1,562.0	-	1,669.6	21.1	-	4.0	**25.1**							-	-		99.7	-	10.9	-	**135.7**	**1,805**	**32,864**	**3,917**	**4,930**	**1,102**	**37,795**
		15	Gurvanbulag	0.06	-	-	-	-	-	-	-	-		-	-	-	-						-	-		-	-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
	Bulgan	16	Mogod * SC	2,199.26	78.0	75,000	31,500	66,000	27,720	9,000	3,780	18,000		-	0.2	1.8	2.0						-	-		178.0		-	180.0	-	1.5	2.7	**4.2**							-	-		178.0		-	-	**182.3**	**362**	**17,818**	**-**	**8,820**	**3,600**	**26,638**
		17	Khishig-Undur * SC	1,476.71	60.6	65,000	27,300	57,200	24,024	7,800	3,276	26,000		-	0.7	1.5	2.2						-	-		99.7		-	102.0	-	2.9	1.5	**4.4**							-	-		99.7		-	-	**104.2**	**206**	**25,896**	**-**	**7,698**	**3,174**	**33,594**
		18	Saikhan * SC	1,849.19	67.0	65,000	27,300	57,200	24,024	7,800	3,276	17,000		-	0.4	1.5	1.8						-	-		161.3		-	163.2	-	3.2	3.4	**6.6**							-	-		242.0		-	-	**248.6**	**412**	**16,751**	**-**	**7,637**	**3,113**	**24,388**
		19	Buregkhangai	1,468.35	42.1	55,000	23,100	48,400	20,328	6,600	2,772	12,000		-	-	0.9	0.9						-	-		82.8		-	83.7	-	-	0.9	**0.9**							-	-		82.8		-	-	**83.7**	**167**	**11,916**	**-**	**6,516**	**2,688**	**18,433**
		20	Orkhon * SC	3,623.11	88.5	130,000	54,600	114,400	48,048	15,600	6,552	58,000		-	0.6	2.5	3.1						-	-		214.2	370.3	-	587.6	-	2.2	2.5	**4.8**							-	-		214.2	-	-	-	**219.0**	**807**	**57,781**	**-**	**15,012**	**5,964**	**72,793**
		21	Khutag-Undur	113.39	2.0	-	-	-	-	-	-	-		-	-	-	-						-	-		-	57.9	-	57.9	-	-	-	**-**							-	-		-		-	-	**-**	**58**	**-**	**-**	**-**	**-**	**-**
		22	Bulgan * AC	88.76	100.0	-	-	-	-	-	-	1,000	3,582	13.6	-	0.7	14.2						-	-		59.4		-	73.7	122.1	-	1.6	**123.7**	76.8	3.7	0.0	24.3	-	**28.1**			13.4	**301.3**	**375**	**699**	**3,354**	**-**	**-**	**625**
		23	Bugat	441.30	13.8	20,000	8,400	17,600	7,392	2,400	1,008	2,000		-	-	0.3	0.3						-	-		23.3		-	23.6	-	-	0.4	**0.4**							-	-		23.3		-	-	**23.8**	**47**	**1,976**	**-**	**2,376**	**984**	**4,353**
	Selenge	24	Orkhontuul	33.03	1.1	-	-	-	-	-	-	-		-	-	0.0	0.0						-	-		2.1		-	2.1	-	-	0.0	**0.0**							-	-		2.1		-	-	**2.1**	**4**					
	Total			23,592.52		945,000	396,900	831,600	349,272	113,400	47,628	448,000	9,606	32.8	5.0	25.2	62.9	-	#	#	#	-	-	-	1,928.6	2,736.4	-	-	4,728.0	268.6	25.3	38.5	**332.3**	207.4	4.8	0.0	44.3	0.0	-	**49.2**	576.7	1,726.0	-	10.9	22.0	**2,924.5**	**7,652**	**445,078**	**9,075**	**109,005**	**43,233**	**553,810**
Downstream part		1	Orkhon	456.97	11.2	17,000	8,500	14,450	7,225	2,550	1,275	6,000		-	-	0.2	0.2						-	-		21.6	-	-	21.8	-	-	0.4	**0.4**							-	-		32.4		-	-	**32.9**	**55**	**5,967**	**-**	**2,528**	**1,253**	**8,495**
	Bulgan	2	Bugat	35.52	1.1	-	-	-	-	-	-	-		-	-	-	-						-	-		-	-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
		3	Selenge	18.60	0.4	-	-	-	-	-	-	-		-	-	-	-						-	-		-	-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
		4	Khangal	91.87	5.6	-	-	-	-	-	-	-		-	-	0.1	0.1						-	-		4.2	-	-	4.3	-	-	0.1	**0.1**							-	-		16.7		-	-	**16.8**	**21**	**-**	**-**	**-**	**-**	**-**
	Orkhon	5	Bayan-Undur *AC	562.94	99.2	18,000	9,000	15,300	7,650	2,700	1,350	9,000	94,354	-	-	-	-						-	-		58.6		-	58.6	3,496.4	-	-	**3,496.4**	231.4	20.0	136.4	1,500.0	22.2	-	**1,678.5**	15,118.0	234.3		-	113.6	**20,872.3**	**20,931**	**-11,872**	**88,947**	**2,641**	**1,291**	**-9,231**
		6	Jargalant * SC	273.00	100.0	10,000	5,000	8,500	4,250	1,500	750	4,000		-	-	0.5	0.5						-	-		40.0	991.3	-	1,031.8	-	3.2	4.8	**8.0**							-	-		93.4	-	-	-	**101.4**	**1,133**	**3,899**	**-**	**468**	**-282**	**4,367**
	Tuv	7	Zaamar	1.90	0.1	-	-	-	-	-	-	-		-	-	-	-						-	-		-	-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
		8	Ugtaaltsaidam	1.68	0.1	-	-	-	-	-	-	-		-	-	-	-						-	-		-	-	-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
		9	Tseel * SC	1,002.75	61.1	11,000	5,500	9,350	4,675	1,650	825	1,000		-	-	0.7	0.7						-	-		29.8		-	30.5	-	1.8	2.8	**4.6**							-	-		119.1		-	-	**123.8**	**154**	**876**	**-**	**1,620**	**795**	**2,496**
		10	Jargalant	7.36	0.4	-	-	-	-	-	-	-		-	-	-	-						-	-		-		-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
		11	Sumber	4.22	0.8	-	-	-	-	-	-	-		-	-	-	-						-	-		-		-	-	-	-	-	-							-	-		-		-	-	-	-	-	-	-	-
	Selenge	12	Orkhontuu	1,968.69	67.1	46,000	23,000	39,100	19,550	6,900	3,450	19,000		-	-	1.9	1.9						-	-		98.9	1,337.5	-	1,438.3	-	-	2.9	**2.9**							-	-		148.3	-	-	-	**230.2**	**1,669**	**18,770**	**-**	**5,462**	**2,012**	**24,231**
		13	Baruunburen * SC	2,334.34	83.2	60,000	30,000	51,000	25,500	9,000	4,500	22,000		-	0.7	1.8	2.6						-	-		115.3	1,773.2	-	1,891.1	-	3.0	2.7	**5.7**							-	-		172.9	-	-	-	**178.7**	**2,070**	**21,821**	**-**	**7,109**	**2,609**	**28,930**
		14	Orkhon * SC	1,040.87	82.3	31,000	15,500	26,350	13,175	4,650	2,325	15,000		-	0.9	1.2	2.1						-	-		48.2	289.3	-	339.6	-	2.1	1.9	**3.9**							-	-		112.5	-	-	-	**116.4**	**456**	**14,884**	**-**	**4,310**	**1,985**	**19,194**
		15	Sant * SC	1,337.48	99.0	25,000	12,500	21,250	10,625	3,750	1,875	19,000		-	1.4	0.9	2.3						-	-		73.1	3,661.5	-	3,736.9	-	3.2	0.9	**4.2**							-	-		73.1	-	-	-	**77.3**	**3,814**	**18,923**	**-**	**13**	**-1,862**	**18,936**
		16	Saikhan	546.27	41.8	11,000	5,500	9,350	4,675	1,650	825	9,000	2,555	-	-	0.9	0.9						-	-		24.9		-	25.8	-	348.6	2.0	**350.6**						476.2	-	**476.2**		58.2		-	-	**885.0**	**911**	**8,115**	**1,728**	**1,624**	**799**	**9,739**
		17	Khushaat * SC	856.88	42.8	10,000	5,000	8,500	4,250	1,500	750	20,000		-	0.6	0.4	0.9						-	-		13.3		-	14.3	-	2.3	0.8	**3.2**							-	-		31.1		-	-	**34.2**	**48**	**19,966**	**-**	**1,486**	**736**	**21,452**
		18	Shaamar * SC	474.53	76.8	4,000	2,000	3,400	1,700	600	300	35,000		-	2.2	0.1	2.3						-	-		19.7		-	22.0	-	8.9	0.2	**9.2**							-	-		29.5		-	-	**38.6**	**61**	**34,961**	**-**	**578**	**278**	**35,539**
		19	Zuunburen	609.05	51.1	4,000	2,000	3,400	1,700	600	300	42,000		-	-	0.3	0.3						-	-		15.9		-	16.2	-	-	1.1	**1.1**							-	-		63.5		-	-	**64.6**	**81**	**41,935**	**-**	**584**	**284**	**42,519**
		20	Sukhbaatar *AC	46.47	99.1	-	-	-	-	-	-	12,000	6,307	36.6	-	0.1	36.7						-	-		15.4		-	52.1	329.1	-	0.3	**329.3**	195.6	102.3	-	160.0		**262.3**			15.0	**838.1**	**890**	**11,162**	**5,520**	**-**	**-**	**11,110**
		21	Altanbulag * SC	674.59	27.7	20,000	10,000	17,000	8,500	3,000	1,500	25,000	2,192	-	-	0.3	0.3						-	-		6.9	1,470.0	-	1,477.3	-	11.9	0.7	**12.6**							-	-		27.8	-	-	-	**40.4**	**1,518**	**24,960**	**2,179**	**1,523**	**23**	**26,482**
	Darkhan-Uul	22	Orkhon	214.33	46.4	2,000	1,000	1,700	850	300	150	10,000	2,008	-	3.1	0.4	3.5						-	-		24.8		-	28.3	-	28.2	0.6	**28.7**							-	-		24.8		-	-	**53.5**	**82**	**9,946**	**1,979**	**272**	**122**	**10,218**
	Total			12,560.31		269,000	134,500	228,650	114,325	40,350	20,175	248,000	######	36.6	9.0	9.9	55.4	-	#	#	#	-	-	-	610.6	9,522.8	-	-	10,188.7	3,825.5	413.3	22.3	**4,261.1**	427.0	122.2	136.4	1,660.0	498.4	-	**2,417.0**	15,197.1	1,273.5	-	-	128.6	**23,704.2**	**33,893**	**224,313**	**100,353**	**30,218**	**10,043**	**254,478**
Grand total				**53,786.89**		**2,345,000**	**1,062,970**	**2,123,390**	**963,273**	**221,610**	**99,697**	**838,070**	######	**69.3**	**21.7**	**69.0**	**160.0**	**-**	**#**	**#**	**#**	**-**	**-**	**-**	**766.6**	**3,734.6**	**12,259.2**	**-**	**-**	**16,920.5**	**4,094.1**	**458.2**	**87.8**	**4,640.1**	**634.4**	**127.0**	**136.4**	**1,704.3**	**498.4**	**-**	**2,466.1**	**15,773.8**	**3,577.3**	**-**	**10.9**	**150.6**	**27,253.2**	**44,174**	**810,836**	**109,428**	**205,079**	**83,166**	**1,015,590**

Remarks: ** The groundwater resource of Akhai Gun groundwater deposit (water resource is 247.5 thousand m^3/day or 90337.5 thousand m^3/year) in the Selenge River floodplain is used as Erdenet city water supply source.*

*** Nelge groundwater source (water resource is 7.0 thousand m^3/day or 2555.0 thousand m^3/year) located in the territory of Orkhon soum of Selenge aimag is used for water supply of Khutul city of Saikhan soum of Selenge aimag.*

Table 100. The Orkhon River Basin water use balance as of 2010, 2015 and 2021

[million m3/year]

Part of basin	Year	Water resources				Water consumption and use																			Balance difference				
							Surface water									Groundwater													
		Possible surface water resource for use (P=50%)	Possible surface water resource for use (P=90%)	Potential exploitable groundwater resource for use	Exploitable groundwater resource for use	Scenarios	Drinking and domestic water for population	Municipal service (hospital, school, office and commercial service)	Industry, energy, construction, road and transport	Mining (mine and processing)	Livestock (pastoral and farming)	Irrigated area	Tourism	Green area	Total	Drinking and domestic water for population	Municipal service (hospital, school, office and commercial service)	Industry, construction, road and transport	Energy (thermopower plants only)	Mining (mine and processing)	Livestock (pastoral and farming)	Irrigated area	Tourism	Green area	Total	Total consumption and use	According to calculation of balance by potential exploitable groundwater resource	According to calculation of balance by exploitable groundwater resource and water use for drinking and industries	According to calculation of balance by surface water (50%)	According to calculation of balance by surface water (90%)	According to calculation of balance by surface (50%) and groundwater
A	B	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG
Calculation																										Q+AA	F-AA	G-R-S-T-U	D-Q	E-Q	AC+AE
Upstream part	2010	67.9	31.9	142.1	-		0.0	-	-	0.8	1.2	-	-	-	**2.0**	0.0	-	-	-	-	0.6	-	-	-	**0.6**	**2.6**	**141.4**	**-**	**65.9**	**29.9**	**207.3**
	2015	67.9	31.9	142.1	-	high	0.1	-	-	1.9	1.9	-	-	-	**3.8**	0.1	-	-	-	-	0.9	-	-	-	**1.0**	**4.8**	**141.1**	**-**	**64.0**	**28.0**	**205.1**
						mid	0.1	-	-	1.0	1.7	-	-	-	**2.8**	0.1	-	-	-	-	0.8	-	-	-	**0.9**	**3.7**	**141.2**	**-**	**65.1**	**29.1**	**206.3**
						low	0.1	-	-	0.6	1.7	-	-	-	**2.3**	0.1	-	-	-	-	0.8	-	-	-	**0.9**	**3.2**	**141.2**	**-**	**65.6**	**29.6**	**206.8**
	2021	67.9	31.9	142.1	-	high	0.1	-	-	5.8	2.1	-	-	-	**8.1**	0.1	-	-	-	-	1.0	-	-	-	**1.1**	**9.2**	**140.9**	**-**	**59.8**	**23.8**	**200.7**
						mid	0.1	-	-	1.2	2.2	-	-	-	**3.4**	0.1	-	-	-	-	1.0	-	-	-	**1.1**	**4.5**	**140.9**	**-**	**64.5**	**28.5**	**205.4**
						low	0.1	-	-	0.1	2.0	-	-	-	**2.2**	0.1	-	-	-	-	1.0	-	-	-	**1.1**	**3.3**	**141.0**	**-**	**65.6**	**29.7**	**206.6**
Midstream part	2010	113.4	47.6	448.0	9.6		0.1	-	-	-	1.9	2.7	-	-	**4.7**	0.3	0.2	0.0	0.0	0.6	1.7	-	0.0	0.0	**2.9**	**7.7**	**445.1**	**9.0**	**108.7**	**42.9**	**553.7**
	2015	113.4	47.6	448.0	9.6	high	0.1	-	-	-	3.1	5.6	-	-	**8.8**	0.6	0.3	0.0	0.1	1.4	2.7	-	0.0	0.0	**5.2**	**14.0**	**442.8**	**8.6**	**104.6**	**38.8**	**547.4**
						mid	0.1	-	-	-	2.8	4.7	-	-	**7.6**	0.6	0.2	0.0	0.1	0.8	2.5	-	0.0	0.0	**4.1**	**11.7**	**443.9**	**8.7**	**105.8**	**40.1**	**549.7**
						low	0.1	-	-	-	2.6	3.5	-	-	**6.2**	0.5	0.2	0.0	0.1	0.5	2.3	-	0.0	0.0	**3.7**	**9.8**	**444.3**	**8.8**	**107.2**	**41.5**	**551.6**
	2021	113.4	47.6	448.0	9.6	high	0.1	-	-	-	3.3	10.0	-	-	**13.4**	0.8	0.4	0.0	0.1	4.5	2.9	-	0.0	0.0	**8.8**	**22.2**	**439.2**	**8.3**	**100.0**	**34.2**	**539.2**
						mid	0.1	-	-	-	3.3	7.2	-	-	**10.7**	0.7	0.3	0.0	0.1	1.0	3.0	-	0.0	0.0	**5.1**	**15.7**	**442.9**	**8.5**	**102.7**	**37.0**	**545.7**
						low	0.1	-	-	-	3.1	4.6	-	-	**7.9**	0.7	0.2	0.0	0.1	0.2	2.8	-	0.0	0.0	**4.0**	**11.8**	**444.0**	**8.6**	**105.5**	**39.8**	**549.6**
Downstream part	2010	40.4	20.2	248.0	107.4		0.1	-	-	-	0.6	9.5	-	-	**10.2**	4.3	0.4	0.8	1.7	15.2	1.3	-	-	0.1	**23.7**	**33.9**	**224.3**	**100.3**	**30.2**	**10.0**	**254.5**
	2015	40.4	20.2	248.0	107.4	high	0.1	-	-	-	0.9	19.6	-	-	**20.6**	6.8	0.6	1.8	2.7	15.7	2.0	-	-	0.2	**29.7**	**50.4**	**218.3**	**95.6**	**19.7**	**-0.5**	**238.0**
						mid	0.1	-	-	-	0.8	16.4	-	-	**17.3**	6.2	0.5	1.4	2.2	15.6	1.8	-	-	0.1	**27.8**	**45.2**	**220.2**	**97.1**	**23.0**	**2.9**	**243.2**
						low	0.1	-	-	-	0.8	12.1	-	-	**12.9**	5.8	0.5	1.1	1.9	15.6	1.7	-	-	0.1	**26.6**	**39.6**	**221.4**	**98.2**	**27.4**	**7.2**	**248.8**
	2021	40.4	20.2	248.0	107.4	high	0.1	-	-	-	1.0	34.7	-	-	**35.8**	7.1	0.9	3.5	4.8	16.8	2.1	-	-	0.2	**35.4**	**71.3**	**212.6**	**91.1**	**4.5**	**-15.7**	**217.1**
						mid	0.1	-	-	-	1.0	25.2	-	-	**26.3**	6.4	0.6	2.3	3.2	16.2	2.1	-	-	0.2	**31.0**	**57.3**	**217.0**	**95.0**	**14.1**	**-6.1**	**231.1**
						low	0.1	-	-	-	1.0	16.0	-	-	**17.0**	5.9	0.5	1.5	2.2	16.1	2.0	-	-	0.1	**28.3**	**45.4**	**219.7**	**97.3**	**23.3**	**3.1**	**243.0**
Grand total	2010	221.6	99.7	838.1	117.0		0.2	-	-	0.8	3.7	12.3	-	-	**16.9**	4.6	0.6	0.8	1.7	15.8	3.6	-	0.0	0.2	**27.3**	**44.2**	**810.8**	**109.3**	**204.7**	**82.8**	**1,015.5**
	2015	221.6	99.7	838.1	117.0	high	0.2	-	-	1.9	5.9	25.2	-	-	**33.3**	7.4	0.8	1.8	2.8	17.1	5.6	-	0.0	0.2	**35.9**	**69.2**	**802.2**	**104.2**	**188.3**	**66.4**	**990.5**
						mid	0.2	-	-	1.0	5.3	21.1	-	-	**27.6**	6.8	0.7	1.4	2.3	16.4	5.1	-	0.0	0.2	**32.9**	**60.5**	**805.2**	**105.9**	**194.0**	**72.1**	**999.2**
						low	0.2	-	-	0.6	5.1	15.5	-	-	**21.4**	6.4	0.7	1.1	1.9	16.1	4.8	-	0.0	0.1	**31.1**	**52.6**	**806.9**	**106.9**	**200.2**	**78.3**	**1,007.1**
	2021	221.6	99.7	838.1	117.0	high	0.3	-	-	5.8	6.4	44.7	-	-	**57.3**	8.0	1.3	3.5	5.0	21.3	6.1	-	0.0	0.2	**45.4**	**102.7**	**792.7**	**99.4**	**164.3**	**42.4**	**957.0**
						mid	0.3	-	-	1.2	6.5	32.4	-	-	**40.3**	7.2	0.8	2.3	3.2	17.2	6.1	-	0.0	0.2	**37.2**	**77.5**	**800.9**	**103.5**	**181.3**	**59.4**	**982.2**
						low	0.3	-	-	0.1	6.2	20.6	-	-	**27.1**	6.7	0.7	1.5	2.2	16.3	5.8	-	0.0	0.1	**33.4**	**60.5**	**804.7**	**105.9**	**194.5**	**72.6**	**999.2**

5.4. Conclusion on water use balance of the Orkhon River Basin

- As of 2010, 44.2 million m^3/year water was used in the Orkhon River Basin.
- Of total water used in the basin, 38.3% is used from the surface water resources and 61.7% is used from the groundwater resources, respectively.
- Of the total water consumption-use in the basin in 2010, Erdenet city water supply comprised 47.4% and is the largest water user. The next large water user is irrigation which comprises 27.8% of the total water consumption-use. Only surface water is consumed in the irrigated areas.
- The 20.9 million m^3/year water used for the Erdenet city water supply is mainly abstracted from the Selenge River floodplain. The remaining water consumption in the Orkhon River basin of 23.3 million m^3/year water is supplied from the Orkhon River Basin.
- The total future water use in the basin in 2015 and 2021 varies according the growth scenarios between 52.2 million m^3/year and 68.8 million m^3/year for 2015 and between 60.2 million m^3/year and 102.4 million m^3/year for 2021. The Erdenet city water supply remains the largest water user in the basin.
- Generally the available total surface water and groundwater resources are much larger than the total water demand. In some soums (Jargalant soum of Orkhon aimag and Sant soum of Selenge aimag) the water generated inside the soum may not be sufficient to supply the demand from irrigation. However shortages do not exist because water generated in upstream soums can be used as this water is available from the Khangal River at Jargalant soum and from the Orkhon River at Sant soum.
- Within the framework of the project impacts by climate change on the surface water runoff in the Orkhon River Basin was tested using various models (PCRGLOB-WB, HBV). Precipitation is predicted to increase resulting in higher river runoff at the end of this century according to the outcomes of these models. The general conclusion is that temperatures will increase in winter by 4.5˚C and in summer by 6˚C (Jaap Kwadijk, 2011). The modelling results are however not conclusive as different global climate models give different outcomes. The effect of climate change on the water use balance in the Orkhon basin is expected to be negligible considering that the water resources are large compared to the water use.
- Hydrogeological investigations carried out in areas near Erdenet revealed groundwater resources for the city water supply but these resources were not enough to supply the water demand of Erdenet city. Therefore, water was abstracted from the Selenge River floodplain and pumped to Erdenet City using a 63 km pipeline. An economical analysis is proposed to study the possibility to put into operation the nearby groundwater resources to replace part of the supply from the Selenge River floodplain, to reduce costs and improve the water supply reliability.
- In 25 soums centres included in the basin an additional hydrogeological investigation is required to determine the related exploitable groundwater resources.

6. WATER RESOURCES ISSUES OF THE ORKHON RIVER BASIN

6.1. Natural impact

Orkhon river flow change: Dr. G.Adyabadam studied the Orkhon river water resources decrease in relation to climate change based on 1973-2007 weather data. Orkhon river water resources decreased by 0.07 km^3 a year on average at Orkhon-Orkhon soum station and 0.17 km^3 a year on average at Orkhon-Sukhbaatar station.

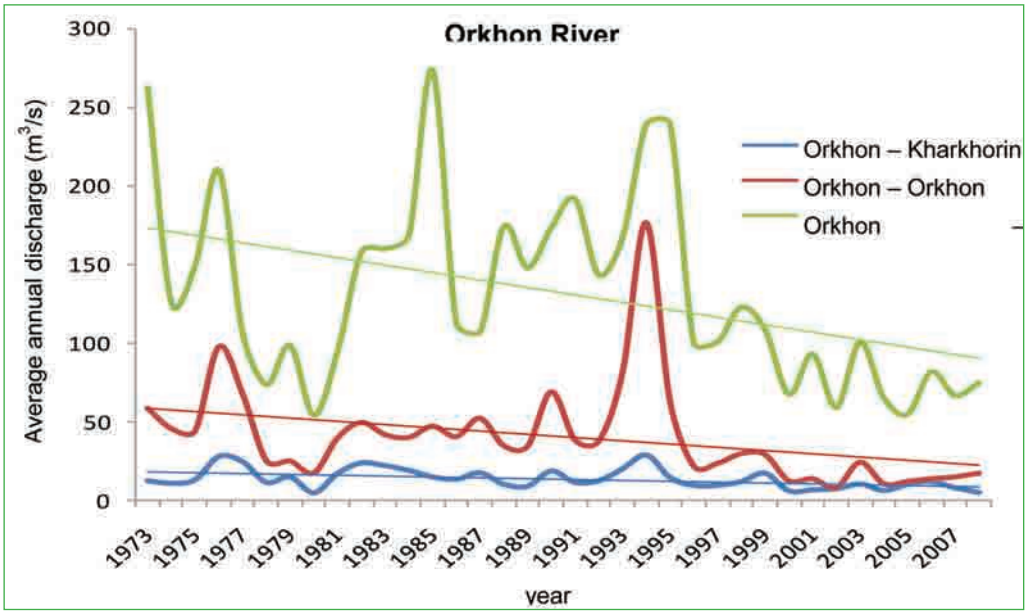


Figure 93. Orkhon river flow change

In the mountain areas where surface water is actively formed, the decrease is lower and it gets 10-20 times higher at the midstream and downstream part of the river (B.Myagmarjav, 2009). Within the framework of the project, 10 climate change models have been tested in the Orkhon river basin. According to the result, average monthly runoff of the river is predicted to be slightly increased in the years 2080-2100. According to the result of the ECHO climate model, average monthly runoff will be slightly decreased.

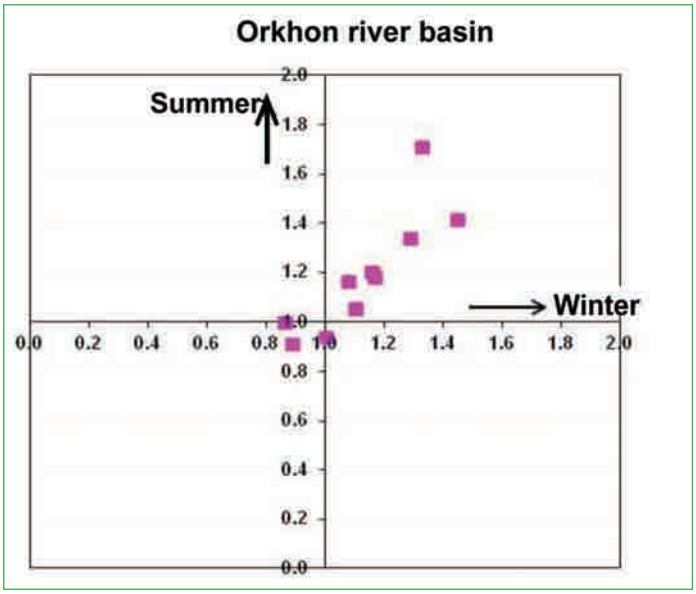


Figure 94. Flow change in Orkhon river basin, calculated by climate models

The basin runoff is expressed by the subtraction of precipitation and evaporation (P-E). There are many factors that impact evaporation. As for big scale, the Busarova formula can be used (Budagovski A.I. Busarova O.E., 1991). Between 1961 and 1990, 24.8 mm runoff used to form in the Orkhon river upstream part (according to Khujirt data). It was 16.6 mm between 1991 and 2008. According to this kind of calculation, runoff decreased by 30 percent in the Orkhon-Tuul river runoff forming areas. In order to determine change in Orkhon river multi-year average flow, average flow since mid-1990's was compared to multi-year average (1978-2008). The Orkhon River annual average runoff decreased by 30-50 percent for the last 15 years (Table 101).

Table 101. Orkhon river multi-year average flow change, m^3/sec

Date of observation and measurement	River part and station name			
	Upstream part	Mid stream part		Down stream part
	Kharkhorin	Orkhon soum	Orkhon bag	Sukhbaatar
1978-2008	12.7	36.7	71.3	122.0
1996-2008	8.7	17.5	33.6	84.4
Change: Increase (+), Decrease (-)	-4.0	-19.2	-37.7	-37.6

Air temperature and precipitation change: Warming is increasing in the Orkhon river basin due to global warming. For example: between 1940 and 2008, 0.043°C/year warming occurred at Baruunkharaa which has a climate station with long-observed data. Since 1990, warming increased to 0.047°C/year. This indicator increased since 2000. It reached 0.14°C/year between 1991 and 2008. The condition of land elevation and latitude impacts on heat resources. The heat resources accumulated during plant growth is increases due to the warming of the climate.

It will be comfortable for garden plants which require much heat, but the water quantity (evaporation) which evaporates from the land surface and water surface increases. It also increases water deficiency of rivers, lakes and reservoirs. According to the last 40 years' observation data of climate stations located in the Orkhon river basin, average annual temperature increased by 0.8-1.3°C. It became much warmer on elevated areas. Warming in winter months is low; it became colder in some way. The warming is increased in summer time. When defining river basin water balance element change,

the following things were used: 3rd assessment report (AR-4) on climate change issues of inter-Government experts' group; "SRES A1B" trend (scenario) of greenhouse gas emission calculated by British "Hadley" center climate model or future climate change results of 2020 (2011-2030), 2050 (2046-2065) and 2080 (2080-2099) after taking measure to decrease greenhouse gas, were used. According to the greenhouse emission scenario of A1B, river water September-October average temperature will be higher than that of 1980-1999 average in 2020, 2050 and 2080 as follows: 2.2°C, 2.8°C, 3.5°C at Arctic basin; 2.3°C, 3.0°C, 3.8°C at Pacific basin; 2.4°C, 3.1°C, 3.8°C at central Asian basin (which has no outflow), respectively. According to A1B scenario, evaporation is expected to be higher than 1980-1999 average in 2020, 2050 and 2080 as follows: 488 mm in 2020, 590 mm in 2050, 642 mm in 2080 at Arctic basin on average; 537, 625, 894 at Pacific basin on average; 310, 451, 482 at central Asian basin (which has no outflow), respectively. According to A1B scenario, river flow will be higher than 1980-1999 average in 2020, 2050, 2080 as follows: 4 mm in 2020, 8 mm in 2050, 13 mm in 2080 at Arctic basin on average; 5,8,9 at Pacific basin on average; 2,3,4 at central Asian basin (which has no outflow), respectively. This increasing flow will be lower than the increasing evaporation in 2020, 2050 and 2080 as follows: 138 mm, 77 mm, 48 mm lower at Arctic basin on average; 115 mm, 75mm, 101 mm at Pacific basin on average and 144 mm, 168 mm, 111 mm at central Asian basin (which has no outflow) on average, respectively. According to the greenhouse emission scenario of A1B, September-October average temperature of river water will be increased as follows in 2020, 2050 and 2080: 1.7-1.9°C in 2020 at Orkhon river basin or Arctic basin; 2.2-2.5°C in 2050 and 2.7-3.1°C in 2080. This model was based on global greenhouse emission scenario. So ecosystem degradation (pasture and land degradation, land damage caused by mining activities) caused by regions' natural condition and human activities is not calculated. But biophysics negative connection mechanism is occurred among climate system components (land, atmosphere, hydrosphere, troposphere, lithosphere) and it activates or weakens the change in the region's climate. For example: if plant cover is weakened, precipitation in the region is decreased and air temperature is increased. As for observation of temperature change distribution, it will get warmer in eastern parts of our country in winter, and in summer it will get warmer in western parts of the country. As for precipitation, it will increase in central and eastern parts in winter and in summer it will increase in eastern and south-eastern parts of the country. As for western parts, precipitation will be decreased by 10 percent by the end of this century.

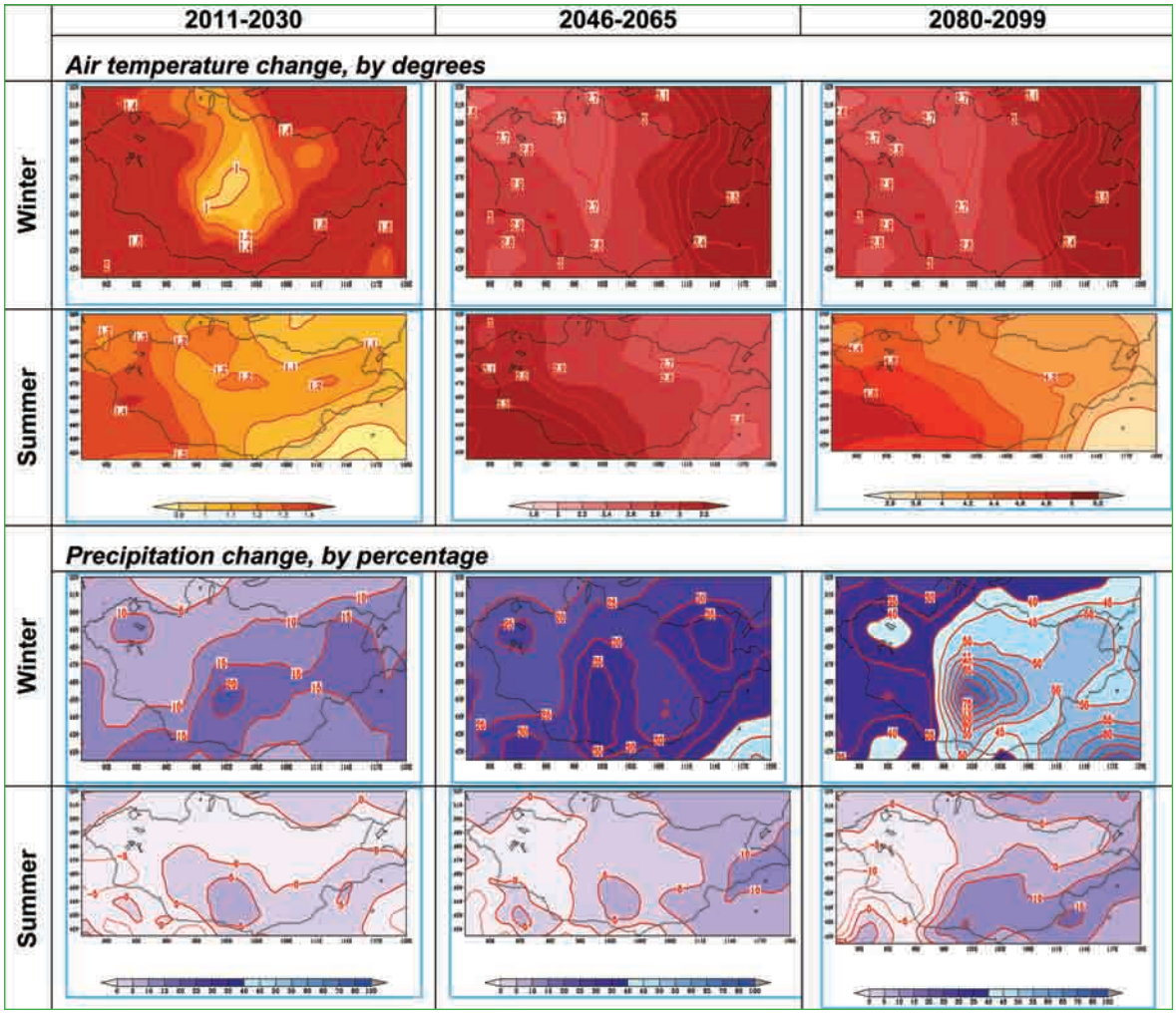


Figure 95. Average temperature of winter and summer and precipitation change

As for the Mongolian climate change trend, air temperature will be increased evenly throughout the entire territory; precipitation will be decreased much in western regions and it will be increased in Govi and desert areas.

Aridity: For the last 10 years, many rivers, ponds, springs and lakes have disappeared. River water flow is decreasing. As for Selenge river, 7 out of 10 years with the lowest flow within the last 60 years happened since 1996. Many factors have impacts off course. But there is a change in water balance due to climate change. The main reason of the aridity in Mongolia and basins is the increasing evaporation (Eo) caused by warming. It can not be replaced by precipitation. But precipitation is decreasing and there is deficiency of the vegetation water supply.

It is shown in Figure 96 by Baruunkharaa weather station data.

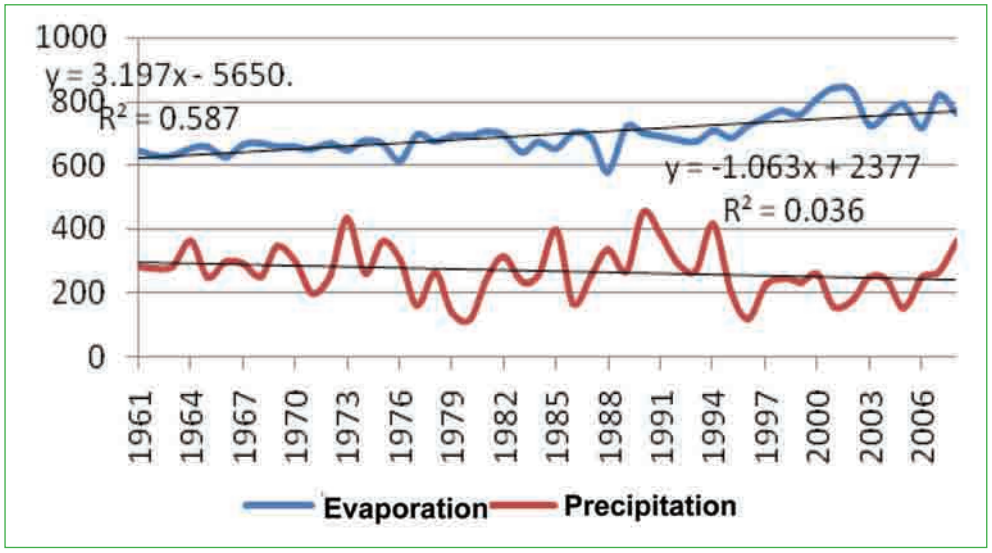


Figure 96. Surface evaporation and multi-year process of warm season precipitation (Baruunkharaa station).

According to the figure, surface evaporation increased by 153 mm between 1961 and 2008. Warm season precipitation decreased by 51 mm. The difference between evaporation and precipitation has intensified since 1990's. The indicator is (Eo-P). In the period 1991-2008 compared with the period 1961-1990 mean values decreased by 30-40 percent in the runoff forming area of Orkhon and Tuul river basins.

XXI century climate change assessment: Dr. L.Natsagdorj and Dr. P.Gomboluudev operated several models that are used in world practice in order to assess Mongolian climate perspectives.

According to the calculations, as for winter temperature, most models showed that each year's fluctuation is high. In general, fluctuation is no more than 6°C and it will increase until 2.6°C in 100 years on average. As for summer, fluctuation is low. The fluctuation is no more than 4.5°C and it will increase by 2.4°C. In winter, temperatures rise more than in summer. Each year's winter precipitation will be changed not more than 50 percent and it will increase by 23 percent in 100 years on average. Summer temperature will change not more than 20 percent and it will increase by 3 percent in 100 years on average.

Winter precipitation is likely increase more than that of summer. This growth will continue until 2070 and it will be stabilized after 2070. As for other elements, they will be increased gradually.

As for Mongolia, climate will be milder in winter and it will get hotter and drier in summer. However, precipitation will increase in summer with a small percentage comparing to the multi-year average. Aridity will increase.

Desertification: As defined by UNCCD "the desertification is the land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities". The researcher D.Dash concluded in his research papers that, "the desertification is the inconvenient phenomena to reduce both natural and economic capacity of local area as a result of the ecosystem productivity decrease in semi-arid areas under natural factors and industrial impacts".

In 1996, Mongolia joined the UNCCD (United Nations Convention to Combat Desertification) and in 2003, the Government of Mongolia developed and approved the "National Action Programme on Combat Desertification (NAPCD)". In this programme,

the current situation of desertification was analyzed and the policies were defined to combat desertification.

The desertification map made by the Institute of Geo-Ecology of the Mongolian Academy of Sciences shows that the desertification in Orkhon river basin covers a total of 246,823 km^2 of land or 45.9 percent of the total territory of the river basin. About 2.9 percent or 1,561.2 km^2 is severely degraded. Used data was of the raster type and the areas were calculated for each category of desertification by image processing technique. The areas for each category of desertification are presented in Table 102. The spatial distribution is shown in Figure 97.

Table 102. Assessment of areas where desertification appeared in the Orkhon river basin

Desertification rate	Area, *km*^{2}	Percentage in areas where desertification occurred, %
Slightly	13,717.7	25.5
Moderately	9,403.4	17.5
Severely	1,561.2	2.9

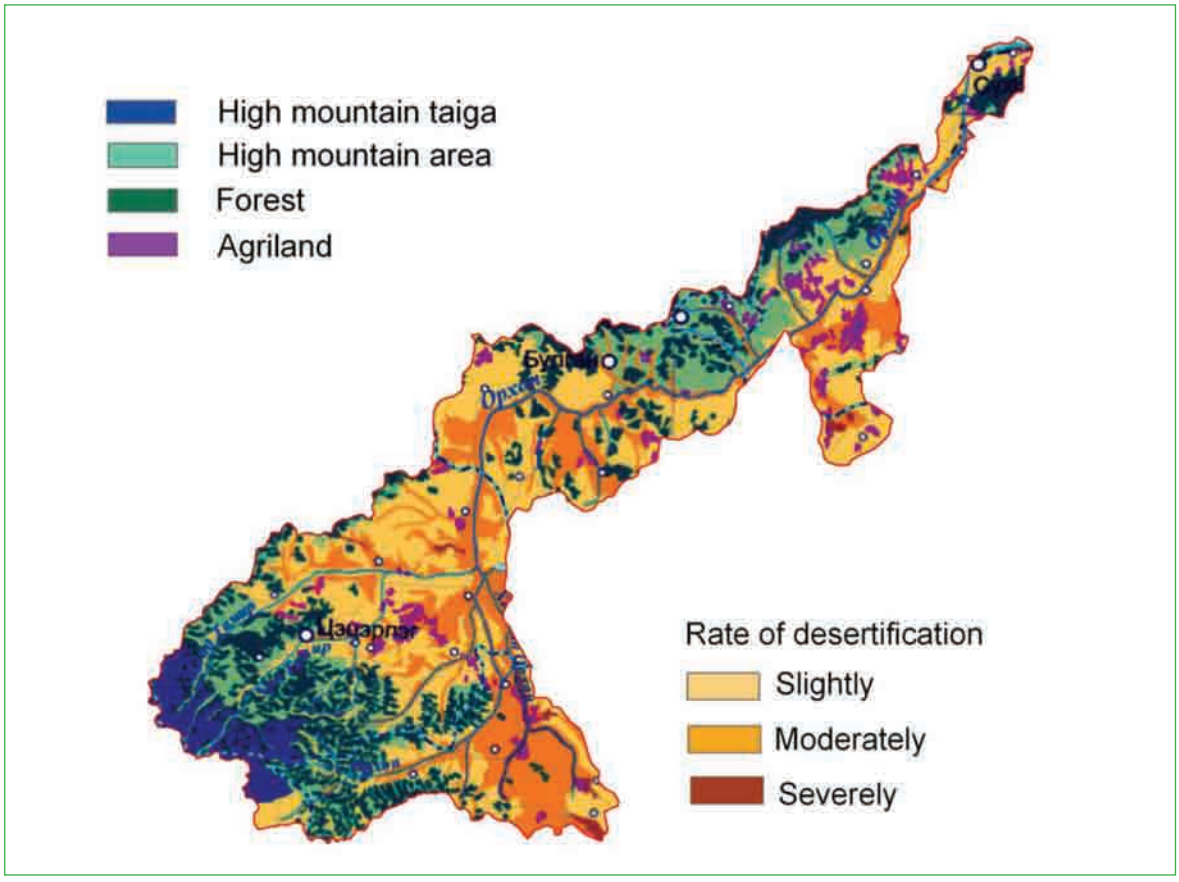


Figure 97. Description of areas where desertification appeared in the Orkhon river basin

6.2. Human induced negative impacts

In the Orkhon River basin, 45.9 percent of the territory is affected by desertification, 23 percent by overgrazing, 3.1 percent by unused fallow crop land and 11.6 percent of the territory is covered by mining licenses, respectively.

6.2.1. Improper mining activity

The Ikh Teel River originates from the Suvarga Khairkhan Mountain in the upstream part of the Orkhon River. Due to research studies which were conducted in 2006 open gold mining, overgrazing and population growth are adversely affecting the ecology of the Orkhon River's tributaries in the upstream part such as Ikh Teel River, Ult River and their tributaries: Ulziit Teel, Budant Teel, Khargui, Shiirt, Zuun Sudut, Baruun Sudut, Guut Rivers. These rivers disappeared and were included in the surface water standard category of 'Polluted'. Due to gold mining, rivers disappeared and livestock has no pasture. The local area residents settle near only one remaining river.

Ikh Teel River has very soft and fresh water (mineralization 148.7 mg/l). It is categorized as polluted by surface water standard. Near Kharkhorin soum, mineralization was 167.3 mg/l, hardness was 1.75 mg-equiv/l and there were turbidity and pollution. It was categorized as very polluted according to surface water standard. There was a change in water quality and chemical components.

6.2.2. Urban area and industrial waste water

The Khangal River has a water quality of the highest mineralization, hardness and pollution of the tributaries of the Orkhon River. The Erdenet and Zun Rivers are upstream of the Khangal River. Water quality and chemical composition of the Erdenet River are completely different from the rivers in the Khangai Region. For instance: it has the highest mineralization (732 mg/l), hardness (7.20 mg-eq/l), polluted (NO_2^- 0.3 mg/l) and cation balance is such that $Ca^{2+} > Mg^{2+} > Na^+ + K^+$ and the anion balance is $SO_4^{2-} > HCO_3^- > Cl^-$. Moreover the Erdenet River is included in the category of 'Very polluted' by surface water standard. Although the Zun River has almost no discharge, waste water from the enriched mining industry flows as discharge. This discharge infiltrates into the sediment or soil, before it joins with the Khangal River.

From the studies by Central Environmental Laboratory it is shown that the main pollution sources from urban areas are:

- Waste water treatment plants
- Solid waste in the dry channels and flood dams
- Sanitation facilities in ger area

Orkhon River after joining Khangal River was classified as "polluted" by Mongolian standard MNS4586-98 but after reconstruction in 2003 (600.0 million tugrugs invested to build new sludge area) water quality has improved much since 2004. Since then, there was a change in the Khangal river water chemical composition and pollution indicator contents. The water quality is improved. Orkhon River and its affluent rivers are likely to be polluted due to mining activities and human activities. During the rainy season and the snow melting period, mineralization and nitrogen as well as organic substance composition in water exceed the tolerated limit.

6.2.3. Land cover degradation, overgrazing and desertification

Due to climate change and human impacts such as overgrazing, mining and improper road network, desertification and land cover degradation is extending causing aridness in the river basin.

Research studies by the Geo-ecology Institute show that 24682.3 km^2 or 45.9 percent of Orkhon basin is occupied by desertification as well as 1561.2 km^2 or 2.9 percent of the territory is occupied by severe desertification. High density of livestock or overgrazing is one of the causes of desertification leading also to a decrease in surface waters sources.

Example: the land cover change map of Orkhon basin (P. Khishigsuren, 2011) shows there were 907 springs in 2011. This number is 300 less compared to the 2007 water inventory and 700 less compared to 1984 data.

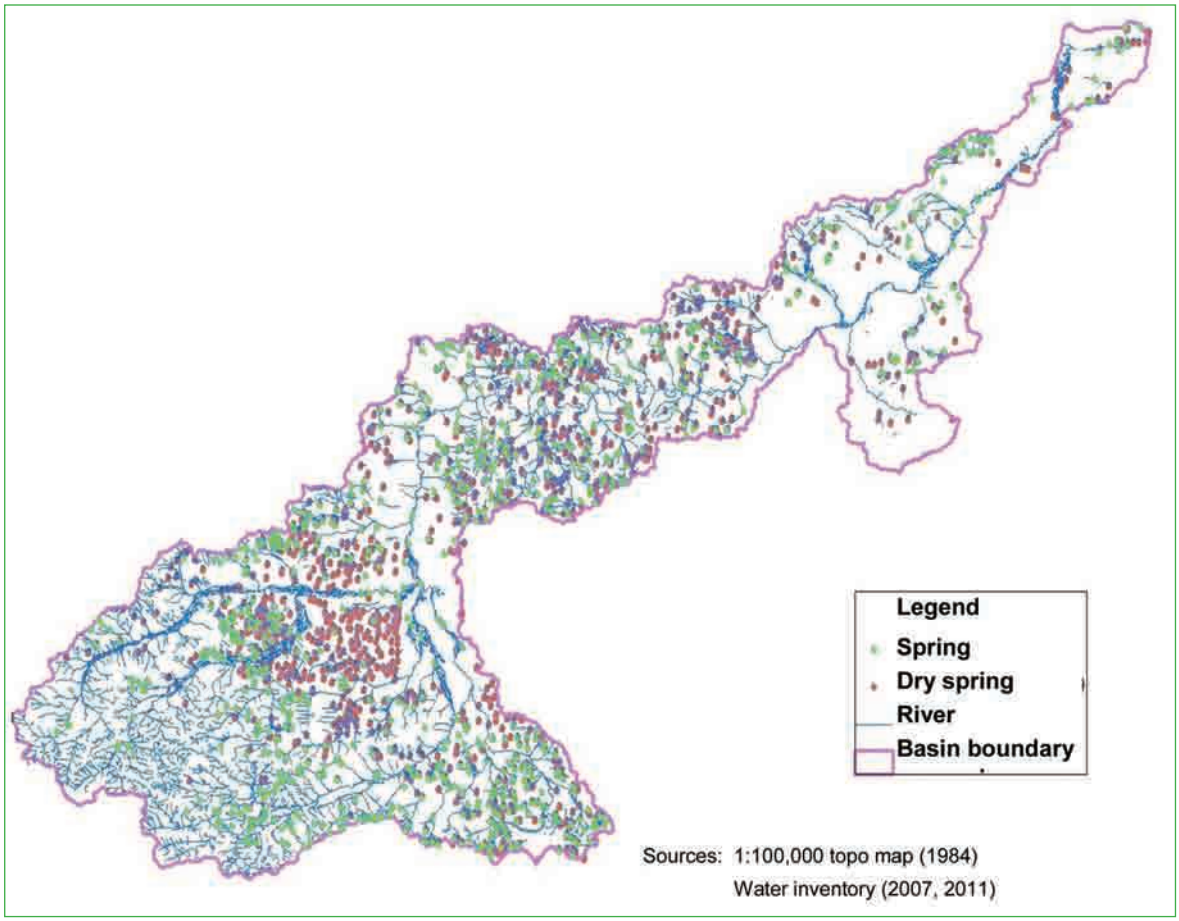


Figure 98. Springs in the Orkhon river basin

Improper road networks are a main reason leading to soil erosion and degradation.

6.2.4. Forest area change, soil and plant cover degradation

Of the forest steppe and steppe plants in the pasture, the percentage of many types of plants has decreased and low quality plants that tolerate livestock grazing very well have increased. In such places, soil moisture is decreased and soils are compacted and become hard. Nutritious substances are decreased. The ability to attract groundwater is reduced and the environment for evaporation is changed.

There is no data on forest area change in the Orkhon river basin. According to aimag data, forest area is decreased. So the following things need to be done: stop illegal logging, prevent forest fires, stop preparation and use of wood for heating, protect river basin and spring sources and conduct forestation. The river basin forest cover management issue which includes the above mentioned measures will be a necessary component of the Orkhon river basin integrated water management plan.

6.3. Provision of environment ecosystem balance

River basins include every square meter of land or water in the catchment of a given system including lakes, rivers, springs and dry beds and have clear and stable physical boundaries so-called watershed or water divide boundaries. The stream network has a hierarchical system (stream order) and this systematic property can serve as basis for the arrangement of other natural and socio-economical systems within the river basin.

Surface and ground water form in the soil layers fed by precipitation. All human and natural processes and activities which occur within the river basin are reflected by changes of physical, chemical and biological properties of the river water.

Research and surveys on ecological change have been done in the Orkhon river basin. For example: research on distribution and location of aquatic insects, fish, birds, mammals and their dynamics, as well as plant cover change, is conducted within the framework of the project to protect the Ugii lake ecosystem which is registered in the Ramsar agreement on wetlands, in conjunction with river and lake water regime research. The research results:

- Due to mining activities in the upstream part of the Orkhon River water quality of Orkhon and Khugshin Orkhon started to change and deceased fish was seen in some parts of the river channels.
- Fish species percentages of Ugii Lake have changed.
- Livestock husbandry of local residents and unplanned tourism facilities development and climate seriously threaten living condition of birds around Ugii Lake.
- Rodents are actively spreading in the Old Orkhon river basin and on the western shore of Ugii Lake indicating its population increase.
- Due to high human and livestock population density on the shore of the Ugii Lake, predator mammals are escaping from those areas. This results in the increase of rodent population around Ugii Lake.
- Survey results show grassland degradation around Ugii Lake. Anthropogenic plant species are increasing.

All these results indicate that ecological poverty is started to be observed around the Ugii Lake area.

The Geo-ecology Institute studies in the Selenge river basin (2005-06) specify that improper mining licensing leads to bad impacts on local environment; as example:

- Large quantity of silt and suspended sediment exit from the mine settling ponds due to poor design, open mine pits, mine roads and improperly reclaimed areas.
- At the Orkhon River tributaries in the upstream part such as the Ikh Teel River, Ult River and their tributaries Ulziit Teel, Budant Teel, Khargui, Shiirt, Zuun Sudut, Baruun Sudut, Guut Rivers an area of 1106 ha. of river terrace, riparian ecosystem and grassland ecosystem is totally destroyed, permafrost layers of the river floodplain are destroyed due to channel diversions and ground water resources have declined by some 50 percent and innumerable damage is made to forest and land cover of the river basin (N. Jadambaa, 2006).
- The Khangal River ecosystem has changed due to the Erdenet waste water entering the river.

The Orkhon River (at Bat Ulzii and Kharkhorin stations) has an average mineralization of 15-160 mg/l reaching a maximum of 488 mg/l in April 1988. When it reaches the

middle part of the river it increases 2-3 times, becoming 200-250 mg/l at Orkhon (Selenge) station (Figure 99).

There are diverse aquatic organisms living in the Orkhon River. For example: Mollusks (Anadontha sp, Radix auricularia, Sphaerium sp, Planorbis sp), Leech (Herpobdella octoculata, Glossiphonia complanata), Aquatic beetles (Rhantus frontalis, Coelambus urgensis, Dytiscus marginalis), Water bugs (Corixa sp), Mayflies (Potamanthus luteus, Baetis sp, Heptagenia werestchagini, Heptagenia kibunensis, Siphlonurus lacustris, Rhithrogena kurenzovi, Caenis macrura, Baetis fenestratum, Ephoron virgo, Ephoron nigridorsum, Ephemerella trispina, Cynigmula sp), Stoneflies (Nemoura arctica arctica, Phasganophora undata, Paragnetina identata, Taenionema japonica, Allocacrys reticulata, Eucapnopsis brevicauda), Dragonflies (Lestes dryas, Sympycna fusca) True flies (Simulium sp, Tabanus sp, Chironomus sp, Conchapelopia sp), and Caddisflies (Apatania majuscula, Lepidostoma hirtum, Hagenella sp, Brachycentrus americanus). The water quality of the Orkhon River is estimated at upstream and downstream sites using the biotic index. At the upstream site, the index showed "Good". However, at two downstream sites water quality was "Fair".

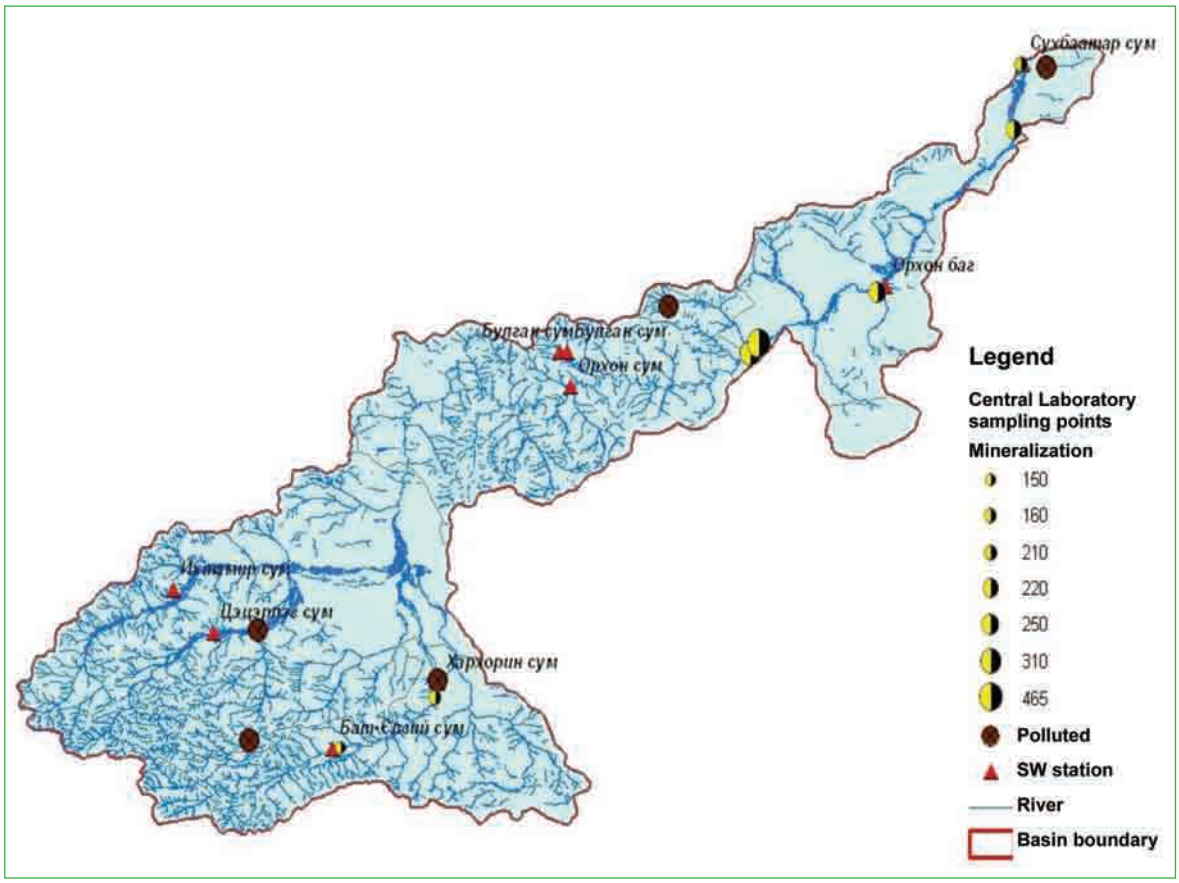


Figure 99. Location of points in the Orkhon river basin which have pollution according to the surface water standard and average mineralization, 2011

It is necessary to monitor aquatic insects in time and space. Also it is suggested to stop mining activities in the upper part of the Orkhon River basin and to improve land reclamation replacing the destroyed tress willows and grasses, preventing erosion by wind, rain or runoff, and planting native shrubs, grasses and trees.

The impacts of human activities in Ugii Lake basin should be reduced and environmental issues needed to be solved as mentioned in the Ugii Lake project recommendations.

Assessment studies related to wetland ecosystems should be done for Orkhon river basin and the environmental awareness of local residents about the importance of the lake and wetlands to nature should be raised through public workshops, seminars and lessons.

6.4. Water service fee, tariff and water price

6.4.1. Current situation

The water price in Mongolia consists of water resource use fee, service fee (tariff) of water supply organizations and subsidies. And the polluter pay principle is just in the beginning. If water is polluted, polluter should pay compensation according to the rules.

According to the Law on Water, water use is classified like water consumption and use. The water consumers are paying water service charges and water users' pay water resource use fees. Mongolia's water price structure is presented in Table 103.

Table 103. Water fee and tariff types and principles which can be used further

Type of price	Scope	Main principle	Payer
Fresh water and waste water tariff	Water supply service	Consumer cost pricing	Consumer
Water resources use fee	Water resource quantity	Pay depending on used quantity	Users
Water pollution fee and compensation	Water quality	Payment based on pollution level and quantity /exceeded the standard/	Water polluters that discharge waste water into nature which exceeds the standard
Subsides	Water supply service, investment	Based on cost recovery	State and local budget, investors and donors

Water and waste water tariff: The public utilities services and companies of cities and local areas, which operate in the business of discharging waste water from utilities and mining as well as distributing fresh water, establish fees based on the rules which are obeyed on the basis of discussion with local Representatives' Khural and the Agency for Fair Competition and Consumer Protection. According to the "Law on Urban and settlement area water supply and sewerage use", which is newly approved in 2011, the Council, which manages urban and settlement area water supply, sewerage use and services, will approve and monitor water tariff and water pricing methodologies.

Usually, water supply and sewerage companies are a monopoly at the local level. Some private water vendors work in ger districts and soum centers. But there are not many and their ability to compete is weak.

The local area administration participates in the water fee establishment. On the one hand, it has the advantage to prevent a monopoly condition, but on the other hand, organizations that operate in the sector suffer from loss due to fixed fees and tariffs. The negative effects are budget pressures and organization bankruptcy. As for expense returns, water supply organizations barely recover operating expenses and depreciation, and in some cases, do not manage to compensate operating expenses at all. It makes water unproductive in economical terms.

The local area Representatives' Khural establishes borehole water fees in soum centers and small urban areas. The tariff is established low compared to the costs and there are few consumers. It leads to small amounts of income which barely compensates operating expenses. The livestock watering boreholes are built and renewed by budget assets and compensation of expenses is hard. The issue is solved in a way that the herder groups own them.

Water resource use fee: The water issue is one of the basic factors that create a stable development of Mongolia. Our country's water resources have an uneven distribution in terms of space and time. It leads to some obstacles when creating a stable social development. According to the "Law on Investment Percentage of Revenue generated from Natural Resource Usage Payments for Measures to protect environment and rehabilitate natural resources", from total revenue of water use fee 35% and more must spend in order to protect water resources and rehabilitate. The local area administration should give some amount of money for the activities to protect water resources and rehabilitate. But, that amount of money is not spent in a useful way.

For example: water resource use fee income reached MNT4.72 billion in 2010 and MNT1.1 billion were spent on water sector management (water sector administration, water resources research and protection) which is 23.8% of the total income.

Water pollution compensation fee: Mongolia's economy is booming and water use increases. Also pollution is increasing along with it. The main reasons of the water pollution are growth of construction material industry, mining and raw material processing industry as well as population concentration and urbanization.

The polluter pay principle is in its initial stage and there is a 1992-approved compensation rule on water pollution. Its implementation is very imperfect.

Subsidy. The water sector requires a lot of subsidies and aid every year due to the low income and insufficient compensation of water supply organizations' expenses. The subsidies are mainly used for population water supply, sanitation and agricultural water supply. In Mongolia, direct subsidy principles are used mainly.

6.4.2. Possibility to change water pricing system

The Mongolian water sector structures are being changed and renewed due to the changing economic situation. It is required to renew water pricing structures which are the main economic condition for the sector's existence. The water fee policy acts as a main leverage for water resources, especially water demand management finance and economy. The following changes should be done systematically for fee forming structures in order to have successful water sector activities based on other countries' experience and the research works conducted within the framework of relevant organizations' recommendations.

The price of water is a key determinant of both the economic efficiency and the environmental effectiveness of water services. A water tariff is a powerful and versatile management tool. It is capable of promoting a number of objectives, although tradeoffs among them are commonly required. When specifying a water fee and tariff, the following common objectives should be defined. They are:

- Economic efficiency, resource conservation
- To meet state policy
- Cost recovery and net revenue stability
- Equity and fairness
- Public acceptable
- Simplicity and transparency
- Taking into account the consumer purchasing power

The fee and tariff types and their basic principles that can be used for the fulfillment of the above mentioned objectives are presented in Table 104.

Table 104. Water fee and tariff types and principles which can be used further

Type of price	Scope	Main principle	Payer
Water and waste water tariff	Water supply service	Consumer cost pricing	Consumer
Water resource use fee	Water use quantity	Interest-pay- say	Users
Water tax	Water system	Public, differential	Consumers and users
Water pollution fee and compensation	Water quality	Polluter pays	Polluter
Subsides	Water supply service O&M and capital cost	Based on cost recovery	State and local budget, investors and donors

Water will be productive in terms of society and economy in case there is full cost recovery or close to full cost recovery. In the future need to develop following pricing structure.

Water and waste water service tariff: Water pricing principles need to be chosen in relation to state policy. The cost recovery issue is the most important principle when specifying water fees according to privatizing and changing directions of national development concept of Mongolia and public utility service sector.

According to other countries' experience, the cost recovery level of water is established by laws and rules. It becomes the main condition of cost sharing and reliable operation of water supply organizations. It is very important to determine other water related fees. So it is important that the expense compensation level of water is discussed by the relevant organizations in relation to state policy and is formed by special rules. Those relevant organizations are MCUD, MEGD, MIA, MF, and the Council for regulation of the urban and settlement area water supply and sewerage use and services. The following organizations need to be involved when establishing fresh water and waste water fees and tariffs. They are MCUD, the Council for regulation of the urban and settlement area water supply and sewerage use and services, local area Representatives' Khural, AFCCP and utility organizations.

Fees and tariffs are required to be based on consumers' interests and they should contribute to new investment conditions and water service organizations' existence.

Water resource use fee: The following organizations should participate in the establishment of water resource use fees, water taxes, water polluting fees and compensations. They are MEGD, which is responsible for water resources and quality issues; MF; GDT and local area Representatives' Khural. The main objectives of the fee are to use water resources wisely, to increase use benefits, to provide ecological balance and to protect and rehabilitate water bodies. The fee income is spent on the following things. They are to use water resources wisely, to finance activities to rehabilitate and increase water bodies (water resources explorations), to protect water bodies and to finance administration expenses (for example: RBA).

Attention needs to be paid on the right use of fees and fee revenues should be increased as this should be used in this or that purpose etc. The current revenues should be increased till the level which encourages users to use water wisely.

Water tax: This tax should be established for the purpose of supporting ecosystem services, protecting water bodies from pollution, protecting from water damages and rehabilitating them. The main organizations for establishing water tax are MEGD, MCUD, MF and local area Representatives' Khural.

The water tax need to be locally and differential. The water tax has to cover following 2 issues. They are:

Ecosystem service: This includes water bodies and their recreation services. Differentiation will be based on locations. For example: it will be high in areas like safe ecological zones which are close to urban areas and water bodies. It will be levied when using water bodies for the purpose of recreation and utility activities. The implementation possibility is high when calculating it within the land fee. The amount will be established in relation to the ecosystem assessment.

Protecting from water damages: (flood, soil water etc). This also depends on location. It will be established differently on the basis of whether land and real estate owners are protected from flood and water damages. The amount should be sufficient for the use and administration fees of water enterprise constructions dedicated to prevent from potential water threats. The implementation possibility is high when it is included in the land fee.

Usually, the capital and O&M costs for activities to protect from water threats are consuming by the state budget. In some cases, flood protection and drainage constructions are not built due to shortage of investment and vast damage occurs due to it. We cannot compensate huge amounts of socio-economic damages caused by threats from the water. But by accumulating special fees in some accumulation fund, even if it will not reach cost recovery, may protect against threats from the water. There will be a possibility to pay back after construction of the objects by issuing bonds before accumulation of some assets from the fees.

Water polluting fee and compensation: It is less costly to prevent than to rehabilitate already occurred damages by implementing the polluter pay principle and forcing water polluters to pay for it. This is clear from international experiences. The main objectives of the fee are to keep ecological balance, to decrease negative impacts of human activities, to protect the environment and most important to prevent from threats caused by negative human activities on human health, society and economy.

Water polluters will pay this tax. Currently, users are considered as polluters. But we must recognize that all users and consumers who change the natural state of water will be considered as polluters. The example of this is: if livestock number increases, it will cause desertification and increase of surface water pollution. In other words, sustainability of natural resources will be destabilized.

The pollution fee will be levied if the pollutant level is under the standard-approved amount. Also, this fee acts as economic leverage for industries, which pollute water much, to introduce new technologies and reuse water. The fee revenue will be established in relation to activity costs to protect and prevent from pollution, to monitor pollution and administration expenses. It will be accumulated in a special fund and used for this activity (For example: constructing WWTPs, monitoring water quality etc)

The compensation will be levied in order to erase already occurred damages. The ecological damage is very high and amount of compensation will at least be equivalent to expenses which used for damage relief. If polluter discharges water to nature whose components have over-standard polluting particles or if polluter pollutes water bodies, fee amount will be levied in relation to its size.

Subsidy: Subsidy should be used wisely due to some reasons. They are: living standard of Mongolian population is low; poverty rate is high; weak financial capacity of water supply and waste water discharge organizations and high expense of water constructions. The subsidy is established in relation to state policy and expense compensation level. The following organizations will participate. They are MF, MCUD, MEGD, MIA, the Council for regulation of the urban and settlement area water supply and sewerage use and service and local area Representatives' Khural.

Many types of taxes will probably cause psychological and economic pressures for tax payers. Advertisements and information should be done. Because understanding on water fee payment is weak. It can be managed as it will be included in other forms of taxes. It is important not to cause trouble for tax payers and to determine environmental and economic indirect influence on the basis of water related taxes and fees. The amount of water fee and taxes will be established when pay back condition is formed after financing activities using economic methods /bond, loan etc/. The activities are to construct required water constructions and to protect the environment.

7. STRATEGY OF THE INTEGRATED WATER RESOURCE MANAGEMENT PLAN FOR THE ORKHON RIVER BASIN

7.1. Water resources management and local area issues

There are 26 soums of 8 aimags in the basin. It is beneficial for the socio-economical and cultural development to solve the water supply and water availability issues. In recent years, development policies of the regions and aimags were defined. But most of them did not focus on water availability and water supply issues. In some cases, many measures were planned without scientific basis as if water resources and its distribution are enough. For example: while population concentration is increasing, water sources for population of new urban areas are not determined. Calculations and surveys of discharging, treating and reusing waste water are not enough. Also when planning big industrial and mining projects, water sources for usage are not calculated. No attention is paid on wise use of water. This is due to the following reasons: there are no experts and organizations that integrate water sector activities; capacity is low in the aimags to plan and organize implementation of water supply for population, industries, agriculture. The meteorological offices, public entities and agricultural offices in each aimag conduct their own activities, but there are no people who can organize implementation work and integration of the measures to protect water resources and to construct and renovate hydro-constructions. River basin councils started managing local area water issues from 2010 but not full-time. From 2012, river basin authorities are responsible for managing water issues, but their activities are in the initial stage. Orkhon river basin council started its activities from 2012 and the river basin authority has not been established yet. The water resources and hydro-construction measures that are included in the development programs of the aimags (with territories in the basin) Uvurkhangai, Arkhangai, Bulgan, Orkhon and Selenge, are not reflected sufficiently.

The IWM plan of the Orkhon river basin determines: how to solve water supply issues in aimag and soum development issues; in what order the measures are implemented; required budget amount; sectors and state administration offices to organize implementation of the measures and their activities; management/regulative organizations and agencies. The “Water” national program was approved by the parliament in 2010. The main issues or challenges of the program include the measures to be implemented in the aimags and soums of the basin and their activities are included in the plan. The Orkhon river basin IWM plan is related to the program and the required regulation is conducted. The challenges and activities of the Orkhon river basin IWM plan are related to the development policies of the Khangai and Central economic regions. When implementing the basin IWM plan, participation of local area administration and residents needs to have a wide-range.

7.2. Wise use and protection of water resources

The following has been defined in relation to the development of the Orkhon river basin IWM plan: wise use of surface water and groundwater resources; implementation of activities to expand protection of surface water and groundwater resources based on research and recommendations; implementation order; phasing; required budget amount. As for the “Water for Environment” part of the plan, the challenge “Protecting Water Resources from Pollution and Scarcity” is defined. In total 6 measures and 17 activities are planned in the planned years.

The measures included in the basin IWM plan are related to protection of water resources from pollution and scarcity, to wise use, to rehabilitation and to expansion of water resources: halt activities of gold mines that are still operating but are not allowed to conduct mining according to the law; organizations that used the mineral deposits, will conduct rehabilitation work; establish special and normal protection zones in water resource areas, re-establish regime; add water metering in sanatoriums which are based on hot spas; establish facilities that treat and discharge waste water; study traditional ways to protect water resources and advertise these to the local residents; separate population drinking water pipelines from industrial water supply pipelines and reuse water by treating and sanitizing it; introduce modern technologies (reuse urban area treated water) in industries that process skin, wool, cashmere and other agricultural products; stop the use of groundwater sources by industries before 2021; establish reservoirs and ponds in areas where rain water and snow water accumulate; create eco environment; organize possibilities to use pasture irrigation in areas with the participation of professional organizations; plan measures to conduct runoff and recharge regime studies of Khugshin Orkhon and Ugii Lake and give assessment and organize its implementation; develop projects to use water resources wisely in the region by constructing big water-accumulating reservoirs and water complex on the Orkhon river, including ecological, socio-economical assessment; increase Iven river runoff of Selenge aimag; study possibility to restore Ishgent lake of Khushaat soum; accumulate rain water from rooftops and use it for sanitation and household farming; use rain generator in pasture and farming areas when required.

7.3. Water resources management and strategic objectives

The mission of the Integrated Water Resource Management /IWRM/ for the Orkhon River Basin is to provide intensive social development with an ecologically-orientated economy which associates to local and sectors' development programmes, maintains an environmental ecosystem balance, improves the legal environment and provides a convenient condition to human life. This is to be based on the results from study works to implement a sustainable management of integrated activities in the water sector on the basis of the water resources in the basin. The main measures to be implemented in order to achieve this objective are described below.

7.3.1. Improving drinking water supply

The objective is to improve drinking water quality, to improve availability in areas where water lacks, to encourage the tradition to use water wisely and to improve the treatment level of domestic waste water. The challenges to be tackled, when implementing objectives to improve drinking water supply, and the required measures and activities are grouped and defined for each water consumer. For example: supplying urban area population with safe water; improving waste water treatment level; improving water supply of public entities; developing water supply technology of sanatoriums and tourist camps; improving rural area population drinking water supply.

7.3.2. Improving industrial water supply

The objective is to increase the industrial sector percentage in GDP while intensifying economic development, improving its sub sectors' water supply, reusing technological water in mining in the production and processing of mineral resources. For example: improving water supply of light and food industries; solving water supply of mining extraction and processing industries; solving water supply of energy industries; solving water supply of construction and building material industries.

7.3.3. Improving agricultural water supply

The objective is to improve livestock and farming water supply and to strengthen this sector's natural and climate adaptability to reduce risks. For example: improving livestock water supply; increasing farming irrigation.

7.3.4. Water for the environment

The objective is to support green development by protecting water resources from pollution and scarcity, rehabilitating and expanding it, decreasing negative phenomenon's related to aridity and desertification, using existing resources wisely and protecting and preventing from floods.

For example: protecting water resources from pollution and scarcity; combating negative phenomenon's of aridity and desertification; using water resources wisely and rehabilitating it; preventing and protecting from floods.

7.3.5. Legal setting and administration of the water sector

The Orkhon river basin IWM plan will work in the framework of the legal setting and administration of the water sector: main issues and challenges (objectives) will be defined by the water use and water consumption sectors. Also legal and administration structure issues of water sector will be included. The objectives are: to reinforce the legal reform of the water sector, to increase the managing capacity of laws and regulations, to develop administration structure in the sector and to strengthen the human resources, to ensure financial sources. The sector activities will be related to the objectives and policies of the local area administration and responsible organizations.

For example: improving the legal environment; developing the administrative structure; strengthening the human resources; establishing the financial sources; increasing the participation of local area administration and residents; carry out surveys, monitoring, database and advertisements.

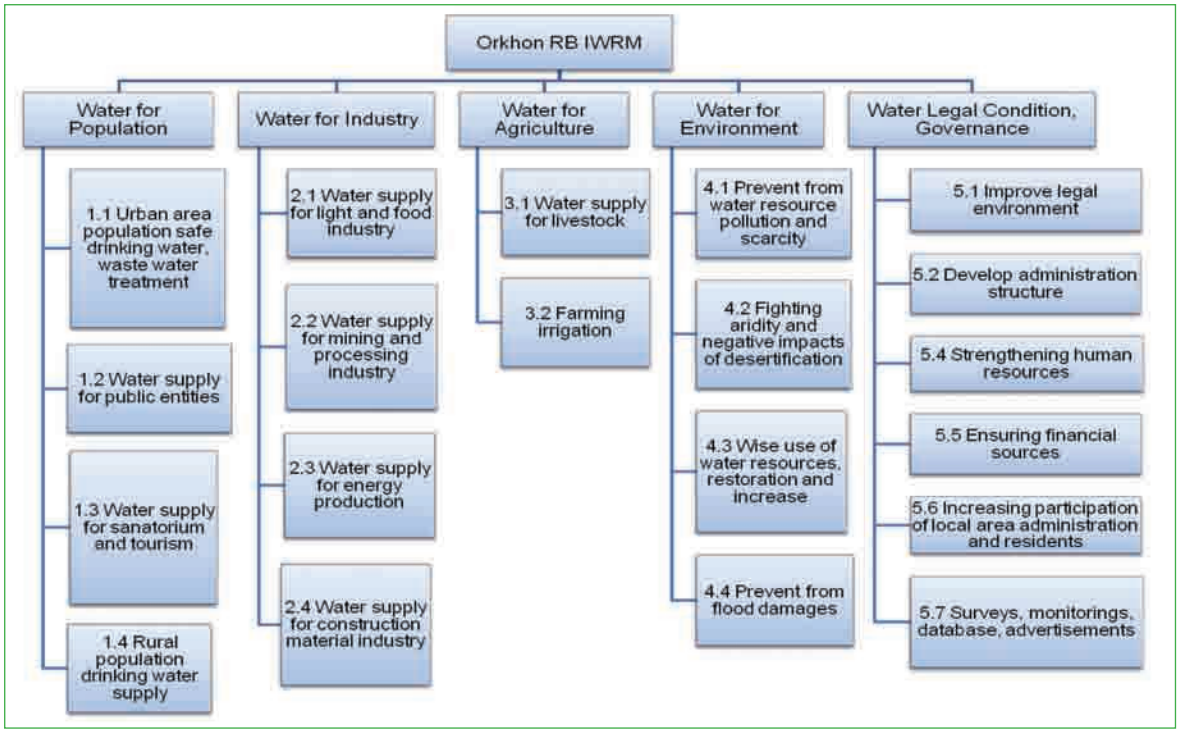


Figure 100. Main challenges of the Orkhon river basin IWM plan

When budgeting the measures to implement the Orkhon river basin IWRM strategy at the level of specific activities, the following has been defined: implementation period, amount of required budget and its sources, implementation.

7.4. Financial issues of basin organizations

Water resources are one of the vital resources of countries. Central organizations determine the water resources policy, as its implementation covers many sides. Water issues should be solved in its complex way involving activities of many economic sectors and their interests. According to international experience, water resource management is implemented through water basins and it proves to have good results. So this method is being implemented in our country. The Law on Water, article 2, clause 19, specifies that a RBC will be established. Orkhon river basin council was established in 2011 according to the law. The river basin council is now being financed from the project. Its financial issue needs to be solved as soon as possible. Except RBC, RBA will be established. Some 10-15 people will be employed there. The administrative expenses of the RBA are presented in Table 105.

The Orkhon river basin authority will have 15 staff members (1 officer and 14 employees). Some 214.5 million tugrugs will be required annually on average. This expense can be financed from the water resources use fee. Around 1 billion tugrugs was accumulated in the budget of aimags in Orkhon river basin from the water and springs use fee income. The above mentioned expense is under 20 percent of the income.

Table 105. Administrative expenses of the river basin authority (as of 2012)

Type of expenses	Annual average, *thous.MNT*
Number of staff, *persons*	15
Total Expenses	214,509.2
Salaries with Social insurance premium	80,197.2
Salaries	72,249.8
Social insurance premium from employer	7,647.5
Chancery, telecommunication, postage and freight	3,600.0
Transport (fuel)	9,600.0
Domestic travel	10,500.0
Utilities	5,000.0
Labor safety facilities	2,500.0
Low value and fact depreciable items	600.0
Research and training	6,000.0
Payment for the others organizations work and service, fee and levies	3,600.0
Information and advertising	2,500.0
Other costs	10,214.7

Also, the financial sources of RBA's can be stakeholder donations and aid. In the future it is necessary to study possibilities to use some parts of water related taxes and fees for RBC's and RBA's. The legal environment should be created.

The above mentioned financial sources will be spent only for administrative expenses of RBA's. Also it is necessary to determine financial sources for the main activities of the RBA's. They are:

- Monitoring water resources
- Developing water related infrastructure, maintaining its condition to operate
- Providing possibility to have stable activities/operation of the organization

Some countries solved finances required for these activities through donation, loans and state investments. As for Mongolia, the most possible method is to solve through state budget.

8. ORKHON RIVER BASIN INTEGRATED WATER RESOURCES MANAGEMENT ACTION PLAN

Table 106. Integrated water resources management action plan of Orkhon river basin, phase I: 2013-2015 and phase II: 2016-2021

No.	Challenges, measures and activities	Implementation period		Approximate amount of required investments /million MNT/	Of this, possible source, by %				Implementing organisation
		2013-2015	2016-2021		State budget	Local budget	Project and programme	Private sector and others	
№	1	2	3	4	5	6	7	8	9
WATER SUB-SECTOR 1: WATER FOR PEOPLE									
1.	Challenge: Safe drinking water for people and waste water treatment in urban areas								
1.1	Measure: To improve drinking and domestic water supply sources, protection and water quality monitoring								
1.1.1	To renovate and expand water supply sources and fresh water pipelines in Kharkhorin, Tsetserleg, Bulgan and Sukhbaatar cities, main centres of Khangai region.	√	√	5,000	80	-	20	-	Aimag and soums' Governor's Office /GO/, Ministry of Construction and Urban Development /MCUD/ and Administration of Land Affairs, Construction, Geodesy and Cartography /ALACGC/
1.1.2	To carry out additional investigation on groundwater for water supply sources of Bulgan and Tsetserleg cities and to newly determine its resources.	√	√	300	100	-	-	-	Aimags' GO, , MEGD
1.1.3	To expand National Agency of Meteorology, Hydrology and Environment Monitoring /NAMHEM/ laboratories in Tsetserleg, Erdenet and Sukhbaatar cities and to enable them to carry out a complete analysis on composition and quality of fresh and waste water.	√		1,200	80	-	15	5	Aimags' GO and Nature Environment and Tourism Department /NETD/
1.1.4	To organise and stabilise a study work to determine microbiological indicator in drinking water sources in urban areas according to MNS 09-2005 standard.	√		800	50	20	20	10	Aimags and soums' GO and NETD
1.1.5	To demarcate landfill sites in 4 aimags and 25 soum centres located in the Orkhon River Basin, to bury solid wastes, to change its position if necessary, to establish dam for protecting soil and water resources from pollution due to flood discharge from landfill site along the ravine, and to hire full-time patrol.	√	√	100	-	80	10	10	Aimags and soums' GO and NETD

№	1	2	3	4	5	6	7	8	9
1.1.6	To carry out survey of groundwater sources for water supply in total 25 soums in the basin and determine their resources, to newly determine and demarcate protection and sanitation zones of water supply sources.	√	√	1,200	100	-	-	-	Aimags and soums' GO, MEGD, River Basin Authority /RBA/
1.2	Measure: To expand and renovate water supply pipelines and to improve water kiosk availability								
1.2.1	To establish water kiosks connected to the central water supply pipelines for not less than 30% of inhabitants or 7000 households in suburban areas of Kharkhorin, Tsetserleg, Bulgan, Erdenet and Sukhbaatar cities.	√	√	4,000	20	10	20	50	Aimag and soums' GO, MCUD
1.2.2	To make a preliminary assessment on water supply and water availability for people, industrial and service organisations in implementing the general development plan for aimag centres, cities and soum centres.	√	√	-	-	-	-	-	MCUD, aimag and soums' GO and RBA
1.2.3	Studying possibility to use Chingel river basin groundwater resources (in territory of Bulgan and Orkhon) for improving Erdenet city ger district water supply	√	√	3000	-	50	-	50	Orkhon and Bulgan aimags' CRM, GO, Erdenet mining industry
1.3	Measure: To renovate, expand and newly establish waste water treatment plant /WWTP/								
1.3.1	To renovate and expand sewerage, waste water treatment, disinfection and waste water discharge facilities and equipments in Kharkhorin and Bulgan cities and Khujirt soum centre.	√	√	100	80	-	-	20	Aimags and soums' GO and MCUD
1.3.2	To provide not less than 50% of sanitation facilities used by suburban area households or 12000 households in Kharkhorin, Tsetserleg, Erdenet, Bulgan and Sukhbaatar cities with bio toilet that meets MNS 6279:2011 standard.	√	√	4,500	80	-	20	-	Aimags' GO, MCUD
1.3.3	To improve waste water treatment level and quality in the basin's aimag centres and cities and to reduce environmental pollution and plus, to reuse treated water first of all in factories and crop that use water at large amount and then in irrigation of green areas in the cities.	√	√	5,000	60	20	20	-	MCUD, aimags' GO and NETD
1.3.4	To install water metre at spa resorts in Khujirt soum centre of Uvurkhangai aimag for controlling water use and to establish the central waste water facility.	√		1,000	-	-	-	100	Aimag and soum's Citizens' Representative's Meeting /CRM/, GO, MCUD
	Total of Challenge 1 - water sub-sector 1			**26,200**	**57**	**12**	**16**	**15**	-
2.	Challenge: Water supply for public utility and service								
2.1.	Measure: To improve water supply								
2.1.1	To connect hospital, school, kindergarten, and public utility and service organisation constructions in the cities' suburban districts and soum centres to the fresh water supply pipelines.	√	√	5,000	50	20	20	10	Aimags' CRM and GO, MCUD, Ministry of Health /MH/ and Ministry of Education and Science /MES/
2.2	Measure: To improve water use registration and water use payment control								
2.2.1	To install water metre in public utility and service establishments for monitoring water use and to improve monitoring on water resources, water use and its payment.	√	√	300	10	10	30	50	Aimags' CRM and GO, NETD and MCUD

№	1	2	3	4	5	6	7	8	9
2.3	Measure: To connect with central waste water pipeline and to establish mini-WWTP								
2.3.1	To connect hospital, school, kindergarten and public utility service organisations constructions in the cities' suburban districts and soum centres to the central waste water pipelines and to establish mini-WWTP.	√	√	10,000	50	20	20	10	Aimags' CRM and GO, MCUD, MH and MES
	Total of Challenge 2 - water sub-sector 1			**15,300**	**49**	**20**	**20**	**11**	-
3.	Challenge: Water supply for tourism and spa resorts								
3.1	Measure: To improve water supply								
3.1.1	To involve spa resorts and tourist camps in water auditing.	√	√	-	-	-	-	-	Aimag's CRM and GO, NETD, MH and soums' GO, MCST
3.1.2	To set hygienic, sanitation and protection zones in water supply sources for spa resorts and tourist camps.	√		20	30	30	-	40	Aimags' NETD, MH and soums' CRM and GO, RBA
3.1.3	To completely provide water meter to spa resorts and tourist camps for monitoring their water consumption and use, and to improve monitoring on water resources use and its water use payment.	√	√	40	10	10	10	70	Aimags' CRM and GO, NETD, MH and soums' GO, RBA
3.2	Measure: To improve sanitation facilities and to launch a new waste water treatment equipment and technology								
3.2.1	To establish improved toilet with air conditioner based on construction normative No.BD40-101-05 according to travel itinerary.	√	√	50	-	-	50	50	Aimags and soums' NETD and ASI, MCST
3.2.2	To launch a new equipment and technology in tourist camps and spa resorts in the Orkhon River Basin without the central water supply and in waste water treatment, disinfection, waste water discharge and sanitation facilities.	√	√	400	-	60	10	30	MCUD, MCST, aimags' GO and NETD
3.3	Measure: To launch the appropriate activities								
3.3.1	To establish Inter-Aimags' Council to regulate a policy on tourism framework at the Orkhon River Basin level and to enable it to work with the Water Basin Council and its Administration.	√		-	-	-	-	-	Aimags' CRM and GO and RBA
	Total of Challenge 3 - water sub-sector 1	**-**	**-**	**510**	**2**	**49**	**14**	**35**	-
4.	Challenge: Drinking water supply in rural areas								
4.1	Measure: To improve water supply								
4.1.1	To provide professional assistance to rural herdsmen and farmers in selecting their drinking water sources, and to enable them to use waste water treatment facilities for household purpose.		√	50	50	-	50	-	Ministry of Industry and Agriculture / MIA/ and aimags and soums' GO
4.1.2	To restore and newly assemble the previously-installed water softening and treatment equipments in Ugii Nuur, Khotont and Ulziit soum centres of Arkhangai aimag, Khishig-Undur soum centre of Bulgan aimag, Jargalant, Bayannuur and Dashinchilen soum centres of Orkhon aimag which are currently using water sources with unmet drinking water quality.	√	√	60	60	20	20	-	Aimags and soums' GO, MCUD

№	1	2	3	4	5	6	7	8	9
4.1.3	To accustom rural herdsmen and farmers to use a water container designed for fetching and storing drinking water	√	√	-	-	-	-	-	Aimags and soums' CRM and GO and MH
4.1.4	To completely renovate WWTPs in Sant and Shaamar soum centres of Selenge aimag and Orkhon soum centre of Darkhan-Uul aimag.	√		6,000	100	-	-	-	Selenge aimag's CRM, GO, MCUD
4.1.5	To learn from experience of Bat-Ulzii soum of Uvurkhangai aimag that uses protection zone of drinking water supply boreholes in soum centre as a park and to introduce this experience in other soums of the basin.	√	√	1,500	-	60	20	20	Soums' CRM and GO
	Total of Challenge 4 - water sub-sector 1	-	-	7,610	80	12	4	4	-
	Total of Water sub-sector 1	**-**	**-**	**49,620**	**58**	**15**	**15**	**12**	-
	WATER SUB-SECTOR 2: WATER FOR INdustries								
1.	Challenge: Water supply for light and food industries								
1.1	Measure: To improve water supply								
1.1.1	To completely connect small-medium sized light and food enterprises in aimag centres and cities to the central water supply and sewerage pipelines.	√	√	5,000	40	20	20	20	MCUD, MIA, Aimags' CRM and GO, Department of Small and Medium Industry and Agriculture /DSMIA/
1.1.2	To improve water supply for small food factories in soum centres.	√	√	1,000	20	40	30	10	Aimags' CRM and GO, DSMIA
1.1.3	To completely install water meter in small-medium sized food and light industries in aimag centers, cities and soum centers for monitoring water use, and to improve monitoring on water use payment.	√	√	100	50	20	10	20	MIA, Aimags and soums' CRM and GO, NETD, DSMIA
1.1.4	To involve water consumption and use of small-medium sized food and light industries of aimag centers and cities in water auditing.	√	√	20	50	30	-	20	Aimags and soums' CRM and GO, NETD, DSMIA
1.2	Measure: To develop industries								
1.2.1	To establish a traditional factories based on soums' advantages and small-medium sized enterprises that produce value-added production.	√	√	7,500	30	20	20	30	MIA Aimags and soums' CRM and GO, DSMIA
	Total of Challenge 1 - water sub-sector 2	-	-	13,620	33	21	21	25	
2.	Challenge: Water supply for mining and processing industries								
2.1	Measure: To improve drinking water supply in urban areas based on mining								
2.1.1	To use drinking and domestic water sources and its use resources in mining-based urban areas by pre-determining based on investigation.	√	√	3,000	50	10	10	30	Ministry of Mining/MM/, MEGD
2.2	Measure: To protect water resources from pollution and scarcity								
2.2.1	To stop mineral resources mining that widespread in the Orkhon River Basin upstream part and to have a technical and biological restoration carried out.	√	√	7,000	-	-	-	100	MM, MEGD, MRA, aimag and soums' CRM, GO and RBA

№	1	2	3	4	5	6	7	8	9
2.2.2	To repair reservoir dam that was built near the Khangal River bridge for the purpose of protecting the river from industrial waste water of the Erdenet city WWTP.	√		100	-	100	-	-	Orkhon aimag's GO, NETD and Agency for Specialized Investigation / ASI/, Erdenet mining
2.2.3	To suspend some gold mining licenses in all the rivers belonging to the Orkhon River Basin within legal framework and to stop issuance of a new exploration and mining license within this basin.	√	√	-	-	-	-	-	MM, Mineral Resources Authority / MRA/, aimags and soums' CRM and GO, RBA
2.2.4	To stop placer mining in all the river sub-basins in the Orkhon River Basin.	√	√	-	-	-	-	-	MM, MRA, aimags and soums' CRM and GO, RBA
2.2.5	To take measure to treat completely turbid industrial waste water from mining industry and to reuse treated waste water.	√	√	2,000	-	-	-	100	MM, MRA and MEGD
	Total of Challenge 2 - water sub-sector 2	-	-	**12,100**	**12**	**3**	**3**	**82**	-
3.	Challenge: Water supply for energy industry								
3.1	Measure: Proper use of water resources								
3.1.1	To 100% reuse waste water from thermo-power plants as well as water used in cooling the plants.	√	√	500	50	-	30	20	ME, MEGD
3.1.2	To make a solution to separate water sources for newly-establishing energy production technology from drinking and domestic water sources in urban areas	√	√	1,000	50	-	30	20	ME, MEG and MCUD
3.2	Measure: To use hydropower electricity								
3.2.1	To produce energy by restoring main channel of hydropower station in Kharkhorin soum of Uvurkhangai aimag and by renovating auto workshop, turbine and power generators.		√	1,000	-	-	-	100	ME, Uvurkhangai aimag's GO and Kharkhorin Co. Ltd
	Total of Challenge 3 - water sub-sector 2	-	-	**2500**	**30**	**0**	**18**	**52**	-
4.	Challenge: Water supply for construction and building material industries								
4.1	Measure: To use water resources efficiently								
4.1.1	To stop any improper action that directly discharges waste water used in construction material factories into environment, and to launch a new technology that reuses treated waste water.	√	√	2,000	50	20	10	20	MCUD, NCCDPUS
4.1.2	To develop construction material industry to replace wood in every soum and to establish main block factories in aimag centres and possible soums.	√	√	5,000	30	30	30	10	Aimags and soums' CRM and GO
4.1.3	To enable every aimag to own local building material location and resources and to improve their use.	√		1,000	-	80	-	20	Aimags and soums' CRM and GO
	Total of Challenge 4 - water sub-sector 2	-	-	**8,000**	**31**	**34**	**21**	**14**	-
	Total of Water sub-sector 2	-	-	**36,220**	**26**	**17**	**14**	**43**	-

№	1	2	3	4	5	6	7	8	9
WATER SUB-SECTOR 3: WATER FOR Agriculture									
1.	Challenge: Water supply for livestock								
1.1	Measure: To improve pasture use								
1.1.1	To organise a framework between aimags and soums to organize water supply in unused pasture due to lack of water.	√	√	5,000	40	40	20	-	Aimags and soums' GO and MIA
1.1.2	To stop surface water-based overgrazing in the districts of Erdenet and Sukhbaatar cities especially in warm season and to limit number of livestock over there.	√	√	-	-	-	-	-	Orkhon and Selenge aimags' GO and NETD, MEGD and MIA
1.1.3	To register number of livestock on an annual basis and to impose the pasture use fee according to the relevant law and procedure.	√		-	-	-	-	-	Aimags and soums' CRM and GO, MIA
1.1.4	To newly set districts' territories of aimag centres, cities and soum centres, and to issue and enforce a procedure for tackling issue of assigning land ownership to herdsman families in these districts in connection with grazing capacity within legal framework.	√	√	-	-	-	-	-	MCUD, Aimags' CRM and GO, NETD and DSMIA
1.1.5	To make assessment on pasture area suffered from overgrazing or desertification with the participation of professional organisation and to organise framework of its restoration and shift use.	√	√	40	50	50	-	-	Aimags' CRM and GO, NETD and DSMIA
1.2	Measure: Irrigation								
1.2.1	To take a particular amount of the investments required for establishing new wells and restoring old ones in pasture area from their users, herdsmen groups, partnerships and cooperatives, to assign water points ownership to them and to charge them for use, protection and maintenance the wells.	√	√	6,000	60	20	10	10	Aimags and soums' GO and MIA
1.2.2	To support citizens and herdsmen who established ponds by collecting snow and rain water and who dug and used hand wells at their own initiatives and expenses.	√	√	80	50	50	-	-	Aimags and soums' CRM and GO, DSMIA, MIA
1.2.3	To support intensive farm in urban area-based areas, to formulate the targeted-programmes for improving its economic efficiency at soum and aimag levels in a way of increasing productivity per livestock head, and to organise its implementation.	√	√	10,000	30	20	20	30	Aimags and soums' CRM and GO, DSMIA, MIA
	Total of Challenge 1 - water sub-sector 3	-	-	**21,120**	**41**	**25**	**17**	**17**	-
2	Challenge: Crop irrigation								
2.1	Measure: To improve irrigation land use								
2.1.1	Based on cartogram and assessment of land that is left uncultivated which were previously used for agricultural purpose, to carry out biological restoration in parts which were left unable to be used for such purpose in the future.	√	√	3,000	60	20	-	20	Aimag's GO, NETD, ALAGC, MIA

№	1	2	3	4	5	6	7	8	9
2.1.2	To carry out monitoring jointly with professional organisation on distribution of herbicides and pesticides used in agriculture and of other substances used in enriching mineral resources and their negative impact on nature through water. If necessary, to charge its polluter to recover the related damage on his/her cost.	√	√	10	50	50	-	-	Aimag's CRM and GO, NETD, MEGD, MIA and ASI
2.2	Measure: To increase irrigated crop								
2.2.1	To enable farmers and economic entities in the basin to harvest 25-30% of seedlings of grain and fodders from irrigated area.	√	√	7,000	60	20		20	Aimag's GO and MIA
2.2.2	In implementing Chatsargana (Sea-buckthorn) programme, to involve contribution of every aimag and soum in the Orkhon River Basin under condition of only planting in irrigated area.	√	√	2,000	30	20	20	30	Aimag's GO and MIA
2.2.3	To carry out investigation on whether there is any opportunity of running irrigated farm (vegetables) in areas with a good infrastructure, soil and water resources, to enable local people to own land in there and to provide them with opportunity of supplying own demand by running farm in manners of household, partnership and cooperative and selling excessive products in the market (to organize experience exchange campaign to learn from Orkhon soum of Darkhan-Uul aimag, Murun soum of Khentii aimag and Bulgan soum of Umnugovi aimag as they are experienced in this field).	√	√	3,000	50	20	10	20	Aimags and soums' CRM, GO, AD and MFALI
2.2.4	To carry out auditing in water use status of economic entities and citizens that run irrigated farm in the basin.	√	√	10	50	30	-	20	Aimags' CRM and GO, NETD and DSMIA, soums' GO
2.2.5	To formulate and enforce a methodology for calculating amount of water used in crop.	√		5	80	-	20	-	MIA, MEGD
2.2.6	To launch a new crop irrigation equipment and technology that meets the requirement of efficient water consumption/use.	√	√	-	-	-	-	-	Aimags GO, MIA
	Total of Challenge 2 - water sub-sector 3	**-**	**-**	**15,025**	**54**	**20**	**5**	**21**	**-**
	Total of Water sub-sector 3	**-**	**-**	**36,145**	**46**	**23**	**12**	**19**	**-**

№	1	2	3	4	5	6	7	8	9
WATER SUB-SECTOR 4: WATER FOR environment									
1.	Challenge: Protection of water resources from pollution and scarcity								
1.1	Measure: To protect water resources from pollution and scarcity								
1.1.1	To set boundaries that "prohibited exploration and mining of mineral resources in upstream part of a river where its runoff originated and protection zone of reservoir area" included in the Orkhon River Basin, to put protection sign and to put control on a regular basis.	√		20	80	20	-	-	Aimags and soums' CRM, GO, MEGD, MM, General Agency for Specialized Inspection /GASI/ and RBA
1.1.2	To accustom locals to organise a public clean-up campaign in urban areas located in the vicinity banks of the Orkhon River and its tributaries on Mar 20 in and Oct 01, respectively.	√	√	30	-	60	30	10	Aimags and soums' CRM, GO, NETD
1.1.3	To improve appearance of sources and yields of Shine-Us and Bayanbulag springs in Tsenkher soum of Arkhangai aimag, and Dogzon and Tsagaan Chuluut springs in Mogod soum of Bulgan aimag, and to put them under local protection	√	√	40	-	50	40	10	Aimags and soums' CRM, GO, NETD
1.1.4	To suspend exploration and mining activities at gold deposits in Tsenkher soum of Arkhangai aimag which included in the Law on "prohibiting exploration and mining of mineral resources in upstream part of a river where its runoff originated and protection zone of reservoir area" and to have damaged areas, river channels restored.	√	√	2,000	-	10	10	80	Aimags and soums' CRM, GO, NETD, ASI and MM, MRA
1.1.5	To completely set regimes of protection zones (ordinary, hygienic and special) in reservoir areas and to put protection sign.	√	√	100	30	30	30	10	Aimags and soums' CRM, GO, NETD, DH and RBA
1.1.6	To newly set protection and sanitation zones of Tsenkher spring of Arkhangai aimag and Khuljiin spring of Bulgan aimag, to install water metre in spa resorts over there for controlling hot water consumption and to establish waste water drainage facility.	√		1,000	50	10	-	40	Aimags and soums' CRM, DH, MEGD and RBA, MCUD
1.1.7	To newly set protection zones of Moilt, Must, Khamar and Mogoit springs in Uvurkhangai aimag, Bor Tal, Jarantai, Gyalgar and Shivert hot springs in Arkhangai aimag and Dalt spring in Selenge aimag, and to take measure for restoration and protection of their yields.	√	√	40	-	50	40	10	Aimags' GO, MEGD, DH and RBA,
1.1.8	To establish improved sanitation facilities and toilet with air-channel and with reinforced and normal linings according to MNS 6279:2011 standard in some districts not connected to the central water supply and sewerage network	√	√	4,000	20	10	20	50	Aimags and soums' GO, MCUD
1.2	Measure: To protect aquatic animal and plant resources								
1.2.1	Based on re-study of fishes and birds in Ugii Lake and identification of their reproductive location, to regulate sport hunting and to stop illegal fishing and bird hunting		√	30	50	20	30	-	CRM, GO, NETD, ASI of Ugiinuur soum of Arkhangai aimag and RBA
1.2.2	Public awareness among locals and hunters regarding difference between Taimen sport-fishing (fly fishing) and traditional fishing in the Orkhon River and its tributaries and to raise control to put on there.	√	√	80	50	20	20	10	Aimags and soums' CRM and GO, NETD and RBA

№	1	2	3	4	5	6	7	8	9
1.2.3	To raise control at all levels for protecting aquatic animals, plants and microorganisms during their breeding and reproductive periods.	√	√	-	-	-	-	-	Aimags and soums' CRM and GO, NETD and ASI
1.3	Measure: To restore a traditional custom and launch the appropriate activities								
1.3.1	To study a traditional custom for protecting water resources and to organise public awareness campaign among locals.	√	√	10	-	50	50	-	Aimags and soums' CRM and GO, NETD
1.3.2	To bring beautiful landscapes, historic and monumental values in the Orkhon River Basin under local protection.	√	√	-	-	-	-	-	Aimags and soums' CRM and GO, NETD and RBA
1.3.3	To implement protection work of a beautiful landscape and historic and monumental values in the Orkhon RB with a participation of local citizens, administrations of protected areas and initiative organisations	√	√	400	30	30	30	10	Aimags' CRM and GO, NETD and DSMIA
1.3.4	To prohibit building wooden fences, using wooden columns for construction work in the basin's aimags and soum centres and using green lumber in rural areas for the purpose of building livestock fences, and to learn from and adopt experiences of herdsmen in self-governed Inner Mongolia and Mongolia how they use mud and stones for building livestock fences.	√		30	50	50	-	-	Aimags' CRM and GO, NETD and DSMIA
1.3.5	To limit wood production for frame of Ger /traditional felt tent/ by using green lumber and to systematically enable producers to be provided with forestry materials.	√	√	-	-	-	-	-	Aimags' CRM and GO, NETD and DSMIA
1.3.6	To separate drinking water supply pipelines from industrial water supply pipelines, to reuse treated waste water /from the related urban areas/ in tannery, wool, cashmere and other agricultural secondary product processing factories, to launch a new advanced technology, and to completely stop fresh groundwater sources use in these industries by 2021.	√	√	1,000	80	-	20	-	Aimags and soums' GO, NETD, MIA, MCUD, MEGD
	Total of Challenge 1- water sub-sector 4	**-**	**-**	**8,780**	**27**	**11**	**16**	**46**	-
2.	Challenge: Fight against draught and desertification								
2.1	Measure: Afforestation, Forest protection								
2.1.1	To protect upstream parts of Khangal and Chingel Rivers and spring sources near the Monastery, to plant trees and bushes and to improve appearance.	√		20	-	60	20	20	Bulgan and Orkhon aimags' GO, NETD and ASI
2.1.2	Implementing following measures annually in the basin: to prevent from forest fires, establish lines to stop the distribution of possible fires, fight forest pests/insects	√	√	9*5=4500	-	100	-	-	Relevant aimags and soums' GO, NETD, MEGD
2.2	Measure: To launch the appropriate activities								
2.2.1	To limit logging and wood cutting for main wood use in the territory of Bat-Ulzii soum of Uvurkhangai aimag and Tsenkher soum of Arkhangai aimag.	√	√	-	-	-	-	-	These aimags and soums' CRM, GO and NETD

№	1	2	3	4	5	6	7	8	9
2.2.2	To implement framework to have forest resources owned according to agreement within the framework of the law, to renovate and expand logging brigade in Bat-Ulzii soum and forestation area in Kharkhorin soum of Uvurkhangai aimag, and to newly establish forestation area in Tsenkher, Ugiinuur, Ulziit soums of Arkhangai aimag, Mogod, Khishig-Undur soums of Bulgan aimag, Jargalant soum of Orkhon aimag, Baruunburen soum of Selenge aimag and Tseel soum of Tuv aimag, Erdenetsogt soum of Bayankhongor aimag.	√	√	2,000	30	30	20	20	MEGD, related aimags' NETD
	Total of Challenge 2 - water sub-sector 4	-	-	**6520**	**10**	**78**	**6**	**6**	-
3.	Challenge: Proper use, restoration and increase of water resources								
3.1	Measure: To prepare study								
3.1.1	To have a new study carried out by professional organisation on composition of springs in the basin, to clarify importance of their therapy and medication, to regulate their ownership in the framework of the law and to put the springs under local protection.	√	√	100	60	20	20		Aimags' GO, MH, MEGD
3.1.2	To create eco-environment in a way of establishing reservoir and pond by collecting snow and rain water in possible areas, and to determine possibility of their use in pasture and irrigation in some areas with the participation of a professional organisation.	√	√	500	50	30	20	-	Aimags and soums' GO, NETD, MEGD, MIA
3.1.3	To carry out study and assessment on Ugii Lake's recharge regime, water resource balance, water environment at level of a professional organisation, to plan measures to be taken and to organise its implementation.		√	1,000	50	-	50		MEGD, NAMHEM, Arkhangai aimag's GO and NETD
3.1.4	To carry out study on Khugshin Orkhon River's runoff regime, its recharge specificity and factors that may affect these with the participation of a professional organisation, to plan measures to be taken and to organise its implementation	√		500	50	-	50	-	MEGD, NAMHEM, Arkhangai aimag's GO and NETD
3.1.5	To establish reservoir and water complex for collecting water on the Orkhon River, to formulate the basis of a project to completely use water resources at regional level, and to make an ecological and socio-economic assessments.	√		4,500	20	-	80	-	MEGD, MED (Ministry of Economic Development)
3.1.6	To carry out study on restoration possibility of water resources of Ishgent Lake in Khushaat soum and Tsagaan Lake in Tsagaan-Nuur soum of Selenge aimag with the participation of a professional organisation.	√		50	50	30	20	-	MEGD, MED and ME
3.1.7	To study and implement a possibility of increasing Iven River runoff in Sant soum of Selenge aimag and improving water availability of individual farmers in the river valley.	√	√	2,000	80	10	-	10	MIA and soum' GO
3.2	Measure: To launch the appropriate activities								

№	1	2	3	4	5	6	7	8	9
3.2.1	To learn from experience that uses rain water in sanitation facilities and household crop by collecting rain water on the roof and to organise the framework for implementing it.	√	√	60	-	60	30	10	Aimags' GO, NETD, MCUD
3.2.2	To use rain generator in pasture and crop areas in the Orkhon River Basin, when necessary.	√	√	100	50	50	-	-	Aimags' GO, NETD, DSMIA and NAMHEM
3.2.3	In the event of a positive assessment on the basis for establishing reservoir and water complex and using it at regional level, to start implementation of the project and connect to central region energy systems.		√	Investment issue of this measure shall be decided at a later time, when necessary.					
	Total of Challenge 3 - water sub-sector 4	-	-	**8,810**	**41**	**5**	**21**	**3**	-
4.	Challenge: Prevention and protection from flood disaster								
4.1	Measure: To renovate and newly establish flood protection constructions								
4.1.1	To make assessment of possible flood disaster in Tsetserleg, Bulgan, Sukhbaatar and Kharkhorin cities, Tsenkher and Khotont soum centres of Arkhangai aimag, Tseel soum centre of Tuv aimag, Orkhon and Shaamar soum centres of Selenge aimag, Orkhon and Bulgan soum centres of Bulgan aimag, and Jargalant soum centre of Orkhon aimag, to expand and renovate flood protection construction in the required areas, and to make design/ drawing of and build a new flood protection construction.	√	√	10,000	60	40	-	-	Aimags and soums' CRM and GO, MCUD
4.2	Measure: To launch the appropriate activities								
4.2.1	To plan and implement additional measures to quickly infiltrate water down to soil which is collected by flood protection dyke in the cities of Tsetserleg, Bulgan and Erdenet.	√	√	100	-	60	30	10	These aimags' GO, NETD, MCUD
	Total of Challenge 4 - water sub-sector 4	-	-	**10,100**	**59**	**40**	**1**	**0**	-
	Total of Water sub-sector 4	-	-	**34210**	**37**	**31**	**18**	**14**	-
	WATER SUB-SECTOR 5: WATER management environment								
1.	Challenge: Improvement of legal environment								
1.1	Measure: Regarding legal system								
1.1.1	Newly define surface water possible usable resources in each sub basin and prove them, put control on implementation	√	√	50	100	-	-	-	MEGD, aimags' CRM, GO and RBA
1.1.2	RBC participation in wise use and protection of water source and resources, will be expanded within the framework of law.	√	√	-	-	-	-	-	MEGD, aimags' CRM, GO and NETD, RBA
1.2	Measure: Regarding controlling system								
1.2.1	To set compensation within the framework of the law that imposes on entity/ person that polluted water and made it scarce and to put control on its enforcement.	√	√	-	-	-	-	-	MEGD, aimags' CRM, GO, ASI and RBA

№	1	2	3	4	5	6	7	8	9
1.2.2	To consolidate a synergy of the Basin Council members, activists, locals and nature conservation cooperatives and to put control on enforcement of the legislation.	√	√	40	-	50	30	20	MEGD, aimags' GO and RBA
1.2.3	To provide enforcement of the law on revenue percentage of water resource use payment to spend for measures to protect, restore and increase water resources.	√	√	-	-	-	-	-	MEGD, MF, aimags and soums CRM and GO
1.3	Measure: Regarding organisational framework								
1.3.1	To provide the basin authority and council's participation in setting and enforcing the water supply service payment.	√	√	-	-	-	-	-	Aimags and soums' CRM and GO
1.3.2	To spend compensation that imposed on violation of water resource pollution and scarcity for measures to recover damage or loss.	√	√	-	-	-	-	-	MEGD, aimags and soums' CRM and GO
1.3.3	To establish the Orkhon River Basin Authority and establish environment for implementation of full rights	√		50	100	-	-	-	MEGD, related aimag's CRM, GO and NETD
	Total of Challenge 1 - water sub-sector 5	-	-	**140**	**50**	**20**	**26**	**6**	-
2.	Challenge: Improvement of the managerial structure and organisation								
2.1	Measure: To renovate control and management system								
2.1.1	To create a joint control by carrying out monitoring of pollution and scarcity of water resources, land soil, forest, plant cover, pasture and hay resources at the Orkhon River Basin level with the participation of the related aimag and soums,	√		-	-	-	-	-	Aimags' NETD, DSMIA and RBA
2.1.2	To participate in putting control on implementation of a plan to preserve nature and monitoring programme which determined by environmental impact assessment of any project to be implemented in the basin	√	√	-	-	-	-	-	Aimags and soums' CRM and GO and aimags' NETD, RBA
2.1.3	To improve performance and to renovate management system of organisations in charge of operation and maintenance of the state-owned hydro-constructions which built by finance of the state budget.	√		-	-	-	-	-	The related ministries, State Property Committee /SPC/, aimags and soums' CRM and GO
2.2	Measure: To improve the coherence between the related organisations								
2.2.1	To cohere implementation work of the IWM plan with any project and programme which is being implemented on water resource-related issue in the basin	√	√	-	-	-	-	-	MEGD, aimags and soums' CRM and GO
2.2.2	To study whether it is able to hire a professional inspector in charge of water issue in soums of the basin and to consult with local administration in this regard and have it resolved.	√		-	-	-	-	-	Aimags and soums' CRM, GO and RBA
2.2.3	To strengthen the coherence between the protected areas and their environmental zones, forest cooperatives' activities and Basin Council's work.	√	√	-	-	-	-	-	MEGD, Protected Area Administration /PAA/

№	1	2	3	4	5	6	7	8	9
2.2.4	To strengthen the coherence of the Basin Council with the public administration authority in aimags, soums and bags /sub-soum/ of the basin and civil society organisations that run activities in the field of nature conservation.	√	√	-	-	-	-	-	Aimags and soums' CRM, GO, MEGD, and RBA
2.2.5	To support the Basin Council's work, initiatives by and participation of cooperating organisations, scientists and experts.	√	√	-	-	-	-	-	MEGD, RBA
2.2.6	To put control on implementation of the basin's IWM plan on a regular basis, to establish a joint working group with representatives of local self-managed executive governance and civil society organisations, and to charge the group to work within the scope of legislation	√		-	-	-	-	-	Aimags' CRM, GO, NETD, RBA, MEGD
	Total of Challenge 2 - water sub-sector 5	-	-	-	-	-	-	-	-
3.	Challenge: To strengthen HR								
3.1	Measure: To launch the appropriate activities								
3.1.1	To organise talks and meetings in the field of improving the Basin Council members' knowledge regarding water sector and the related legislation on an annual basis.	√	√	80	50	30	20	-	MEGD
3.1.2	To support the Basin Council members and the council's work and to organise training for the purpose of improving partners' legal knowledge and management skills.	√		60	50	30	20	-	MEGD, RBCA
3.1.3	To work with other Basin Councils and to exchange work experiences.	√	√	20	50	30	20	-	RBA
3.1.4	To assign the jurisdiction of Ecological information and public awareness centre based at Ugii Lake to professional water organisation and to expand its activities.	√		300	80	-	20	-	MEGD, RBA
	Total of Challenge 3 - water sub-sector 5	-	-	**460**	**70**	**10**	**20**	**0**	-
4.	Challenge: Verification of financial sources								
4.1	Measure: To launch the appropriate activities								
4.1.1	To have the Basin Council's right, duties and operation cost sources resolved.	√		-	-	-	-	-	MEGD, aimags' CRM, GO and RBA
4.1.2	To study and implement opportunity to resolve cost of some measures to be implemented at initiative by the Basin Council with the participation of other projects and donators.	√	√	-	-	-	-	-	MEGD, aimags' CRM, GO and RBA
4.1.3	To support participation of local public authorities, other organisations and projects and to improve financial capacity in recovery of the Basin Council's operation cost.	√	√	-	-	-	-	-	Aimags and soums' GO and RBA
4.1.4	To specifically collect water environment use fee from tourism businesses based on negotiation with aimags and soums' governors, and to spend it for measures to implement the IWRM according to a joint resolution.	√	√	-	-	-	-	-	Aimags' CRM, GO, NETD, RBA, MEGD
	Total of Challenge 4 - water sub-sector 5	-	-	-	-	-	-	-	-

№	1	2	3	4	5	6	7	8	9
5.	Challenge: Improvement of local administration and citizens' participation								
5.1	Measure: To cohere with development programmes of aimags and soums								
5.1.1	To identify the possibility of tackling water resource-related issue amid regional, aimags' and soums' development programmes and objectives which are subject to the Orkhon River Basin.	√	√	-	-	-	-	-	Aimags and soums' CRM, GO and RBA
5.1.2	To improve the coherence between the public administration centres in charge of environmental issues and implementing agencies in charge of water issue, and public administration authorities in aimags and soums.	√	√	-	-	-	-	-	MEGD, aimags and soums' GO
5.1.3	To assess the possibility of tackling water resource-related issues in implementing the sectors' development programmes and objectives.	√	√	-	-	-	-	-	Ministries and agencies of all the water using sectors, MEGD
5.2	Measure: To increase participation of the related organisations and citizens								
5.2.1	To implement recommendations resulted from the research work which previously carried out in the field of creating a convenient environment for water bird breeding, migration and stopover, fish and aquatic animals in Ugii Lake (joint study in cooperation with MEGD and JICA in 2005, etc)	√	√	50	30	30	20	20	CRM, GO in Ugiinuur soum of Arkhangai aimag, and aimag's NETD and RBA
5.2.2	To assign ownership of hay field and riparian vegetation (brushwood and aspen, etc) on island and floodplain of the Orkhon River and its tributaries to local citizens, and to expand forest conservation cooperatives.	√	√	20	-	40	40	20	Aimags and soums' CRM and GO and aimags' NETD
5.2.3	To organise restoration work in the Orkhon River Basin with the participation of professional organisations, protected area administrations, local citizens and forest conservation cooperatives.	√	√	80	30	30	20	20	Aimags and soums' CRM, GO, MEGD and PAA
5.2.4	To set and enforce a new procedure, prior to tackling any issue related to water resource management, that submits the issue to the related local citizens and experts, and considers their proposal and request.	√		-	-	-	-	-	Aimags and soums' CRM, GO, NETD, MEGD, RBA
5.2.5	To set and enforce a new procedure that makes a resolution after hearing water resource-related proposals and requests from local citizens' initiative organisations and professional associations at decision-making level, and after submitting locals a draft resolution and mutual understanding.	√		-	-	-	-	-	Aimags and soums' CRM, GO, NETD, MEGD, RBC
5.2.6	To make the water resource management plan in a way of which its outcome completely meets local citizens' demand and doesn't conflict their interest.	√	√	-	-	-	-	-	Aimags and soums' CRM, GO, NETD, MEGD, RBA
5.2.7	Public administrative and civil society organisations including Tushee Gun association, Orkhonii Duu Khooloi NGO, Administration of Orkhon Valley National Park Conservation in Uvurkhangai aimag and Ariun Suvraga and Ugii Nuur NGOs in Arkhangai aimag, etc shall support the Basin Council's cooperation.	√	√	-	-	-	-	-	Aimags and soums' CRM, GO, NETD, MEGD, RBA
5.2.8	To organise 'We are the same river's' campaign in order to involve aimag and soums' people of the Orkhon River Basin in water management.	√	√	10	20	20	30	20	Aimags and soums' GO, CRM, RBA, NETD, MEGD
5.3	Measure: To launch the appropriate activities								

№	1	2	3	4	5	6	7	8	9
5.3.1	To carry out cleaning in the forest at the basin level and to take measure to launch a new technology that uses dead wood.	√	√	100	50	20	20	10	Aimags and soums' GO, MEGD
5.3.2	To have the guilty entity/person carried out restoration on damaged area suffered from exploration and mining of mineral resources in cooperation with local public organisation, civil society organisation and local citizens.	√	√	-	-	-	-	-	Aimags and soums' CRM, GO, NETD, MNET, WA and RBC
5.3.3	Destinations which are able to develop aimags that included in the Orkhon River Basin based on the integrated water resource management: Arkhangai aimag: pastoral farming-dominated farms, tourism, milk products, livestock product processing factories, crop farming and domestic wooden products factories Bulgan aimag: animal husbandry combined with pastoral and non-pastoral farming types, crop farming, tourism and agricultural products processing factories Orkhon aimag: Manufacturing factories based on mining products, intensive animal husbandry and irrigated crop Uvurkhangai aimag: pastoral farming-dominated farms, tourism, spa resorts, irrigated crop and domestic wooden products factories Selenge aimag: Crop farming, sea-buckthorn, fruits and vegetables processing factories, intensive animal husbandry, and pig and bee farms.	√	√	8,000	30	20	20	30	Aimags' CRM, GO and MED
	Total of Challenge 5 - water sub-sector 5	-	-	**8,260**	**30**	**20**	**20**	**30**	-
6	Challenge: Study, monitoring, database and public awareness								
6.1	Measure: To expand study and monitoring network								
6.1.1	To select temporary water resource and quality monitoring points on some small rivers in the Orkhon River upstream part and to carry out measurement on a quarterly/seasonal basis.	√	√	40	80	20	-	-	NAMHEM, Institute of Meteorology and Hydrology /IMH/ and Uvurkhangai aimag's DMHEM
6.1.2	To establish regular water pollution monitoring points in the Khugshin Orkhon, Orkhon-Tuul and Orkhon-Khangal confluences, South and North Tamir, Shariin, Kharaa and Eruu Rivers which located in the Orkhon River midstream part.	√		90	100	-	-	-	NAMHEM and IMH
6.1.3	To expand the basin's environmental monitoring network, to prepare water inventory and to create a database.	√		50	50	-	50	-	RBA, NAMHEM and IMH
6.1.4	To carry out a complete study on environmental ecosystem related to establishing reservoir and water complex on the Orkhon River.	√		300	30	-	60	10	MEGD
6.1.5	To renovate equipments to carry out a hydrological and water quality study in the Orkhon and Selenge confluence.	√	√	300	50	-	50	-	MEGD, NAMHEM and Selenge aimag's DMHEM
6.1.6	To carry out a regular measurement on groundwater monitoring points which newly established in the Orkhon River Basin and to inform its results on a regular basis.	√	√	40	-	100	-	-	The related aimags' NETD and RBA

№	1	2	3	4	5	6	7	8	9
6.1.7	To establish regular operating points in areas which can represent annual pasture and hay crop, and to carry out monitoring in particular months.	√		-	-	-	-	-	Aimags' NAMHEM and AD, and soums' GO
6.1.8	To plan that local citizens to be the first force to prevent from any forest or steppe fire and extinguish the fire, and to create express data and information network which will be operated in the event of fire.	√		-	-	-	-	-	Aimags' NETD
6.2	Measure: To improve data processing and public awareness of its outcome								
6.2.1	(Data) processing on outcome of water resources study, observation and inventory on the ground of science and to create the integrated database of the basin.	√	√	80	80	20	-	-	NAMHEM and IMH
6.2.2	To provide information regarding the duties of Mongolian and Russian side and its implementation at the Orkhon River Basin level according to the agreement on transboundary water.	√	√	-	-	-	-	-	MEGD
6.2.3	To create a system that immediately provides the related aimag and soums' citizens with the results of analysis carried out by the regular and temporary water resource quality monitoring points.	√		-	-	-	-	-	MEGD, NAMHEM and aimags' NETD
6.2.4	To release a poster showing general status of overall polluting sources including wastes from activities, urban areas and constructions, and water polluter originated from crop farming and animal husbandry which all negatively affect water resources and natural resources in the Orkhon River Basin, and to organise public awareness campaign.	√		10	40	40	20	-	Aimags' NETD and RBC
6.2.5	To publicly announce the Orkhon River Basin's IWM plan and its implementation process, achievement and drawback through local publications and media on a regular basis.	√	√	5	-	5	-	-	RBC and aimags' NETD
6.3	Measure: To launch the appropriate activities								
6.3.1	To accustom people to show respect for image of the Luvaanjalbuu god painted on the rock located in the territory of Orkhon soum in Selenge aimag and the Monastery that chants for nymphs and demons which built on the ruin of an old temple in Kharkhorin soum in Uvurkhangai aimag, and to organise eco-tourism and cognition training every year based on above places.	√	√	80	30	30	30	10	RBC and aimags' NETD
6.3.2	To prepare handbook serials for people and total water consumers with regard to saving water and to make it more socialized.	√		10	-	-	10	-	MEGD and aimags' NETD and RBC
6.3.3	To publicly announce the Orkhon River Basin's IWM plan and its implementation process, achievement and drawback through local publications and media on a regular basis.	√	√	5	-	5	-	-	MEGD, NAMHEM, aimags and soums' CRM, GO, NETD and RBC
6.3.4	To make a documentary showing the appropriate measures to be taken in the field of protection and efficient use of water resources and increase of water sources at the Orkhon River Basin level.		√	100	40	30	20	10	MEGD, NAMHEM, aimags and soums' CRM, GO, NETD and RBC

№	1	2	3	4	5	6	7	8	9
	Total of Challenge 6 - water sub-sector 5	-	-	1,1310	47	11	38	4	-
	Total of Water sub-sector 5	-	-	9,970	34	19	22	25	-
	GRAND TOTAL	-	-	166,165	43	21	15	21	-

Remarks:

- *Required investment calculation is as of 2010 year cost.*
- *Hydropower plant is planned to be constructed at soon-to-be-built (water accumulating) reservoir and water complex on Orkhon river. It is one of the main measures to compensate the investment benefits of the complex.*

9. THE ORGANIZATION AND CONTROL OF THE ACTIVITIES TO IMPLEMENT THE ORKHON RIVER BASIN IWM PLAN

9.1. River basin IWM plan guidelines

The river basin IWM plan was developed based on surveys of river basin water resources, supply, water consumption-use and water sector issues. The stakeholders and organizations need to organize the implementation of this plan. The river basin IWM plan will be implemented in 2 phases between 2013-2015 and 2016-2021 in relation with the "MDG-based National Comprehensive Development Strategy" and other relevant policies. It is required to estimate the investment needs according to guidelines of the sector's general budget administrator and to include these in the state budget to prepare the coming years' budget on implementation of activities by stakeholders. The general scheme of the plan implementation is presented in Figure 101.

Figure 101. Scheme of the river basin IWM plan implementation

The following things are defined in the river basin IWM plan: activity plan, required budget, planning of the implementation of the measures, main implementers and stakeholders. According to the Mongolian Law on Water, the Orkhon river basin IWM plan is developed by the river basin authority and it is approved by the Government member responsible for environmental issues based on relevant aimag and soum Citizen Representative Khural recommendations and support. The relevant aimag and soum CRK and governors are responsible for organizing measures and activities of the plan in the basin. The Orkhon river basin authority will provide the professional management.

The Government members in charge of the relevant sectors, their professional agencies, centers and research organizations will participate in the implementation, management and organization of the plan implementation activities. The plan implementation activities will be organized in coordination with the "Water" national program and the "Millennium Development Comprehensive Policy" implementation activities and their results. According to the concept to stimulate the regional economical development, amendments can be made by discussing with the MEGD while implementing the plan to support the regional, aimag and soum development. It is required to create a suitable environment that stimulates participation by all parties in order to implement the river basin IWM plan. In the IWM plan of Mongolia, attention will be paid to the legal environment required for implementing the IWM plan in each phase. The improvement activities are included. MEGD will play a key role. The river basin authority is responsible for managing activities, ensuring all stakeholders' equality in the plan implementation.

9.2. Stakeholders to implement the river basin IWM plan and their duties

The stakeholders' role is vital for implementing the river basin IWM plan. Their participation and activities are connected to a successful implementation of the plan. But their duties are not the same when addressing basic issues and implementing measures.

The stakeholders' role is presented in Table 108. The stakeholders are classified as follows:

- **Initiator:** to lead the implementation of measures and to lead other stakeholders; to organize. It is marked by (+) in the table.
- **Partner:** to participate actively in the implementation of measures, but will not play a key role. It is marked by (**).
- **Consultant:** their interests are met by the implementation of the measures; it is possible to give their opinions and advice, but their words will not play a key role in implementation of the measure. It is marked by (*) in the table.

The stakeholders should include measure in a detailed way in the annual sectoral action plan. It is one way to implement the river basin IWM plan successfully.

9.3. Financial sources for implementation of the river basin IWM plan and means of finance

Some 166.2 billion tugrugs investment is required for the implementation of the Orkhon river basin IWM plan (Table 107).

Table 107. Budget of river basin IWM plan

Challenges	Required budget amount, *mln tugrugs*
Challenge 1. Water for people	49,620
Challenge 2. Water for industry	36,220
Challenge 3. Water for agriculture	36,145
Challenge 4. Water for environment	34,210
Challenge 5. Water legal environment and administration	10,015
Total required investment	166,210

Most of the required investment will be used for addressing the population drinking water supply issues.

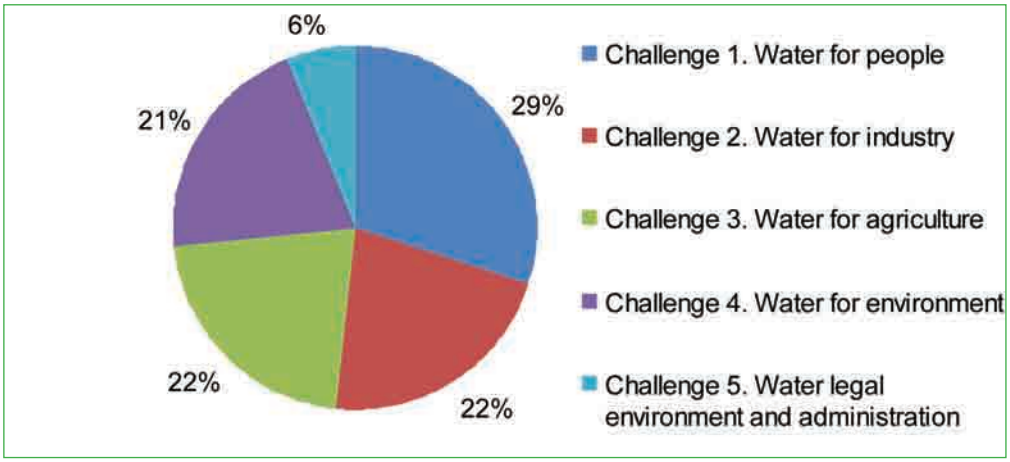


Figure 102. Investment structure of the river basin IWM plan

The following was used when defining the required investment: budget of previously-developed similar projects and expenses defined by increased assessment of projects. As for measures included in other projects and programs, they are included in the calculation with their established expenses. The assessment is based on the 2011 cost.

Table 108. Stakeholders' roles in the implementation of river basin IWRM

Sub-sector	Challenges and measures	MEGD	MCUD	MIA	MT	MM	ME	MCST	MH	MED	SPIA	NEMA	MF	Aimag and soum CRM and GO	RBA	NGOs	Required investment, million tugrugs	Start year	End year
Sub-sector 1: Water for people	Challenges: Urban and rural area population safe drinking water and waste water treatment																26,200	2013	2021
	To improve drinking water supply source, their protection and water quality monitoring	**	+				*						*	+	*	*	8,600	2013	2021
	To expand water supply pipelines and improve availability of kiosks		+										*	+	*		7,000	2013	2021
	To expand waste water treatment facility and construct new ones	**	+										*	+	*	*	10,600	2013	2021
	Challenges: Public utilities water supply																15,300	2013	2021
	To improve water supply		+										*	+	*	*	5,000	2013	2021
	To improve monitoring of water use registration and fees		+										*	+	*	*	300	2013	2021
	To connect to the integrated networks of waste water; construct small size WWTP		+						**				*	+	*		10,000	2013	2021
	Challenges: Sanatorium and tourism water supply																510	2013	2021
	To improve water supply		**					+	*					+	*		60	2013	2021
	To improve sanitation, to introduce new technology		**					+	*					+	*		450	2013	2021
	To introduce tourism activity in collaboration with RBA													**	+	*	-	2013	2015
	Challenges: Rural population drinking water supply																7,610	2013	2021
	To improve water supply		**	**									*	+	*		7,610	2013	2021
Sub-sector 2: Water for industry	Challenges: Food and light industry water supply																13,620	2013	2021
	To improve water supply		**	**									*	+	*		6,120	2013	2021
	To develop industrialization		**	**									*	+	*		7,500	2013	2021
	Challenges: Mining and processing industry water supply																12,100	2013	2021
	To improve water supply of urban area (where there are mining and processing industries) population		**	**					*				*	+	*	*	3,000	2013	2021
	To prevent water resources from pollution and scarcity	+				**							*	*	+	*	9,100	2013	2021
	Challenges: Energy industry water supply																2500	2013	2021
	Wise use of water resources	**					+						*		**	*	1,500	2013	2021
	To use water energy	**					+							**	*	*	1,000	2013	2021
	Challenges: Construction and building material production water supply																8,000	2013	2021
	Wise use of water resources	*												+	**	*	8,000	2013	2021

Sub-sector	Challenges and measures	MEGD	MCUD	MIA	MT	MM	ME	MCST	MH	MED	SPIA	NEMA	MF	Aimag and soum CRM and GO	RBA	NGOs	Required investment, million tugrugs	Start year	End year
Sub-sector 3: Water for agriculture	Challenges: Livestock water supply																21,120	2013	2021
	To improve pasture use	**		+										+	*	*	5,040	2013	2021
	Pasture irrigation	*		+										+	*		16,080	2013	2021
	Challenges: Farming irrigation																15,025	2013	2021
	To improve use of tenure lands			+									*	**	*	*	3,010	2013	2021
	To increase irrigated farming			+									*	**	*		12,015	2013	2021
Sub-sector 4: Water for environment	Challenges: Prevent water resources from pollution and scarcity																8,780	2013	2021
	To prevent from pollution and scarcity	+	**										*	**	+	*	7,230	2013	2021
	To protect aquatic fauna and flora species	**											*	+	**	*	110	2013	2021
	To introduce activities that restore traditional methods	*											*	+	+	*	1,440	2013	2021
	Challenges: To fight with aridity and negative aspects of desertification																6,520	2013	2021
	Forestation	+											*	**	**	*	6,520	2013	2021
	Challenges: Wise use, restoration and expansion of water resources																8,810	2013	2021
	Research process	**											*	*	+		8,650	2013	2021
	To introduce appropriate activity	+											*	**	+		160	2013	2021
	Challenges: To prevent from water flood damages																10,100	2013	2021
	To renovate flood protection facilities and construct new one		+									**	*	+	**		10,000	2013	2021
	To introduce appropriate activities											**		+	+		100	2013	2021

Sub-sector	Challenges and measures	MEGD	MCUD	MIA	MT	MM	ME	MCST	MH	MED	SPIA	NEMA	MF	Aimag and soum CRM and GO	RBA	NGOs	Required investment, million tugrugs	Start year	End year
Sub-sector 5: Establishing enabling environment for water management	Challenges: To improve legal environment																140	2013	2021
	About legal structure	+												**	*	*	-	2013	2021
	About monitoring structure	+									+			**	**	*	40	2013	2021
	About organization	+									**			**	+		100	2013	2021
	Challenges: To develop administration structure																-	2013	2021
	To renovate structure of monitoring and administration	+												*	+		-	2013	2021
	To improve work coherence with relevant organizations	+												*	+		-	2013	2021
	Challenges: Strengthening human resources																460	2013	2021
	To introduce appropriate activities																460	2013	2021
	Challenges: To ensure financial sources																-	2013	2021
	To introduce appropriate activities	+											**	+	**		-	2013	2021
	Challenges: To increase participation of local area administration and citizens																8,260	2013	2021
	To be related to aimag and soum development programs	*												**	+	**	-	2013	2021
	To increase participation of relevant organizations and citizens	*												**	+	**	160	2013	2021
	To introduce appropriate activities	*												**	+	**	8,100	2013	2021
	Challenges: Studies, monitoring, database and advertisements																1,155	2013	2021
	To expand network of studies and monitoring	+											*		+		870	2013	2021
	To improve data processing and result advertisements	**											*		+		95	2013	2021
	To introduce appropriate activities	**											*		+		190	2013	2021
Total amount																	166,210	2013	2021

Explanation: + *Initiator: to lead the implementation of measures and to lead other stakeholders; to organize.*
** *Partner: to participate actively in the implementation of measures, but will not play a key role in it.*
* *Consultant: their interests meet with implementation of measures; it is possible to give their opinions and advice; their words will not play key roles in implementation of measure.*

The required budget for the implementation of the plan will consist of the following sources:

- State budget
- Local area budget
- Projects, programs
- Other sources

Some 45 percent of the total investment is from the state budget, 17 percent is from the local area budget, 17 percent is from project and program budgets and the remaining 21 percent is from other sources. The other sources include: Development Fund of Mongolia, Science and Technological Fund, Fund for Natural Resources Conservation, foreign and local as well as international organizations' loans and aid, citizens' and entities' aid for water measures. The expense of the measures planned to be implemented is to be included in the sector's general budget for financing. The measures will be financed based on article 7.3 of the Mongolian Law on Water (pollution fee) and on article 18.1 (natural resources use fee). The income from the water pollution fee and the water use fee will be collected in a fund for natural conservation according to the annual budget. The river basin IWM plan measures, implementation of activities, reports and data on finance will be open for the public to obtain the trust of investors and donators.

9.4. Risk management

While implementing the IWM plan, there might be risks related to activities and natural factors. The risks and their management which might occur while implementing the Orkhon river basin IWM plan are included in this sub-chapter.

9.4.1. Activity risks which might occur during the implementation of the project

When implementing the Orkhon river basin IWM plan successfully, several types of risks may occur: environmental condition, economy and finance, level of infrastructure development, administrative structure, work force, availability of specialized workers, their capacity, discipline and initiative and work responsibility. The measures, to define risks correctly, to prevent from risks and to decrease the potential loss, will be planned and it is vital.

Policy and administrative structure risk. The risk which may occur first is that at the level of decision-makers, water issues are not assessed fully and relevant decisions may not be made in time. All economical activities are related to water and they have an impact on water resources and water quality. So before making economic development related decisions on constructing hydro constructions, decision-makers should have required knowledge and data on negative impacts on water resources by implementing the measures. The state executive governance structure in Mongolia is not stable in the upper and middle stage. It is changed due to the result of parliamentary elections. Along with these changes, the following has been observed: specialized state administration employees are not stable enough; their knowledge, capacity and work method do not meet current requirements.

In the long run, there will be risks due to instability of executive governance when implementing the management plan. There will be positive impacts in the sector activities when choosing an employee (who manages, implements and administrates) who has a good reputation among sector's employees and has good work experience in the

field. There are gaps and overlaps in the current water sector administration structure, units and experts' duties and rights.

These may pose risks when implementing the river basin IWM plan. There is not a structure that integrates water issues in the sectors at the level of decision-making. It is just in its infant age. It increases this type of potential risk. The work coherence and policy management of general orientation and specific orientation ministries, local area administration, public and private entities in water sector and their representative organizations are not enough. This poses a risk as well.

One of the main principles of IWRM is that stakeholders cooperate and that they are responsible for their duties in order to implement the IWM plan. But in our condition, as for legal matters, data exchange among organizations is available and data from state organizations is open for public.

But having data or information takes much time. Depending on some stakeholders' features, some types of data are not available or are limited. Maybe there will be a risk to implement the management plan since discussion on transboundary water was unsuccessful. For example: due to impacts on downstream ecosystems, there might be a risk in constructing hydro constructions. This issue should be included in the transboundary water agreement and it needs to be solved. In 2011, the Orkhon river basin council was established. It was vital for implementing this plan. But this organization is new and young, and it will take time to be noticed by public and finance also is needed. RBC and RBA will play a key role for developing cooperation between the stakeholders.

Financial risk. This is one of the biggest risks that can occur during the implementation of an IWM plan. The Mongolian economy depends on the world market. It is the reason that investment and activity risks occur. The investment is from state budget and foreign loan. In most cases, it is difficult to compensate expenses. It increases sector's investment risks. On the other hand, sector activity expenses are mostly from state budget and water supply companies finance themselves by their own income. They can not compensate service expense at the moment, so there is a high probability of risk. For example: according to the 2011 auditing on activity and financial reports of entities that have special permission on public manufacturing and service, Orkhon aimag's Erdenet mining industry's energy factory had a loss of 5778.4 million tugrugs in 2010. The Mongolian economy is growing strong and international grants and loans are decreasing gradually. Loan conditions are likely to be strict and it can cause a decrease of investment sources. In this condition, water sector's capacity to finance itself needs to be increased and there needs to be a special fund to accumulate money. It is included in the plan. As mentioned earlier, letting people realize about water value is one way to decrease potential risks.

Environmental risks. Economical development, especially development of industrialization exerts pressure on environmental quality. When industrialization increases, the amount of wastes discharged into the environment increases along with it. It impacts on expenses. So, one of the methods to prevent from this kind of risk is to let people realize about environmental conservation. In the plan, prevention of water resources from pollution and its rehabilitation measures are included.

Figure 103. Orkhon river channel is damaged by mining activities

Water pollution is one of the environmental risks. It has a negative impact on people's health. It also belongs to social risk. Discharging fluid and solid wastes into the water environment has much social and economical damage. People need to realize this and it is one of the ways to prevent from potential risks and damages.

Social risks. It is mostly connected to public awareness formation. People perceive water as simple daily demand and they do not fully understand that their approach can have negative impacts on water resources and quality. In other words, they do not notice that their approach on wise use of water and water protection has some sort of influence in water resources. On the other hand, water price does not compensate expenses. This is socially-oriented and it decreases the true understanding of water value. In terms of economy, it causes an obstacle to develop this sector's independent status.

There are 2 principles: polluters pay and water users pay. By implementing these 2 principles, it will be a big help to develop wise use among the public and people will realize what they pay for. One example is that our citizens are accustomed to price increases of some items and they are sensitive to water price increases. So people's understanding on water value needs to be developed. Their understanding on river basin IWRM is low, so their participation in the implementation of the plan is insufficient. It can cause a risk since they do not care about river basin organizations' activities. Some sort of training needs to be organized among the residents. It can decrease risks.

Technical risks. As for our country, for construction of hydro constructions and its renovation, approved-in-other-countries technology is used. So this kind of risk is low. The risk can occur when using technology that is not suitable for an extreme climate. Recently there has been much talk about reuse of water. Our country has little experience on it. It can cause risks related to health and society. These measures need to be implemented based on reliable studies and tests.

The ways to prevent these risks are to improve information exchange between stakeholders who introduce technologies and to improve database activities. The information should not be considered as technology for small groups. For example: water resources amount and quality data is vital for decreasing risks that occur during installation and choice of the technology.

9.4.2. Natural and uncertainty risks

Climate change. Natural risk is related to the change of the Mongolian climate. The climate change is observed as air temperature change. According to the last 10 years' survey results, temperatures increased and are likely to increase further according climate models. According to climate change HADCM3 model, Orkhon river basin average air temperature will increase by 3.2˚C in winter and 5.7˚C in summer by the year of 2100. However the future perspective of river flow and evaporation change are relatively uncertain.

According to most of the global climate model calculations, evaporation is likely to increase. According to the result of hydrological PCRGLOB-WB model (which used 10 models' results), flow/runoff will be increased in all seasons of the year. As for climate change HADCM3 model calculation, runoff will be decreased in summer. The uncertainty of runoff change future shows that future runoff might be different from the current runoff. In order to decrease risks, average flow should be taken by upper and lower estimates in the plan. It is included in the plan scenarios.

Air temperature increases can have a strong impact on soil evaporation and plants. When temperatures increase, evaporation increases as well. But it does not impact directly on precipitation. Due to this, plant growing conditions will worsen and desertification increases. The speed of the change is uncertain but it is certain that soils will dry and the situation will worsen. According to the Mongolian desertification map from Geo-Ecology Institute of Mongolian Academy of sciences, some 24,682.3 km^2 of the Orkhon river basin or 45.9 percent has observed desertification in some ways and 2.9 percent or 1,561.2 km^2 has observed strong desertification. There is pasture degradation in flood plain area. The desertification and land degradation is increasing and it is the issue for our country since we have pasture livestock. Currently our country is implementing "National Program for Fighting Desertification".

When the changes increase, natural disasters increase as well. In other words, drought or flood frequency will increase.

Earthquake. Earthquakes can cause risks for the implementation of the management plan. The territory of Mongolia is located in the active earthquake zone of Central Asia. Selenge and Bulgan aimags of Orkhon river basin are in the high earthquake active zone. Some 15 percent of the strong earthquakes in Mongolia happened in the Orkhon and Selenge areas. There was a 7.5 magnitude earthquake in Mogod area in January of 1967. There were damages on facilities and constructions in the following areas: Orkhon, Saikhan, Khishig-Undur and Bulgan soums of Bulgan aimag; Khashaat, Tuvshruulekh, Ugiinuur, Ulziit and Tsetserleg soums of Arkhangai aimag.

Earthquake-related issues should be included in the layout of hydro constructions of soum centers near active earthquake zones. It will prevent potential risks.

Flood damage. Spring yellow water floods and summer rain water floods are observed in all rivers of the Orkhon river basin. High runoff of summer rain water flood is always more than that of spring yellow water floods. So during summer rain floods, much loss is inflicted on residents and entities. There is a probability that a 800-1000 m^3/sec flood flow happens once in 100 years along the Orkhon River.

Figure 104. Flood in Orkhon aimag in July, 2012.

In July 2012, there was much precipitation in all areas. Two people lost their lives during the flood in Orkhon aimag and some 300 households' gers were flooded with water. The roads, bridges, electricity poles and field of vegetables were destroyed and damaged. Fresh water pipelines were damaged as well. In Khushaat soum of Selenge aimag, 45 ha crop field of 48 households was destroyed due to the flood. As for our country, hydro constructions calculation is conducted with 1 percent probability. The rain water floods are increasing each year. The risk of large precipitation in a lifetime period needs to be calculated.

Forest and steppe fires. It is one of the uncertain risks in our country. There is 8,005 km^2 forest in Orkhon river basin. When forest resources decrease, forest cover's natural properties that manage river flows, are decreasing. Due to it, river water regime is changed and annual flow is decreased as experts say.

Release of chemical substances and hazardous substances. One of the risks in the basin is the release of hazardous chemical substances. There are many entities that use chemical substances and manufacture chemicals in the basin. It increases the risks. For example: Khangal river, an affluent river of the middle section of the Orkhon river, has polluted water which has the highest mineralization and hardness. The mineralization and azote in the water below where the Khangal River joined the Orkhon River, exceeded the standard. It has been observed many times. Orkhon river water mineralization increased, hydrochemical content for example, ratio of anions in water changed and sulphate ion percentage increased a lot.

Drought, famine. There are periods with low precipitation in our country. The scarcity of water resources has negative impacts on pastoral animal husbandry and agriculture. Between 1999 and 2002, some 50-70 percent of the total territory was affected by a gigantic drought and many rivers, ponds and lakes dried and much loss was inflicted on animal husbandry. At that time, agriculture especially grain production suffered. Implementing an objective to have 100 percent supply of vegetables and 25-30 percent supply of fodder from irrigated areas in 2021, is one of the main measures to decrease drought risks that occur a lot in the agricultural sector.

So irrigation measure itself has to have little risk. Famine causes much damage in our country since we have nomadic animal husbandry. According to the researches conducted since 1945, there were 12 occurrences of famine with a frequency of 1-10 years. Due to the 2009-2010 dzud, 8 million livestock was lost and 8.5 thousand households lost all of their livestock. About 32.7 thousand households lost some 50 percent of their livestock. A dzud occurring after a summer drought causes much damage. The drought and famine do not have a direct risk for the implementation of

the IWM plan. The risk occurs through population employment, living standard and migration.

Natural risk management. The government approved a Law on Protection from Disasters in 2005. In 2011, the state policy on protection from disasters and national program to strengthen the capacity to protect from disasters, were approved and are being implemented. According to the state policy, the IWM plan implementing organizations and stakeholders will participate actively in the following: "Country's stable socio-economic development will be provided through the activities including strengthening management structure to protect from disasters, teaching people how to live safely, decreasing disaster's vulnerability, providing participation of local area state organizations, professional organizations, private entities and residents in the activities to protect from disasters".

9.5. Indicators of plan implementing activity results

The river basin IWM plan plays an important role in the implementation of the Millennium Development Objectives of Mongolia, the "Water" National Program and the development programs of the regions and aimags. The following main results will be achieved by implementing the plan:

- Protection of river basin urban areas' drinking water supply sources; conducting extra groundwater research for Bulgan, Tsetserleg and 25 soum center water supply sources; re-estimating resources; rehabilitating facilities and installing water purifiers and softeners; by doing so, it will be possible to supply more than 80 percent of river basin population with safe drinking water sources.
- No less than 30 percent of the suburban district households of Kharkhorin, Tsetserleg, Bulgan, Erdenet and Sukhbaatar cities will have kiosks connected to the central water supply networks.
- By introducing technology that improves population drinking water supply and uses water wisely, the daily water demand of one person of households with a connection to the central network will be decreased to 160 l/day and the ger district and rural area daily water demand will be increased to 20-25 l per person.
- Improved water supply of urban area districts' and soum centers' hospitals, schools, kindergartens and public utility services; water metering their water demand; connecting them to the waste water integrated networks or constructing small-size WWTP; supporting the establishment of healthy and safe environment for people.
- To introduce new technology and equipment for waste water treatment, disinfection and discharging facilities at river basin sanatoriums and tourist camps that have no water supply networks; by doing so a comfortable environment for tourists can be established.
- River basin water users will be included in the water auditing and water use will be totally water metered.
- Aimag center and cities' small and medium light and food industries will be connected to the central water supply and sewerage networks; to improve small food industry water supply in soum centers.
- To stop activities to extract natural resources in the upper part of the Orkhon river basin runoff-forming area; conducting technical and biological rehabilitation; abating permission to use gold deposits according legal restrictions; to stop

distribution of exploration permissions in the basin.

- To increase reuse of mining production water.
- Part of investments required for drilling new boreholes and rehabilitating existing ones in the pasture will be collected from users including herder groups and partnerships; they will be responsible for use, protection and rehabilitation of the boreholes.
- The size of irrigation areas will reach 11 thousand ha and the harvest from one hectare will increase. In total 25-30 percent of grains and fodders will be harvested from irrigation fields.
- The boundaries in the Orkhon river basin will be defined along water bodies and river runoff-forming sources where "natural resource exploration and use are prohibited"; the boundaries will be signed and will be under regular protection.
- To rehabilitate spring sources in the following areas: Shine-Us and Bayanbulag of Tsenkher soum of Arkhangai; Bat-Ulzii soum center springs of Uvurkhangai; Dogzon and Tsagaanchuluut springs of Mogod soum of Bulgan; Khangal and Chingel rivers' upper part springs of Bulgan and Orkhon aimags; springs near Lam monastery. To define protection and sanitation zones at hot spas of Moilt, Most, Khamar, Mogoit of Uvurkhangai aimag and Bor tal, Jarantai, Gyalgar and Shivert of Arkhangai aimag as well as Dalt hot spa of Selenge aimag. The yield will be protected.
- To separate domestic drinking water pipelines from industrial water supply pipelines; to introduce modern technology that reuses urban areas treated water at industries which produce agricultural products including tanneries, wool and cashmere. The use of groundwater sources will be stopped before 2021.
- To study the possibility to rehabilitate water resources of Khugshin Orkhon and Ugii and Ishgent lakes in the level of professional organization; assessment will be given and required measures will be organized.
- Water complex and reservoirs will be constructed on Orkhon River; project basis for water resource use in the region will be developed; ecological and socio-economic assessment will be conducted; if assessment is positive, hydropower projects will be implemented and there will be a connection to the central region energy system.
- Potential flood damage assessment will be conducted in following areas: Tsetserleg, Bulgan, Sukhbaatar, Kharkhorin cities; Tsenkher and Khotont soum of Arkhangai; Tseel soum of Tuv aimag; Orkhon and Shaamar soums of Selenge aimag; Orkhon soum of Bulgan aimag; Jargalant soum of Orkhon aimag. Flood protection facilities will be constructed in required areas.
- Conducting inspection and monitoring on Orkhon river basin water resources pollution, scarcity, land soil, forest, plant cover and pasture resources with the participation of relevant aimags and soums.
- To improve the activity of organizations responsible for hydro constructions' (owned by state and constructed from state budget) use and maintenance; administration structure will be renewed.
- River basin council activities, related to state administration organizations of river basin aimags, soums and bags and civil social organizations operating in the field of environmental protection, will be strengthened.
- Water resources and quality monitoring temporary points will be chosen at some

small rivers in the upper part of the Orkhon river basin and measurements will be conducted in each season; regular water pollution monitoring points will be established at 9 rivers including Khugshin Orkhon, Orkhon-Tuul and Orkhon-Khangal confluence, Tsenkher river, Urd and Khoid Tamir rivers, Shariin river, Kharaa and Eroo.

The Orkhon river basin plan implementation will be assessed by the following indicators:

- Population percentage that use water from safe drinking water sources
- Percentage of population who have connection to central water supply networks
- Water demand per person
- Percentage of population who have connection to improved sanitation
- The use of urban area sewerage and WWTPs;
- Urban area and public entities' water supply service and growth of water availability;
- Availability of sanatorium and tourism water supply and sewerage facilities; technological development;
- Water supply of industries, construction and building material productions; water use measures and activity growth;
- Their waste water quality and composition improvement;
- Water saving per unit product;
- Agricultural irrigation measures, activities, for example: number of water points for pasture livestock;
- Harvest growth of irrigated harvest field, technological development;
- Number of purified water sources that belong to natural water areas;
- Growth of length (treated/purified section) along the rivers;
- Number of aridity and desertification phenomena which are caused by natural and human wrong doings; decrease of areas;
- Number and amount of water resources which were rehabilitated and expanded due to implemented measures and activities;
- Amount of protected area size, natural resources and wealth due to the results of protection and prevention measures of floods;
- Quality and readiness of all-stage services of water sector;
- Human resources growth of water sector;
- Budget source increase and proof to be spent on implementation measures and activities in the basin;
- Local area state organizations and other organizations as well as residents' participation in the implementation of river basin IWM plan;
- Increase of water resources surveys, monitoring and database indicators and their service-framework growth;

Some issue indicators are summarized in the table below.

Table 109. Issue result indicators in the Orkhon river basin IWM plan

Indicators		Measuring unit	2010 level	Level	
				2015	2021
1. Main issue: Water for people					
1.1	Percentage of people supplied from safe drinking water sources in urban areas	%	96.3	97	98
1.2	Percentage of people supplied from safe drinking water sources in rural areas	%	42.7	50	70
1.3	Percentage of ger district people supplied from kiosks connected to the central networks	%	21.1	Not less than 30	50
1.4	Percentage of people with improved sanitation in urban areas	%	32.3	60	70
1.5	Percentage of people with a connection to the sewerage system	%	30.4	45	55
1.6	WWTP with normal operation (urban areas)	*piece*	4	4	5
2. Main issue: Water for industry					
2.1	Number of industries with separate WWTPs	*piece*	1	2	3
2.2	Reuse level of industrial water	%	-	-	10
2.3	Size of areas where technical and biological rehabilitation is conducted in upper section of Orkhon river basin runoff-forming	km^2	-	10	25
2.4	Water reuse level in mining	%	70	80	85
2.5	Thermo power plant cooling and waste water reuse level	%	70	90	100
3. Main issue: Water for agriculture					
3.1	Number of boreholes newly constructed and rehabilitated	*piece/year*	-	40	35
3.2	Number of ponds newly constructed	*piece*	-	2	3
3.3	Number of herder groups responsible for borehole use	*piece*	-	10	30
3.4	Irrigated field size	*ha*	4,683	7,450	11,430
3.5	Percentage of wheat and fodder plant harvest from irrigated field	%	-	10	30
4. Main issue: Water for environment					
4.1	Number of protected ponds and drinking water sources to be increased	*piece*	-	3	6
4.2	One person water demand in apartments with connection to central network	*l/day*	230	220	160
4.3	Ger district and rural area person's water demand	*l/day*	7-9	10	20
4.4	Length of river channels where rehabilitation was conducted	*km*	-	5	15
4.5	Decrease of number of polluted rivers and lakes	%	-	10	50
4.6	Number of ponds whose sources are rehabilitated and trees are planted	*piece*	-	3	5
4.7	Tree-planting areas newly established	*piece*	-	2	4
4.8	Number of rivers where ecological flow is defined	*piece*	-	2	3
4.9	Number of spas protected	*piece*	-	2	6
4.10	Number of lakes where research on water resources rehabilitation is conducted	*piece*	-	1	1
5. Main issue: Water legal environment and administration					
5.1	Implementation of polluters pay principle	-	-	To be included 100% in the water polluters' fee according to the rules	
5.2	Implementation of law	-	-	Monitoring will be conducted no less than 2 times a year	
5.3	Number of water pollution monitoring points newly constructed	*piece*	-	4	5

9.6. Monitoring:

It is one-sided if we consider stakeholders include their implementing measures in the action plan and implement the plan. So monitoring is required on the performance of measures.

Monitoring of the river basin IWM plan consists of the followings:

- The stakeholders in the first phase prepare the performance of measures by number, time and quality indicators. The execution is compared with plan indicators. Obstacles occurring during the implementation, will be defined.
- Orkhon RBA, with the cooperation of RBC, will conduct the following: main direction of the plan, strategic objectives, their implementing methods, activity execution and results. Monitoring and assessment will be conducted.
- Monitoring and assessment on plan implementation will be annually conducted and measures as well as implementing activities will be clarified.
- If the results of professional sector measures and activities which were implemented and included in the river basin IWM plan, are required, some defining measures will be organized with the collaboration of lay-out/plan and client organizations.

The results of measures which were implemented in the first phase of the river basin IWM plan between 2013 and 2015 will be monitored and assessed before January 31, 2016. The results of measures which were implemented in the second phase of the river basin IWM plan between 2016 and 2021 will be monitored and assessed before January 31, 2021.

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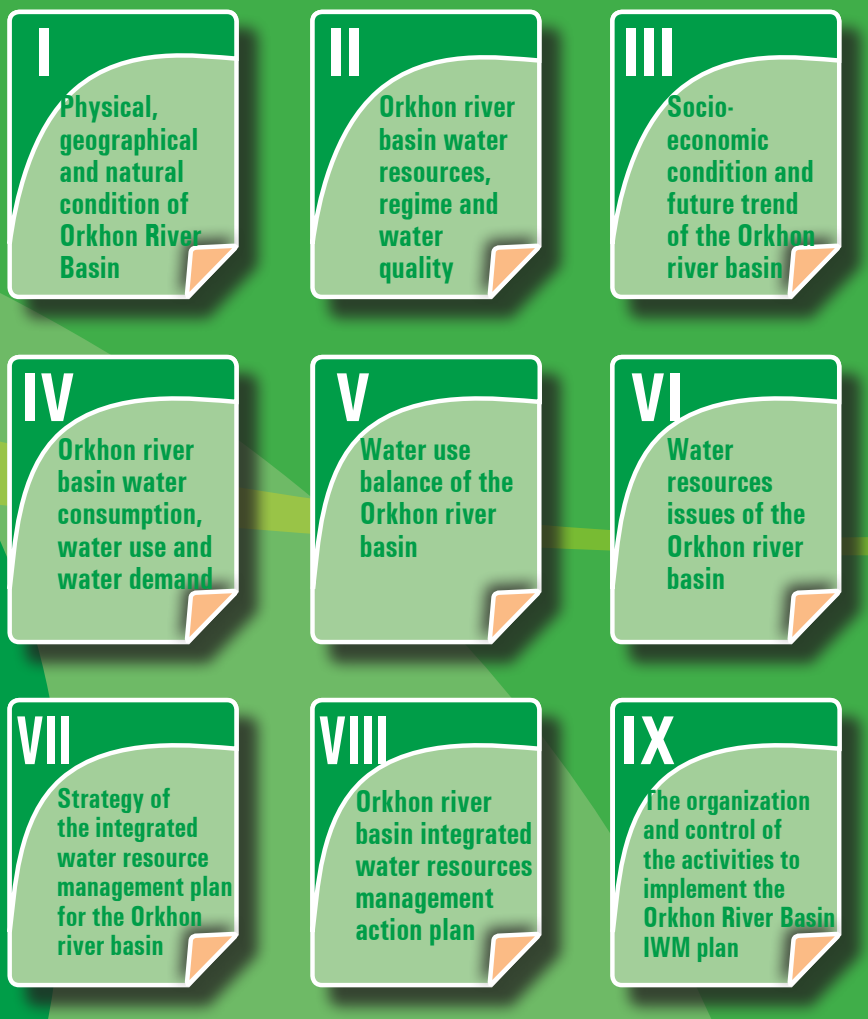

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