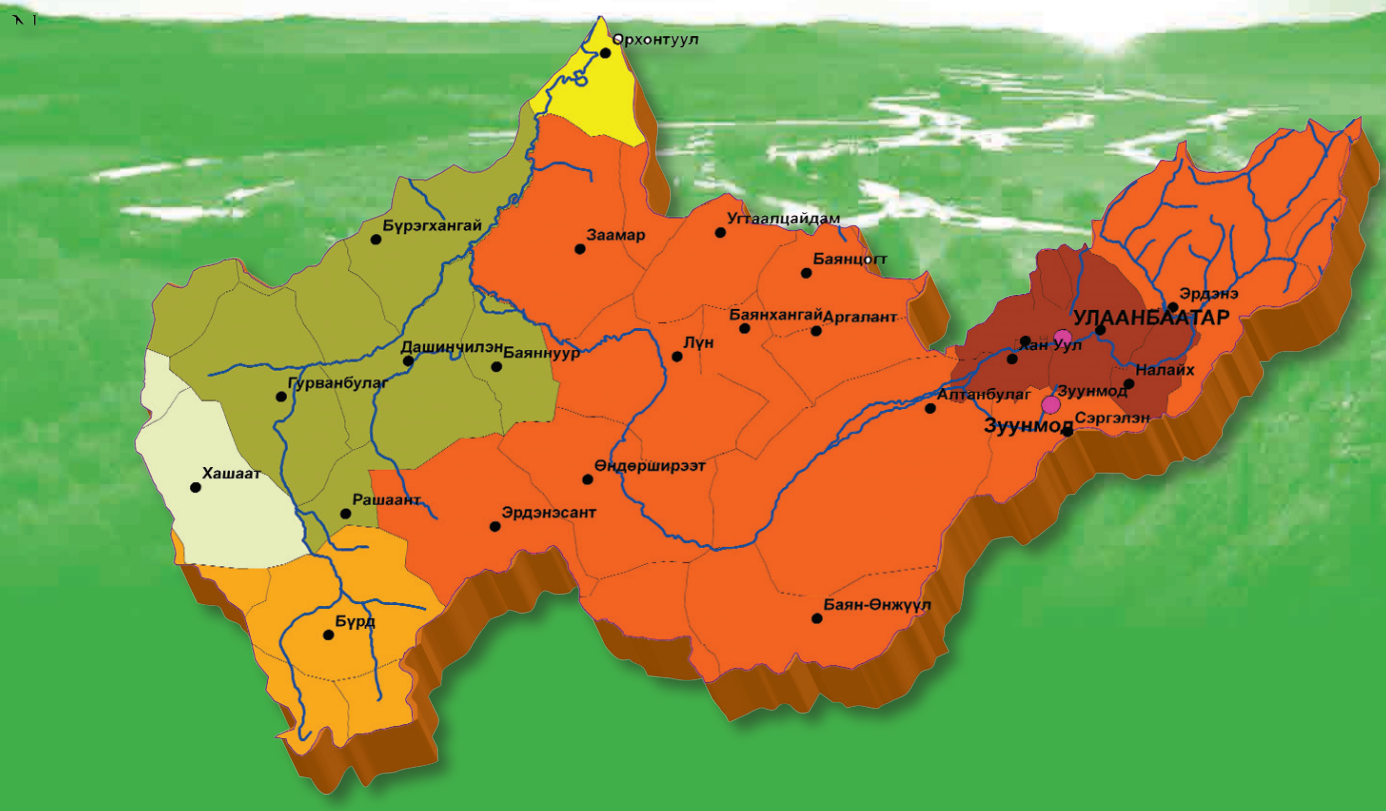
GOVERNMENT OF MONGOLIA

MINISTRY OF ENVIRONMENT AND GREEN DEVELOPMENT

TUUL RIVER BASIN
INTEGRATED WATER MANAGEMENT PLAN



Ulaanbaatar
2012

Annex *1* of the Minister's order № *A-102* of Environment and Green Development, dated on *03 December, 2012*

TUUL RIVER BASIN INTEGRATED WATER MANAGEMENT PLAN

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

Ulaanbaatar 2012

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TUUL RIVER BASIN INTEGRATED WATER MANAGEMENT PLAN

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PREFACE

International organizations and famous scientists argued that in the 21st century the cultural and economic development of the world population will depend on the countries, provinces and continents water resources quantity, availability and purity. Due to climate change, water use-demand growth and water pollution, water resources are becoming less and water demand is increasing due to population growth and economic expansion. It is a big issue facing us. Each country needs to use, protect and expand its water resources based on the millennium development goals. Each country needs to make it an objective and should put much attention to it. Transboundary rivers will have to be used by applying integrated water management in each basin. As for our country, we pay much attention to this issue. The Law on Water was approved by the parliament in 2004 and it was amended in 2012.

The Law on Water states: "The 'Integrated Water Resources Management Plan' will be approved and implemented by the Government and the 'River Basin Integrated Water Resources Management Plan's will be approved and implemented by the central state administration organization in charge of environmental issues". In order to implement this, within the framework of the cooperation between the Mongolian Government and the Government of the Netherlands, the Mongolian Minister of Nature and Environment and the Dutch ambassador in Beijing signed an agreement in 2006 to cooperate in the implementation of the "Strengthening Integrated Water Resources Management in Mongolia" project. In 2007, the Ministry of Nature and Environment of Mongolia and the Ministry of Development Cooperation of the Netherlands, signed an agreement to implement the project main phase. It was the basis of this project.

The document of the project main phase specifies that an "Integrated Water Resources Management Plan of Mongolia" and two basin model plans will be developed. One of them is the "Tuul River Basin Integrated Water Resources Management Plan". It is approved to be implemented.

In 2010, according to the order of the Minister of Nature and Environment, the Mongolian territory was divided into 29 water basins. The Tuul river basin has the highest importance in water use and water demand in the country. Ulaanbaatar city is located in the basin and the population density as well as the concentration of production and services has increased in the last two decades. Also water use and water demand and negative impacts on the environment increased. Water resources are getting less and the water regime is changed, while the sectors future development depends on the river basin water resources.

This plan is approved and implemented for the purpose of conducting inter-sectoral management and defining the sectors' future development on the basis of the river basin water resources. The Tuul river basin management plan has 9 chapters and 122 sub topics. The table of measures consists of 19 challenges and 232 activities. The 1st chapter describes the geography and natural conditions; the 2nd chapter describes the water resources and water quality; the 3rd chapter describes the socio-economic development; the 4th chapter describes the water use and water demand of the socio-economic sectors and about hydro constructions; the 5th chapter describes the water use balance; the 6th chapter describes the negative impacts on the water resources and about water fees and water tariffs; the 7th chapter describes the challenges of the water management plan and the strategic objectives; the 8th chapter describes the

integrated water resources management plan measures; and the 9th chapter describes the implementing organization, structure and monitoring of the plan.

We need to pay attention to the following issues while implementing the plan:

- Groundwater sources currently used at Ulaanbaatar city, will not be sufficient to supply the water demand of the area after 2015.
- Surface water resources need to be secured by regulating the Tuul river runoff.
- Activities that pollute water need to be stopped if water treatment does not meet the standard to ensure the supply of fresh water.

The Tuul river basin administration was established according to the Law on Water. The administration has the responsibility for the management of the local area and the water use sectors and for the plan implementation. The administration will organize these activities. I would like to note the importance of the work by the water sector researchers, project senior consultants, national and international consultants and project national team experts who actively participated in the development of the plan.

Also on behalf of the Ministry of Environment and Green Development I would like to express my gratitude to the Government of the Netherlands, the Ministry of Development Cooperation, the Dutch Embassy in Beijing, the entities and other administrative organizations that supported in terms of administration, organization and data for the development of the plan.

This plan will act as a basic document to protect the Tuul river basin water resources from pollution and scarcity and to use the water resources wisely. Also, it will be a model for the implementation of the measures specified in the Mongolian water basins' water resources management plans. I do believe that ministries, agencies, local area administrations, NGOs, citizens and entities that operate in the basin, will do their best for the implementation of each measure of the plan and the successful implementation of the Tuul river basin integrated water resources management plan.

May Khatan Tuul be full of water and may the public prosper!

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
AGO	Aimag Governor's Office
CRM	Citizen Representative Khural
CSID	City's Specialized Inspection Department
DET	Depertmant of Environment and Tourism
GASI	General Agency for Specialized Inspection
GDP	Gross Domestic Production
GEI	Geo Ecological Institute
GIS	Geographical Information System
GOUC	Governor's Office of Ulaanbaatar city
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
MD	Ministry of Defence
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
MIA	Ministry of Industry and Agriculture
MH	Ministry of Health
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 Authority
RBC	River Basin Council
SPC	State Property Committee

TRB	Tuul 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

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

1.1. Physical and geographical conditions

The Tuul River flows into the Orkhon river and it originates from Chisaalain aiguilles and Shoroot mountain pass (2289.2 m above sea level). The elevation ranges between 770-2800 m above sea level. Many tributaries of the Tuul River originate from the Baga Khentii mountain. The Tuul River flows at the beginning through mountain taiga and forest steppe region, then down from Ulaanbaatar, the river flows through the steppe region which occupies 80% of the river basin area. The valley becomes wider downstream of Ulaanbaatar and it reaches a width of 8-10 km at Ulaanbaatar city.

The Tuul River Basin covers the territories of 7 districts of Ulaanbaatar city, 37 soums of 5 aimags and occupies a total area of 49774.3 km^2.

The Tuul River basin includes 65.5% of the Ulaanbaatar city area, 39.8% of Tuv aimag, 20.8% of Bulgan aimag, 6.0% of Uvurkhangai aimag, 4.4% of Arkhangai aimag, 2.2% of Selenge aimag (Figure 1 and Figure 2).

Figure 1. Location of the Tuul river basin

The size of the Tuul River watershed area and the length of the river are different in previous and current research materials. It is due to differences in calculation methods. In the Tuul river basin IWRM plan, the Tuul River watershed area is 49774.3 km^2 and the length is 717 km.

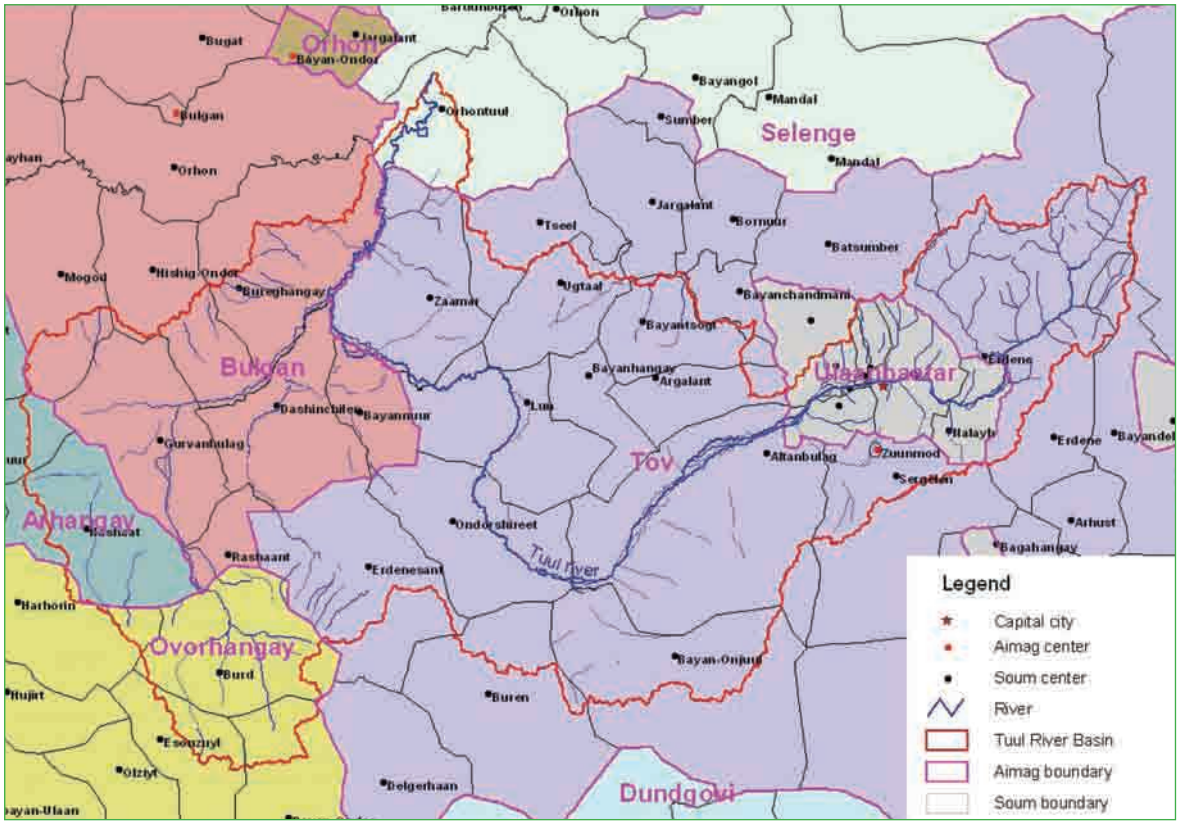

Figure 2. Administrative units in Tuul river basin

1.2. Climate

Climate condition

The Tuul river basin is highly elevated, far from the sea, surrounded by mountains. So the climate condition is determined by height differences of day and night temperature, long winter, short summer and most precipitation falls in summer.

Summer is dominated by warm dry air and thunderstorms fall during the summer. At the end of August and the beginning of September a sudden cold is observed and in the autumn the precipitation decreases. At the end of October and the beginning of November, winter condition forms. The climate of the Tuul river basin area is represented by the observation data of Gurvanbulag, Erdenesant, Ugtaal, Zuunmod, Buyant-Ukhaa, Ulaanbaatar and Terelj meteorological stations.

The mean air temperature ranges from -3.3˚C to -0.4˚C from Terelj and Ulaanbaatar but from Ulaanbaatar to Orkhontuul -0.4˚C - 1.1˚C. January is the coldest month. The monthly average air temperature is at Terelj and Ulaanbaatar -21.6˚C , at Buyant-Ukhaa -25.2˚C, at Lun -25.7˚C , at Erdenesant -17.8˚C, at Gurvanbulag -19.0˚C and at the confluence of the Tuul and Orkhon -24.8˚C. July is the warmest month. In this period the air temperature is at Terelj 13.0˚C, at Zuunmod 18.7˚C, at Erdenesant 17.5 ˚C, at Gurvanbulag -19.0˚C and at the confluence of the Tuul and Orkhon 19.3˚C (Table 1). During the last 10 years the global warming impacts appeared in Mongolia and its future prediction could indicate that the annual average air temperature will increase by 3˚C and 6˚C in winter and summer respectively over Tuul river basin by 2070 (L.Natsagdorj, 2010).

Table 1. Average air temperature, ^0C

Station name	Month												Average
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Zuunmod	-18.6	-16.3	-8.5	1.4	8.5	16.1	18.7	16.0	9.1	-0.4	-11.5	-18.7	-0.4
Buyant Ukhaa	-25.2	-19.8	-9.5	1.2	9.4	15.2	17.8	15.5	8.2	-0.9	-13.8	-22.5	-2.0
Ulaanbaatar	-21.6	-16.6	-7.8	2.0	10.0	15.6	18.0	16.0	9.2	0.7	-11.3	-19.1	-0.4
Terelj	-21.6	-18.6	-11.7	-1.6	5.8	11.0	13.0	11.3	5.6	-2.2	-11.9	-18.5	-3.3
Erdenesant	-17.8	-16.4	-6.8	2.4	10.3	15.6	17.5	15.7	9.5	1.1	-8.5	-15.5	0.6
Ugtaal	-23.8	-19.3	-8.6	2.3	10.3	15.3	19.7	15.5	9.5	0.4	-11.6	-20.5	-0.9
Gurvanbulag	-17.2	-13.3	-5.9	4.5	12.3	16.3	16.5	16.3	10.5	2.0	-8.9	-16.1	1.4
Lun	-25.7	-19.1	-6.8	4.7	12.1	18.0	18.2	17.8	11.3	1.1	-11.9	-22.4	-0.2
Mean	-21.6	-17.5	-8.4	2.0	9.8	15.4	17.4	15.5	9.0	0.1	-11.4	-19.3	-0.7

The long term precipitation is at Ulaanbaatar 275 mm and at Gurvanbulag 242 mm.

Table 2. Precipitation, mm

Station	Month												Sum
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1. Ugtaal	1.8	1.7	4.0	6.9	20.3	54.9	69.8	66.4	27.3	8.8	5.9	3.5	271.2
2. Zuunmod	2.7	2.5	3.7	8.0	17.7	48.5	70.5	74.6	29.0	8.8	6.3	3.1	275.3
3. Buyant Ukhaa	1.7	2.1	2.7	6.9	18.2	39.9	65.7	67.4	32.5	7.7	4.9	3.1	252.9
4. Ulaanbaatar	2.7	2.6	3.7	9.5	18.3	50.0	65.3	72.4	32.3	8.1	6.1	4.0	275.0
5.Terelj	1.4	1.5	3.1	9.5	16.3	41.4	76.2	50.0	13.9	6.6	3.6	1.9	225.3
6. Erdenesant	1.9	2.4	4.3	8.5	18.6	47.6	76.1	63.5	26.4	7.5	5.2	3.4	265.2
7. Gurvanbulag	1.1	1.4	2.1	5.7	17.7	50.6	69.5	57.6	23.7	6.8	3.5	1.7	241.5
Mean	1.9	2.0	3.4	7.9	18.2	47.6	70.4	64.6	26.4	7.8	5.1	3.0	258.1

1.3. Soil, vegetation, forest

Soil

Mountain soils occupy more than 50 % of the Tuul River basin area, it is distributed evenly. Table 3 shows soil type and classes, respectively their percentage.

Table 3. Soil type percentages

No	Soil type	Percentage
1	Mountain soil	56.3
2	Soil of steppe valley and depression	26.2
3	Low mountains and rolling hills soil	8.3
4	Soil of humid areas	6.6
5	Other soils and bare land /water, sand	1.4
6	Saline soil	1.1
7	Riparian soil	0.1
	Total	100

Vegetation

The vegetation is rich in the Khentii region, but poor in the steppe region because of the climate and elevation zones within the river basin area. The types of vegetation are changing from high mountain to low steppe.

The basin is occupied by tundra and valley-steppe vegetation.

Forest resource area and its change trend

According to the Law on Land, forest resources include "forests, forest glades and logged areas, and forest strips, as well as land for growing forests and areas adjacent to forests to allow forest expansion".

Most of the forest fund of the Tuul River basin belongs to the Khan Khentii protected area and Gorkhi Terelj natural area, and to the Batkhaan and Khustai special protected area (Table 4).

Originally there was around 5000 km^2 forest in the Tuul River basin. However, wood preparation works started since 1940 until now. Since then, the forest area is reduced approximately 100-200 thousand ha by entities or private people every year and the forest fund was reduced by 35%. Scientists /D. Enkhsaikhan, G. Davaa/ believe that the natural influence of the forest fund to the river flow regulation is unbalanced as well as changing river flow regime and reducing annual flow value.

It is difficult to assess the change in forest area in the river basin. The data available is from 1972 and 1986 only. Research work updating this information does not cover the river basin area.

Table 4. Forest in protected areas

Name	Forest, ha
Khan Khentii SPA, Gorkhi-Terelj NP	208,056.4
Batkhaan mountain NR	335.7
Bogd Khan mountain SPA	19,940.1
Khustai mountain NP	1,868.7
Khugnu Khan mountain NR	2,365.2
Total	232,566.1

1.4. Wildlife

In order to determine distribution of animals in this basin, the basin is divided into 5 sub basins based on the following grounds:

- State of Tuul River and its tributaries being affected by human activities (low, medium and high)
- Natural zones (mountain taiga, forest steppe and steppe)
- Concentration of population and industries (low, medium and high density)
- Climate conditions and location of runoff observation point (Terelj, Zaisan, Altanbulag, Lun and Orkhon-Tuul)
- General formation of fauna distribution (Common feature of fauna in the natural zones)
- Parts that subject to balance use of water recourses in the Tuul River basin (upstream, midstream and downstream parts)

Sub basins as follows:

1. The 1st sub basin (From Tuul river upstream to Tuul-Terelj monitoring station)
2. The 2nd sub basin (From Tuul-Terelj station to Zaisan monitoring station)
3. The 3rd sub basin (From Tuul-Zaisan station to Altanbulag bridge)

4. The 4th sub basin (From Altanbulag bridge to Tuul-Lun monitoring station)
5. The 5th sub basin (From Tuul-Lun station to Orkhon-Tuul confluence)

The 1st sub basin overlaps with the upstream part of water recourses use balance. The 2nd and 3rd sub basins are included in the midstream part, and the 4th and 5th sub basins are included in downstream part.

Due to the Tuul river basin is located across mountain taiga, forest steppe and steppe, fauna in this basin keeps a general feature of fauna distribution in these natural zones. On the other hand, natural feature of fauna distribution needs to be precisely considered as it is changing to some extent. The steppe consist 82.8% of a total territory in the basin, forest steppe 11.8% and mountain taiga 5.4%, respectively. As the steppe animals which cover most part of the basin are different from others, they are subject to the 4th and 5th sub basins. There is a small change in fauna in the vicinity of Ulaanbaatar due to human activities and they are subject to the 2nd and 3rd sub basin.

Biodiversity database of Mongolia has been created and published online in 2006 by the Steppe Forward Program implemented under the National University of Mongolia /NUM/ in cooperation with professional organisations such as 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 the 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 14 fish species, 50 mammal species and 2 amphibian/reptile species in the 1st sub basin, 8 fish species, 39 mammal species and 2 amphibian species in the 2nd sub basin. 9 fish species, 37 mammal species and 2 amphibian species in the 3rd sub basin, 9 fish species, 33 mammal species and 2 amphibian species in the 4th sub basin, and 13 fish species, 45 mammal species and 2 amphibian species in the 5th sub basin.

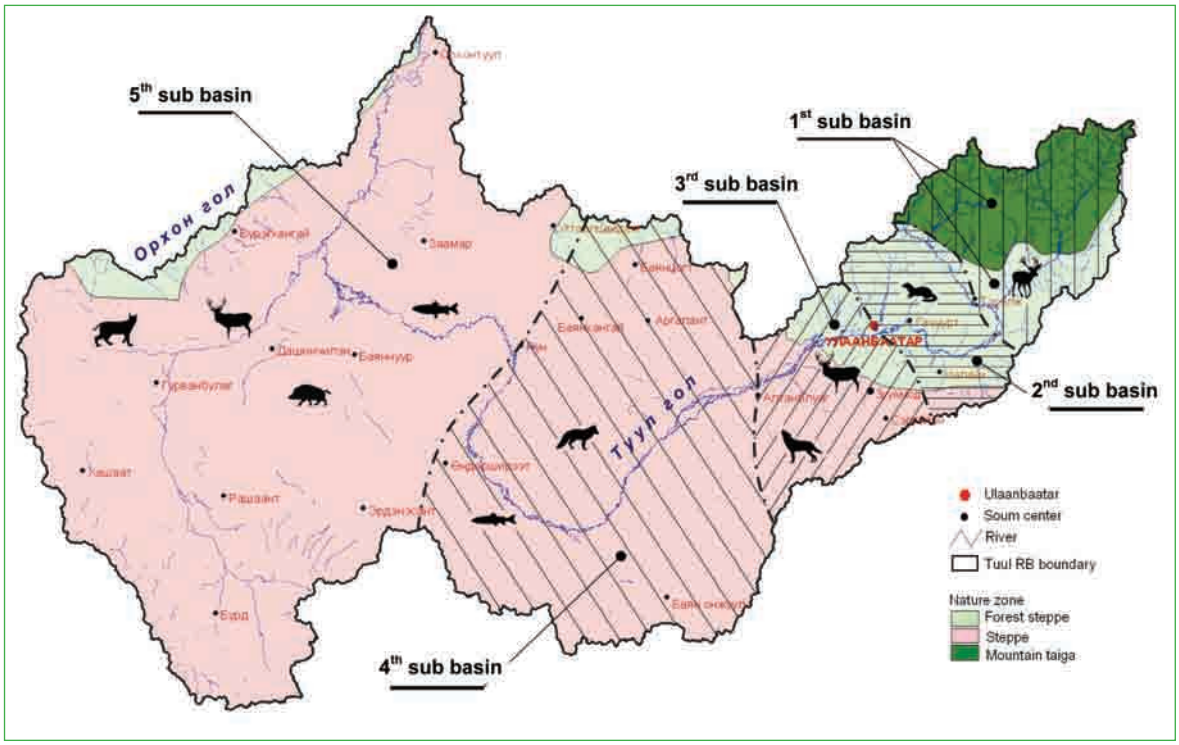

Figure 3. Overview of fauna zones and rare and endangered animals in the Tuul River Basin

Fish. There are 16 fish species of 10 families in this river basin. Of these, 5 fish species such as Siberian sturgeon (asipenser baerii), ide (leuciscus idus), lenok (brachymystax lenok), taimen (hucho taimen) and arctic grayling (thymallus arcticus) might become rare or vulnerable. Also some fishes that reveal purity of water in the basin are included. Fish species of cyprinids including for perch, East Asian catfish (silurus asotus), Siberian spiny loach (cobitis melanoleuca), siberian stone loach (barbatula toni) and pike (esox lucius) have been observed in the Tuul River downstream of Ulaanbaatar at small number. But taimen (hucho taimen), fish of salmonids has not been found here according to study.

There are many factors which negatively affect aquatic animals in the Tuul River basin. For example, increase of mineralization, extreme fluctuation of a temperature, change in hydrogen content, lack of oxygen, detection of heavy metals, wastes, drawdown, etc negatively affect fishes and aquatic animals. Particularly, taimen (hucho taimen), lenok (brachymystax lenok) and grayling (thymallus) which are semi-migratory fishes, and ephemeroptera, plecoptera and trichoptera which are weather indicating insects are vulnerable in these changes. Therefore, it is obviously important issue to conserve fishes and other aquatic animals and to provide natural restoration and development of vegetation as well as normal ecological conditions.

Amphibians and reptiles. There is a few variety of reptile and amphibian species in the basin and is distributed along areas with a convenient habitat condition on a limited scale. One species of amphibian Mongolian toad (Bufo raddei) and one species of reptile steppes rat snake (elephe dione) have been reported in the Mongolian Red List of Amphibian and Reptiles.

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.

There is a probability that its population might become rare recently due to degradation of its habitats, water pollution, mining of natural resources, and 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, except mountain zone [22].

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.

Mammals. There are 'Endemic' 128 mammal species, 'Invasive' 4 mammal species and totally 132 mammal species in Mongolia. Of these, approximately 60 mammal species of 18 families of 7 orders are in the Tuul River basin. These include 7 insectivore species, 23 species of simple toothed rodents, 4 species of double toothed rodents, 7 species of wing handed animals, 14 carnivore species and 5 artiodactyla orders.

Some 20% of a total 60 mammal species which inhabited in the Tuul River basin were included in the Mongolia's Red List of Mammals as rare and near threatened classes. Also these mammals were registered in the Mongolian Red Book and in Mongolian Law on Fauna as rare and very rare animals. Some representatives of these rare mammals as follows:

Eurasian otter (lutra lutra). It is found in the upstream part of the basin from Tuul-Bosgo Bridge monitoring station to Terelj monitoring station.

Since 1930 it has been prohibited to hunt the Eurasian otter and included in the Red List as very rare according to the Mongolian Law on Hunting in 1995. 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.

Eurasian elk (alces alces). It is mainly found in Khentii and Khuvsgul taiga, and Onon, Kherlen, Tuul, Kharaa, Eruu and Minj River basins. This species included in the Mongolia's Red List of Mammals as 'endangered' as it was considered that its population decreased by 50% due to scarcity and pollution of its habitat and uncontrolled hunting. Also it was included in two editions of the Mongolian Red Book as 'very rare'. In addition, this species is forcefully pushed into lack of habitat due to water pollution caused by mining activities (mining of gold and minerals).

Birds. Approximately 171 bird species have been reported in the Tuul River basin. Of these, some 37 bird species are non-migratory birds, 134 species are migratory birds and totally 142 species lay their eggs in the basin. Also some 8 bird species such as bean goose (anser albifrons), mandarin duck (aix galericulata), smew (mergus albellus) and pallid harrier (circus macrourus) summer here. Vice versa, 5 species such as mallard (anas formaosa), gold crester wren (regulus regulus), siskin (cardullis spinus), yellow bunting (emberiza citrenilla) and snow bunting (plectrophenax nivalis) winter here.

The reason of why 134 bird species or 78.36% of overall birds in the basin are migratory birds is the main migration way for migratory birds migrate to/from Mongolia is passed by this basin.

There are 12 rare bird species and 1 very rare species which is a white-naped crane (grus vipio) in the basin. As we see from above, some 9.12% of all the birds found in this basin are subject to rare and very rare bird species.

Wild animals at Bogd Khan Mountain National Park. This national park is totally included in the Tuul River basin. Diversity of fauna is distributed in this park. This is one of the oldest national parks in the world (considered that its protection status started from the 13th century). As biodiversity has been originally conserved in this national park for the centuries, it is highly important not only at national level, but the global level. There are 54 mammal species such as marmot, squirrel, hedgehog, palla's cat, martin, lynx, deer, Siberian roe deer, wild sheep and Siberian ibex, and 205 fish species of 36 families of 14 orders, and 1660 insect species of 174 families of 16 orders, 259 mezofauna species of 13 families, 93 microorganism species of 14 orders, 2 amphibian species of 2 families, 4 reptile species of 4 families, 612 vascular plant species of 70 families, 163 moss species of 33 families, and 160 lichen species of 16 families in the Bogd Khan Mountain. Of these, 13 mammal species, 10 bird species, 5 species insects, 23 vascular plant species, 4 moss species, 6 lichen species are considered as rare at level of Bogd Khan Mountain. Of these species, 2 mammal species, 4 bird species, 1 butterfly species and 1 vascular plant species were registered in CITES. Also 3 mammal species, 5 bird species, 5 insect species, 4 vascular plant species and 6 lichen species were registered in the Mongolian Red Book published in 1997.

As the Bogd Khan Mountain belongs to very southern branch mountain of Khentii taiga, it becomes a south boundary of fauna distribution in taiga and forest zones. There are some rare biological formations such as distribution of spruce across mountain ranges. The spruce is a rare tree species in Mongolia.

Conclusions on wildlife

- There are 16 fish species of 10 families, 2 species of amphibians and reptiles, approximately 60 mammal species of 18 families of 7 orders, 171 bird species at the Tuul River basin level. Of these, 5 bird species and 11 mammal species are included in near threatened class, 12 bird species and 1 mammal species 1 bird species in rare class, 1 mammal species in very rare class:
  - Of fishes, mammals, amphibians and reptiles included in the 1st sub basin, 1 fish species and 2 mammal species are endangered, 2 fish species and 5 mammal species are near threatened, and 1 fish species and 1 mammal species are vulnerable. Also moose elk (alces alces), Eurasian otter (lutra lutra) and sable (martes zibellina) are found only in this sub basin. Compare to other sub basins, relatively high number of animals have been registered here. This is due to low impact from human activities in this sub basin.
  - Of fishes, mammals, amphibians and reptiles included in the 2nd sub basin between Tuul -Terelj monitoring station and Tuul-Zaisan monitoring station, some 3 mammal species are endangered, 1 fish species and 1 mammal species are vulnerable.
  - Of fishes, mammals, amphibians and reptiles included in the 3rd sub basin between Tuul-Zaisan station and Altanbulag Bridge station, 1 fish species, 2 mammal species are endangered and 2 fish species are vulnerable.
  - Of fishes, mammals, amphibians and reptiles included in the 4th sub basin between Altanbulag Bridge station and Tuul-Lun station, 2 mammal species are endangered, 1 fish species and 5 mammal species are near threatened and 1 fish species is vulnerable.
  - Of fishes, mammals, amphibians and reptiles included in the 5th sub basin between Tuul-Lun station and Orkhon-Tuul confluence, 1 fish species and 2 mammal species are endangered, 2 fish species and 6 mammal species are near threatened and 1 fish species is vulnerable.
- As we can see from fauna distribution in these 5 sub basins, the biggest number of fauna registered in the 1st sub basin in which human impact on environment is lower than others. But variety of fauna decreased in the 2nd and 3rd sub basins in the vicinity of Ulaanbaatar. While the distribution is the least and animals and birds which tolerant to environmental pollution are dominated in the 4th sub basin. This is due to lack of habitats for animals and birds caused by urbanization, industrialization and environmental pollution. Variety of fauna is tended to increase in the 5th sub basin between Lun monitoring station and Orkhon-Tuul confluence and it shows that habitat and conditions for wild animals are better than other sub basins.
- For variety of fish species, lenok (brachymystax lenok) and arctic grayling (thymallus arcticus), etc inhabited in a relatively fresh and stream water are found in the 1st and 5th sub basins. There are cyprinids and non-hunting fishes which tolerant to environmental change and inhabited in warm water are dominated in the 2nd, 3rd and 4th sub basins.
- City of Ulaanbaatar, Zuunmod, state-owned large factories, economic entities, organizations are located in the Tuul River basin and some 44.8% of a total population is based in this basin. Also majority of the basin population is concentrated in the city Ulaanbaatar. In this connection, most of water use, consumption and water resource population are occurred in the midstream part of the Tuul river basin, too. This bad situation triggers pollution of air, water and soil

and degradation of plant cover and leads these animals to migrate to other areas and change their life habits.

- As there is a rapid change in population of wild animal, birds, fishes and aquatic microorganisms as well as their life habits, it is necessary to carry out the detailed study on their location, population, species and life habits and possibility to verify them and to make further actions clear to take in the future.
- It needs to improve living conditions of rare and endangered wild animals, birds and fishes, etc and breed them and to organize framework.
- When organizing any industrial activities in any part of the basin, it is important to specifically focus on a complete conservation of living conditions for animals, birds and fishes, etc then make planning and performance.
- It is considered that it would be essential to carry out the detailed study on animals and birds, and to plan protection of them based on a regional assessment.

1.5. Land use

Land use type

In the Tuul River basin agricultural land occupies 4560.9 thousand ha or 91.2%, forest 338.6 thousand ha or 6.8%, water 16.1 thousand ha or 0.3%, roads 15.2 thousand ha or 0.3%, urban and local settlement land 72.1 thousand ha or 1.4%. It was specified according to the unified land classification of the Mongolian Law on Land.

In this estimation, the classification of the land for special needs includes agricultural land, urban and local settlement area, roads, forests and water. Figure 4 shows the unified land classification.

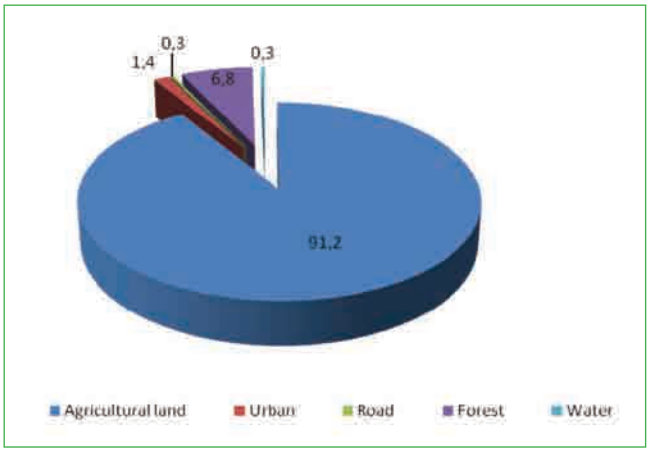

Figure 4. Unified land classification

The Tuul River Basin includes the Khan Khentii, Bogdkhaan strictly protected area, Gorkhi –Terelj nature park, Moltsog Els, Khustain Nuruu, Batkhaan mountain range, Khogno Khan-mountain natural reserves. The total special protected areas occupy around 584.2 thousand ha of land which is 11.7% of the Tuul River basin.

Table 5. Area of the protected areas

Protected area	Area, km²
Khan Khentii SPA	100,561.6
Gorkhi-Terelj NP	289,190.9
Bogd Khaan mountain SPA	41,348.5
Moltsog els NR	487.9
Khustai mountain NR	48,399.4
Batkhaan mountain NR	20,111.5
Khugno Khaan mountain NR	84,143.2
Total	**584,243.0**

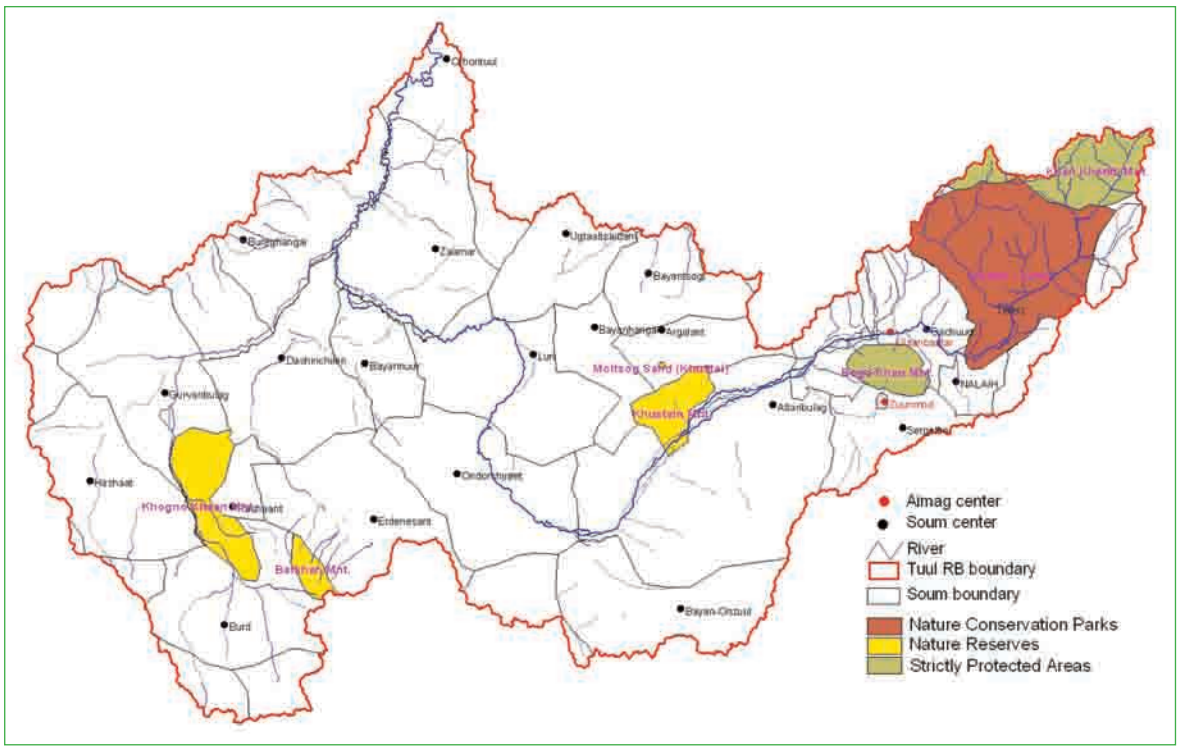

Figure 5. Location of the protected areas

Following developments in social needs and requirements as well as economic developments that have taken place there is a noticeable change in land use. As of today land use in the Tuul River Basin includes the following 10 main types: Pasture, Cultivation, Hay-field, Virgin land, Bare land (sand, rock cliff etc), Settlement, Roads, Forest, Water, Industries and mining

By land use type the largest area is occupied by pasture land in total 42660.9 km2 or 85.7% of the total basin area. Crop land, settlement area, road and forest area varies between 0.1 – 6.8%. River and lake area occupies in total 16079 ha from which 13899 ha is occupied by rivers and 2180 ha by lakes.

Table 6. Land use type in the Tuul river basin

No	Land use type	Area, km²	%
1	Pasture	42,660.9	85.7
2	Cropland	668.7	1.3
3	Hay	777.3	1.6
4	Abandoned land	1,093.8	2.2

No	Land use type	Area, km²	%
5	Sand	67.8	0.1
6	Urban	497.3	1.0
7	Industry/Mining	336.8	0.7
8	Road	151.2	0.3
9	Forest	3,361.0	6.8
10	Water	159.6	0.3
	Total	**49,774.3**	**100.0**

As mentioned in the unified land reports, urban and local land area is expanded and pasture land area is reduced due to the urbanization and infrastructure development. But there are no significant changes in hayfield land area despite the increase of the agricultural area due to ownership of the winter and spring quarter places. Also, the road network is increased by asphalt road constructions. Particularly, around 350 ha road area was increased by 3.5 km road construction work in Lun soum of Tuv aimag in 2008.

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.

It has been almost 10 years since the 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 2008 about 5700 citizens own land in total of 41.2 km² area in Tuul river basin.

Measures for land protection include restoration of destroyed land, destruction of rodents, forest cleaning, etc. To protect the land a centralized annual plan of land organizational structure is implemented by aimag and soum center. Since 2008 several protection measures covering an area over 3471 km² have been implemented such as pasture rotation in about 1500 km², extermination of rodents on 600 km². 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 2008 reports that protective measures have been taken on damaged lands of 68.1%. However, holes and destroyed land caused by mining or private activities neither are nor reflected in the plan for rehabilitation work because they do not comply with legal specifications as stated in the report.

Land use approaches

The Tuul River basin is located strategically and in the most beneficent geopolitical position with a relatively favourable condition of nature and climate. It is the centre of Mongolian gravitation. Also, it comprises Zuun mod city as a key centre of the regional development concept. And it is a suitable territory which has well developed infrastructure and substantial market volume. Thanks to all these positive impacts, the social-economic sector of the Tuul River basin is sustainably developing in recent years.

Therefore, the land use in the basin is expected to be economically beneficial without any ecological crisis based on its current capacity in as possibly as intensive way. This issue determines not only the land use policies in coming 20 years, but the socio-economical policies.

Before 1990, Mongolian land use planning was directed to socially efficient land use. Nowadays, it is tried to regulate social activities on the bases of natural resources availability and to prevent land degradation, desertification, and deficiency of crop land, forest, and soil and water resources shortage. Hence this land planning, it was processed general plan of land organizational structure of each aimags in last many years. It was financed from local governments. A main objective of this general plan is focusing on land management policy which supporting current and further land utilization development with economically efficient and devoid of ecological adverse impacts.

It is right to include general plan of land organizational structure in processing of integrated water resources management plan of Tuul River basin.

Central regional mid-aimags reserve pasture land which named on ''Dashinchilen'' and ''Khukh del'' are included in state special needs land. Borderlines of this land are established according Mongolian government resolution # 64 of 2010. It comprised the whole territory of ''Dashinchilen'' (33740 ha) and half of ''Khukh del'' (14660 ha) reserve pastureland areas in the Tuul river basin. Figure 6 shows the location of reserve pastureland areas in the Tuul river basin.

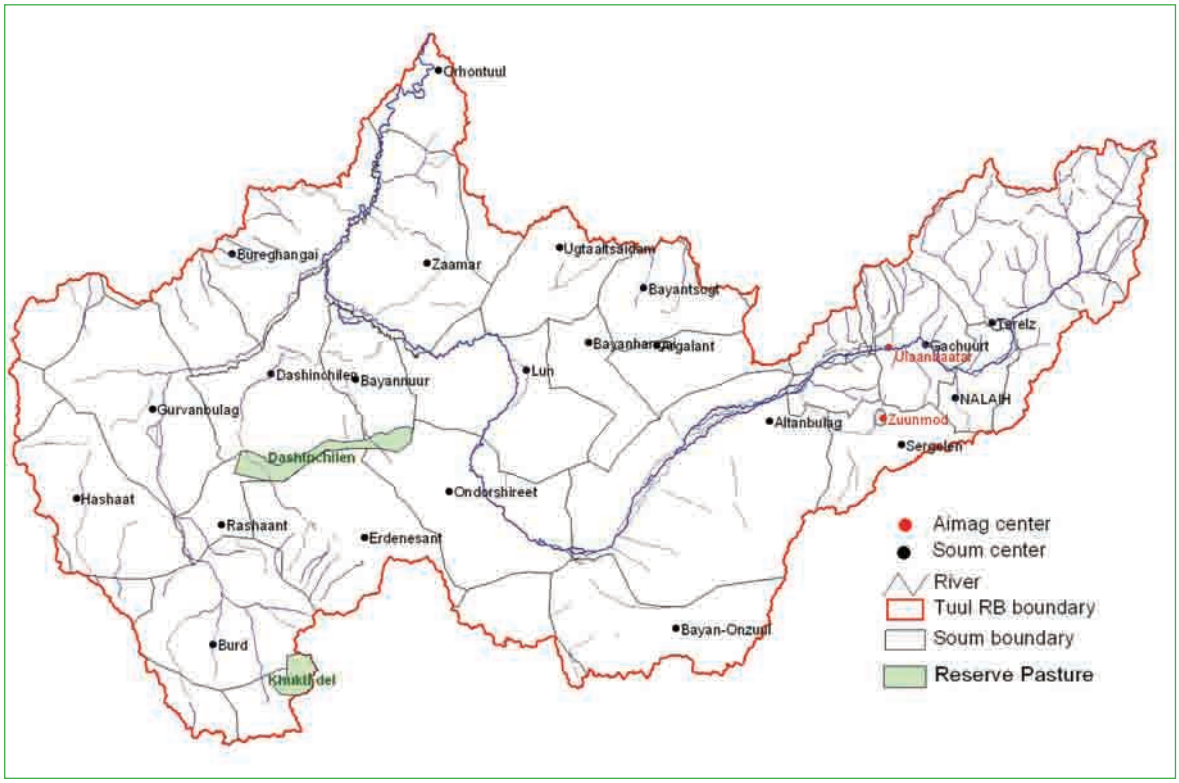

Figure 6. Reserve pastureland

2. TUUL RIVER BASIN WATER RESOURCE AND WATER QUALITY

2.1. Surface water resource and regime

The Tuul River basin is located in the central part of Mongolia, collects water of rivers originating from the southwestern slopes of the Khentii mountain range and drains into the Orkhon River, the main tributary of the Selenge River which is part of the Arctic Ocean basin.

The Tuul starts from a small stream named Nomin at a height of 2289 m above sea level which is part of the Baga Khentii mountain peak /2534.0 m/ and after joining five small streams it takes the name of Tuul River. The catchment area of the Tuul River is 49774.3 km^2 with a length of 717.0 km. The river network density ranges between 0-998 m/km^2 with the highest value in the upper part of the catchment and the lowest in the steppe and low land areas. Due to the differences in morphology the distribution of long term runoff varies from 0.2-7.0 l/s/km^2. In the higher part of Terelj, from 3.0-7.0 l/s/km^2 in the Tarnai River basin, from 2.0 to 3.0 l/s/km^2 in the middle part, while it decreases to 0.2-1.0 l/s/km^2 in the lower part of the basin.

Currently, there are 8 hydrological gauging stations operating in the Tuul River basin including Tuul-Bosgo, Ulaanbaatar, Altanbulag, Lun and at Selbe river-Sanzai and Dambadarjaa, Terelj-Terelj, Uliastai-Uliastai (Table 7). These stations belong to the National Agency for Hydrology and Meteorology.

Table 7. Description of hydrological gauging stations in the Tuul river basin

No.	River	Station	Coordinates		Period of observation	
			Lat.	Long.	Open	Closed
1	Tuul	Bosgo bridge	48.03333	107.73333	1985.X.22	
2	Tuul	Ulaanbaatar	47.88333	106.93333	1975.IV.14	Moved
3	Tuul	Altanbulag	47.945	106.54056	1997.VI.01	
4	Tuul	Lun	47.88861	105.27222	1997.V.27	
5	Terelj	Terelj	47.96667	107.46667	1969.IX.01	
6	Uliastai	Uliastai	47.96667	107.33333	1992.X.01	
7	Selbe	Sanzai	48.13333	106.88333	1993.VI.01	
8	Selbe	Dambadarjaa	47.98000	106.92000	1984.I.01	Cut off

In the river basin it is necessary to increase the density of gauging stations in terms of space and time and to improve the equipment of the stations to allow conducting continuous measurements.

2.1.1. Flow regime and resources of the perennial rivers

By the Horton law the Tuul River river system has an order of 6. The Tuul River basin has 1222 1st order rivers, 320 2nd order rivers; 64 3rd order rivers; 14 4th order rivers and 4 5th order rivers, respectively.

According to above classification Selbe, Uliastai, Khul, Kharbukh Rivers belongs to very small rivers, Terelj, Tuul (till the confluence with Terelj) to small rivers, Tuul (after confluence with Terelj) is considered as medium or big river.

According to the above classification Selbe, Uliastai, Khul, Kharbukh Rivers belong to the very small rivers, Terelj and Tuul (until the confluence with the Terelj) belong to

the small rivers and the Tuul (after the confluence with the Terelj) is considered as medium or big river.

One of the specific peculiarities of the runoff source of the Tuul River is the relatively low portion of groundwater contribution. It was estimated that about 69% of the annual runoff forms from rainfall, 6% from snow melting and 25% from groundwater source. This indicates that according to the flow regime classification the Tuul River belongs to the rivers with spring snow melting and rainfall floods. After the spring flood a short warm season low flow is observed. During July to September the rainfall flood is observed with several flow peaks. The maximum discharge of the rainfall flood exceeds the spring flood amount by 1.5-2 times. After the rainfall flood, the water level recedes until the beginning of the ice phenomena (Figure 7).

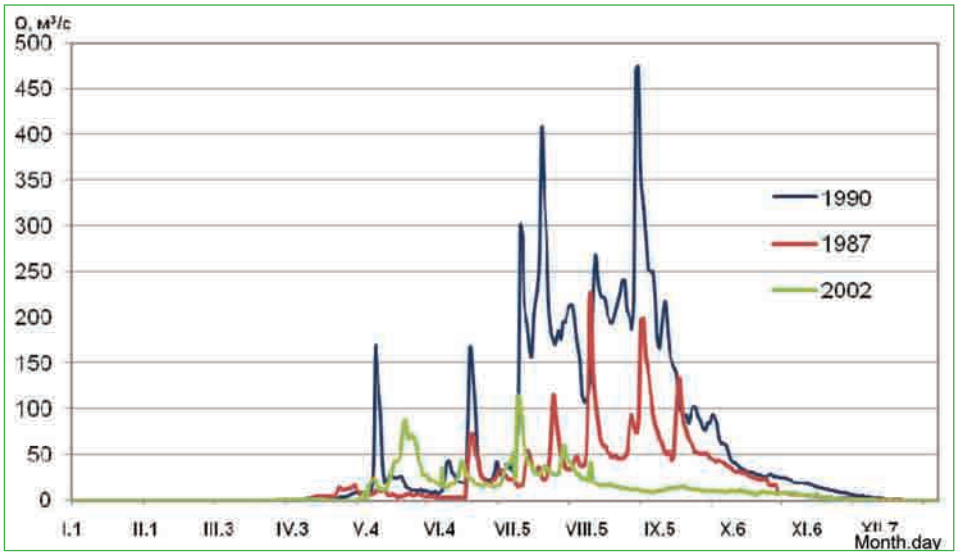

Figure 7. Typical annual hydrograph: wet-1990, average-1987, dry-2002 (Tuul - Ulaanbaatar)

Annual distribution of runoff: Depending on flow condition, 62-64 percent of annual runoff forms within VI-VIII months. Runoff of the Tuul River recedes, freezing up to bed in winter season limiting water use (Table 8).

Table 8. Annual runoff distribution (percentage from annual mean)

River-station	Month											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Tuul-Bosgo bridge	0.07	0.06	0.18	2.45	10.1	15.2	23.1	25.0	16.3	7.40	1.73	0.31
Terelj-Terelj	0.01	0.01	0.12	2.38	9.96	15.0	23.0	24.8	16.2	7.31	1.67	0.25
Tuul-Terelj	0.02	0.03	0.16	2.06	9.95	14.6	24.8	25.3	16.0	5.42	1.34	0.15
Tuul-Gachuurt	0.02	0.03	0.16	2.07	9.97	14.6	24.8	25.3	16.1	5.43	1.34	0.15
Tuul-Ulaanbaatar	0.02	0.03	0.16	2.06	9.95	14.6	24.8	25.3	16.0	5.42	1.34	0.15
Tuul-Zaamar	4.4	8.4	9.9	17.1	19.3	18.2	14.3	7.2	1.3	0.0	0.0	0.0

Long term mean runoff: the long term mean runoff of the Tuul River at Ulaanbaatar station is 21.6 m^3/sec. During high flow years, the mean runoff with 5 percent probability of occurrence can reach 59.1 m^3/sec and in case of low flow years with 97 percent probability of occurrence, the mean runoff of the Tuul River is 6.0 m^3/sec.

The Tuul River shows a fluctuation in runoff: it was decreased between 1945 and 1957, increased between 1958 and 1975, decreased between 1976 and 1981 and increased between 1982 and 1995. A low water period has continued until 2010. The long term mean runoff with different probability of occurrence is presented in Table 9.

Table 9. Long term mean runoff with different probability of occurrence, m^3/sec

River-station	P, %								
	1	5	10	25	50	75	90	95	97
Tuul –Bosgo bridge	22.8	17.1	14.5	10.9	8.23	6.66	5.36	4.32	3.75
Terelj-Terelj	19.8	14.8	12.5	9.43	7.09	5.73	4.60	3.70	3.20
Tuul -Terelj	31.0	26.0	21.0	15.0	9.49	6.58	4.40	3.39	2.64
Tuul -Gachuurt	62.7	52.6	42.6	30.3	19.2	13.3	8.9	6.9	5.3
Tuul-Ulaanbaatar	70.4	59.1	47.8	34.0	21.6	15.0	10.0	7.7	6.0

To estimate the long term mean runoff for river stations with a short period of observation, such as Tuul-Gachuurt, Tuul-Bosgo and Tuul-Terelj, the records of observation were extended using simultaneous observation data of the Tuul-Ulaanbaatar and Terelj-Terelj long records.

The estimated long term mean runoff of the Tuul River at Ulaanbaatar station is 21.6 m^3/sec, at Gachuurt 23.2 m^3/sec, at Tuul-Terelj 12.8 m^3/s, and at Bosgo Bridge 9.1 m^3/s. As for Terelj River the mean long term runoff is 7.8 m^3/s at the Terelj site. The long term mean runoff of the Tuul River was estimated also at the downstream sites Undurshireet and Zaamar using observed data at Undurshireet, Lun and some field measurements at Zaamar sites (1989). The estimation shows that the long term mean runoff at Undurshireet and Zaamar is 21.1 and 17.9 m^3/s respectively (Table 10).

Table 10. Long term mean runoff in the Tuul river basin

No.	River-station	Period of coverage	Basin		Long term mean runoff			Cv	Cs
			Area	Mean elevation	Q, m^3/s	q, l/sec km^2	h, mm		
1	Terelj-Terelj	1971-2008	1,220	2067	7.8	6.4	202.3	0.4	0.8
2	Selbe-Sanzai	1994-2008	34.2	1620	0.1	3.8	120.0	0.7	1.4
3	Selbe-Dambadarjaa	1985-2008	188	1510	0.4	2.2	70.5	0.6	1.3
4	Uliastai-Uliastai	1990-2008	317	1400	0.6	1.8	56.7	0.8	1.6
5	Tuul-Ulaanbaatar	1945-2008	6,300	1852	21.6	3.4	108.1	0.6	1.2
6	Tuul-Undurshireet	1983-94	18,427	1563	21.1	1.14	36	0.26	0.52
7	Tuul-Lun	1998	23,850						
8	Tuul-Zaamar	-	47,850	1248	22.2	0.70	22.1		

Maximum flow: the maximum flow of the Tuul River is observed during summer rainfall floods. The maximum discharge observed at Ulaanbaatar and will be attenuated after Ulaanbaatar due to the flood routing. The magnitude of the spring flood maximum due to snow and ice melting is less compared to rainfall flood maximum. For example the estimated maximum discharge with 1 percent of probability of occurrence of the spring flood at Tuul-Ulaanbaatar is 480 m^3/sec and at Terelj-Terelj - 140 m^3/sec.

But the rainfall flood maximum discharge with 1 percent of probability of occurrence is estimated at 1850 m^3/sec at Tuul-Ulaanbaatar and at 822 m^3/sec at Terelj-Terelj (Table 11). To estimate the maximum flood discharge of the Tuul River some statistical models were used including EV-1, Log-normal with 3 parameters. But these methods provide an underestimation and therefore we recommend to use the empirical curve. In order to calculate rainfall flood at the Tuul-Gachuurt dam site, the 1994 and 1986-1988 Tuul-Ulaanbaatar and Tuul-Gachuurt flood discharge measurements were used. There is no regular observance of runoff in Gachuurt. The maximum rainfall flood runoff is more in Ulaanbaatar than in Gachuurt.

Table 11. Maximum rainfall flood discharge, specific runoff and depth for different probability of occurrence

№	River-station		Maximum rainfall flood discharge *Q* (m^3/sec), specific runoff *q* (l/sec/km^2), depth *h* (cm)					
			0.1	1	2	5	10	25
1	Tuul- Ulaanbaatar	Q	3076	1850	1480	1120	800	500
		q	488	294	235	178	127	79
		h	-	139	111	80	56	35
2	Terelj-Terelj	Q	1375	822	670	500	386	243
		q	1127	674	549	410	316	203
		h		92.0	86.5	77.6	70.5	60.0
3	Selbe - Dambadarjaa	Q	1002	350	216	113	67.4	25.8
		q	3630	1268	790	409	244	93.5
		h	-	40.0	24.6	27.0	13.5	16.0
4	Tuul-Gachuurt	Q	-	1536	1238	947	689	447
5	Tuul-Zaamar	Q	-	1039	790	527	392	242

Low flow: the mean 30 days low flow of the warm period is 4.09 l/sec/km^2 in the upstream part of the Tuul River and 3.55 l/sec/km^2 in the Terelj River. It decreases to 1.69 l/sec/km^2 at Ulaanbaatar and to 0.32 l/sec/km^2 at Lun.

Table 12. Minimum flow of the Tuul River

№	River-station	30 days low flow (l/sec/km^2) for different probability of occurrence						Cv	Cs
		50	75	80	90	95	97		
1	Tuul river -Bosgo	4.09	2.85	2.65	2.29	2.13	2.07	0.51	1.53
2	Tuul river – Ulaanbaatar city	1.69	1.05	0.95	0.76	0.67	0.64	0.61	1.83
3	Tuul river-Altanbulag soum	0.75	0.49	0.45	0.38	0.34	0.33	0.58	1.74
4	Tuul river – Undurshireet soum	0.86	0.74	0.72	0.68	0.66	0.66	0.35	1.05
5	Tuul river –Lun soum	0.32	0.23	0.22	0.19	0.18	0.18	0.54	1.62
6	Terelj river –Terelj camp	3.55	2.36	2.17	1.82	1.66	1.60	0.66	1.98
7	Uliastai river-Uliastai	1.09	0.75	0.70	0.60	0.56	0.54	0.88	2.64
8	Selbe river-Sanzai camp	1.28	0.22	0.05	0.00	0.00	0.00	1.53	3.06
9	Selbe river -Dambadakhiid	0.99	0.56	0.49	0.36	0.30	0.28	0.96	1.92

Potential surface water resources: The total surface water resources of the Tuul River basin are 1.49 km^3/year calculated from the specific runoff map of the Tuul River basin (Figure 8).

Source: IMH, 2011

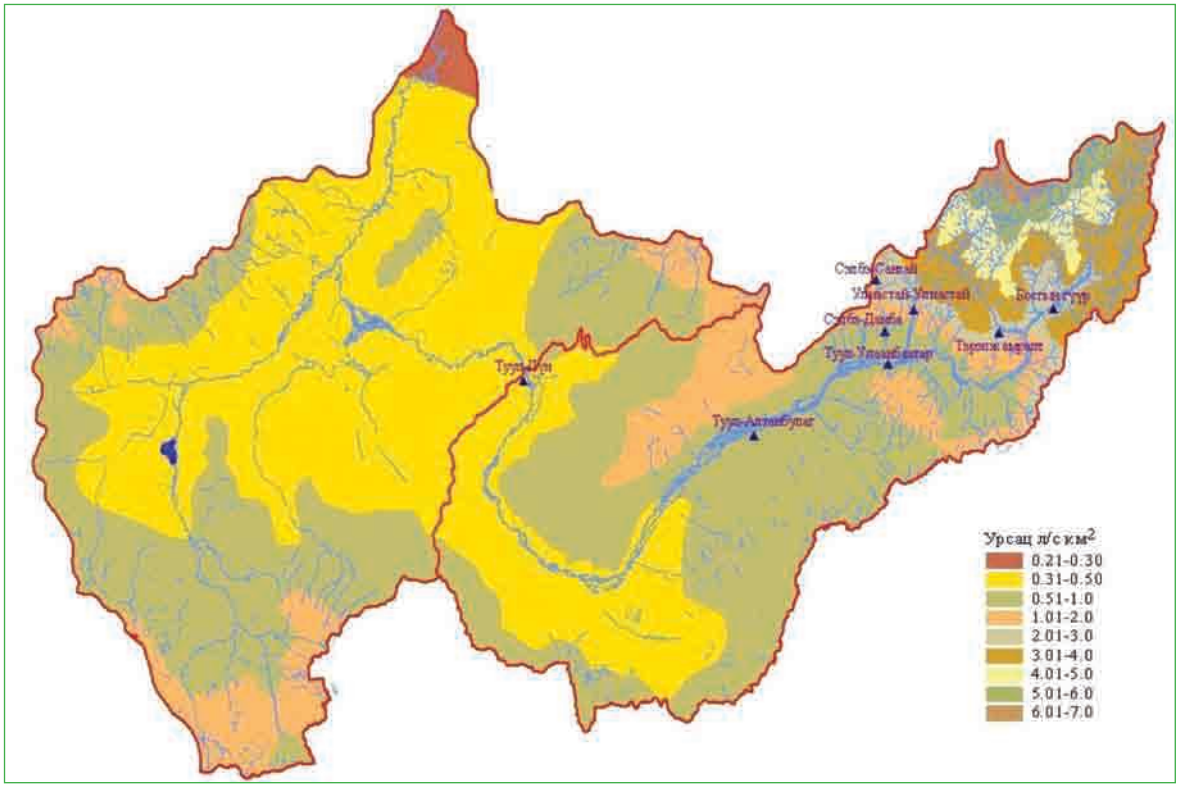

Figure 8. Specific runoff map of Tuul basin

Table 13. Total surface water resources of the Tuul River sub basins

No	Sub basin name	Area, km²	Specific runoff, l/s/km²	Flow type	Total water resources, km³/year
1	Upper Tuul	2,682.80	2.0-6.5	perennial	0.33
2	Terelj River	1,278.89	2.0-6.5	perennial	0.17
3	Selbe, Uliastai Khuliin River	3,325.77	0.5-3.5	temporary	0.15
4	Bukhug River	1,674.30	0.5-1.5	temporary	0.040
5	Guniin River	3,142.12	0.3-2.0	temporary	0.095
6	Tuul-Altanbulag	3,492.37	0.3-2.0	perennial	0.088
7	Khalzan River	3,396.42	0.3-1.0	temporary	0.062
8	Tuul-Undurshireet	2,594.32	0.3-1.0	perennial	0.044
9	Tuul- Lun	3,518.97	0.3-1.5	perennial	0.058
10	Khaliuchiin River	1,459.32	0.3-1.0	temporary	0.029
11	Tuul-Zaamar	4,601.74	0.2-1.0	perennial	0.058
12	Mars River	2,376.22	0.3-1.0	temporary	0.036
13	Badiin River	3,198.54	0.3-1.0	temporary	0.058
14	Tarnain River	5,380.29	0.3-2.5	temporary	0.15
15	Doloon gol	1,699.04	0.3-1.0	temporary	0.031
16	Khar bukh	4,946.34	0.3-1.5	perennial	0.088
Total		48,767.45	0.2-6.5	perennial -7 temporary -9	1.49

The specific runoff within each sub-basin is shown in Figure 9 and Table 13. Because the watershed area was derived from the SRTM 90m DEM the total area is different from the area which was determined from the 1:100,000 scale topographic map (49,774.4 km²).

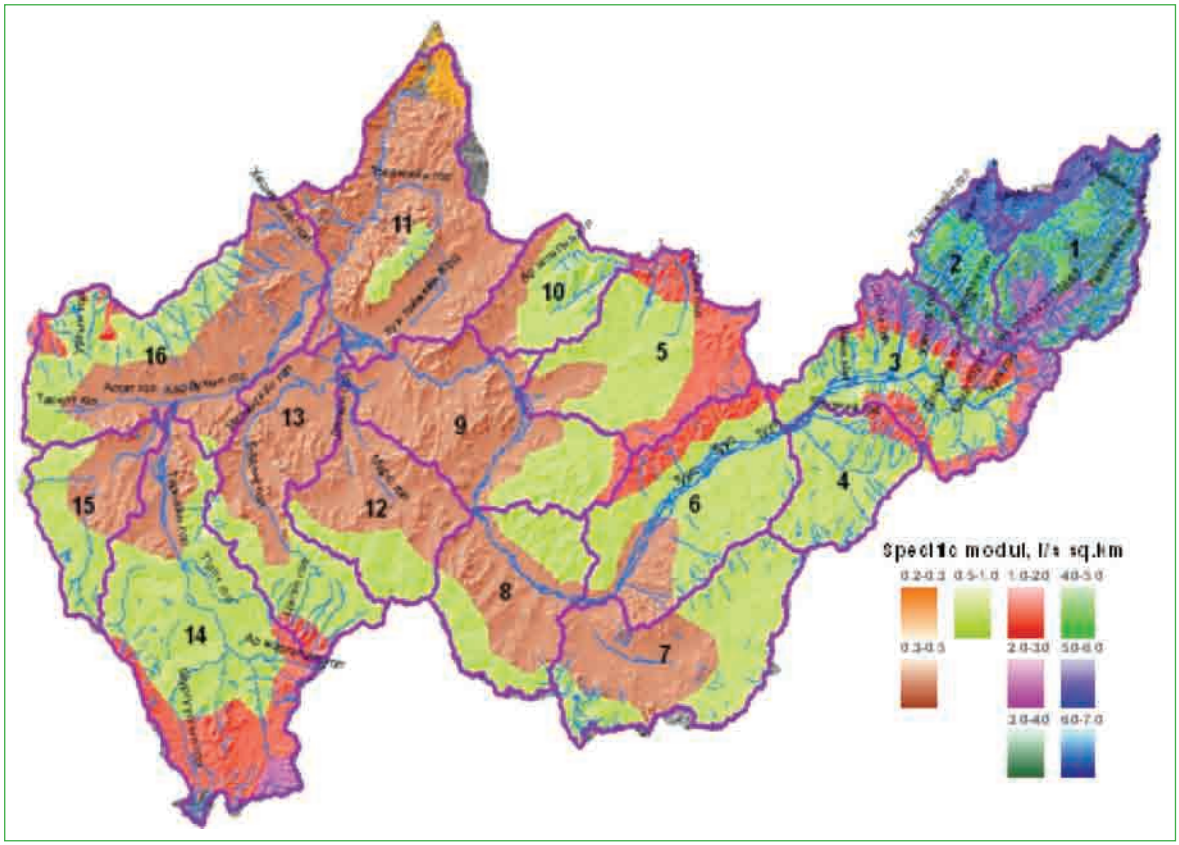

Figure 9. Specific runoff map of Tuul basin with sub basins

2.1.2. Rivers with temporary flow

The Tuul basin has a high mountainous area with steep slopes in many parts where rivers and dry channels transport spring and summer floods. Flash floods are high intensive turbulent flows with rocks, sediments and other surface materials due to heavy rain along the steep dry beds and small rivers. Hill slope, soil, sediment, intensity of rain and urbanization are key factors for flash flooding. In southern part of the mountain is highly populated. There is a dry channel with a length of 7.3 km, a catchment area of 12.2 km^2 and a basin mean elevation of about 1515m above sea level. A hydrological investigation conducted in 1999 showed that in the upper part of the basin the channel slope is114-200 m/km, in the middle part 67-144 m/km and about 25 m/km in the lower part which collects runoff from the basin during a short period.

As of last 5 years, thunderstorms happened 1-2 times per year in Ulaanbaatar city and there were flash floods. For the flood research, distance observation methods were used. Maps were made of Ulaanbaatar city settlement zones and areas which will be flooded.

2.1.3. Basin lakes

There are numerous small lakes but no big lakes in the Tuul basin. According to the surface area lakes can be classified into the following groups: very little (0.1-1.0 km^2), little (1.1-5.0 km^2), very small (5.1-10.0 km^2), small (10.1-20.0 km^2), medium (20.1-50.0 km^2), middle (50.1-100.0 km^2), big (100.1-500.0 km^2), very big (500.1-1000.0 km^2), great (>1000.1 km^2) (J.Tserensodnom, 2004).

Due to this classification there are 5 small, 42 very small, and around 900 little and very little lakes (1984). The biggest lake is the Tsaidam Lake (3.5 km^2) which is located on

the border of Zaamar and Tseel soum of Tuv aimag. Lake water levels are affected by: climate, dryness, land surface degradation and internal and external factors. The origin of lakes may be divided in: internal, external and mixture factors. Internal factors are tectonic uplifts, external factors are rain, snow, glacier and continuous permafrost. The mixture factor: lakes originated from snow, ice and soil influences.

In the upper part of the Tuul River basin exist many attractive lakes like Ulaan Baitsiin Nuur, Khar Khadnii Nuur, Mungun, Burkhet and Khiidiin Sumiin Nuur. They support the flow of the Tuul River and have an essential role for the ecosystem. Many small lakes in the middle and lower part of the basin are used for livestock water supply, livestock minerals and salt resource production and lake mud is also used for traditional healing/cure.

Table 14. Morphometric and chemical characteristics of some lakes in Tuul basin

No	Lake name	Location		Chemical 2010				
		Aimag, soum	Coordinates	pH	Conductivity μS/cm	Turbidity	Colour	T,°C (July, Aug)
1.	Tsaidam	Tuv Zaamar		-	-	-	-	-
2.	Khagiin Khar	Tuv Erdene	107.91, 48.41	-	-	-	-	15.0-17.0
3.	Bust	Tuv	107.34, 47.78	8.5	3040	slightly	yellow	
4.	Jirem	Tuv	106.09, 47.93	8.8	3320	Very turbid	grey	
5.	Ikh Tsagaan	Bulgan Dashinchilen						
6.	Shil	Tuv	106.12, 47.02	9.08	2320	slightly	greenish	
7.	Burd Tsagaan	Bulgan Dashinchilen	106.29, 50.20	9.46	1330	clear	grey	
8.	Khukh	Tuv						13.5-15.3
9.	Kherkheluur	Tuv						14.5-16.1

Morphometric								
No	Lake name	Area, км^2	Elevation m	Average				Water regime type
				Length км	Width км	Depth m	Shore length км	
1.	Tsaidam	3.5	1056	3.0	2.0	-	9.0	permanent
2.	Khagiin Khar	2.0	1820	2.5	1.1	11	6.2	permanent
3.	Bust	0.06	1397	-	-	-	-	temporary
4.	Jirem	0.35	1252	-	-	-	-	temporary
5.	Ikh Tsagaan	2.2	960	2.9	1.5	2.6	6.8	permanent
6.	Shil	0.26	1300	-	-	-	-	temporary
7.	Burd Tsagaan	0.8	950	1.8	0.8	-	4.0	temporary
8.	Khukh	0.6	1840	1.2	0.8	16	3.0	permanent
9.	Kherkheluur	0.5	1830	0.9	0.5	7.0	1.2	permanent

2.1.4. River water temperature, ice regime, sediment

Ice and thermal regime of the Tuul river: Ice phenomena begin in the Tuul River in the second decade of October and by the mid of November an ice cover is established along the Tuul River. The Tuul River has on average 149 days with ice cover until the end of April. The mean depth of the ice cover of the Tuul River is 43 cm in November and it increases up to 66 cm in December. The maximum ice depth is observed in mid February reaching 116 cm. Spring ice phenomena begin from mid April and by the third decade of April ice drifting is observed. Spring ice phenomena end by late April.

***Tuul river water temperature*:** In the last decade of April, the water temperature of the river exceeds 0.2 °C and by May it warms to 7.0 °C. The maximum temperature is observed in July with a monthly mean of 14.0 °C. The daily maximum observed in mid of July reaches 20 °C after which the water temperature begins to cool down until autumn when ice phenomena begin. This is the natural water regime of the Tuul and its affluent rivers.

In order to protect the natural water regime, the Tuul and its affluent rivers' natural and ecological balance should be protected, including forest, soil and plants. The land surface should keep its existing shape.

Sediments: Sediments originate and are formed due to basin mountain rock damage and weathering. Temporary runoff originates from precipitation and washes the surface part of the soil. It flows into rivers and lakes by carrying small-piece sediments. In the steppe zone, sediments are composed of gravel, sand and sandy loam with landwaste and rock debris. In the mountain rivers, stones and gravels dominate.

The turbidity of the Tuul River varies from 0.2 to 650 g/m^3 and the maximum value of turbidity is observed in June and July. About 80 percent of the annual suspended sediments pass during the mentioned months, 10 percent is observed in May and August. The mean value of the sediment discharge of the Tuul River is 2.65 kg/sec and the mean value of the turbidity is around 109 g/m^3. In total 92.5 percent of suspended sediments are composed of hard parts with a diameter of 0.1-0.001 mm. The average is 0.031 mm.

2.2. Groundwater resources and regime

2.2.1. Geomorphology, geology and hydrogeology of the basin

Groundwater research in the Tuul river basin was conducted at different scales. The hydrogeological mapping of the total area of the Tuul river basin was done at a scale of 1:500,000 and the mapping of the surrounding of Ulaanbaatar City at a scale of 1:100,000. The hydrogeology and engineering geology of the Tuul river valley was studied with a comparatively higher accuracy.

Geomorphology and geology: The geomorphology of the Tuul river basin is included generally in the mountainous regional area and is formed from mountain range, mountainside and foot, streams, river mount, valley and narrow ravines. The Tuul river source is located 2600 m above sea level in the Khentii mountain range and the downstream end consists of a wide valley at an elevation of about 800 m where it merges with the Orkhon River. The mountains surrounding the river basin are the recharge area of groundwater, the valley at Ulaanbaatar City is an accumulation area. The Tuul river valley has narrow and wide parts, with the narrow parts formed as pushed foot region.

The geological structure of the named basin covers granite rock penetrated the sedimentary, magic rocks of Cambrian, Devon, Carbon periods frozen on depth at Jurassic and Triassic periods that distributed covering these main rocks consists of sandstone of light-grey color, aleuropelite, tertiary gravel sand of red, reddish color and pelagic clay, loam, sand thin stratum, also sand, gravel, clay and shingle rocks formed in quaternary period.

Tertiary (Neogene, Paleogene) sediments are on average 80 m thick, mainly have clayish structure of not penetrated water. Modern quaternary or Holocene aged alluvial, lacustrine, aeolian originated sediments are distributed along the Tuul river valley and contain comparatively high quantities of groundwater resources.

Hydrogeology: In the Tuul river basin there are two kinds of aquifers: granular (unconsolidated) and fissured aquifers (consolidated). There are mineral springs emerging from both granular and fissured aquifers (Ulaanbaatar, Ar Janchivlan, Ovor Janchivlan carbon dioxide cold springs). The granular formations are formed within the lower Cretaceous, Neogene and Quaternary deposits and the fissured aquifers are formed within the Cambrian, Devon, Carbon sedimentary, metamorphic rocks or the sedimentary rocks of Jurassic and Triassic periods.

Age and lithology /the branch of geology that studies rocks: their origin, formation, mineral composition and classification/ types of sedimentary rocks are distributed all over the Tuul river basin and are generally integrated and classified as granular when dominantly granular and as fissured when dominantly fissured. Taking into consideration hydrogeological and geological characteristics 6 types of granular aquifers and 2 types of fissured aquifers are distinguished. All these formations, including hydrogeological basic data are shown in Table 15.

Table 15. Aquifers in the Tuul River Basin

No	Aquifer formation, name of region	Used borehole numbers	Water depth (low-high) [m]	Drawdown (low-high) [m]	Yield [l/sec]	Minerali-zation [g/l]
1	Holocene alluvial formation	300	0.2 - 6.0	0.0 - 23.0	1.0 - 105.0	0.1 - 0.6
2	Pleistocene proluvial, proluvial-alluvial formation distributed along Tuul river valley	200	2.0 - 11.5	1.9 - 20.5	0.5 - 24.1	0.5 - 1.5
3	Holocene-Pleistocene alluvium, proluvium formation distributed along affluent rivers	270	0.2 - 12.0	2.0 - 40.0	0.5 - 8.0	0.3 - 1.2
4	Neogene sediment formation	20	19.37 - 119	2.0 - 40.0	0.5 - 3.8	0.5 - 1.6
5	Cretaceous sediment formation	85	1.5 - 80.0	-	0.3 - 10.0	-
6	Formation in rock in Triassic-Jurassic sediment	45	3.0 - 33.0	1.0 - 15.0	1.0 - 1.3	0.2 - 0.3
7	Zone in sedimentary, metamorphic, effusive rocks of Paleozoic period	30	3.7 - 60.0	4.5 - 17.0	0.07 - 25	0.1 - 1.2
8	Zone in intrusive rocks	115	8.6 - 26.5	2.7 - 5.1	0.1 - 4.3	0.1 - 0.7

2.2.2. Natural renewable groundwater resources

The total area of the Tuul River Basin is 49,774 km^2 where renewable groundwater resources are formed annually to a total of 960.0 million m^3. There are 19 soum centers and 2 cities: Zuunmod and Ulaanbaatar City located in this basin.

From these 12 soum centers have extremely low renewable resources or 0-5 mm/year*km^2, 2 soum centers have low renewable resources or 5-10 mm/year*km^2, 1 soum center has average renewable resources or 20-50 mm/year*km^2 and 6 soum centers have mixed renewable resources of 40-80 mm/year*km^2. The maximum of the renewable groundwater resources in the whole Tuul river basin is 160 mm/year*km^2 near the source of the Tuul river. Along the river valley it is 40-100 mm/year*km^2 with the comparatively higher renewable resources near the Khentii mountain range.

Table 16. Renewable groundwater resources calculated in the Tuul basin

	Classification of renewable resources (mm/year/km²)	Area (km²)	Average flow (mm/year)	Renewable resources (mln m³/year)
1	Extremely low (0-5)	33,923	5	170
2	Low (5-10)	2,512	8	20
3	Low to average (10-20)	2,053	15	31
4	Average (20-50)	2,157	35	76
5	Average to high (50-100)	2,859	75	214
6	Mixed (40-160)	6,270	40-160	450
	Total	**49,774**		**960**

It is clear from this table that extremely low renewable resources cover an area of 33,923 km² or 68.1% of the total area of the Tuul river basin containing 17.7 percent of the total renewable groundwater resources. An area of 6270 km² or 12.5% of the total basin area has mixed renewable resources of 40-160 mm/year containing 46.8 percent of the total renewable groundwater resources. Most of the renewable groundwater resources are formed and recharged in the granular alluvial deposits of the river valley.

The renewable resources indicate the potential water recharge of the groundwater depending on precipitation, climate, river properties and soil features of the area. It is possible to use the renewable resources in case of favorable resource-accumulating geological-hydrogeological conditions. The potential exploitable resources are calculated based on the renewable resources.

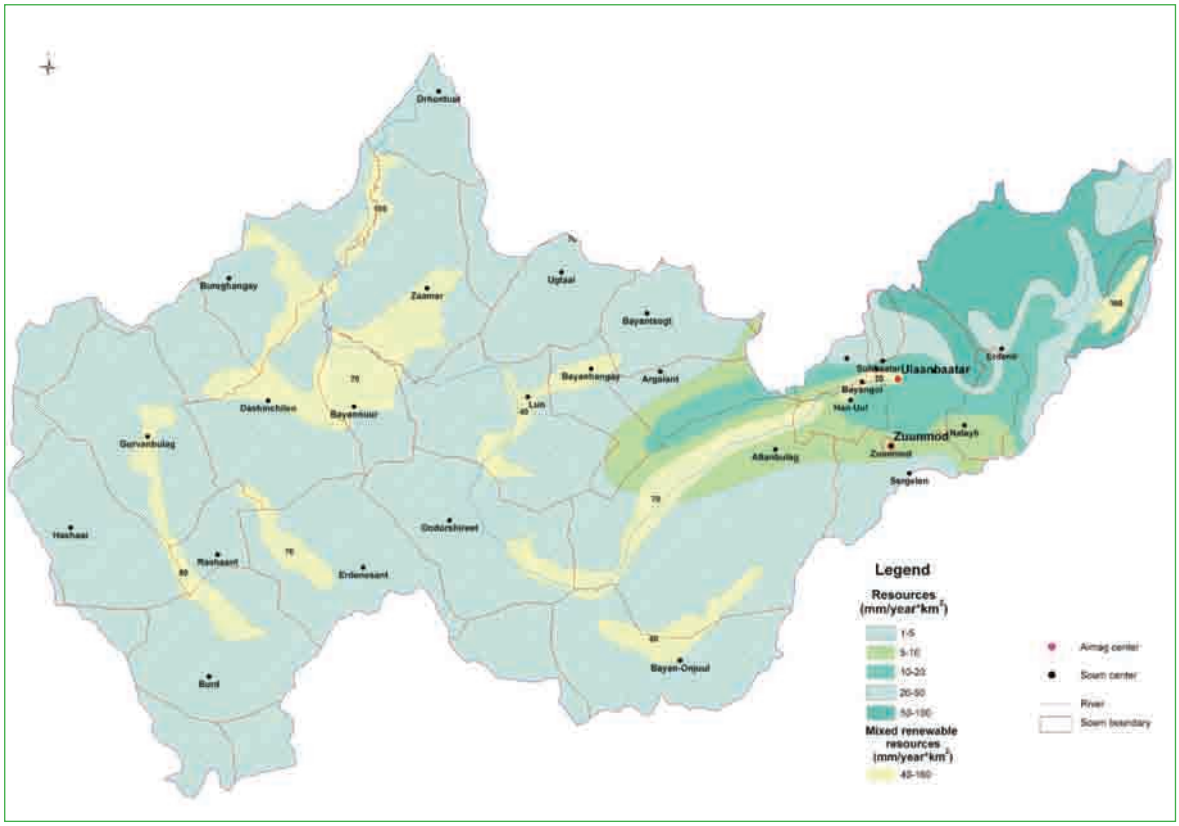

Figure 10. Renewable groundwater resources map of the Tuul River Basin

2.2.3. Potential exploitable groundwater resources

Table 17 shows that on the area of the Tuul river basin of 49,774 km^2 a total of 641 million m^3/year (0.641 km^3/year) of potential exploitable groundwater resources are formed of which 596 million m^3/year or 92.9 percent of the total resources are formed in 20 percent of the total area.

Table 17. Potential exploitable groundwater resources

Index	Classification	Area (km^2)	l/s/km^2	m^3/year / km^2	Resource (mln m^3/year)
1	Granular aquifer, large resources (>10 l/s)	165.6	10	315360	52
2	Granular aquifer, larger than medium resources (3-10 l/s)	3,705	3	94608	351
3	Granular aquifer, Medium resources (1-3 l/s)	6,123	1	31500	193
5	Granular aquifer, lower than medium (0.3-1.0 l/s)	246	0.65	20500	5
6	Granular aquifer, lower than medium (0.3-1.0 l/s)	633	0.65	20500	13
7	Granular or fissured aquifer, low resources (0.03-0.3 l/s)	1,278	0.165	5203	6
8	Granular or fissured aquifer, low resources (0.03-0.3 l/s)	2,239	0.165	5203	12
9	Granular or fissured aquifer, very low resources (0.003-0.03 l/s)	49	0.0165	520	0
12	Fissured aquifer, very low resources (0.003-0.03 l/s)	12,879	0.0165	520	7
13	Granular or fissured aquifer, basically no water resources (<0.003 l/s)	22,456	0.003	94.6	2
Total		49,774			641

Table 17 does not include index numbers 4, 10 and 11 because these resources are not found in the basin. The index numbers are explained in the map legend of Figure 11.

The potential exploitable resources (Table 17) are used to calculate the exploitable groundwater resources by soum which are used in the water use balance.

2.2.4. Exploitable groundwater resources

There are 19 soum centers and 2 cities: Zuunmod and Ulaanbaatar City located in this basin. Water exploration prospecting work for the purpose of water supply was executed in Ulaanbaatar and Zuunmod cities only. There are 4 main water supply sources of Ulaanbaatar city. These are the well fields Upper, Central, Meat and Industrial. There has not been any groundwater prospecting works for the purpose of water supply of the soum centers. Geophysical research is conducted in order to find water supply sources and single use borehole locations. In recent years, groundwater research was conducted at Khashaat soum (Arkhangai), Rashaant and Dashinchilen soums (Bulgan) water supply sources (Table 18). It was organized by the Water Authority.

Soum center people use springs and river water for drinking water depending on soum location and availability of surface water and groundwater. Each soum center has 1-5 boreholes for the population water supply. They are used by soum center organizations and households.

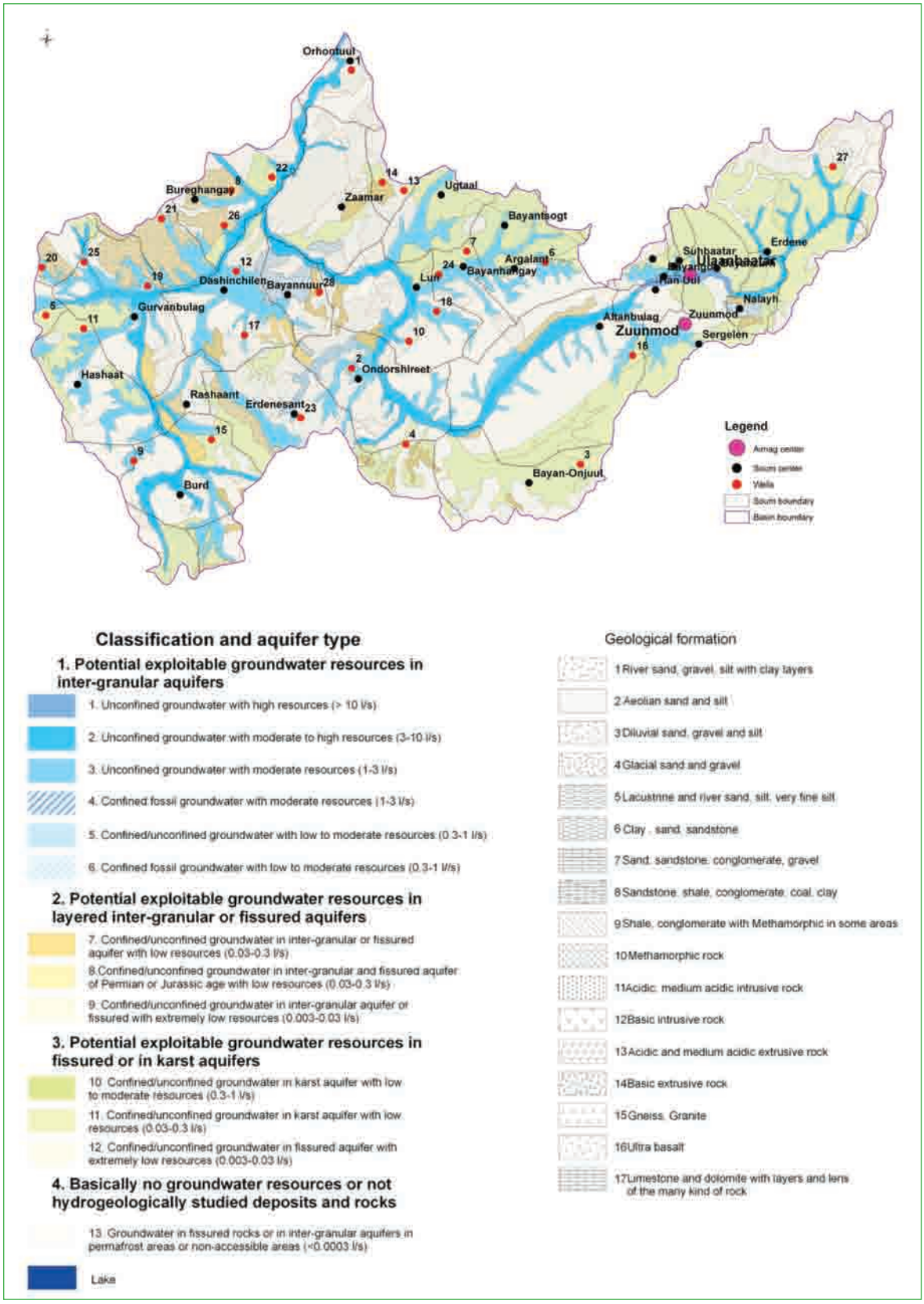

Figure 11. Groundwater potential exploitable resources

Table 18. Properties of soum center water supply wells and aquifers

No	Aimag	Soum	Drilled year	State number	Number of database code	Static water level, m	Dynamic water level, m	Specific yield, l/sec	Pumping yield, l/sec	Drawdown, m	Depth of well, m	Depth to top of aquifer 1, m	Thickness of aquifer 1, m	Depth to top of aquifer 2, m	Thickness of aquifer 2, m	Maximum permitted yield from one well, l/sec
1	Ovorkhangai	Burd	1971		84	9.5	16.0	1.2	8.0	6.5	92	15.2	5.6	22.8	3.2	1.7
2		Burd	1982		306	16.0	17.0	1.3	5.0	1.0	85	39	4	72	10	6.9
3	Tuv	Lun	1975	4102	75	13.0	14.0	7.0	7.0	1.0	50	22	9			Large resources
4		Lun	1989	9475	522	5.0	6.0	2.5	2.5	1.0	29	7	11	20	9	8.3
5		Lun	1988	9433	480	12.0	13.6	1.6	2.5	1.6	40	14	1	24	8	2.6
6		Bayan-Onjuul	1975	4120	90	23.0	43.0	0.1	1.0	20.0	50	33	7			0.6
7		Bayan-Onjuul	1984	7538	366	25.5	27.0	0.2	3.0	15.0	60	28	4	45	13	1.2
8		Ondor-Shireet	1978	5736	168	64.0	67.0	0.4	1.2	3.0	125	64	61			8.5
9		Ondor-Shireet	1990	9510	557	8.5	24.0	0.5	8.0	16.0	56	12	16	39	2	1.6
10		Altanbulag	1974	3317	59	10.5	26.0	0.1	2.0	15.5	61	41	10			1.6
11		Altanbulag	1989	9455	502	29.0	31.0	1.0	2.0	2.0	53	40	10			6.3
12		Argalant	1982			53.0	40.8	0.3	3.8	12.2	90	47	18			1.1
13		Argalant	1982			49.0	35.2	0.3	4.2	13.8	90	85	5			3.7
14		Bayankhangai	2009			37.0	64.0	0.1	2.0	27.0	70	38	12	54	6	0.5
15		Bayantsogt	1986	9375	423	35.0		0.6	4.0	6.5	69	40.5	19.5			4.7
16		Zaamar	1974	3322	58	15.0	23.0	0.3	2.0	8.0	52	28	14	44	6	1.2
17		Sergelen	1980	6196	228	29.7	30.7	1.3	1.3	1.0	58	30	28			11.0
18		Sergelen	1980	6197	229	29.5	30.4	1.6	1.4	0.9	56	41	10			10.1
19		Sergelen	1986	9359	408	24.0	32.0	1.0	8.0	8.0	61	40	3	50	5	3.6
20		Sergelen	1988	9431	478	35.0	46.0	0.9	2.5	2.7	65	46	8			5.3
21		Ugtaal	1979	6160	200	30.0	34.0	0.4	1.6	4.0	109	37	13	86	23	2.6
22		Ugtaal	1987	9395	442	22.0	36.0	0.7	2.8	4.0	60	42	10			6.3
23		Erdene-Sant	1982			35.0	48.0	0.2	2.5	13.0	73	48	4	51	8	1.4
24	Bulgan	Rashaant												Large resources		7.8
25		Gurvanbulag	1973	2635	71	4.0	8.0	0.3	1.2	4.0	50	6.1	47.9			4.5
26		Gurvanbulag	1978	4777	107	36.0	40.2	0.3	1.3	4.2	96	36	25	74	8.5	3.6
27		Dashinchilen	1974	3145	80	5.2	10.9	0.2	1.3	5.7	55	5.2	34.8	Large resources		7.5
28		Bayannuur	1982	6575	183	5.0	10.0	0.6	3.0	5.0	88	73	11			14.2
29		Bureg-Khangai	1976	3658	100	5.5	6.8	0.8	1.0	1.3	10	5.5	31.5			8.5
30		Khishig-Ondor	1989	6710	311	3.5	4.0	2.0	1.0	0.5	32	19	11			7.7
31	Arkhangai	Khashaat				12.0	19.0	0.6	4.0	7.0	56	25	5	Large resources		9.0
32	Selenge	Orkhon-Tuul	1965	956	67	4.8	5.0	16.6	3.3	0.2	73	7	23			Large resources

Exploitable groundwater resources of Ulaanbaatar city: As of 2007 there are 96 wells in operation at the Central Source: № 1-9 and 12-27 wells (boreholes) were put into operation in the period 1961-1974, № 40-46, 48-51 and 52-63 wells were put into operation in the period 1980-1984 respectively. By decree number 7 dated 20th June, 1980 of the joint meeting of Mineral Resource Reserve Commission of the People's Republic of Mongolia and USSR /former Russian Federation/ it was officially approved as groundwater resource in alluvial aquifer in the wide part of the Tuul River near Ulaanbaatar City. Other deposits in the Tuul Valley which were approved later are: Yarmag, Sonsgolon, Buyant-Ukhaa new district, Confluence of Tuul and Uvur Gorkhi, Confluence of Tuul and Terelj (Table 19).

Table 19. Exploitable groundwater resources in alluvial aquifer of the Tuul River near Ulaanbaatar City

Name of sources	Classification, resources (thousand m³/day)		Consumption, type of use (as recommended)
	A+B	C1	
Central	90.3	34.8	Domestic, industrial
Upper	89.7	-	Domestic, industrial
Industrial	30.3	-	Domestic, industrial
Meat Complex	8.6	-	Domestic, industrial
TES-1	3.5	-	Used in technical
TES-2	4.9	-	Technical use
TES-3	2.5	-	Technical use
TES-4	41.4	-	Technical use
Other	7.2	35.8	Technical use
Total	278.4	70.6	Consumption, use

Table 20. Recently studied groundwater deposits for water supply of Ulaanbaatar city

City	Deposit name	Resources, m^3/day
Ulaanbaatar	Tuul valley of Yarmag, Sonsgolon (2011)	26,201
Ulaanbaatar	Buyant-Ukhaa new district (2010)	22,550.4
Ulaanbaatar	Confluence of Tuul and Uvur Gorkhi (2003)	11,750.4
Ulaanbaatar	Confluence of Tuul and Terelj (2007)	40,061.9
Total		100,563.7
Ulaanbaatar	Khui doloon khudag (2007); this deposit is located in the Kharaa river basin but can be used for water supply of UB.	3,844.8
Total		104,408.5

Taking into consideration the high risk of groundwater pollution in the delta deposits of the Selbe River it is necessary to deduct 24.0-34.8 thousand m^3 from the estimation of the Central Source as it is specified in 1980. Currently it is becoming clear, that groundwater is polluted in some boreholes of the Central Source (for example, boreholes located close to Narantuul market). The approved water resource volume of the central water supply of Ulaanbaatar City is impossible to be extracted, as explained by officials of USUG (the Ulaanbaatar Water Supply and Sewerage Company) to the population. Therefore, it is necessary to define the current situation in detail using boreholes and groundwater flow estimation.

Exploitable groundwater resources of Zuunmod city: Zuunmod city has two kinds of water sources: central source and private wells. The central source is composed of exploitation wells in Khushig valley alluvial-proluvial aquifer and hydrogeological research was conducted in 2007. The result of the investigation was a total of 6356.25 m^3/day (73.6 l/sec) of groundwater exploited resources. The research was conducted for the purpose of the international airport water supply. The resource was 3921.53 m^3/day.

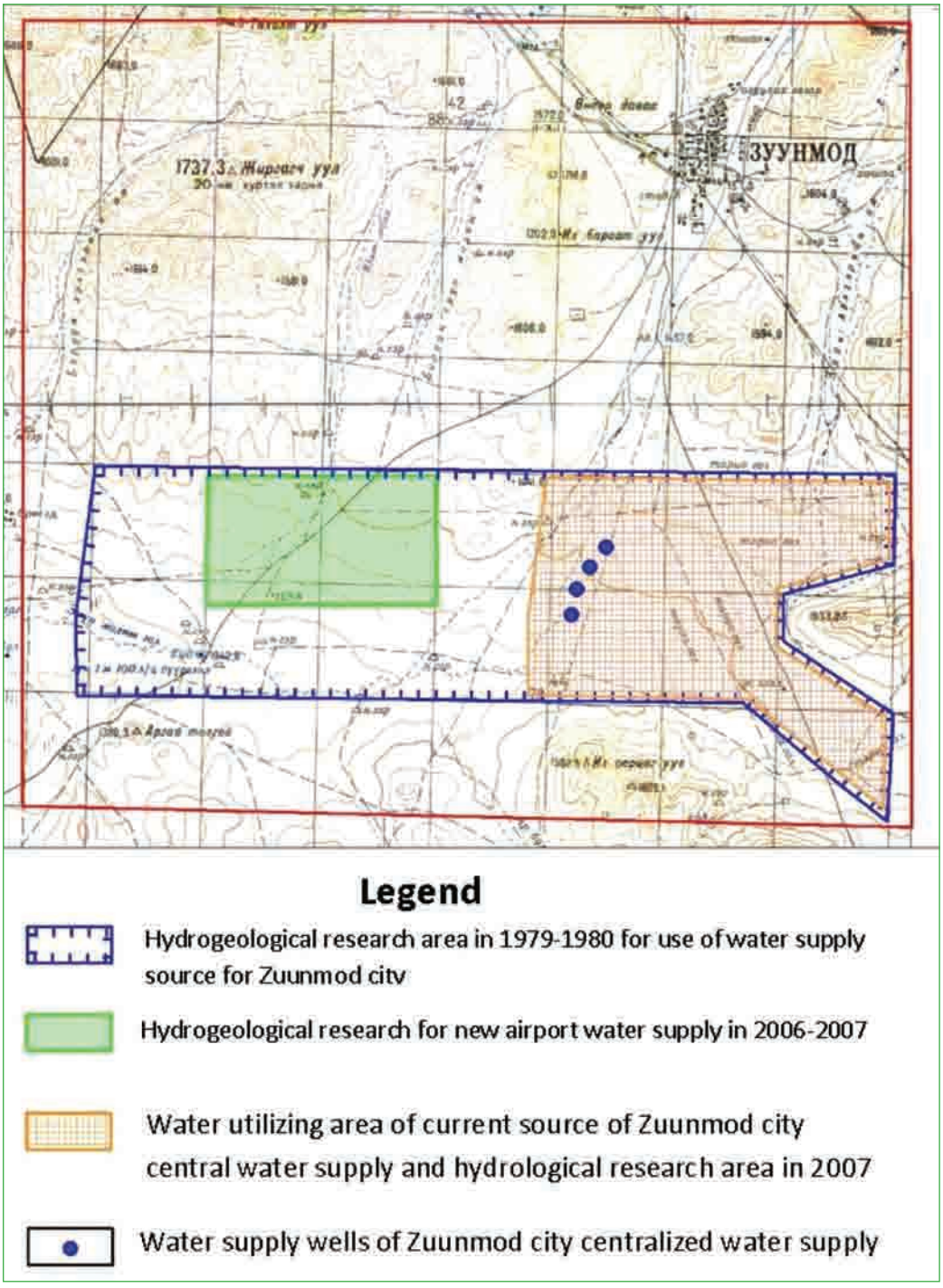

Figure 12. Overview of Khoshigiin khondii valley deposit of Zuunmod, Tuv aimag

Groundwater deposits: In recent years by state budget financing prospecting work on groundwater resources was done and re-evaluation was made in Khoshgiin khondii valley and at Khui doloon khudagt of the Tuv aimag. Also prospecting works were done in the valley of Ovor Gorkhi, arm of the Tuul river basin and the Terelj-Tuul river confluence with the purpose to increase the water supply of Ulaanbaatar city.

Ar Janchivlan is a mineral spring deposit and a study was done to use the mineral spring water for the purpose of treatment.

Table 21. Registration of groundwater deposits with approved resources

№	Aimag	Name of deposit	Resource, m³/day
1	Bulgan	Rashaant	678.2
2	Arkhangai	Khashaat	776.92
3	Tuv	Zuunmod /1979, 2007/	4500, 6356.2
4	Tuv	Ar Janchivlan	96.36
5	Tuv	Arguitiin river	16606
6	Ulaanbaatar	Confluences of Tuul river and 'Ovor Gorkhi' or South stream	11750.4
7	Bulgan	Dashinchilen	7.5
8	Ulaanbaatar	Terelj and Tuul valley	40061.9
9	Ulaanbaatar	Buyant-Ukhaa new district	22550.42
10	Ulaanbaatar	Tuul valley of Yarmag, Sonsgolon	26201

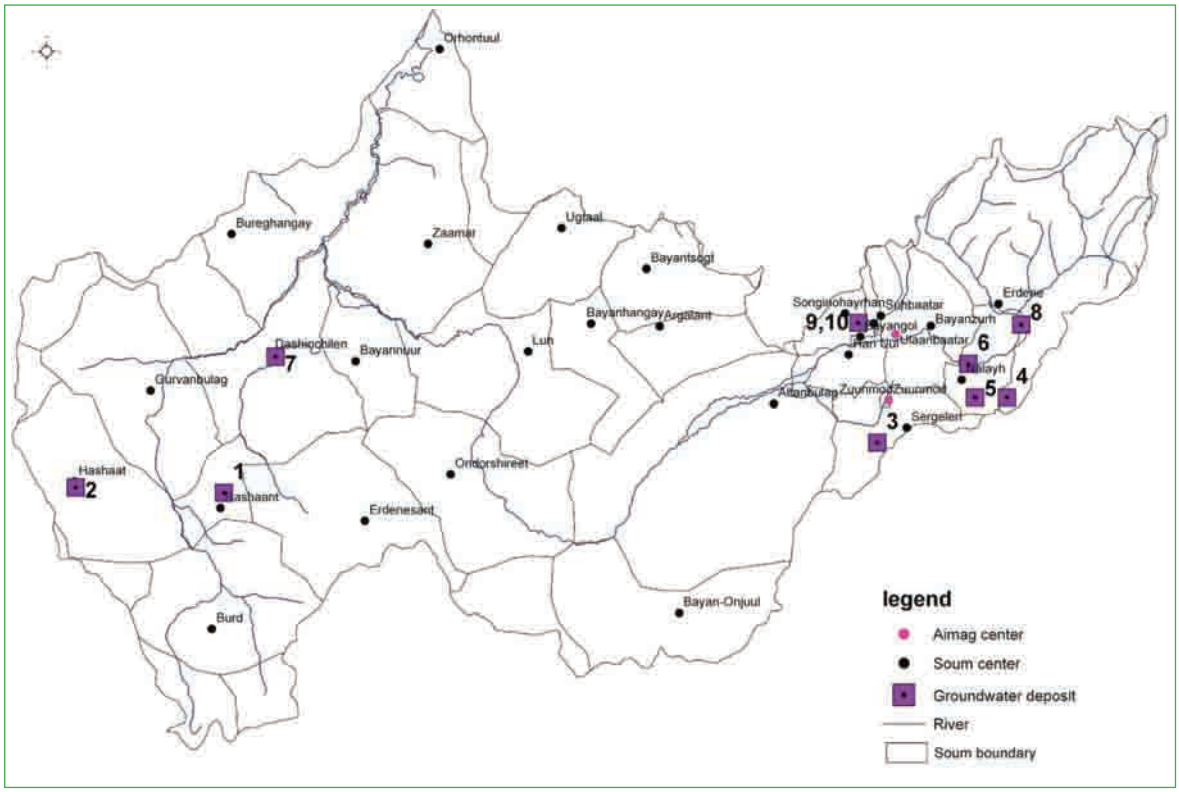

Figure 13. Location map of groundwater deposits

2.2.5. Groundwater monitoring

Research of groundwater regime at Ulaanbaatar city water supply sources: The groundwater level in the alluvial deposits of the Tuul river valley decreased 1-2 m since 1959-1960 due to the abstraction of water for drinking water and technical water supply. It decreased by 0.5 m at downstream parts of affluent rivers.

By results of water regime observations made by the expedition of the PNIIS Institute of the Russian Federation in the period of 1979-1980 the amplitude of groundwater level fluctuation was 2.7 m and by result of water regime observations made by Geo-Ecology Institute in period of 1997-1998 amplitude of groundwater level fluctuation was 3.1 m and prognosis it will be 3.7 m in 2020, 4.6 m in 2050. It means that the groundwater drawdown increases in the production wells of the urban water supply sources and that

further increase in groundwater abstraction will not be possible in 2050. In addition water shortages may happen soon in dry years with a probability of 5 percent.

In the production wells No 30, 32 located far away from the river, the groundwater drawdown was 13.1-13.3 m at the beginning of the recharge period in March and April 2001, and was 5.6-7.2 m during the peak recharge period in 2001. The groundwater drawdown was 12.9-14.1 m at the beginning of the recharge period in 2003, and was 6.2-6.1 m during the peak recharge period in 2003. The daily groundwater extraction is increasing due to water demand and use increase of Ulaanbaatar city. The groundwater use in winter time when there is no recharge causes the groundwater level to decrease (Geoecological institute, 2010).

Current monitoring of groundwater resources for water supply: The water supply sources of Ulaanbaatar City, including the technical water sources of Power Plant 3 and 4, should be under regular control and its water level monitoring points should be subjected for measurement work regularly. Ulaanbaatar city USUG installed monitoring equipment at 3 boreholes in the Central source and is conducting groundwater monitoring.

Within the framework of the "Strengthening Integrated Water Resources Management in Mongolia" project, 6 boreholes were drilled and equipped in Tuul river basin for the purpose of conducting groundwater monitoring.

Table 22. Groundwater monitoring wells in the Tuul basin

No	Aimag and city	Soum	Well depth m	Measurement start date	Coordinate	
					E	N
1	Ulaanbaatar	Central source	25	2011.02.16	106°58'21.6"	47°54'13"
2	Ulaanbaatar	Central source	25	2011.06.14	106°58'24.4"	47°53'57"
3	Tuv	Altanbulag	41	2011.08.26	105°56'40.7"	47°32'45.3"
4	Tuv	Lun	35	2011.08.26	105°11'47.4"	47°51'21.2"
5	Bulgan	Dashinchilen	23	2011.06.03	104°01'46.7"	47°53'14"
6	Ovorkhangai	Burd	50	2011.01.19	103°46'59.5"	46°58'42.2"

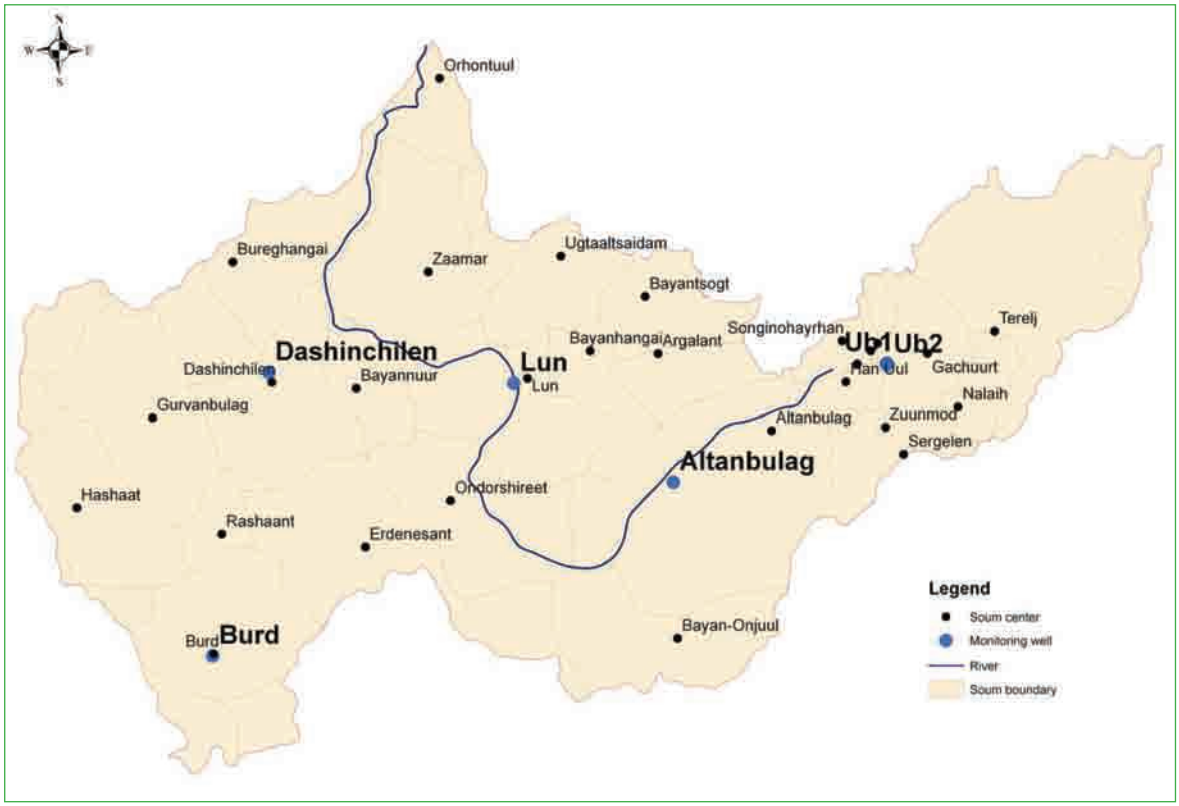

Figure 14. Location of monitoring boreholes in the Tuul river basin

The measurement data obtained from the monitoring wells established in the Central Source of Ulaanbaatar City in 2011 shows that the groundwater level was decreasing in the period of December-May and increasing in the period of May-August because of recharge from river and rain. The groundwater level was decreasing very small in August-December. In this period abstraction and recharge were almost in proportion in the area of both wells.

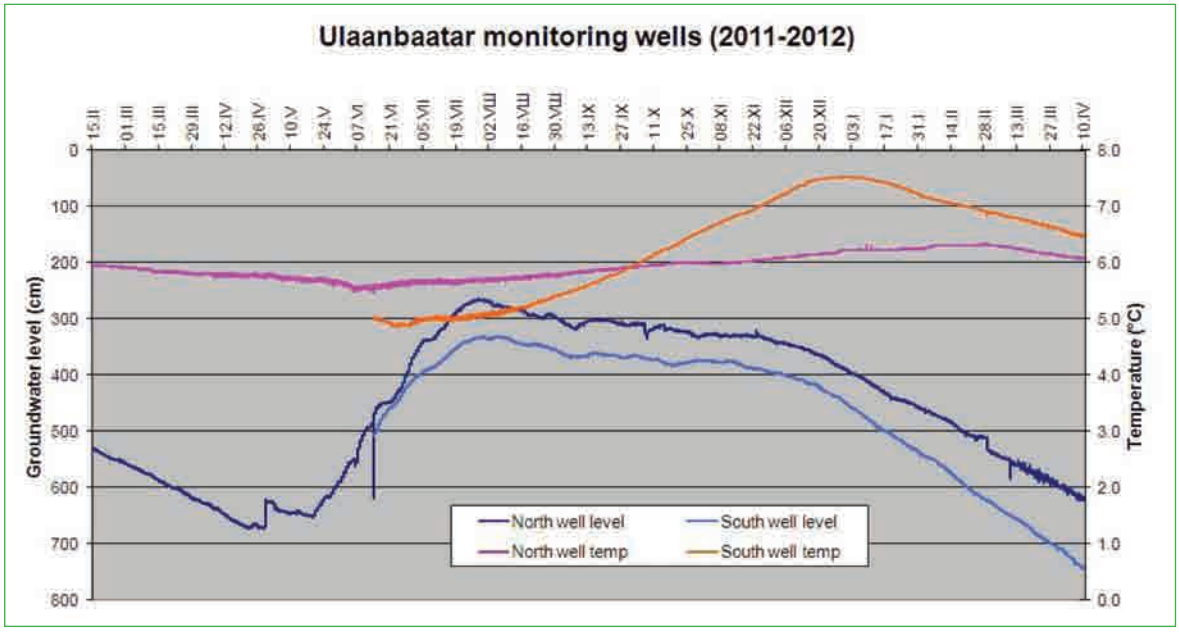

Figure 15. Data from monitoring boreholes located in Central Source of Ulaanbaatar City

2.2.6. Measures and recommendations on basin groundwater

- With a purpose to improve infiltration capacity of aquifer in alluvial deposits of Tuul river valley it is necessary to build cascades in small part of the Tuul river or to develop a feasibility study for a big dam in the Tuul river regulating the surface water for water supply and energy production.
- To find new small groundwater resources by executing exploration work in Gachuurt, Selbe, Tolgoit, Deendii river valley.
- The Millennium Challenge project with a purpose to develop farming around Ulaanbaatar City is implementing project works to drill wells with a minimum capacity of 0.6 l/sec (2160 l/hour or drinking for 150-200 cows within 2 hours).
- To conduct surveys in Ulaanbaatar and Zuunmod city water supply sources to set new hygienic zones and recharge zones at these sources.
- To obtain accurate measurements of annual groundwater use and to carry out regular monitoring on water resources of Ulaanbaatar and Zuunmod cities to operate groundwater model using this data.
- To develop and implement measures to limit negative effect of activities within protection and infiltration zones of water supply resources of Ulaanbaatar and Zuunmod cities, to define its location and scale
- To determine the regime adhered to take region and zones under protection
- To implement design projects to furnish and protect drinking water and spring resources around Ulaanbaatar and Zuunmod cities including their affluent rivers
- To provide mapping of groundwater in the Tuul river basin at a scale of 1:200,000
- To prepare detailed data of all wells drilled in the area of Ulaanbaatar City to be registered in State cadastre water information fund
- To establish a new database on groundwater quality and chemical compositions, expanding each year systematically
- To develop a groundwater monitoring plan as part of a national monitoring network.

2.3. Basin water quality and ecological issues

2.3.1. River basin surface water composition and quality

Tuul river water composition and quality:

Of all big rivers in Mongolia the most strong ecological change is happening in the Tuul River. The upstream part of the Tuul River is of primarily undisturbed nature, unpolluted and has very low mineralization because of minimal human activities. Also many clear and fresh mountain rivers flow in to the river. But starting from the capital, the chemical composition and water quality changes because of the technological influence and human activities along the flow of water.

In June and September of 2002-2004, the Institute of Geoecology carried out at 13 sampling points along Tuul river from Lun Bridge to the Tuul confluence with the Orkhon River to study the effects on the Tuul river ecology caused by companies exploring for gold in Zaamar region. The results of the study showed increased mineralization, hardness and pH from neutral (7.1) to weak alkalinity (8.1) along the Tuul River. General hardness is 0.94-2.35 mg-eq/l, mineralization fluctuates between 99.5-263.9 mg/l.

In 2009-2010, according to studies by the Institute of Geoecology, the mineralization of the Tuul River is very low. At most points under 100 mg/l upstream in the river from Bosgo Bridge until the confluence with the Nalaikh waste water discharge into Tuul River. On the other hand the mineralization increased to 269.56 and 129.40 mg/l, respectively at the next point which is below the Nalaikh waste water discharge with high mineralization flow into river. But it is purifying within its flow from Bayanzurkh Bridge to upstream of the Ulaanbaatar WWTP. Mineralization of the river is increased again from Upper Songino waste water discharge, and the mineralization running constant when compared to points before capital. The river flows into Orkhon River without purifying because of pollution from Zaamar area and waste water discharge of the CWWTP.

The June 2010 research conducted along the Tuul river showed that the water is included in the hydrocarbonate class, calcium group, it is in the first category, very fresh (mineralization 57.45 mg/l) and very soft (hardness 0.45 mg-eq/l) with neutral environment (pH=7.5). The chemical composition changed and the mineralization and hardness increased in downstream direction. For example: at the Orkhon-Tuul confluence, the last point in the basin, mineralization was increased to 324.45-212.70 mg/l and hardness was increased to 2.65-1.90 mg-eq/l. It is in hydrocarbonate class, sodium and calcium group, the first category, fresh and pH is 8.5.

2.3.2. Study on the aquatic fauna

Invertebrates: Among the previous records of invertebrates of the Tuul River, 170 species were reported, with most of them distributed in the upper part of the Tuul River, upstream of Ulaanbaatar. According to study of researchers of the Institute of Geoecology in 2003-2004, 43 species were found in places with 'good' water quality. Of these, 31 species are inhabitants of very clean water. In the Bayanzurkh part of the Tuul River 30 species were collected, from which 15 species are found in water of "fairly good" water quality. 8 species were reported in Tuul River of the Songino, all of which can live in water of 'very poor' quality.

In Sonsgolon and Songino, the number of aquatic organisms has been declining due to pollution and were dominated by species such as *Herpobdella sp* from Hirudinea, *Tubifex tubifex* of Oligochaeta, Chironomus plumosus of Chironomidae, Limnea stagnalis and Planorbis sp of Mollusca. Plankton, which are able to live in fresh water, are mostly found in the upper part of the Tuul and plankton which live in polluted environment, are found near Zaisan, Songino and Hadan Hyasaa where water is polluted. It acts as an indicator on Tuul river pollution.

Fish: Quality was assessed based on fish samples collected from 6 stations beginning at Bosgo Bridge until the confluence of Orkhon and Tuul. Near the confluence of the Tuul and Terelj, water is fresh to slightly polluted category due to Phoxinus phoxinus 70% and Loaches 30%. Near Bosgo Bridge water is fresh due to 80% of fish was Phoxinus phoxinus with 2.8 index of S-saprobe. Around Nalaikh 4 species of fishes are found and 90% of these were Burbot which is indicator of polluted water. Therefore, this part of the river is becoming polluted. Fish species of slightly polluted water are mainly found from Nalaikh until the confluence of the Orkhon and Tuul.

2.3.3. Pollution of the Tuul River

As can be seen from the last year's research results, the pollution indicators are rapidly increasing, bringing a change to 'polluted' category due to the discharge of waste water when the Tuul river runoff decreases or when the waste water from waste water treatment plant flows into the river. This is related to the rise in the amount of waste water by increasing water use of organizations, industries and city population.

Also it can be related to old equipment and technology and insufficient capacity of the treatment plants.

The pollution of the Tuul River has increased each year, negatively affecting the river water quality, ecological condition and hydrobiological regime. Below some water analysis results from 2009-2010 are presented and compared with previous analysis results to determine the pollution of the Tuul River.

Concentration of ammonium: The concentration of ammonium in the Tuul river water after the discharge of the waste water from Nalaikh is 3.8-3.2 times more than the 'much polluted' category of the surface water standard. At the next point after the waste water discharge from the Ulaanbaatar CWWTP, ammonium azote is 5.4-12.4 times more than the 'much polluted' category of the surface water standard. Thereafter ammonium ion is observed at other points, and is included from 'polluted' to 'much polluted' category. It is clear that flow from the Tuul River into the Orkhon River is not purified.

The concentration of ammonium azote in the treated waste water of the Nalaikh and Ulaanbaatar WWTP compared with the standard of 'Effluent treated wastewater general requirements (MNS 4943: 2011)' shows that the concentration of ammonium azote in the Nalaikh treated waste water did not exceed the permissible maximum level and the concentration of ammonium azote in the treated waste water of CWWTP is 1.4 -1.3 times more than the wastewater effluent standard.

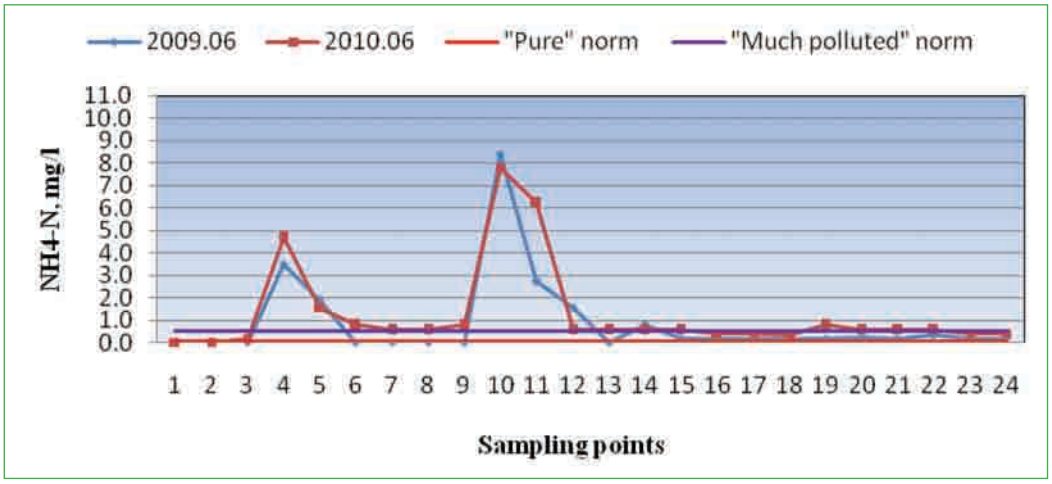

Figure 16. Concentration of ammonium in the Tuul River (2009 – 2010)

Sampling points: *1-'Bosgo' bridge, 2-Kharztai, 3-before confluence with waste water of Nalaikh, 4-The waste water stream from Nalaikh district, 5-Tuul-after confluence with waste water of Nalaikh, 6-"Bayanzurkh" bridge, 7-"Zaisan" bridge, 8-"Yarmag" bridge, 9- Upstream of the UB WWTP, 10-Waste water of UB WWTP, 11-Upper Songino after waste water discharge, 12-Shubuun factory, 13-Altanbulag, 14-Khustai, 15-Undurshireet, 16-"Lun" bridge, 17-Tumstui, 18-Zaamar-clear point, 19-"Zaamar" bridge, 20-Near "Shijir Alt" Co, Ltd 21- Near "Khos Khas" Co, Ltd, 22-Ariin khundii, 23-Near Orkhontuul soum, 24-Confluence of Orkhon and Tuul*

As can be seen from Figure 17, in 1997 the concentration of ammonium exceeded the 'much polluted' norm for surface water at Songino, Shubuun factory and Khadan Khyasaa points. The concentration of ammonium in 2010 increased when compared with 1997 at Bayanzurkh Bridge, Zaisan Bridge and Altanbulag points. Aquatic animals and vegetation will degrade if the amount of ammonium continues to increase in the future.

Therefore, there is a need to take substantial measures to protect the Tuul River from pollution.

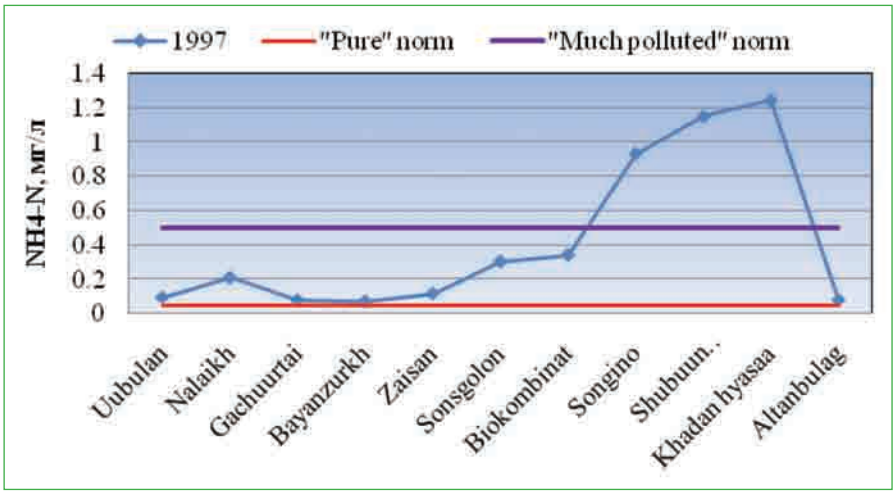

Figure 17. Concentration of ammonium in the Tuul River (1997)

Dissolved oxygen: When dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills. Many aerobe (oxygen need for life activity) organisms cannot survive when the concentration of dissolved oxygen decreases below a certain level.

The concentration of dissolved oxygen differs in natural water. Factors affecting the concentration of dissolved oxygen fluctuate during day and season: volume and velocity of the water flowing in the water body, climate/season, type and number of organisms in the water body, altitude, dissolved or suspended solids, concentration of nutrients in the water, organic wastes, riparian vegetation and groundwater inflow.

The treated waste water of the CWWTP is included in the 'extreme polluted' category of the surface water standard due to the concentration of dissolved oxygen. The river water downstream of the waste water discharge is included in the 'polluted' category of the surface water standard until Khustai; thereafter it is flowing to the Orkhon River with less pollution.

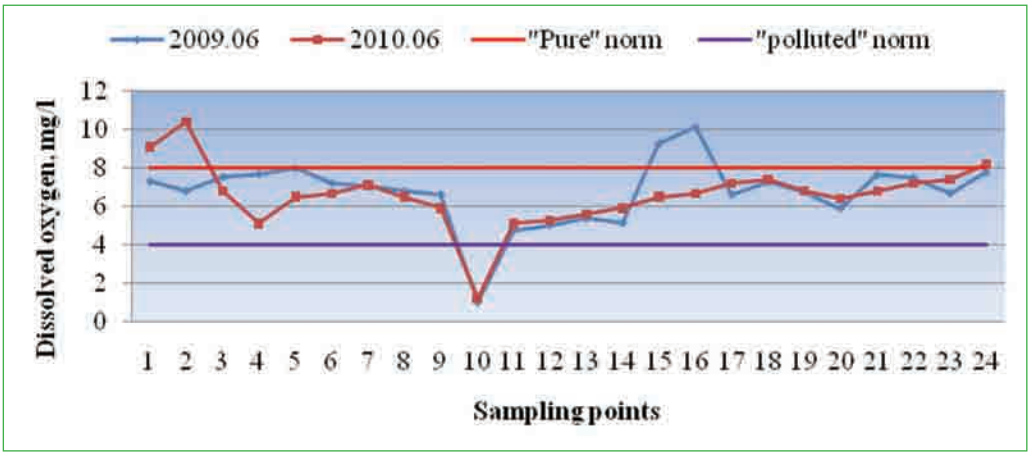

Figure 18. Concentration of dissolved oxygen in the Tuul River

Sampling points are the same as in Figure 16.

In past years, scientists and researchers from the Institute of Geoecology and the Center for Ecological Research, Kyoto University are doing a survey of the Tuul River. In 2006, they made a 48 hours measurement in the treated waste water of the CWWTP. They observed that fish cannot breathe because no oxygen was available during the night caused by a reduced concentration of dissolved oxygen in the treated waste water from the CWWTP.

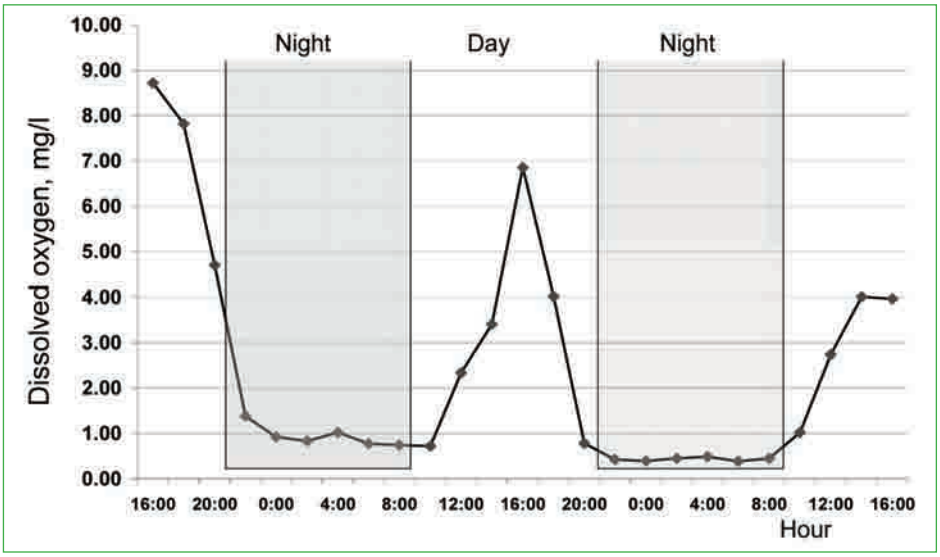

Figure 19. Daily fluctuation of dissolved oxygen at CWWTP (2006)

Concentration of phosphate: All sampling points from Biokombinat until Undurshireet are included in the 'Polluted' category of the surface water standard according to the concentration of phosphate.

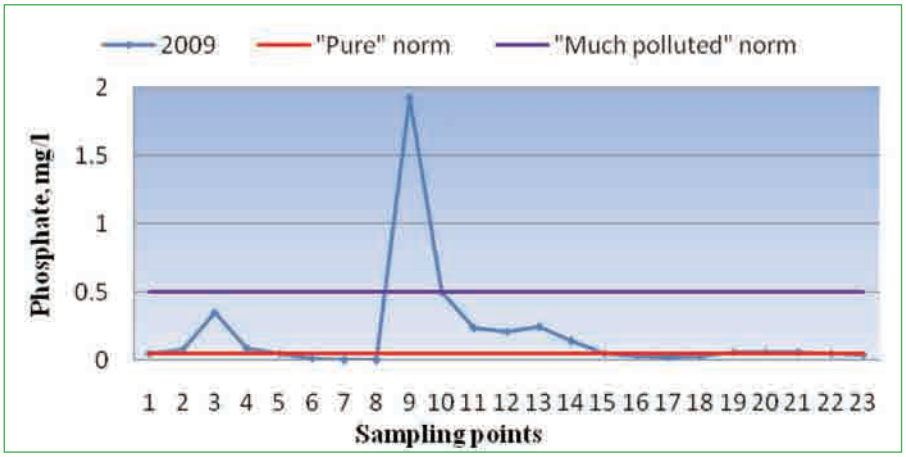

Figure 20. Concentration of phosphate in the Tuul River

Sampling points are the same as in Figure 16.

Suspended solids: The concentration of suspended solids in the Tuul River is 2.0-5.6 times increased at the Bayanzurkh bridge, Zaisan bridge, Yarmag bridge and upstream of the Ulaanbaatar WWTP when compared to the concentration at Bosgo bridge and Kharztai. In 2008 and 2010 after waste water from CWWTP joins the river, the suspended solids in the river water are included in "polluted" and "slightly polluted" category of the surface water standard.

In 2009 and 2010, the concentration of suspended solids is 1.4-4.4 times more than the 'pure' category of the surface water standard near gold, gravel and sand mining in the area of Altanbulag, Lun, Zaamar soum, Tuv aimag. It is included in the 'Slightly polluted' to 'Polluted' category of the surface water standard.

The gold, gravel and sand mining in the Ulaanbaatar, Altanbulag and Zaamar area incurs mechanic pollution of the Tuul river water.

Oxidation of permanganate. The Tuul River water is relatively low polluted by concentration of oxidation of permanganate.

Water bacterial pollution: According research results by the General Agency for Specialised Inspection from May, July and October 2007, the Tuul River water is included in the 'Extreme polluted' or category V due to bacteriological pollution and in May in category III-IV due to ammonia, nitrite and oxidation of permanganate. By analysis of General Agency for Specialised Inspection in 2007, one bacterie per 18.75-19.2 ml shows very pure water /more than one per 10 ml/ near Uubulan and Gachuurt but further downstream one bacterie per 0.18-0.74 ml indicates bacteriological pollution at an amount to cause illness.

Heavy metals in the Tuul river: According to analysis results of heavy metals the concentration of heavy metals were at all stations below category II or pure by surface water standard. Most heavy metals have an increasing tendency going downstream. The relatively high concentration of heavy metals near the Tuul -Terelj confluence can be related to geological conditions because this point is pure as there are no external factors.

2.3.4. Water quality and chemical composition of tributaries of the Tuul river

Scientists of the Institute of Geoecology analysed around 60 samples taken in 2006 in lakes, streams and rivers in the upstream tributaries of the Tuul River. The upstream tributaries of the Tuul River have under 100 mg/l mineralization, are very soft, mostly less than 1 mg-eq/l hardness and often pure. The water of Tsagaan bulag, Tosongiin bulag, Khailaastiin bulag and Bayangoliin bulag in Zaamar soum of Tuv aimag is in the hydrocarbonate class, calcium group, the second category, fresh-medium level of mineralization and softish -hardish. The water in the upstream part of the Toson and Khailaast rivers is included in the hydrocarbonate class, sodium group, the first category, fresh-medium level of mineralization and soft-softish. The concentration of suspended solids is 67-150 mg/l in the Tsagaan bulag and Toson river water, respectively. It is 3.35-7.5 times more than the 'Pure' category of the surface water standard.

2.3.5. Quality and chemical composition of mineral water in the Tuul river basin

Mineral water is natural water of unusual quality and composition which has positive affects for the human body. Mongolians use mineral water for medical purposes since a long time such as bathing, drinking and washing etc.

The mineral water divides into 3 basic zones in the whole Mongolian territory. Including:

1. Cold mineral water (zone I) with carbonic, carbonate calcium or calcium magnet. In this zone includes mineral waters of Orkhon River Basin, Ulaanbaatar, Ar and Ovor Janchivlan.
2. Cold mineral water (zone II) with high mineralization and mixed composition.
3. Hot mineral water (zone III).

Mineral water chemical composition and quality: Research by Dr. Tseren and other researchers found over 40 mineral waters in the Tuv aimag. From these Minj and Estei are located in the deep of the taiga and others are located in the forested mountain and steppe zone. North of Ulaanbaatar includes in the hot mineral water zone and south of Ulaanbaatar includes in zone I with carbonic water. Acid, alkaline and different type of mineral waters are located in Tuv aimag as the aimag locates in the center of 3 zones.

Table 23. Chemical composition and quality of healing of mineral water in the basin

№	Name of mineral water	Location	Minerali-zation, mg/l	Hardness, mg-eq/l	pH	T °C	CO_2 mg/l	Description
1	Ulaanbaatar	On the bank of the Tuul River	0.5-1.5	6.0-19.0	5.8-6.0	3-4	1.8	Total iron Fe (22-49 mg/l)
2	Selbe	5km north from center of city	0.23	2.45-2.60		2.0	Carbonic, used for uterus, liver and choler.	
3	Ar Janchivlan	47°36′ 107°37′	1.2-1.76	14.50-17.95	6.2-6.45	1-2	1.6-1.89	*Fe (25-39mg/l)*
4	Galttai (Bulnai)	48°09′20″ 108°05′	0.26	1.30	7.98	1.4		Cold mineral water with hydrosulfuric.
5	Gutai	48°10′ 107°56′30″	The mineral water is good for uterus illness, blood loss, and leukemia and weight loss. There is a need to study accurately.					
6	Khailaastain	48°08′ 104°29′	It has slightly carbonic and iron, and used for increasing stomach acid and hypoacidity in autumn. But it destroyed due to Zaamar gold mining.					
7	Devsen bulag	47°10′ 104°30′12″	1.0	6.08	7.8	3	0.02	Hydrosulfuric and muddy
8	Dondogdulamiin rashaan	Sharga morit	0.24	3.70	7.0	2		It was used for stomach problems but suddenly infiltrated.
9	Ikh tengeriin rashaan	In the mouth of Bogd mountain						Drink for increase of stomach acid. There is a need to study accurately.

There is a clear need to protect the water resource, to establish accurately the medical properties, to protect the mineral water from pollution and to expand the study of mineral water in the basin.

2.3.6. Quality and chemical composition of the lakes in the Tuul river basin

Khutul lake: The lake is salty and located at 1361 m, 10 km east from center of Erdenesant soum. Its total length is 1.9 kilometers, 1.4 kilometers width, 2.0 km^2 square and 6.2 kilometers shoreline length. The bottom of the lake has black muddy clay and under mud has saline layer. The lake is recharged by rain and groundwater. Mineralization is 104.3 g/l and it is included in the sodium chloride and sulphate magnesium type. It is rich in salt resource.

Tsaidam lake: The lake is salty and located at 1056 m, 18 km east from center of Zaamar soum. Its total length is 3.0 kilometers, 2.0 kilometers width and 3.5 km^2 square. The bottom of the lake has black muddy clay and a saline aquifer. The mud is used for hospital and salt for animal food. Mineralization is 147.07 g/l and it is included in the sodium chloride and sulphate magnesium type.

Khar lake: The lake is salty and located at 960m in Ugtaaltsaidam soum. Its total length is 2.9 kilometers, 0.7kilometres width, 2.2 km^2 square and 6.6 kilometers shoreline length.

Tugul lake: The lake is salty and located at 960m in the Ugtaaltsaidam soum. Its total length is 1.3 kilometers, 0.8 kilometers width, 1.1 km^2 square and 4.0 kilometers shoreline length.

Khagiin khar lake: The lake is fresh and located at 1820 m in the upstream of the Tuul River in the Erdene soum. It exists due to a block in the aquifer of early glaciations, very beautiful and surrounded by mountain and forests. Its total length is 2.5 kilometers, 1.1kilometres width, 2.0 km^2 square and 6.2kilometres shoreline length. Maximum water depth is 25 m. Several rivers and streams empty into the lake and it flows into the Tuul River via Khooloin River. Water temperature is 15.0-17.0 ^{0}C in July and August.

On the bottom of lake spreaded black clay, sand and boulder stone. In the shallow part have algae. There are abundant fish, wild animal and births of The Arctic Ocean. It is possible to use for onshore relaxation, journey, sport and hunting.

Khukh lake: The lake is fresh and located at 1840 m near Khayankhonkhor River in Erdene soum. It exists due to a block in the aquifer of early glaciations, very beautiful and surrounded by mountain and forests. It empties into the Khayankhonkhor River by a small stream which flows into the Tuul River. Its total length is 1.2 kilometers, 0.8 kilometers width, 0.6 km^2 square and 3.0 kilometers shoreline length. The water depth is 16 m. Water temperature is 13.5-15.3 ^{0}C in July and August which is considered cool.

On the bottom of lake has aquifer of early glaciations. There are fish of The Arctic Ocean, and Elk come to drink water during summer time. Mungun and Mungun Khul lakes locate near the lake. It is possible to use for onshore relaxation, journey, sport and hunting.

Khonog tolgoin lake: The lake is fresh and located at 2020 m at front of Khentii Mountain in Erdene soum. Its total length is 1.1 kilometers, 0.7 kilometers width, 0.6 km^2 square and 2.8 kilometers shoreline length. The maximum water depth is 4 m. The lake has different kind of fish. It is possible to use for onshore relaxation and journey.

Khurkhree (Kherkhluur) lake: The lake is fresh and located at 1700 m at front of Khentii Mountain in Erdene soum. It is from glaciations and beautiful island with forest. Its total length is 0.9 kilometers, 0.5 kilometers width, 0.5 km^2 square and 1.2 kilometers shoreline length. The water depth is 7 m.

The Kherkhluur stream flows into the lake, and a small stream from the lake empties into the Tuul River. Water temperature is 14.5-16.1 ^{0}C in July and August so water is cold. On the bottom of lake spreaded black clay and boulder stone. Algae grow in the shallow part of the shore. There are abundant fish. It is possible to use for onshore relaxation, journey, sport and hunting.

All above mentioned lakes such as Khagiin Khar and Khukh lakes (fresh) need to be protected from overuse and pollution.

2.3.7. River basin groundwater chemical composition and quality

Groundwater quality and chemical composition at Ulaanbaatar City: The districts of Ulaanbaatar City may be grouped by similar chemical composition of the groundwater. Especially, Sukhbaatar and Chingeltei district's groundwater have high mineralization and hardness, but Khan-Uul district's groundwater is relatively fresh and soft. The multi year average groundwater mineralization at Ulaanbaatar categorized by district is presented in Figure 21.

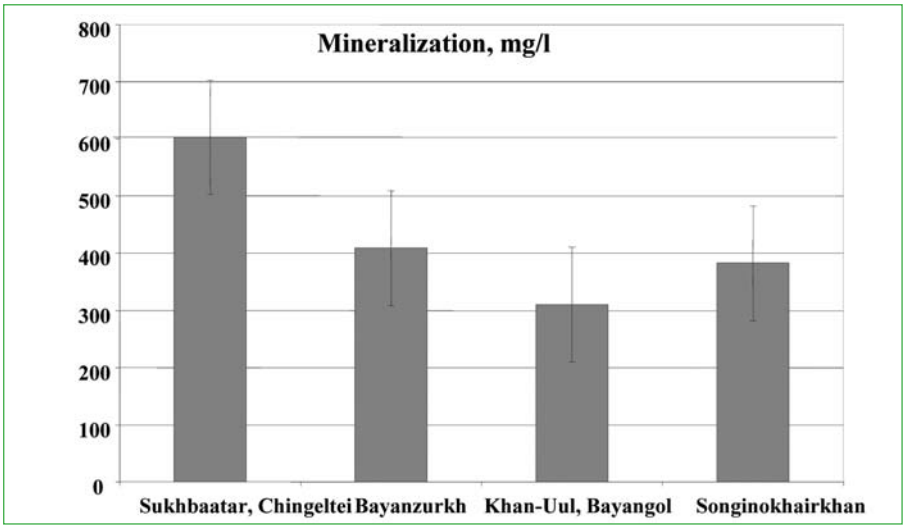

Figure 21. The average groundwater mineralization of districts in Ulaanbaatar

The groundwater at Ulaanbaatar city is mostly fresh and has average mineralization. In some places, water is salty.

The Ulaanbaatar area groundwater average hardness grouped by district is presented in Figure 22.

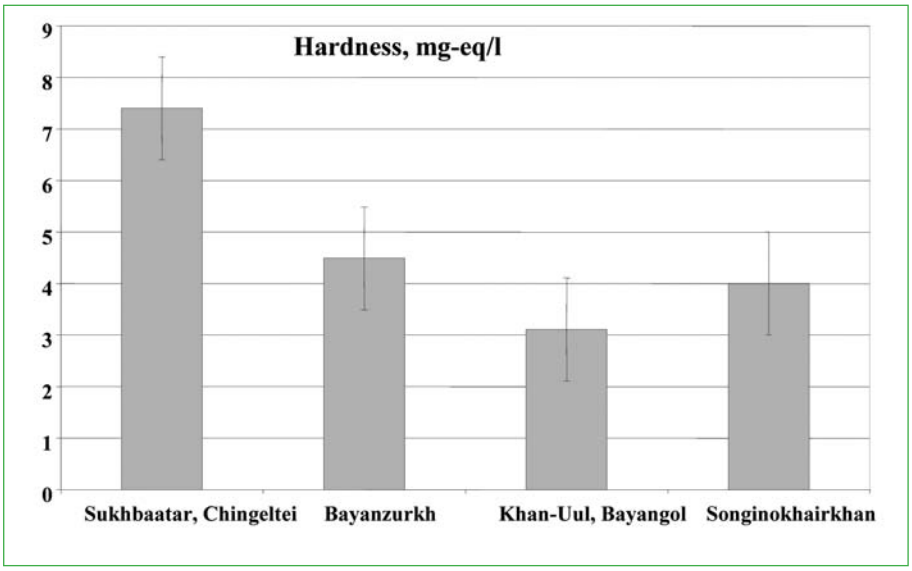

Figure 22. Average groundwater hardness of districts in Ulaanbaatar city

According to Figure 22, most districts' groundwater is soft. The hardness at the Sukhbaatar and Chingeltei districts is higher than at other districts. The hardness is higher than the approved maximum (7 mg-eq/l) and standard (5 mg-eq/l).

The pH is shown in Figure 23. The pH is indicated between 6.5-8.5 in the drinking water standard and the pH of groundwater of the Ulaanbaatar city suitable for drinking water standard. In other words, pH is slightly acid to slightly alkalinity /pH 6.5-8.5/.

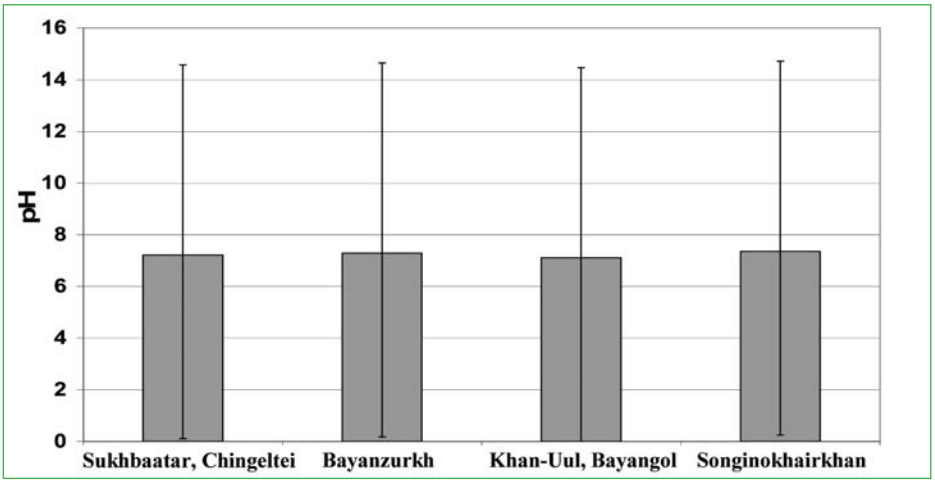

Figure 23. The pH of districts in Ulaanbaatar city

The analysis of heavy metals in Ulaanbaatar city groundwater is taken from 5 representative points. It was analysed in the water research center of the Material Technology School of MUST. Table 24 shows that no elements exceed the standard limits.

Table 24. Concentration of heavy metals in the groundwater

Sample name	Elements, *mg/l*						
	Mn	Fe	Cu	Cd	Pb	Zn	Cr
Nisekh-apartment stop well	<0.01	0.36	0.06	<0.003	<0.02	0.20	<0.01
Well of last stop, Chingeltei district	<0.01	0.13	0.07	<0.003	<0.02	0.20	<0.01
Well of child jail, Zaisan	<0.01	0.09	0.08	<0.003	<0.02	0.04	<0.01
Well of the Sharkhad's hospital	<0.01	0.16	0.10	<0.003	<0.02	0.03	<0.01
Well at left side of the temple, Dambadarjaa	<0.01	0.27	0.08	<0.003	<0.02	0.04	<0.01
MNS 900:2005	0.1	0.3	1.0	0.003	0.01	5.0	0.05

Chemical composition and quality of Ulaanbaatar city central water supply boreholes: The results of groundwater sampling in Ulaanbaatar city water supply sources and boreholes in the Tuul River channel in 2005 is compared with 1996 and 1997 sampling results.

According to 2005 analysis results of water points, pH was between 6.74 and 6.94, conductivity was 0.056-0.55 ms/cm, mineralization was 50.4-398.0 mg/l, hardness was 0.50-4.24 mg-eq/l.

As for chemical components, it is in the hydrocarbonate class, calcium group, from first to second category of the classification. It is classed as very fresh to fresh and from very soft to softish. The total mineralization and hardness from groundwater analysis results is presented in Figure 24 and Figure 25.

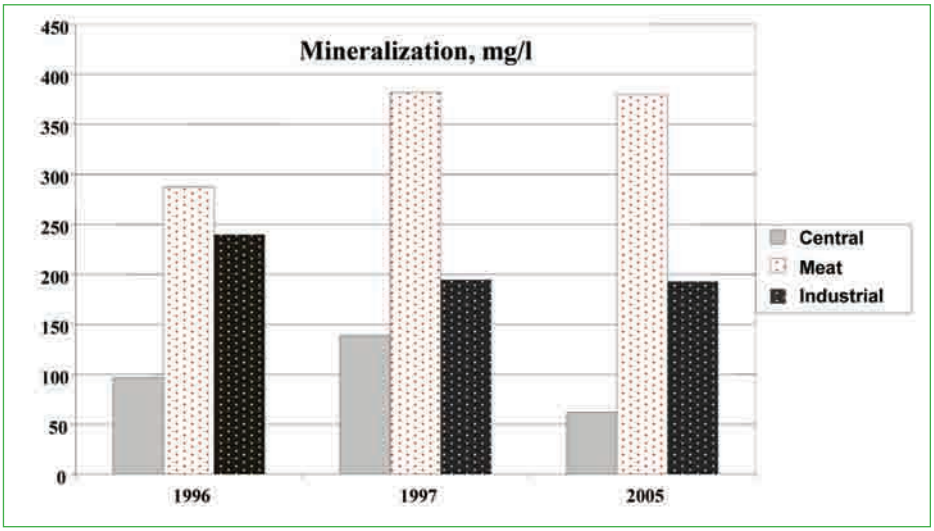

Figure 24. Groundwater mineralization of Tuul river flood plain

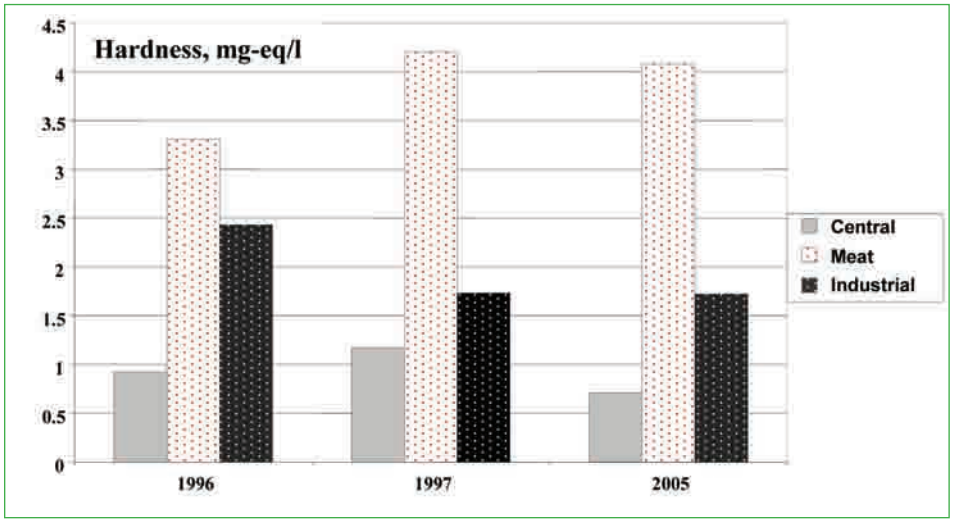

Figure 25. Groundwater hardness of Tuul river flood plain

Tuul river flood plain groundwater belongs to the category “very fresh” to “fresh”, “very soft” to “softish”. Water mineralization and hardness near Meat well field are relatively high. This is associated with local pollution of the groundwater.

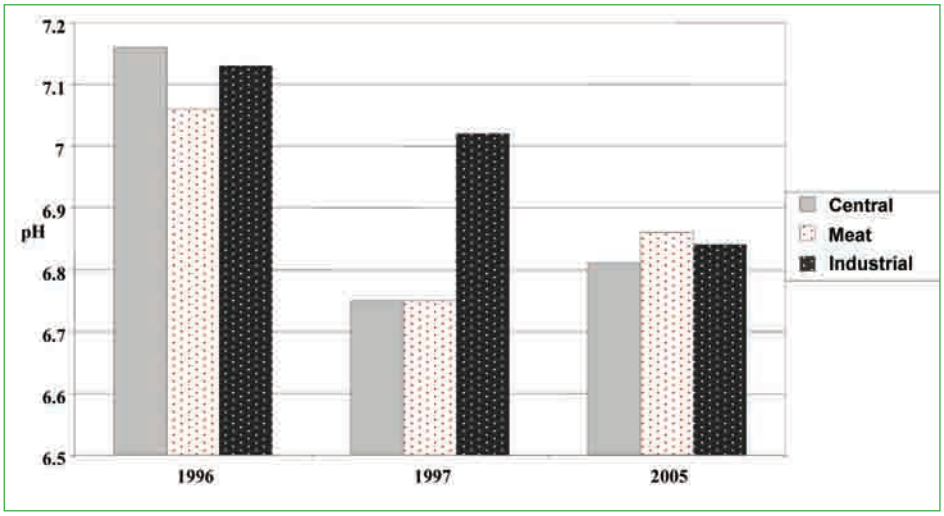

Figure 26. Groundwater pH of Tuul river flood plain

Groundwater pH is from weak acid to weak alkaline. Compared to the 1996 results, the pH has decreased in 1997 and 2000. The relevant chemical analysis results show that the chemical composition of the boreholes' water in the Tuul river flood plain is changing in space and time.

The groundwater chemical composition and quality of the Central and Industrial sources are relatively stable. The chemical composition and quality of groundwater in the Meat well field is consistently worse than at other sampling sites along the Tuul River. The groundwater composition shows that human activities are the main factor in the change of the groundwater quality and chemical composition.

Groundwater quality and chemical composition at soums and aimags in the Tuul river basin: Sampling included wells located in the 24 soums of the 5 aimags in the Tuul River Basin. The aimags and soums are shown in Table 25.

Table 25. The soums and aimags in the Tuul river basin

№	Aimag	Soum
1	Arkhangai	Khashaat
2	Bulgan	Rashaant, Bayannuur, Dashinchilen, Gurvanbulag, Buregkhangai, Khishig-Undur
3	Uvurkhangai	Burd
4	Selenge	Orkhontuul
5	Tuv	Buren, Tseel, Sergelen, Bayan-Unjuul, Erdene, Erdenesant, Argalant, Bayantsogt, Ugtaal, Altanbulag, Zaamar, Bayankhangai, Undurshireet, Lun, Zuunmod

Tuv aimag: Analysis results are available from 52 wells in 2005-2011 and from 133 wells in 1973-1990 from a total of 15 soums in Tuv aimag (Institute of Geoecology). The mineralization and hardness are shown in Figure 27 and Figure 28. As seen from the graphs, average mineralization and hardness of drinking water fluctuated between 264.0-564.0 mg/l and 2.07-5.2 mg-eq/l, respectively. Results are in the fresh-medium level of mineralization and soft-hard. All wells that were involved in the research are suitable to use as drinking water for people considering all analysed parameters as specified in the drinking water standard.

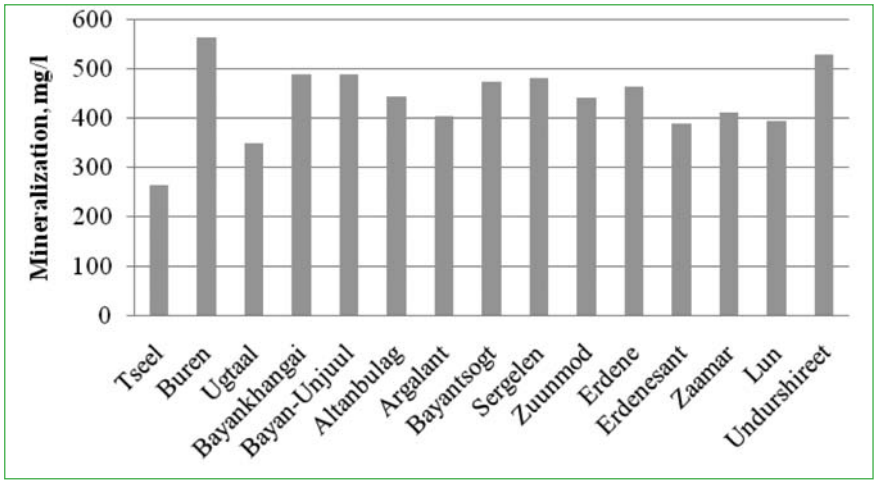

Figure 27. Tuv aimag's soums' average groundwater mineralization

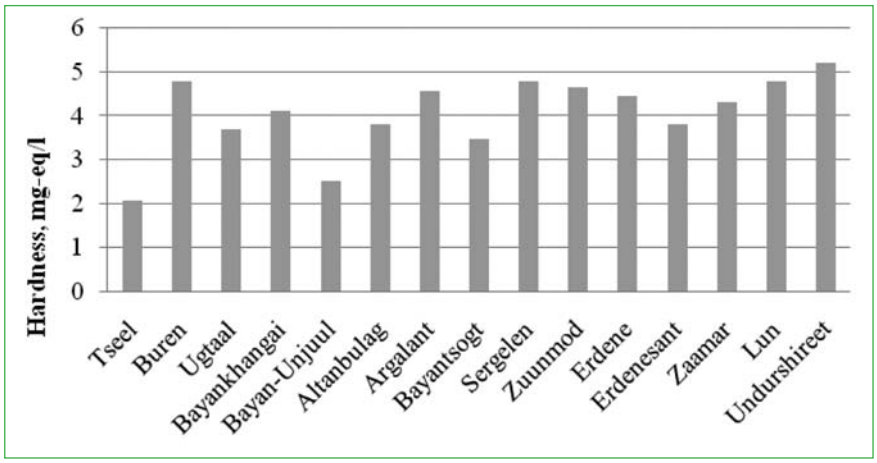

Figure 28. Tuv aimag's soums' average groundwater hardness

Uvurkhangai aimag: Some 93.4 percent of Burd soum territory is located in the basin. Samples were taken from 13 boreholes in Burd soum. The hardness is presented below.

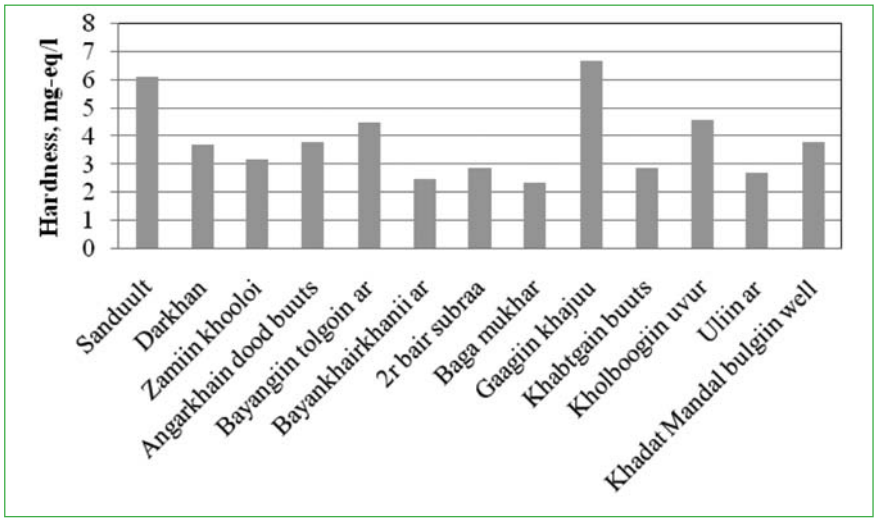

Figure 29. Groundwater hardness in Burd soum of Uvurkhangai aimag

Bulgan aimag: The mineralization and hardness is available of groundwater from wells in 6 soums, Bulgan aimag and is shown in Figure 30 and Figure 31. As can be seen from the graphs, the mineralization and hardness of drinking water in the soums fluctuated between 436.5-651.4 mg/l and 3.8-5.3 mg-eq/l, respectively. Results are in the fresh-medium level of mineralization and softish-hard. All wells that were included in the research are suitable to use as drinking water for people by all analysed parameters as specified in the drinking water standard. But some wells water has high concentration of mineralization and hardness. Particularly, mineralization of the Toormiin Khooloi water (1010 mg/l) and hardness (12.8 mg-eq/l) in the Gurbanbulag soum, mineralization of the Bayantsagaan water (1730 mg/l) and hardness (13.7 mg-eq/l) in the Khishig-Undur soum, mineralization of the Baashint Denj water (1570 mg/l) and hardness (10.7 mg-eq/l) in the Bayannuur soum, are not suitable for drinking water. Therefore, there is a need to treat them.

The analysis results are shown in Figure 30 and Figure 31 of 2 wells in Rashaant soum from 1986 and 2006, 9 wells in Bayannuur soum from 1971-1989, 21 wells in Dashinchilen soum from 1962-1985, 2006, 2009, 32 wells in Gurvanbulag soum from 1965-1987, 2006, 19 wells in Buregkhangai soum from 1966-1989, 2007, 2010 and 10 wells in Khishig-Undur soum.

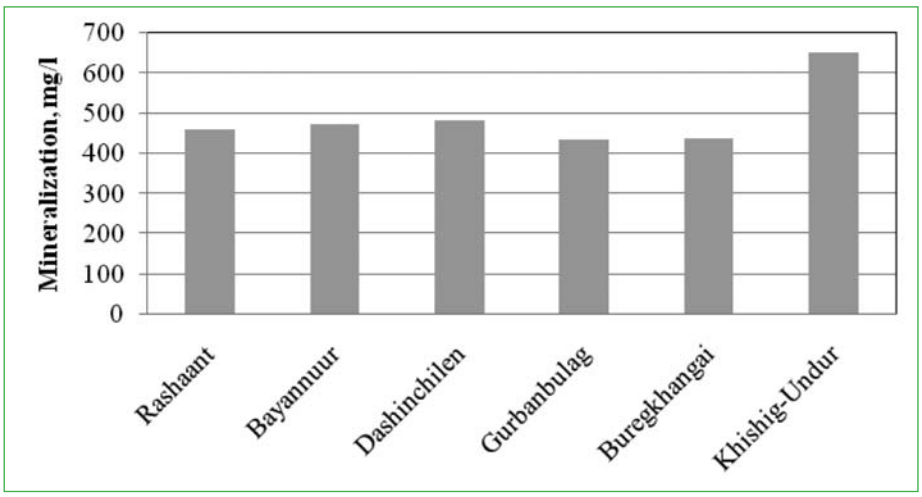

Figure 30. Groundwater mineralization of soums in Bulgan aimag

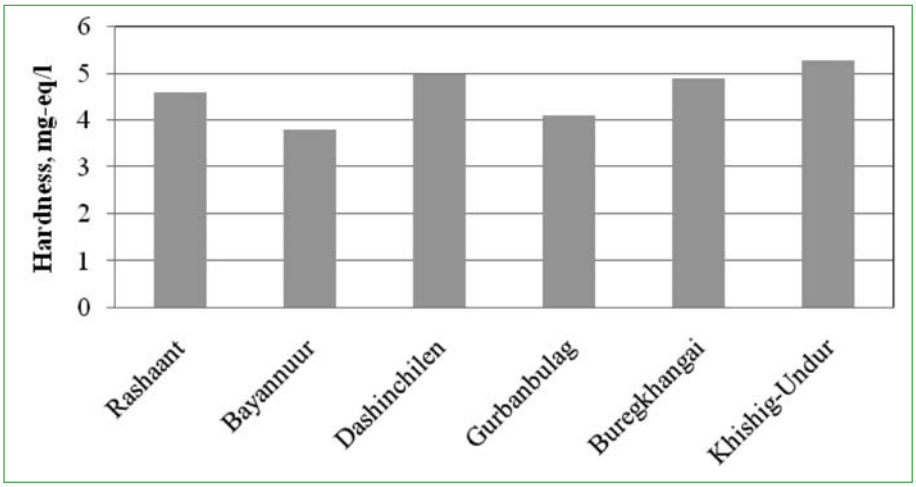

Figure 31. Groundwater hardness of soums in Bulgan aimag

Arkhangai aimag: In 1985, water from wells in the Khonkhoriin ekh and Berkhiin dugii, Khashaat soum is fresh (mineralization 300 mg/l) and softish (hardness 3.2-3.1mg-eq/l), pH=7.

Selenge aimag: The mineralization and hardness from 8 wells in Orkhontuul soum, 1979 and 2011 is shown in Figure 32 and Figure 33. As seen from the graphs, the water is fresh to salty (mineralization 403.0-1682.0) and softish to hard (3.3-6.9 mg-eq/l).

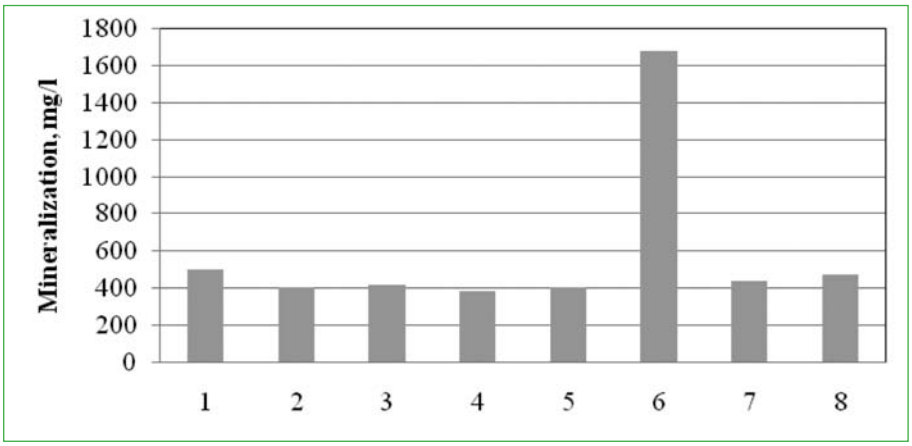

Figure 32. Groundwater mineralization of Orkhontuul soum, Selenge aimag

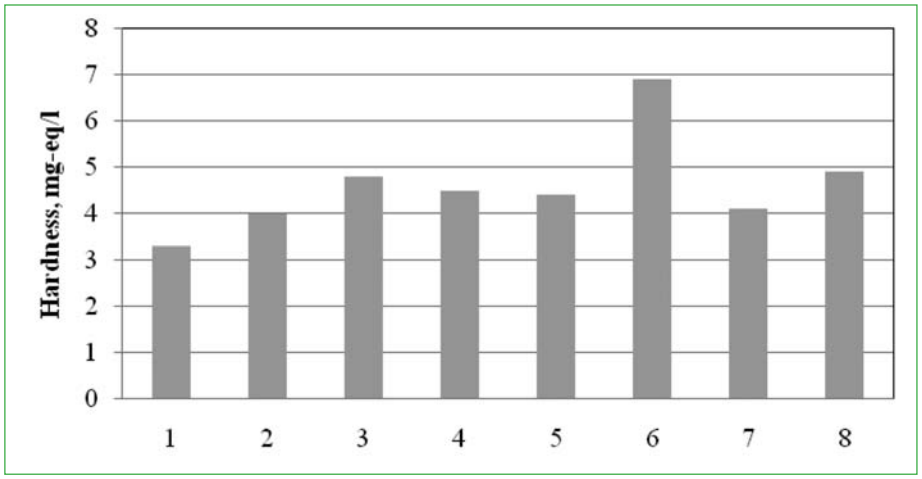

Figure 33. Groundwater hardness of Orkhontuul soum, Selenge aimag

Sampling points: 1. Constructional office, 2. "Suun Dalai" herders group well, 3. "Nukhurlul" herders group well, 4. "Bayantuul" herders group well, 5. "Bayan-Uguumur" herders group well, 6. Rashaant tosgon, "Ikh Nomt" LLc well, 7. Bore well(IV), 8. Bore well

The groundwater is generally fresh and soft. Only Rashaant village's "Ikh Nomt" LLC borehole water is salty and water is hard. In other words, it does not meet the drinking water standard. The borehole water needs to be softened and freshened. It is not possible to make conclusions about the chemical composition in the soum by analysis results of the above mentioned soum's wells because the whole area of the soum is not included. It is only possible to express the general tendency.

It may be possible to deliver different kind of natural water in one soum area. There is a need to do analysis of hydrochemical and bacteriological water quality by drilling a well and conduct repeated analysis during time of use.

2.3.8. Aquifer vulnerability assessment

There are various methods to assess groundwater vulnerability to pollution in regional aquifers. This type of assessment is widely used in water resources management. The assessment of the vulnerability to pollution is conducted and expressed in tables and figures which contain vital information for conducting groundwater quality management, providing authorities with information for decision making and establishing protection levels.

The vulnerability assessment for groundwater pollution is conducted by the DRASTIC method. The DRASTIC method is an empirical model which was conducted by the US Environmental Protection Agency (Aller.et.al. 1985). The equation is:

$$DVI = \sum_{i=1}^{n} F_i * W_i$$

where: *DVI* - *Drastic Vulnerability Index*

F_i - input variables including aquifer depth, recharge, aquifer properties, soil properties, vadose zone properties and hydraulic conductivity. The input variables are categorized depending on feature and size. They have factors which range from 1 to 10.

W_i - impact weight of pollution vulnerability for each input variable. The impact weight varies from 1 to 5.

The classification, factors and weight can be changed according to data quality and accuracy and are determined based on the knowledge and the experience of the people who collected, processed and used the data and the condition of the areas. The accuracy of the vulnerability index for groundwater pollution depends on the input data accuracy, weight and factors and calculation-making experts' capacities.

Vulnerability calculation in Zuunmod city water supply source: When determining the vulnerability index for groundwater pollution, data from the report on hydro-geological research was used. The research was conducted in Khushgiin Khundii in 2007.

Table 26. Input variables and calculated vulnerability index by each borehole

Borehole	Depth to aquifer, m	Rain recharge, mm/year	Soil texture	Topography, degrees	Conductivity m / day	Soil between the soil texture and the aquifer	Type of aquifer	Vulnerability index
1	3.35	6	Plant layer, 0-20cm	0-2	10.8	Gravel	Smooth gravel of sandstone and shell	146
2	3.2	6	Brown soil, plant layer, 0-30cm	0-2	4.57	Sand	6-8 cm diameter gravel	138
3	6.05	6	Brown soil, plant layer, 0-30cm	0-2	3.76	Gravel stone	Big particle gravel stone	127
4	3.8	6	Brown soil, plant layer, 0-40cm	0-2	4.16	Fine particle sand	Big and average particle gravel	123
5	5.8	6	Brown soil, plant layer, 0-30cm	0-2	15.75	Compact-layered sand	Sand rock layer	147
6	5.52	6	Brown soil, plant layer, 0-40cm	0-2	5.13	Compact-layered clay	1-6 cm diameter gravel	133
7	10.7	6	Brown soil, plant layer, 0-50cm	0-2	2.16	Fine particle sand	1,5-5 cm diameter gravel	109

The calculated groundwater vulnerability is compared in Table 26Table 27 with the DRASTIC method vulnerability classification limits.

Table 27. Calculation-conducted boreholes' vulnerability index, by vulnerability classifications

Vulnerability classification	Index	Borehole numbers where vulnerability assessment was conducted						
		1	2	3	4	5	6	7
Extremely low	50-63							
Very low	63-76							
Lower	76-89							
Low	89-102							
Average	102-114							+
High	114-127			+				
Higher	127-140		+		+		+	
Very high	140-153	+				+		
Extremely high	153-166							

According to the calculation results the vulnerability index in Khushigiin Khundii fluctuates between 109 and 147. The boreholes are for the drinking water and water supply of Zuunmod city. The vulnerability classification is higher than average and all boreholes except borehole 7 are included in the category of high, higher and very high in terms of pollution vulnerability. The aquifer appears easy to be polluted due to human activities.

2.3.9. Conclusions and recommendations on basin water quality and some issues of ecology

- Tuul river pollution becomes fresh after 130 km. Currently it is impossible to become fresh in this distance according to recent hydrobiological research results.
- After waste water discharge from upper Songino to the Altanbulag Bridge river water is not suitable for livestock and resident use.
- The mineralization of the Tuul River water is very fresh, under 100 mg/l at most points in the upstream part of the river which is from Bosgo Bridge to the discharge point of Nalaikh waste water. The mineralization of the river increases again from Upper Songino after the waste water discharge of the Ulaanbaatar CWWTP and the mineralization content without decreasing when compared to points before the capital. From the results of mineralization, the river flow into Orkhon River is without natural purification because of pollution from Zaamar area and waste water discharge of the CWWTP. Water class, group and category and increasing mineralization changes downstream because of chemical pollution and human activity starting from Ulaanbaatar city and it flows into Orkhon River without self purification.
- As can be seen from last year's research results, the pollution indicators are rapidly increasing downstream after the waste water discharge of the Ulaanbaatar CWWTP. At the next sampling point after discharging the waste water, ammonium azote is 5.4-12.4 times more than 'much polluted' category of the surface water standard. This is related to out of date treatment plant equipments and technology, unsatisfactory primary cleaning of the industries and enterprises waste water, insufficient capacity. The treatment productivity is no more than 60-70 percent.
- The water pollution of the Tuul River has increased each year, negatively affecting the river water quality, ecological condition and hydrobiological regime.
- Under-refine or completely untreated waste water from industries and enterprises in the Ulaanbaatar and Nalaikh district discharging into Tuul River and capital waste water network is basic reason of river water pollution.

- The groundwater system surrounding Ulaanbaatar recharges from both the Tuul River and from precipitation. General groundwater is hydrocarbonate class, in the calcium group and the first category of very fresh and soft water. The mineralization of the groundwater naturally increases with the downstream flow.
- The chemical composition and water quality of groundwater from wells beyond the Tuul River flood plain differs. Specifically, water of some wells in the Khan-Uul district contain ferrous iron and are slightly acidic. This water has similar properties to naturally occurring mineral waters.
- As can be seen from the study results in Ulaanbaatar, the wells in the Khailaast, Denjiin Myanga, Bayanburd and Zuun Ail areas have relatively high mineralization and very hard water. The wells in the Dari-Ekh, Ulaankhuaran, Amgalan, Tolgoit and Bayankhoshuu exhibited slightly less mineralization and hardness.
- Contamination indicators are increasingly higher due to the expansion of population and industry of districts in Ulaanbaatar.
- The Tuul River water near Ulaanbaatar city is greatly affected by chemical and household pollution. It is also possible to affect the groundwater quality of the river floodplain.
- Mineral waters in Tuv aimag are used mainly for stomach pain, and contain hydrosulfuric acid, iron and carbonic.
- Groundwater of soums in the Tuul River Basin is mainly fresh and soft, but some areas have high mineralization and hardness. Notably, Toormiin khooloi of the Gurvanbulag soum and Bayantsagaan of the Khishig-Undur soum, Baishint Denj of the Bayannuur soum in the Bulgan aimag and "Ikh Nomt" Co.Ltd in the Rashaant tosgon, Selenge aimag wells water are not satisfactory for drinking water.
- In the down section of the basin, boreholes for livestock watering are out of use and damaged. Pasture capacity near surface water source is exceeded and soil and plant cover is degraded. The surface water is polluted by livestock dung.
- There is no detailed research on basin's agricultural weeds, herbicide, use of chemical fertilizer and its impact on water quality. As of 2002, 4.9 kg/ha azote fertilizer was used in whole country. It was increased to 8.2 kg/ha in 2008. It is very small compared to quantities used in the Netherlands or the USA (2008 >100 kg N/ha). Farmers use little chemical pesticides and fertilizers due to poor financial capacity.
- Ulaanbaatar city tanneries use chrome. They pollute river water with 6 and 3 valent chrome. There is a risk that they will pollute groundwater sources of the water supply.
- The WWTPs in Mongolia are not designed to treat heavy metal pollution in waste water. In order to prevent discharge of 3 valent chrome into rivers, pre-treatment facilities should be constructed at WWTPs. Using zeolite in pre-treatment is good for decreasing chrome concentration in waste water.
- In Zaamar, companies wash sand with gold by river water. There is bad-designed "filtration pond" constructed for the purpose of reusing water. Turbid water overspills and pollutes river water. It causes much sediment in the river. In summer, gold mining is conducted and it causes obstacles for fish to migrate river upstream section. It causes negative impact on breeding and it may cause extinction of species.

- River flood plain and channel are damaged due to mining of gold, sand and gravel. Soil and plants near riverbank are degraded. There is a negative impact on ecology. It also limits possibility of herders' migration/move and herders' way to water. Soil removing does not meet standard requirements and removed external soil is not kept in a correct way. Rehabilitation work is not conducted.
- Forest cover is decreasing due to illegal logging, forest fire and insects. It affects the upper part of the basin, the quality and water resources of the Tuul river and its affluent rivers.
- If the forest is destroyed, soil infiltration is decreased, fine particles are carried by rainfall runoff and organic and nutrients increase in affluent rivers. Eutrophication may occur in deep parts of the river.
- A dam is going to be constructed in the upper section of the basin. There are many negative impacts related to dam construction: eutrophication in reservoirs, sediments are accumulated in reservoirs, fishway is blocked, fish population is separated, eco environment in down section flood plain of the dam is deteriorated.

2.3.10. Recommendations of measures on basin water quality improvement

- Every organization and industry (especially, leather and wool processing and washing) implementing activities in the Tuul River floodplain and valley need to meet the level required for primary cleaning of their waste water. Therefore, it is necessary to strengthen internal control (laboratory analysis and its control), restructuring of the equipments and monitoring. Also it is necessary to stop direct discharge of waste and under-treated waste water into the Tuul River.
- Restrict discharge of waste water and half treated waste water into the Tuul river
- Implement and decide immediately on issue of rehabilitation of treatment plant facility and extension of the CWWTP. The Nalaikh waste water must be treated according to waste water standards.
- Implement control work of soums, aimags and state with precise schedule for treated waste water and technological activity of the central treatment plant and enterprises in the Tuul River Basin.
- In accordance with the future needs there is an urgent need to apply reuse of treated waste water technologies in the enterprises in order to protect against river water pollution and support water saving policy. Relocate industries and enterprises from capital city that discharge deeply polluted water and need to take extra measures.
- Take all measures for protecting river water against pollution such as regulation to wash cars and materials in the river water and eliminate trash problems because rain and snow runoff water in creeks carry pollutant to the river.
- Restrict construction activities within the flood plain of the river according to the laws on water and forest.
- Take measures to increase water yield and flow, and stop activities that exploit sand, gravel and mining work along bank and source of the Tuul River which directly affects water yield and causes pollution.
- Groundwater chemical composition and features near Ulaanbaatar city are different from one another. In order to implement wise management of water use, researches should be expanded, water needs to be extracted from areas where water quality meets the standard. The government and public need to participate

in water use activity, especially sanitation and hygienic organizations' participation in water use activity needs to be broadened.

- Industries and individuals are required to perform more and more water treatment due to increasing mineralization and hardness of supplied water.
- Specialists such as chemists, chemical technologists, hydrogeologists, doctors, hygienists and hydro-engineers need to organize together in order to continuously monitor surface and groundwater, protection from pollution, assure suitable use water resources, apply modern technologies of water treatment and develop integrated database of water information.
- Take measures to rehabilitate boreholes in down section of the basin, limit livestock numbers in areas where pasture capacity is exceeded, plant cover and soil are deteriorated.
- "Ninjas" in Zaamar are using mercury for the gold mining. It is hard to give assessment on river pollution caused by mercury. Soil and water research will be conducted, restrict use of mercury and limit polluting source.
- Forest fire is a major factor that destroys forest, control on visitors who visit Khan Khentii special protected area in spring and autumn, needs to be strengthened, preventing from forest fires.
- Concentration of nutrients in some parts of Tuul river is increasing. When water temperature is increased, dissolved oxygen in surface water is decreased and environment is formed for the growing of bacteria and algae. Tuul river bank plant cover needs to be protected in order not to increase water temperature.
- In order to prevent reservoir water from organic pollution when Tuul water complex is constructed, the following measures should be taken: protecting water shed areas, constructing facility that prevents from sediments in reservoirs, removing sediments in reservoirs by using flood gate, constructing fishway, maintaining ecological flow.

3. SOCIO–ECONOMIC DEVELOPMENT AND FUTURE TREND OF THE TUUL RIVER BASIN

3.1. Economic Importance and Role of the Orkhon River Basin in the Socio-Economic Development of Mongolia

The Tuul River Basin is located in the central part of Mongolia crossing the economic regions of Ulaanbaatar, Tuv and Khangai. Ulaanbaatar City and five aimags: Arkhangai, Bulgan, Uvurkhangai, Selenge and Tuv are located in this basin. As for administrative units, Ulaanbaatar City and 37 soums (including Zuunmod regional pillar city) of above-mentioned five aimags are located in this basin. In total 19 soum centers, 8 soums with whole territory and another 29 soums with part of the territory belong to the basin (Figure 34).

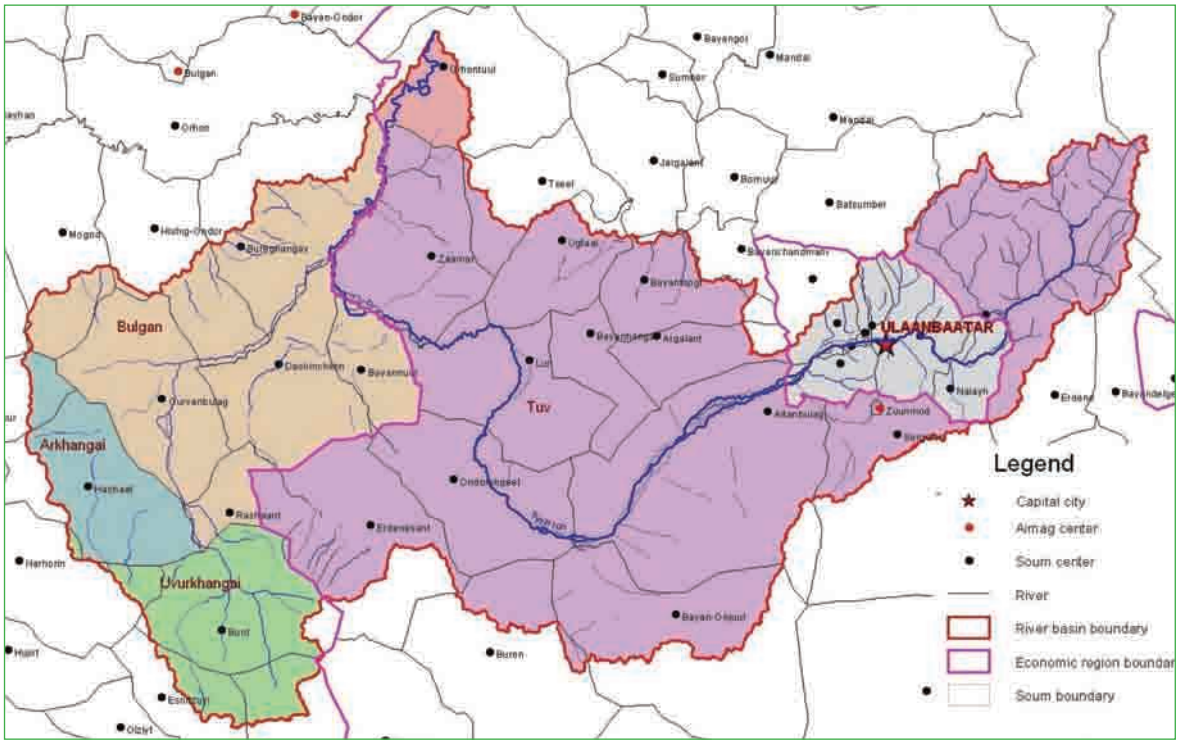

Figure 34. Administrative units and economic regions in the Tuul RB

Tuv aimag occupies the largest part of the basin area: 59.3% and Selenge aimag occupies the smallest part of the basin area: 1.6%. The socio-economic analysis of the Tuul River Basin was conducted based on 7 districts of Ulaanbaatar and Zuunmod City and 29 other soums, which have more than 5% of pasture land inside the basin.

The Tuul River Basin occupies only 3.2% of Mongolia's territory. But over 40% of the population lives there. It is a very vital region in terms of society and economy. Ulaanbaatar is the cultural, scientific, educational and industrial center of Mongolia.

In 2010 in Ulaanbaatar value produced was MNT 5174.1 billion and in Tuv aimag was MNT 120.8 1 billion, which was some 64.9% of Mongolia's GDP. In other words, some

60% of Mongolia's GDP is produced in the Tuul River Basin, which shows the economic importance of the basin. [17]

When calculating GDP of the basin, we have focused on Ulaanbaatar and Zuunmod, the economic center of Tuv aimag (Figure 35).

Source: NSO

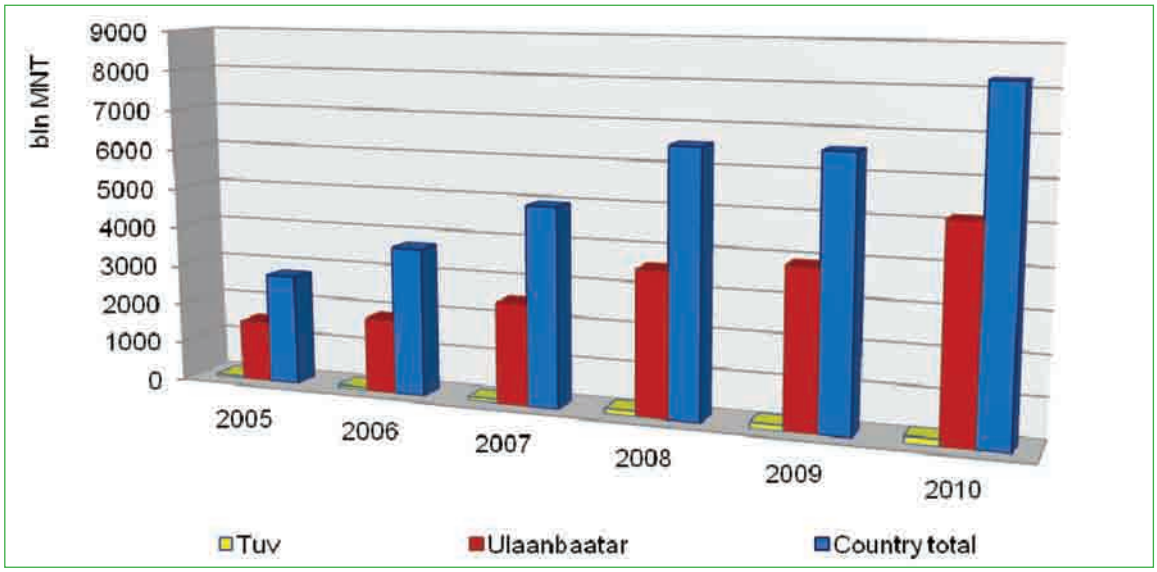

Figure 35. GDP of aimags and Ulaanbaatar in the Tuul RB at current year prices

Between 2004 and 2006, the percentage of GDP produced in the basin decreased from 56% to 52%. This is related to the increase in production of the Khangai region and the agricultural production of the Central region. Since 2007 the share of Ulaanbaatar's GDP in Mongolia's total GDP has been increasing. The percentage of GDP and its structure are presented in Table 28.

Table 28. Share of Ulaanbaatar City and Tuv aimag in the country's GDP, at current year prices

Aimag and capital	2005	2006	2007	2008	2009	2010
Tuv	2.1	2.0	1.8	2.1	2.3	2.2
Ulaanbaatar	54.9	50.0	51.2	54.8	59.4	62.7

The service sector produced about 60% of Ulaanbaatar's GDP and 74% of Tuv aimag GDP is from agriculture. Most part of the production comes from agriculture in other aimags and soums in the basin. The reason is that there are not any big centralized towns and industries.

As of 2010, the GDP per capita in Ulaanbaatar was MNT 4493.0 thousand, which was 1.5 times higher than the state average, due to the high development of the industry and services (See Table 29). For other aimags, it was 12-66% lower than the state average. The reason is that they mainly focus on agriculture and the other economic sectors' least development.

Table 29. GDP per capita in the basin in MNT thousand/year, at current year prices

Region, aimag, capital	2006	2007	2008	2009	2010
State average	1969	1896	2465	2432	2993
Khangai region	2453	2409	2631	2300	2638

Region, aimag, capital	2006	2007	2008	2009	2010
Arkhangai	1021	1012	1593	1543	1543
Bulgan	1161	1107	1766	1804	1936
Uvurkhangai	773	729	1002	1030	1012
Central region	1190	1069	1638	1634	1993
Selenge	1384	1318	2051	1828	2361
Tuv	1198	1062	1605	1707	2019
Ulaanbaatar	2568	2459	3354	3519	4493

In consideration of some factors which may affect the future development of the Tuul river basin:

Advantages:

- A relatively high development of infrastructure,
- Good market condition due to high density of population and concentration of industry,
- Possibility to develop foreign trade by railway and aviation,
- Plenty of human resource with relatively high education,
- Near the science and technological centers,
- Excellent condition for the development of tourism due to large number of historical and cultural places and natural sites connected by a well developed infrastructure,
- Convenient soil and climate to run intensified livestock husbandry and crop farming,
- Good condition for the industrial development related to the financial condition.

Disadvantages:

- Loss of land use policy and the high concentration of population in Ulaanbaatar,
- Increasing trend in unemployment and poverty due to high migration rate of the population,
- Infrastructure capacity cannot meet the needs of ger and suburban areas,
- Share of the manufacturing is low,
- Due to overgrazing, ecological conditions may deteriorate such as desertification and pasture degradation, etc.
- Environmental degradation due to man-made impacts is occurring. For example: air pollution, Tuul river water pollution, groundwater pollution, soil pollution near Tuul river area and increase of negative mining impacts.

3.2. Demography

In 2010, about 1191.4 thousand people were living in aimags and soums, located in the basin. This is 42.8% of the total population of Mongolia. Some 97.4% of the population was living in urban areas and soum centers and 2.6% in rural areas. The urban population percentage is high due to Ulaanbaatar City located in the basin. In 2010, out of the total population of the Tuul RB 52.7% are female.

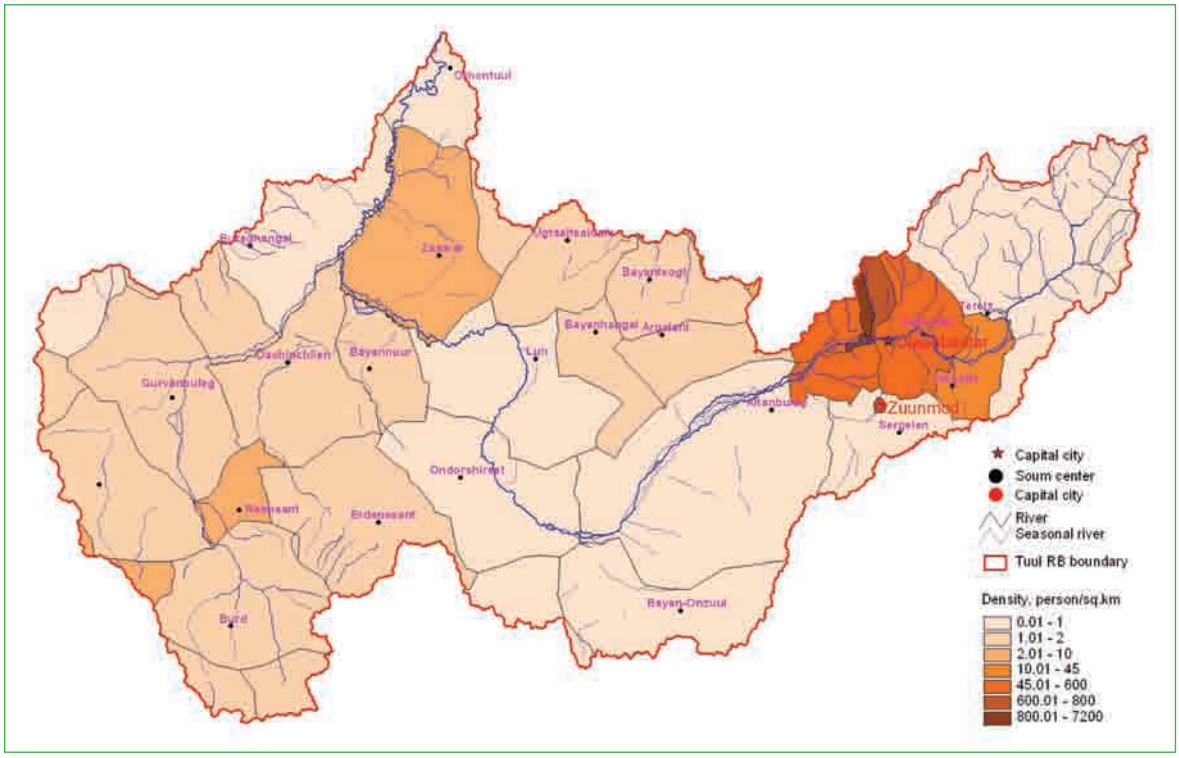

Figure 36. Population density of the Tuul RB

The population density of the basin is presented in Figure 36 and the population numbers in Table 30. In 2010, population density was 24 persons per kmI, which is 14 times higher than that of state average (1.7). The highest density is 6277 persons/kmI in Bayangol district and the lowest density is in Erdene soum of Tuv aimag[1], which is 0.3 persons/kmI.

Table 30. Population of the Tuul RB, in thousand persons

Capital and aimag	2004	2005	2006	2007	2008	2009	2010	
							Total	rural
Arkhangai	3.6	3.6	3.5	3.4	3.3	3.3	3.4	2.2
Bulgan	13.3	12.9	13.1	13.2	13.1	13.6	13.6	8.0
Uvurkhangai	4.5	4.6	4.6	4.6	4.5	4.5	4.2	3.7
Selenge	1.7	1.7	1.7	1.5	1.5	1.7	2.0	0.6
Tuv	43.7	44.4	43.6	43.8	43.7	42.9	42.8	15.2
Ulaanbaatar	882.5	918.5	952.6	990.1	1032.4	1082.9	1125.4	0.0
Total	949.4	985.8	1019.1	1056.5	1098.5	1148.9	1191.4	29.7
Average growth, %		3.8	3.4	3.7	4.0	4.6	3.7	-

Recently, the average population growth was 3.4-4.6%, which is 1.8-2.7 times higher than the average growth of the country. The main reason of the high growth rate is migration to the Capital.

In 2010, some 6.1% of the total population were over 60 years old, 67.1% were 16-59 years old and 26.8% under 15 years old people. The demographic burden on 100 working age persons was 49, from which some 40 were children and 9 are elder people.

The population growth is important for estimating future drinking water demand. In the Tuul basin management plan, three scenarios have been used for estimating the water demand: high, medium (basic) and low that correspond with the scenarios of The

Population Prospect of Mongolia 2010-2040 by NSO, and first scenario of population growth of Ulaanbaatar city estimated by Design and Research Institute of the Capital. According to the medium scenario, the total population of the Tuul RB may reach 1552.4 thousand persons and the population of 7 UB districts, which belong to the Tuul RB, 1485.8 thousand persons (see Figure 37).

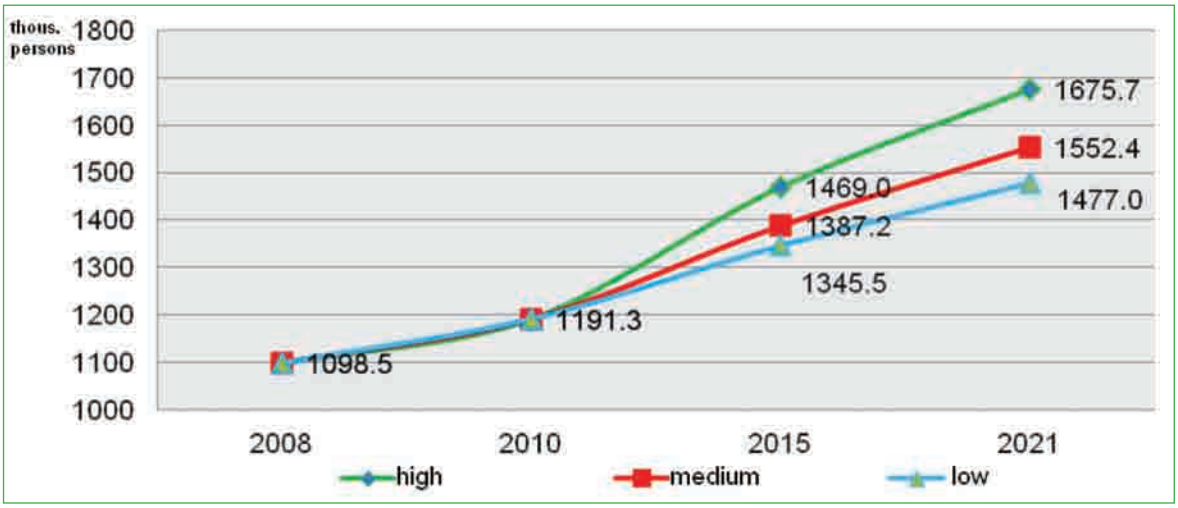

Figure 37. Population forecast of the Tuul RB

In 2008, there were some 260.7 thousand households in the basin which is 38.5% of the total number of Mongolian households. In 2010 this increased to 303.8 thousand households or 40.9% of the total number of Mongolian households. There are on average 3.9 persons per household which is higher than the national average (3.7). The average household size is highest in Songinokhairkhan district (4.4) of Ulaanbaatar City and lowest in Bayandelger soum of Tuv aimag and Bayan-Undur soum of Uvurkhangai aimag (2.6).

3.2.1. Location of the Population

Urbanization of the basin is high due to Ulaanbaatar and the relatively high development of infrastructure, services and employability.

In 2010, about 95.7% of the total Tuul RBs population was living in the urban area. Urban and soum center population was in total 97.4% from the total Tuul RBs population of 1160.7 thousands persons. From which 1125.4 thousand persons were living in Ulaanbaatar, 15.3 thousand in Zuunmod city and 20.0 thousand in soum centers and other settlements. From soum centers and settlements: 2 soum centers have under 500 persons, 10 soum centers 500-1000 persons, 5 soum centers 1000-1500 persons, 2 soum centers 1500-2000 persons and Khailaast village of Zaamar soum over 2 thousand persons. The soums with the highest population are Rashaant of Bulgan aimag (1687 persons) and Zaamar of Tuv aimag (1548 persons) and the soums with the lowest Sergelen (487 persons) and Undurshireet (357 persons) of Tuv aimag (see Figure 38).

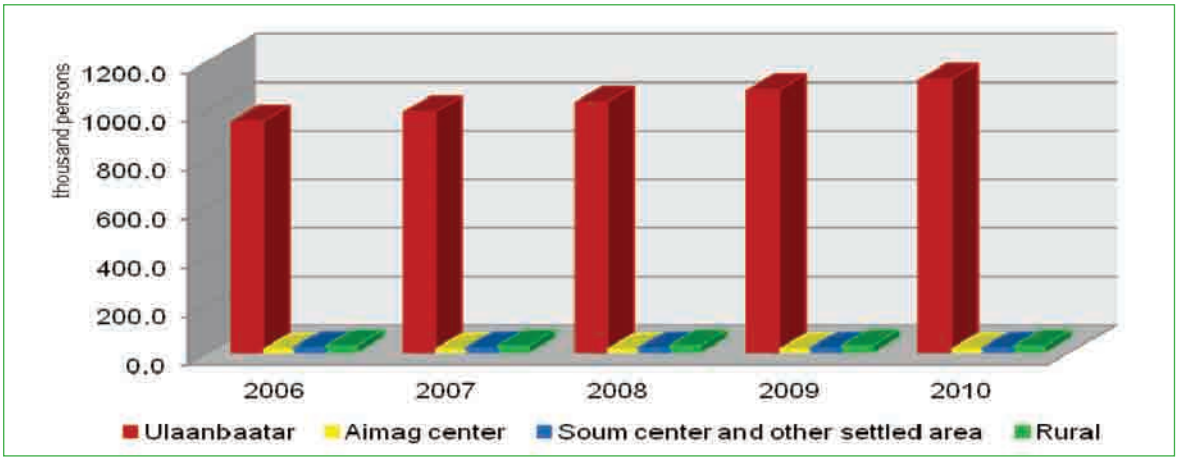

Figure 38. Tuul River Basin population

Table 31. Urban and rural population in thousand persons

Capital, aimag and soum centers	2008	2009	2010	2015	2021
Arkhangai	0.8	0.8	1.1	1.1	1.2
Bulgan	4.5	5.1	5.5	5.4	5.6
Uvurkhangai	0.5	0.5	0.5	0.5	0.6
Selenge	0.9	1.1	1.3	1.3	1.4
Tuv	28.0	27.7	27.6	27.4	28.1
Zuunmod	14.8	14.8	15.3	15.1	15.5
Ulaanbaatar	1032.3	1082.9	1125.5	1322.3	1485.8
Total	1067.0	1118.1	1161.5	1358.0	1522.7

According to the Tuul RB medium scenario population projection, in 2021 urban and soum center population will reach 1522.7 thousand persons, which is a 42.6% increase from the 2008 population of 455.7 thousand persons. This growth depends mainly on the Ulaanbaatar population growth.

3.2.2. Population of Ulaanbaatar

Bayangol, Bayanzurkh, Nalaikh, Chingeltei, Khan-Uul, Sukhbaatar and Songinokhairkhan (except Jargalant village) of Ulaanbaatar belong to the Tuul RB. In 2010, the population of Ulaanbaatar reached 1151.5 thousand persons or 41.4% of the total country population. From these 97.7% or 1125.4 thousand persons were living in the Tuul RB, which is 94.7% of the total basin population.

The last 10 years' average growth of the basin population was 3.9%. In 2010, the population of Ulaanbaatar increased by 5% or 55.1 thousand persons, and the last two years increased by 8.8% or 94.4 thousand persons from which 93.1 thousand people were in the Tuul RB. As of 2010 statistics information, 45.8% of the population growth was an additional growth of officially migrated people to the Ulaanbaatar.[1] In the same year 39.7 thousand persons migrated to Ulaanbaatar, from which most were unemployed people and 10.1 thousand were persons illegally residing longer than 6 months. This concentration of people in the capital is becoming one of the critical problems for Ulaanbaatar and Mongolia.

The economy and population of Ulaanbaatar is growing rapidly, creating problems regarding safety and healthy living conditions for the population; regarding the land

1 NSO, Migration data

use situation in and near the city; regarding deteriorating environmental conditions; regarding increasing pollution and pressure on the ecosystem; and regarding the imbalanced economic development of the regions. To tackle the problems the General Development Plan of Ulaanbaatar City was developed until 2020 and development tendencies until 2030. In the general plan, new towns and villages are planned to develop near the city, and city development regions are identified in order to reduce the rapid population growth of Ulaanbaatar and to decrease the ger area.

Table 32 presents the current and future population of towns, villages and new settlements around Ulaanbaatar. In 2021, out of 1.5 mln persons of Ulaanbaatar about 200 thousand live in the new settlements around the city. Most of these towns are not connected to the central water and waste water systems and in the future should focus on their infrastructure development.

Table 32. Population of towns and villages around Ulaanbaatar

No	Town	Definition	Location	Population, *thousand persons*				
				2008	2009	2010	2015	2021
1	Nalaikh	town	Nalaikh district	27.9	28.9	30.2	34.3	40.0
2	Emeelt, Argalant	town	CKhD, 20th khoroo	9.9	10.0	9.3	11.1	13.6
3	Tuul-Shuvuu	village	KhUD, 13th khoroo	3.5	2.6	3.7	4.6	5.9
4	Gavijiin shand	new settlement						
5	Bio-Songino	village	KhUD, 12th khoroo	5.6	5.8	5.8	7.2	9.3
6	Ulziit	village	KhUD, 14th khoroo	2.5	2.8	3.1	3.8	4.9
7	Gachuurt	village	BZD, 20th khoroo	6.6	6.2	6.1	7.8	10.3
8	Aero city	New city	Khushgiin khundii	-	-	-	100 thous. people	
9	Student city *	New city	Shiveetiin khundii	-	-	-	100 thous. people	
10	Terelj	village	Nalaikh, 6th khoroo	1.2	1.3	1.3	1.5	1.7
11	Nisekh	village	KhUD, 9,10,16th khoroo	20.3	21.1	22.3	27.6	35.6
12	Yarmag	khoroo	KhUD, 7,8th khoroo	14.7	14.9	15.7	19.5	25.2
13	Nukht	khoroo	KhUD, 6th khoroo	7.8	7.9	7.9	9.8	12.7
14	Uliastai	village	BZD, 10th khoroo	10.0	10.5	10.9	13.9	18.5
15	Khonkhor	village	BZD, 11th khoroo	4.2	4.8	5.5	7.0	9.3
16	Nairamdal	village	SKhD, 22nd khoroo	10.5	11.9	12.9	15.3	18.9
-	**Total**			**124.7**	**128.6**	**134.7**	**163.2**	**206.0**

Explanation: ** The student city was planned near the Nalaikh district but later replaced to Shiveetiinh khundii, which is located in the Kherlen River basin.*

The population projections of the seven districts of Ulaanbaatar, which belong to the Tuul RB, are presented in Table 33.

Table 33. Population prospect of Ulaanbaatar

Districts	2008	2010	2015	2020	2021
Total	1032.3	1125.5	1322.3	1458.5	1485.8
Bayangol	169.3	185.1	217.5	239.9	244.4
Bayanzurkh	235.2	266.0	312.5	344.7	351.2
Nalaikh	29.1	31.5	37.0	40.8	41.5
Songinokhairkhan	226.8	246.5	289.6	319.4	325.2
Sukhbaatar	133.1	136.9	160.9	177.5	180.8
Khan-uul	98.8	112.1	131.7	145.3	148.0
Chingeltei	140.0	147.4	173.2	191.0	194.7

3.3. Education, cultural level, custom and religion

3.3.1. Education

The education index[2] of Mongolia is relatively high: 0.925 in the 2010. The education system of Mongolia consists of pre-school education, primary and secondary education and higher education.

Due to the location of the science and education center of Mongolia-Ulaanbaatar, the Tuul river basin has a relatively large number of educational organizations. Most of the universities, colleges and vocational and technical schools are located in Ulaanbaatar. In the 2010/2011 academic year, there were over 160 thousand students studying in over 100 universities and colleges and 13 thousand students in the vocational and technical schools. These were about 90% of the high educational organizations and students of Mongolia.

In the 2010/2011 academic year, 200 thousand children were studying in over 230 schools, of which about 200 schools or 89% are located in Ulaanbaatar and about 93% children in Ulaanbaatar. According to the statistical information, the number of schoolchildren in the rural area is reducing, while in Ulaanbaatar it is rapidly increasing due to the migration to the Capital. Some schools are engaged in three shifts. In Ulaanbaatar, the average schoolchildren number is over 900 per school and outside Ulaanbaatar 600 per school. [17]

In same year of 2010/2011, about 45 thousand children are enrolled in about 260 kindergartens, of which about 90% is located in Ulaanbaatar.

3.3.2. Culture

The Mongolians are one of the nations who preserved their nomadic cultures to this time. The people of Mongolia have a coherence with mother nature and respect it as the basis of life. This ideology is absorbed in Mongolian tradition and custom. The Mongolians consider water as a source of life and name rivers as mother. For example: Tuul river is named as “Khatan Tuul” in a respectful way. Some 300 years ago, a city was founded near Khatan Tuul river and Khan Bogd mountain. Later the city became the center of the country’s development, and it is known as Ulaanbaatar now. Mongolian famous poets and writers praised the Tuul River in their works.

Until this time, herders follow the Tuul riverside in 4 seasons with their livestock in search of good pasture. The work schedule within households became traditional also. The women are responsible for water in the household. Mostly, men carry the water. In the urban ger districts, children sometimes carry water. A questionnaire was conducted in ger districts of Ulaanbaatar City which showed: 45% adult men, 29% adult women, and 26% children carry water for the household. Another questionnaire was conducted in Altanbulag soum of Tuv aimag. The result of the questionnaire is: 62.7% adult men, 20.9% adult women and 16.3% children carry water. When comparing this questionnaire to a survey called “Who carry water in the household” which was taken in 2004, the participation of men increased and participation of women and children decreased.

In urban areas, 50% of people carry water from a distance of 200 meters, 43% from up to 1 kilometer and 7% of people carry water from a distance of more than 1 kilometer. In soum centers, the indicator is 22.9%, 50% and 27.1%. For carrying water, 73% of people in Ulaanbaatar and 68.8% of people in rural areas spend 1 hour. In Ulaanbaatar,

2 One component of HDI (see section 3.4.2), which 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.

10% of people and in rural areas 4.2% of people spend some 2 hours for carrying drinking water from the kiosks.

The herders still use less than 10 liters water per person a day. Central water supplies and sewerage networks were introduced in Mongolia during the 1960s. As of 2010, 37.9% of the population who live in the Tuul River Basin had a connection to the central water supply and sewerage network. Only 1.2% of the population obtains their water from unprotected water sources like springs and ponds. One of the issues in Tuul River Basin is the river water pollution. Due to the river water pollution, households who live along the downstream part of the river face difficulties. For example: it is impossible to water livestock from the Tuul River downstream of Ulaanbaatar City due to water pollution.

It is clear that this has affected daily life of people. In soums like Altanbulag and Undurshireet, people drill wells along the river streams and water their livestock. Also there will be an extra fee added to drinking water production and it will be impossible to spend some quality time near water due to pollution and nasty smell. In this situation in developed countries, water users in the upstream part of the river pay compensation and tax depending on the pollution severity.

3.4. Employment and Living Standard

3.4.1. Employment

In 2010, *there were 1863.4 thousand potentially productive people* on *the national level, of which* 1147.1 thousand were actually economically active, and 1033.7 thousand were employees. From the economically active population some 415.1 thousand persons or 36.2% and 379.4 thousand employees or 36.7% were living in the Tuul RB.

In 2010, the labour participation was lower than the country average due to the high student numbers. The economic active population was 1071.5 thousand in Tuul RB. Table 34 gives an overview of the employment indicators of the Tuul RB by capital and aimags. In the Selenge and Uvurkhangai aimags labour participation rate and employment were high, in the Bulgan and Ulaanbaatar unemployment was high. For example, in Ulaanbaatar there were 33.1 thousand unemployed people, from which only 8.8 thousand were registered as unemployed. In 2010, unemployment in Ulaanbaatar was 8.7%.

Some 97.4% of the Ulaanbaatar City economic active population, 97.5% of the employees, 36.2% of the country's economic active population and 37.6% of the employees live in the basin.

Some 6% of the total employees worked in agriculture, 15% in industry and over 70% in the service sector.

Table 34. Employment in the Tuul RB in thousand persons, 2010

Indicators	Ulaanbaatar	Arkhangai	Bulgan	Uvurkhangai	Selenge	Tuv	Total	Country total	Percentage in the country total
Total population	1125.4	3.4	13.6	4.2	2.0	42.7	1191.3	2780.8	43.2
Population of working age	756.6	2.2	8.9	2.6	1.3	28.1	799.6	1863.4	42.9
Economically active population	382.7	1.8	7.1	1.9	0.9	20.6	415.1	1147.1	36.2

Indicators	Ulaanbaatar	Arkhangai	Bulgan	Uvurkhangai	Selenge	Tuv	Total	Country total	Percentage in the country total
Employed	349.6	1.7	6.1	1.8	0.9	19.4	379.4	1033.7	36.7
Unemployed	33.1	0.1	1.1	0.1	0.02	1.2	35.7	113.4	31.5
Registered unemployment	8.8	0.1	0.01	0.04	0.5	1.5	10.9	38.3	28.4
Labour force participation rate, %	50.6	85.3	80.5	74.5	68.0	73.4	51.9	61.6	-
Employment rate, %	91.3	93.0	84.8	95.1	97.9	94.0	91.4	90.1	-
Unemployment rate, %	8.7	7.0	15.2	4.9	2.1	6.0	8.6	9.9	-

3.4.2. Living Standard

Human Development Index

The Human Development index (HDI) is one of the socio-economic indicators that measure the country's development by combining indicators of life expectancy, educational achievement 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 [122]. 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".

According to the NSO information in 2010, the HDI of Ulaanbaatar City was higher than the state average by 0.026 units and other aimags of the basin were lower by 0.025-0.070 units. Recently the average life expectancy is increasing and in 2010, it was in Ulaanbaatar 63.8, in Tuv aimag 69.8, in Selenge, 68.9 and in Bulgan 69.4 and they were higher than the state average (68.1). Two aimags were lower than the state average: 67.7 in Arkhangai and 67.9 in Uvurkhangai. The development programs of regions and aimags aim to improve HDI by increasing life expectancy, education level and per capita GDP.

Household Income and Expenditures

The NSO started conducting researches on population, household income and expenditures since 1966. In 2010, monthly average household income was MNT 448.0 thousand: in Ulaanbaatar was MNT 529.3 thousand, which was higher than the state average by MNT 81.3 thousand (Table 35)

Table 35. 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

Indicators		2006	2007	2008	2009	2010
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

At the national level, 86.4% of the household income is monetary income and 9.3% is from household business. In Ulaanbaatar 97.1% of the household income is monetary income and 2.9% is from household business and other sources. In Ulaanbaatar from total monetary income, 51.7% is from salary and wages and 17.4% is from pensions and allowances.

In 2010, the monthly average expenditure per household reached MNT 450.6 thousand at national level, which is translated in an urban expenditure of 501.0 thousand MNT and rural expenditure of MNT 391.9 thousand. The share of monetary expenditure in the average expenditure per household was 86.5%.

According to the survey on average wages and salaries of employees, the average wages and salaries are calculated by economic sector, type of enterprise, ownership form and by age, gender and occupation type. According to the survey results the average monthly salary of employees was MNT 341.5 thousand in 2010, which is an increase of 13.6% compared to the previous year and a 24.5% increase compared to 2008 [17]. Furthermore, the average monthly real wage of employees increased by 3.2% compared to 2009. In the mining and quarrying sector the average real wages and salaries even grew with 28.1%. However in the social services sector it decreased by 11.7%.

As for the results of the questionnaire taken in Tuul River Basin, the majority of the poor people live in Ulaanbaatar City ger districts. In Ulaanbaatar City ger districts, 1 liter of water costs MNT 1-1.5 and it takes on average 1-2 hours per day for carrying water. One person uses 7-10 liter water per day for drinking water. This is 2.0-3.6 times lower than the water demand per person (20-25 liter) which was estimated as sufficient by the World Bank and international organizations.

According to the Tuul River Basin survey, water and wastewater 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 MNT 18.7 thousand (water 12.8 and wastewater 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.

Poverty and Living Standard

One of the indicators showing the living condition of the country is the poverty indicator. The poverty indicator includes poverty headcount, gap and severity. Table 36 shows the minimum subsistence levels in 2006-2010.

3 By recommendation from EBRD water and waste water expense have to be under 5% of household income.

Table 36. Minimum Subsistence Level of Population

Region	Minimum Subsistence Level, *MNT/per month per person*					
	2006	2007	2008.II	2008.X	2009	2010
Central: Tuv, Selenge	39 000	56 700	73 100	90 800	91 200	91 700
Khangai: Uvurkhangai and Bulgan	38 300	54 600	70 600	89 000	90 600	91 500
Ulaanbaatar	42 800	60 100	73 300	94 800	101 100	101 600

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 to reduce poverty".

Contrary to the MDGs aims, the poverty headcount index has increased to 39.2% in 2010, which is composed of an increase of 7.9% in the Capital, 4.5% in rural areas, 1.3% in Aimag centers and a decrease of 3.2% in Soum centers (Table 37).

Table 37. Poverty headcount index, by region and %, (NSO)

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
	Ulaanbaatar	27.3	21.9	26.7	29.8
Location	Capital	27.3	21.9	26.7	29.8
	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

3.4.3. Health

The Mongolian Human Development Policy aims to have a sustainable population growth and establish decent conditions for a long and healthy life.

According to statistics, there were about 2.3 thousand health institutes at national level as of 2010 and 40% or over 900 institutes are located in aimag and soums of the basin. From which 90% are located in Ulaanbaatar.

Maternal mortality which took place in the river basin was 47% of the total maternal mortality in the country in 2010 while infant mortality was some 40% of the total infant mortality. Also the number of patients suffering from infectious diseases was 53% of the total of the country (22 thousand). Of the patients in the basin, some 50% suffered from a viral hepatitis, one of the infectious diseases caused by polluted water.

3.4.4. Future Trend of Social Development

It is stated in the 1st guidance of the six leading guidance's of the integrated national development policy which is based on the Millennium Development Goals that "it shall achieve the Millennium Development Goals and develop Mongolian citizen in all aspects". In scope of this guidance, it is also stated that "it shall adhere to a policy to fully achieve the Millennium Development Goals and bring the human development index at 0.83 by 2015".

Development programmes of the region and aimags have been processed and approved based on above guidance. The Tuul river basin is crossing the economic regions of Ulaanbaatar, Central and Khangai. It is stated in the development programme of the Central region that the average life expectancy of the population is about to reach age of 66 and unemployment level as of 1998 is to decrease two times by 2015. The development programme of Khangai region aims at bringing the average life expectancy at 69, increase the population growth to 1.8%, decrease number of registered unemployed below 2% and bringing the number of households under normal living standard below 10%. Also it will seriously focus on improving the level of housing supply for the population.

The Ulaanbaatar economic region development program aimed in 2015 to decrease the growth of migration by 50% compared to 2005, to reduce poverty level 2 times, to improve education facilities and education quality.

3.5. Infrastructure

The river basin houses Ulaanbaatar City which is the country's social and economic center. The infrastructure is well developed in the basin. The Chingis Khaan international airport is located 18kms south west of Ulaanbaatar and it has communication with the following cities: Tokyo, Seoul, Berlin, Moscow, Erkhuu and Beijing.

The railway is very important for Mongolia, which is located between 2 big countries and it connects Europe and Asia. The railway is vital in terms of economy. In Mongolia, we have 1.8 thousand kilometers long railway network. Some 1.1 thousand kilometers railway is connected with the trans-Siberian and Chinese railways. The railway is about to be increased due to increasing development of mining.

Auto road

Mongolia has a total of 11 thousand kilometers paved and improved gravel state roads and some 38 thousand kilometers paved and improved local roads.

Since 2001, the "Millennium Road" started to be built along the horizontal and vertical axis. It started from Ulaanbaatar City. Between 2000 and 2009, investment in the auto road sector increased 9.8 times. In total 1960 km paved road, 480 km pebble-covered road were built. In 2010, 1.5 thousand kilometer road is projected to be built, including 110 kilometer paved road from Bulgan's Dashinchilen to Arkhangai Orkhon.

State roads connecting to 7 other aimag centers pass through Tuul River Basin, except Ulaanbaatar City, from which 40% were paved road. Ulaanbaatar and Zuunmod city connected by paved road with some 45 km long and are connected with each other by local road. Ulaanbaatar City is connected with the following places by asphalt road: Nalaikh, Gatsuurt, Shuvuun fabric, Terelj camp, Baganuur and Northern camps.

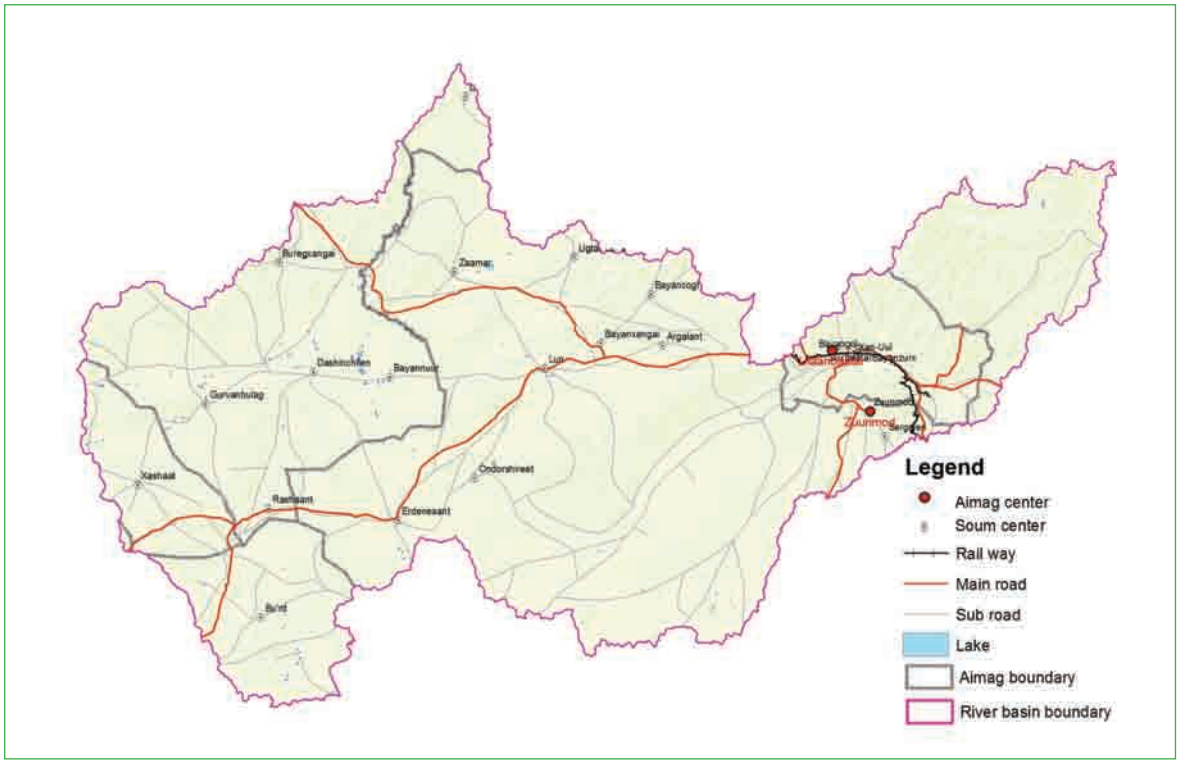

Figure 39. State and local road map Of Tuul river basin

Ulaanbaatar has some 427.6 km auto road, from which 76.9 km is state, others are local level road. Ulaanbaatar City is connected with the following places by paved road: Nalaikh, Gatsuurt, Shuvuun fabric, Terelj camp, Baganuur and Northern camps. Between 2005 and 2008, some 60 km auto road and one bridge were built and expanded and some 304.7 thousand m^2 repairing work was conducted in central roads and roads within districts of Ulaanbaatar. In 2010, some 24 km paved road was built and 21.0 thousand m^2 roads were repaired.

Energy

Tuul River Basin belongs to the Central energy system. Therefore it has a more reliable energy supply than other regions. The basin occupies some 90% of the central energy network. There are 3 power plants and the total installed electricity capacity is 712 MW. The total installed thermal capacity is 1786 Gcal/h. 35-220 KW -1300 km long electricity transmitting lines are used for distributing electricity to the consumers.

Figure 40. Electricity network in the TRB

The part of the energy system, which are located in the TRB presented in *Figure 40*. The soum centers of the basin are connected to electricity. There are central thermal systems in the soums of Ugtaal, Argalant, and Zaamar. The other soum organizations supply their thermal needs from heating stoves. Some 50% of the households use solar and wind energy and it plays an important role in their lives. In Mongolia, we need to expand the size of renewal energy use.

Ulaanbaatar City is well supplied by electricity, but in the last few years, population growth has increased as well as services and productions are developing rapidly. Due to these issues, energy demand is rising quickly. In some cases, sub-station and transparent centers' capacity decrease in ger districts and city center. Also, the level of energy supply decreases, and it becomes impossible to supply big energy consumers with energy and heat in the city center in terms of equipment.

It shows that consumers need to be supplied by nature friendly, cheap and reliable energy. The power plant number 5 is scheduled to be built and it will increase the basin's water demand.

Water supply and sewerage system

Due to high urbanization in the TRB, there is a relatively good developed water supply and sewerage system.

Water supply system. Ulaanbaatar city has a water supply network with a large capacity. The Ulaanbaatar city's water supply system include 4 water sources, 6 water transfer pumping stations, 175 deep wells (boreholes), 232 kiosks connected to the central system, and 298 unconnected kiosks, 350.3 km water supply pipes and 172 km water supply lines in the ger area. The pipelines inside apartment area belong to the OSNAAG. Ulaanbaatar City supplies good quality ground water for the drinking water needs. The water is purified by chlorination stations and then distributed to the consumers.

Nalaikh district is isolated but its drinking water is supplied from the upper sources of USUG. The Nalaikh district has a central water supply network, and water for ger areas population is provided by 23 kiosks. Also Nisekh, Bayangol and Biocombinat have local water supply systems.

On example of Ulaanbaatar, about 10 years ago only 14.5% of the total consumers had their water metered, the ratio between pumped and sold water was 50.6% and only

49.1% of the pumped water per day was billed. Nowadays USUG has metered 99.9% of the consumers that is 100% of the organizations. Due to the installation of water meters and activities related to water losses reduction, the drinking water use per person in 2010 decreased to 230.8 l/per day compared to 272.3 l/per day in 2008.

Zuunmod city has a water supply and sewerage system. The water supply source with capacity of 1550 m^3/ per day is located in the Khushgiin khundii. The water supply system includes 2 reservoirs, 2 pumping stations and 20.5 km distribution pipelines. In the ger area 17 kiosks provide drinking water for the population. Moreover Bayannuur and Rashaant soum centers of the Bulgan aimag, Orkhontuul of the Selenge, and Argalant, Bayankhangai, Zaamar and Erdenesant soum centers, and Khailaast village of the Tuv aimag have local water supply system.

Sewerage system. The Ulaanbaatar's sewerage system includes 147.7 km long sewerage pipelines, a Central wastewater treatment plant with treating capacity of 230.0 thousand m^3/per day, and "Khargia" wastewater treatment plant, which has a capacity to treat 13.8 thousand m^3 industrial wastewater per day.

The wastewater treatment plant of Zuunmod city was built in 1993 and has 25.5 km long sewerage pipelines. In 2010-2012, this wastewater treatment plant was reconstructed by state budget (MNT 1700 mln.)

Although water supply and sewerage system is developed adequately most of these networks were constructed in 1960s and technologies need to be renewed. For example: for the 2009 survey, 70%-treated waste water from Nalaikh district waste water treatment plant flowed through ger districts and joined the Tuul river. It causes infection diseases in the warm season. It should be noted that much attention is paid on industrial waste water treatment. Last few years, state policies on water supply are intensified. But USUG and some Housing and Communal Service Authorities are in loss. It means that cost and tariff system should be renovated and water loss needs to be minimized.

From soums, there were located in the TRB, Rashaant of the Bulgan aimag, Orkhontuul of the Selenge aimag, and Erdenesant of the Tuv aimag and Khailaast village have working a local treatment plant, but treatment level is very low. Also in the Bayannuur of Bulgan, Bayankhangai, Bayantsogt, Zaamar, Sergelen and Ugtaal of the Tuv aimag was built wastewater treatment plants, which were broken down.

Some tourist camps and sanatoriums have their own treatment plant and treated wastewater is discharged to the soil or nearby cities wastewater treatment plant by truck.

Due to rapid urbanization, expanding city, industrial development there are increasing needs for repair and expand water and sewerage systems. Some developed countries stopped using chlorination stations since 1990s and started using silver-sand filter and UV radiation. These new technologies are better for people's health. So we need to introduce these kind of new technologies in Mongolia.

3.6. Agriculture

Agriculture plays an important role in the Mongolian economy. This sector provides for the population's needs for food and agro-industry.

In 2010, the production of the agriculture sector amounted 15.9% from Mongolia's GDP. As of 2010, agricultural production occupied 0.8-78.9% in the Basin aimag GDP. The minimum was in Ulaanbaatar City, 0.8%. It was 68.1-78.9% in the other aimags.

3.6.1. Livestock

Development outline of livestock

Pastoralism has developed in a classical way in many countries with a high level of urbanization. Under the current condition where climate change has intensified, it is good for our country to have a combined development of intensified animal husbandry and agriculture. By doing so, the aim is to decrease the dependence on natural conditions like drought and famine.

Herders: In 2008, there were some 171.1 thousand herder households nationally which decreased to 160.3 thousands herders families in 2010. In 2010, of the country total 5.7% or 9.1 thousand herder families and 5.6% of 18.3 thousand herders live in this basin.

Livestock. In 2008, there were 2951.2 thousand livestock which decreased to 2853.5 thousand livestock in 2010. Some 8.8% of Mongolia's total livestock lives in this basin.

Table 38 shows livestock numbers and number of livestock per 100 ha in term of sheephead. In 2010 there were some 4808.9 thousand animals in term of sheep heed.

Table 38. Livestock types, 2010

Aimag and capital	Livestock, *thousand heads*						In term of sheephead	
	Total	camel	horse	cattle	sheep	goat	number	per 100 ha of pasture
Arkhangai	214.8	0.3	12.2	8.0	125.3	69.1	321.9	133
Bulgan	888.0	0.6	59.9	44.7	471.8	311.0	1442.1	148
Uvurkhangai	233.5	0.3	15.5	6.1	132.5	79.1	350.3	99
Selenge	43.0	0.1	2.7	2.9	20.6	16.7	72.6	106
Tuv	1357.7	0.8	101.4	74.1	678.7	502.8	2289.0	93
Ulaanbaatar	116.5	0.1	10.3	31.6	37.7	36.8	332.9	271
Total	**2853.5**	**2.2**	**201.9**	**167.4**	**1466.5**	**1015.6**	**4808.9**	**114**
Country Total	**32392.2**	**267.1**	**1901.7**	**2151.0**	**14273.9**	**13798.5**	**54821.0**	**49**
Share of the country total	8.8	0.8	10.6	7.8	10.3	7.4	8.8	-

Nationwide, there have been good conditions of nature and weather since 2002. This had a positive impact on the livestock numbers. In 2008 the livestock of the TRB was doubled compared to 2004. Due to the 2009 dzud the livestock number decreased. The highest losses were in Ulaanbaatar.

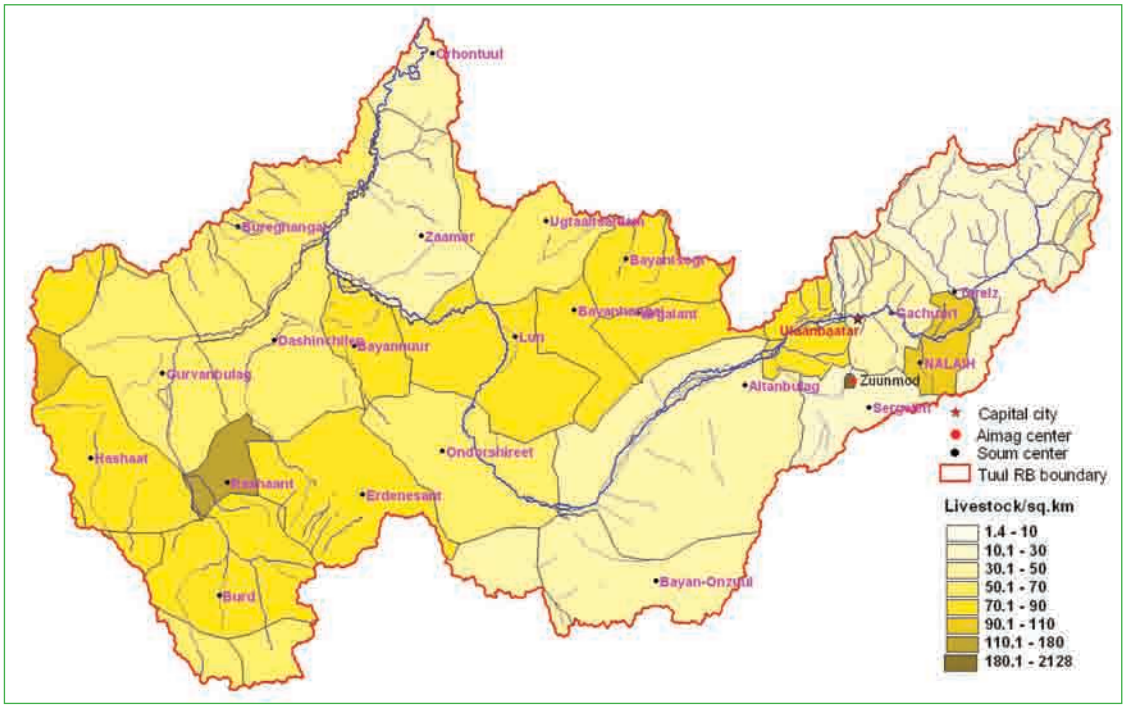

Figure 41. Livestock density

Figure 41 presents the livestock density. Most densely soums of the TRB were Zuunmod of Tuv (1654 head/per 100 ha) and Rashaant of Bulgan (195 head/per 100 ha) and lowest density were in Sergelen of Tuv (16 head/per 100 ha), Erdene of Tuv (22 head/per 100 ha).

In 2010, 47.6% of total livestock of the TRB was in Tuv aimag, 31.1% in Bulgan aimag, 8.2% in Uvurkhangai, 7.5% in Arkhangai and 1.5% in Selenge aimag. From the total of the TRB livestock 87% are small animals and 13% are big animals. The share of the goats in the small animals is 41% which is close to the appropriate proportion defined by scientists. In Mongolian traditional pasture animal husbandry experience, it is normal if the goat percentage in the small cattle is 25-30%.

In 2010, nearby Ulaanbaatar there were some124 farms with about 5 thousand cows; in Tuv aimag were some188 farms with about 8 thousand cows, which were 48.1% of the Mongolian high breeding animal farms. An average cows per farm was 40 in Ulaanbaatar, 43 in Tuv aimag, which was higher than nationwide average (33 cows). While near Ulaanbaatar are located most of the dairy farms of Mongolia that cannot satisfy the milk demand of Ulaanbaatar city. In addition in the Tuv aimag located 11 meat farms and one wool farm.

The regions' development program planned to develop intensive livestock farming near Ulaanbaatar for the purpose to meet food needs of the population.

Apart from the 5 main kinds of livestock, other livestock is raised and used for the population food demand in the basin. As of 2010, some 100 households and 10 entities managed pig husbandry; about 300 households and 9 entities managed chicken farming. There were in total 8.2 thousand pigs which are 28% of the total number of pigs counted nationally. Some 239.1 thousand chickens are bred which is 66.4% of the state total. The following animals are bred in a small number as well: deer, donkeys, rabbits, bees and musk deer.

Pasture and hay resources

In 2010, The Tuul River Basin had 43438.2 km^2 of pasture and 4808.9 million livestock in term of sheep head equals. There were 114 sheep head per 100 ha on a basin average. This is 2.3 times higher than the national average.

Animal husbandry foremost relies on pasture and water. As of the survey on pasture, an annual pasture grass reserve of Mongolia in term of fodder unit is about 33 mln tons. According to the assessment on pastureland use of the Research Institute of Animal Husbandry and other related organizations from 2000, it is enough for 70-86 million livestock in term of sheep head equals, if climate and environmental conditions are stable and water supply is adequate. However, grazing capacity can decrease to 50 million livestock in term of sheep head equals depending on climate and environmental conditions like dzuds, droughts or severe precipitation. [78]

NAMHEM each year define grazing capacity of the winter and spring pasture, based on livestock number, yield and grazing period. According to the 2011 survey of grazing capacity by NAMHEM, of the soums which belong to the TRB, in Orkhontuul of Selenge aimag overgrazing was very high and some bags of Khashaat of Arkhangai aimag, of Bayankhangai, Ugtaal, Erdenesant, Erdene and Undurshireet of Tuv aimag had overgrazing (*Figure 42*).

Figure 42. Grazing capacity in the TRB, 2011

Pasture capacity depends on the yield, grasses and number of livestock and other factors. The average yield of grasses per ha are 3.8 centner in spring-summer and 2.2 centner in autumn-winter from which will be eaten by livestock 2.7 centner in spring-summer and 1.7 centner in autumn-winter. Sheep needs 2 kg grass per day and an average 7.3 centner grass per year. If pasture is used 2 times per year then grazing capacity is 50-60 sheep per 100 ha. According to this estimation, in most of the TRB aimags the pastureland is overgrazed.

According to calculation of the basin's pasture yeild as of 2010 by using national average indicator, the required annual fodder amounted to 1579.7 thousand ton fodder unit, pasture resource amounted 575.9 thousand ton fodder unit and hay preparation resource amounted to 31.5 thousand ton fodder unit, respectively. In other words, it was able to provide approximately 40% of the required fodder unit. Other lacking part is needed to be replaced with other planted fodders or it needs to reduce number of livestock. The Ministry of Food, Agriculture and Light Industry is adhering to a policy on maintaining

the number of livestock on a fixed basis and improving the breeds of livestock. On one hand, herding livestock with a high productivity enables to increase number of products. On the other hand, it will make demand of fodders, nutrients and water, etc used by livestock higher than pastoral livestock's.

In view of grazing intensity in pasture areas of the capital city and aimags included in the Tuul River Basin, the overgrazing was 150% in almost overall pasture areas of Ulaanbaatar city while most pasture areas in Tuv, Uvurkhangai and Bulgan aimags were subject to the grazing intensity to some extent. It was determined that there are two main factors affect this grazing intensity: lack of pastoral water supply; and a new practice which uses pasture with only two rotations of winter and summer (this is due to herdsmen's intention to get closer to the market and reduction in number of water point, etc) as traditional one was had rotations of four seasons[4].

Table 39 show hay harvesting and forage production in the TRB. In 2010 in the TRB there was harvested 67.1 thousand ton hay and produced 2.8 thousand ton forage, which were in term of fodder unit 33 thousand ton. It satisfies only 25.1% of fodder needs of the livestock in the TRB.

Table 39. Hay harvest and forage of the TRB

Aimag, capital	Hay, *ton*				Forage, *ton*			
	2007	2008	2009	2010	2007	2008	2009	2010
Arkhangai	2024.0	3036.0	1554.2	2295.0	124.4	172.0	69.0	33.4
Bulgan	7076.5	10158.0	9059.1	12846.6	191.6	387.2	298.5	404.5
Uvurkhangai	4335.7	4195.9	1404.1	1815.1	477.4	502.1	607.9	742.0
Selenge	4215.0	2810.0	3372.0	8992.0	0.0	0.0	0.0	0.0
Tuv	29896.8	39894.0	40847.8	31095.5	599.9	372.2	1184.8	1171.1
Ulaanbaatar	11632.6	15725.8	21318.5	10022.4	353.6	393.0	309.8	446.0
Total	59180.6	75819.7	77555.7	67066.7	1746.7	1826.5	2470.0	2797.0
Total of the country	933100	1030900	912300	1137300	35388.7	34440.8	25815	32745
Share of the country total	6.3	7.4	8.5	5.9	4.9	5.3	9.6	8.5

Livestock water supply

Water supply is vital to develop animal husbandry. The number of livestock increased a lot and pasture is getting insufficient. The Government is paying attention to this problem and taking measures to improve pasture water supply. New wells are being drilled and maintained (for more detailed information see Chapter 4).

In 2010, in Ulaanbaatar 5 new boreholes were constructed and 4 wells were repaired and in the Tuv aimag some 89 new wells were constructed and 66 wells were repaired. Some MNT 11.5 billion was spent on kiosk maintenance and rebuilding in 2007. In 2008, it was MNT 8.9 billion and in 2010 was MNT 7.4 billion. Table 40 presents the construction and rehabilitation investment costs of aimags, which are located in the TRB.

4 B.Tserendash, Methodology of estimation grazing capacity

Table 40. Investment for well construction and rehabilitation in million MNT

Type of investment	year	Construction			Rehabilitation and repair		
		Bulgan	Tuv	Ulaanbaatar	Bulgan	Tuv	Ulaanbaatar
TOTAL	2006	260.6	367.4	178.7	93.4	233.1	12.3
	2007	589.8	549.6	288.4	69.1	108.8	3.7
	2008	533.6	877.5	335.2	83.5	96.8	10.6
	2009	352.4	1 179.3	340.5	18.4	37.3	4.4
	2010	605	800.9	27.5	26.9	66.5	2
State budget	2006	53.2	42.6	33.2	21	39.2	4.1
	2007	372.5	341.9	49.7	23.2	73.3	2.2
	2008	281	487.7	162.2	30.1	66	0.1
	2009	86.5	721.7	64	13	0.9	1.8
	2010	211.5	400.4	12	11	5	1.6
Foreign aid and projects	2006	188.8	141.5	78.3	58.8	131.2	3.6
	2007	195.3	99.4	179	43.4	24.6	0.9
	2008	238.8	175.5	165.5	51.8	1	2.5
	2009	253	189	142.9	0.3	22.9	1.9
	2010	365.1	236.2	0	11.7	44.1	0
Private (herders)	2006	18.6	183.3	67.2	13.6	62.7	4.6
	2007	22	108.3	59.7	2.5	10.9	0.6
	2008	13.8	214.3	7.5	1.6	29.8	8
	2009	12.9	268.6	133.5	5	13.5	0.8
	2010	28.4	164.3	15.5	4.2	17.4	0.4

According to the field work, more attention need to be paid to the livestock water supply of Argalant, Bayan-Unjuul, Bayankhangai, Bayantsogt, Buren, Ugtaaltsaidam, Zaamar and Erdenesant of the Tuv aimag and of Dashinchilen of the Bulgan aimag.

Production of livestock husbandry

In 2010, some 8373.7 thousand livestock were used for food nationally and 745.6 thousand livestock was used for food in the basin. In the TRB there produced 17.7 thousand ton meat by slaughter weight. Also was produced over 10 ton pork.

As of 2010, 338.4 million liters of milk was produced on a national scale and some 40.6 million liters of milk was produced in the Tuul RB. This supplies only 55.5% of the Ulaanbaatar City and Tuv aimag milk products demand. Also, there were produced about 7.2 thousand tons of camel wool, 2.8 thousand tons of sheep wool, 0.5 thousand tons ff cashmere and 844.2 thousand pcs of leathers and skins.

In the future it is necessary to develop high breeding animal farms for purpose of reduce or keep on at an acceptable level the livestock number and increase livestock production.

The ongoing policy implemented by the Government of Mongolia to provide the domestic demand with domestic products and to improve the food security is creating convenient conditions for the development of agriculture and food production.

Development trend of livestock husbandry

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.

The Ulaanbaatar regions' program planned to improve livestock sectors the organization of labour, to develop the livestock intensive farming and to increase supply of agriculture products. In the Tuv aimag development program aimed to maintain the sustainable development of livestock sector, to develop rapidly the intensive livestock farming and to improve pasture use and protection.

Livestock growth forecasting: When calculating the Tuul River Basin livestock growth forecasting, it is compared with the projection done by the Ministry of Food, Agriculture and Light Industry and the tendency of last 5 years' growth of the river basins aimag and soum livestock. The growth was calculated by each aimag and soum by livestock type.

The Tuul River Basin livestock number will reach 3297.5 thousand in 2021 by medium scenario (Table 41 and Figure 43).

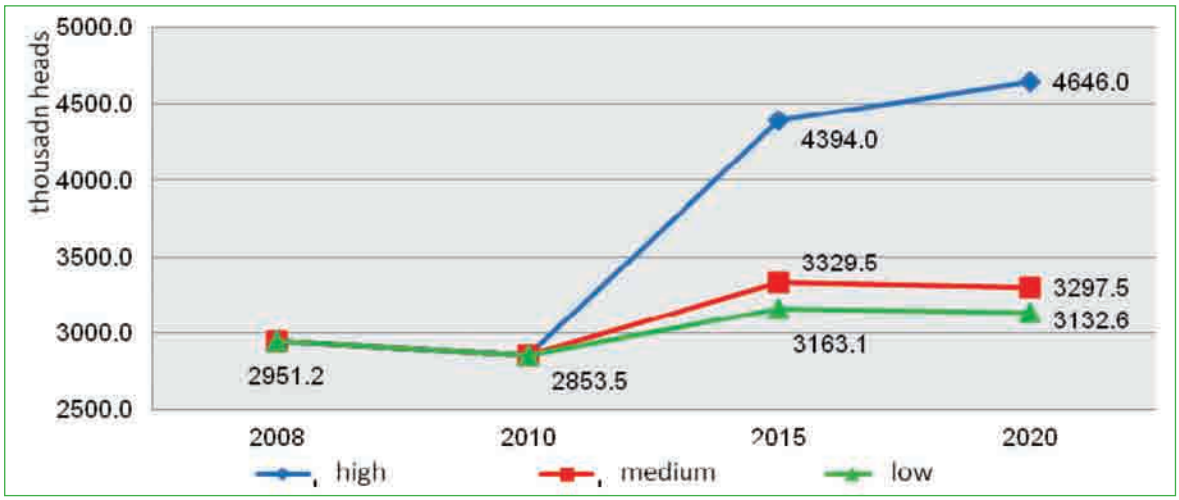

Figure 43. Livestock growth scenario

Table 41. Livestock growth projection of the Tuul River Basin until 2021

Thousand head

Aimags	2008	2010	2015	2021
Arkhangai	221.9	214.8	248.8	243.1
Bulgan	821.1	888.0	1034.4	1019.9
Uvurkhangai	264.5	233.5	267.7	259.0
Selenge	34.0	43.0	50.2	49.7
Tuv	1435.6	1357.7	1581.6	1561.8
Ulaanbaatar	174.2	116.5	146.9	164.0
Total	2951.2	2853.5	3329.5	3297.5

3.6.2. Crop farming

Farming is one of the basic agricultural production sectors. The basin is located close to the market. This region has a suitable condition in terms of economy and weather.

Ulaanbaatar City. As of 2010, crop was planted on 1042.7 hectares. The irrigation area was 116.5 hectares or 11.2%. The following is harvested by 51 farming-companies and 5.2 thousand household. In 2010, there were harvested 4870.9 tons of potatoes from 597.2 hectares, 2566.3 tons of vegetables from 354.3 hectares, 30.5 thousand tons of hay and 497.5 ton of hand-fodder. [20]

In 2010, there were planted 59.3 ha and harvested 314 tons cucumber and 211.5 tons tomatoes. Greenhouses' plants and part of the potato and vegetable are cultivated on irrigated area.

Aimags and soums of the basin. In the last few years, the cultivation of grain, potatoes and vegetables has intensified. Most people of soum centers supply their vegetable demand by cultivation and they also sell vegetables in the market.

As of 2010, the aimags and soums in the Tuul River Basin there were cultivated: 20.4 thousand ha cereals, 831.7 ha potatoes and 384.6 ha vegetables and were harvested: 25 thousand tons of cereals, 8 thousand tons of potatoes and 3.6 thousand tons of vegetables

The grain cultivation depends on the year's weather conditions. The reason is that it is mostly cultivated without irrigation. The following soums have harvested more cereals from 1 hectare than state average as of 2010: Dashinchilen of Bulgan aimag and Ugtaaltsaidam of Tuv aimag. The potatoes and vegetables are cultivated with irrigation and higher-than-state-average crops were harvested in Altanbulag and Bayan-Unjuul of Tuv aimag in 2010. In some soums harvest volume was low like 13.9 and 18.5 centners. Also, there were harvested over 70 tons sea-buckthorn and 9.5 tons of blackberries.

The basin supplied 6.9% of Ulaanbaatar City potato demand and 3.4% of vegetable demand in 2008 and it's increased to 18% of potato demand and 7% of vegetable demand. It is effective to increase the vegetable production in this region.

Between 2005 and 2010, 17 irrigation systems with capacity of 800 ha were rehabilitated and built with state investment in the Tuul River Basin (Table 42).

Table 42. Irrigation systems of the Tuul River Basin, 2010

№	Location		Name of irrigation system	Area, *ha*
1	Tuv	Sergelen	Uvurbayan Ulaan	60
2			Uguumuriin am	100
3			Khushigiin khundii	10
4			Bayanburd	10
5		Altanbulag	Akhmad	9
6			Bayariiin sanaachlaga	10
7		Bayantsogt	Dund urt	57
8			Guna	70
9		Argalant	Sagsai	55.6
10		Ugtaaltsaidam	Manz	150
11	Ulaanbaatar City	Khan-Uul	Turgenii goliin adag	75
12			Munkh-Undarga	90
13			Songinii mod urjuuleg	43
14			Songinii mod urjuuleg	22
15			Batiin	3
16		Bayanzurkh	Gatsuurtiin bayantuhum	8
17			Artsat	22
Total				794.6

Development trends of farming. The Government of Mongolia is following a policy to supply the population food demand, food security, grains and vegetables in the country. The policy is being implemented successfully.

Although this basin is located in the Khentii mountainous region and it is possible to cultivate crops, regional desertification has been noticed in recent years. This is due to climate change. So, in order to have a reliable harvest, it is required to develop irrigation. The irrigation is required to develop farms of potatoes, vegetables, fruits, and trees. The Ministry of Food, Agriculture and Light Industry has set a goal to increase the irrigation area and make it to the level of 1990.

In 1990 there were some 30 irrigation systems with capacity of over 2 thousand ha engineering irrigation in the Tuul River Basin. It will be possible to increase the irrigation area to the level of 1990 only when maintaining these irrigation systems. There are 66.9 thousand hectares of crop area in the basin and some 20% is used.

The Ulaanbaatar region development program aimed to develop ecological clean technologies based on livestock and crop row materials. The Tuv aimag development program planned to increase wheat production to the 20% of total wheat production of Mongolia. Moreover in the development program aimed to complete irrigate vegetable area and to define irrigation development zone and in 2023 to reach irrigated are to 2500 thousand ha. But the use of irrigation field in Tuv aimag is 45.1 percent and it indicates that it is important to repair and use old irrigation systems very soon.

According to the National Security Concepts of Mongolia, in the future it is needed to decrease the ground water usage by irrigation and industry and to increase surface water use; to develop flow regulation by building dams and reservoirs, and collecting rain water and snow.

3.7. Industry

Tuul river basin is the region where industries are most developed in Mongolia. The industrial concentration is high in Ulaanbaatar City and in other aimags the concentration is mainly in the aimag centers. In soum centers, there are small industries that supply the local area.

In 2010, in Ulaanbaatar City were produced MNT 1914.5 billion industrial products and sold MNT 2187.3 billion industrial products at current prices, which increased industrial output by 47.4% and sales by 57.9% compared to 2009 [20]. The industrial sector employed 26.3 thousand people. Recently, the industrial output and sales of Ulaanbaatar are growing rapidly. In 2010, share of the export to the sales reached to 56.6% compared to 38.2% in 2008. Main reason for growth of the industrial outputs is the growth of mining and quarrying, milk and dairy production, flour and chemical production.

In 2010, the entities of Tuv aimag made the products of MNT 7457.5 million at current prices and of MNT 3847.6 million at constant year prices of 2005, which is decreased by 12.8% from 2008 The reason is that decrease of the alcohol and beverage production, milk and dairy production and mining and quarrying. There is a high chance of losing possibilities to sell the products in the case that competitiveness is insufficient although the entities' location is good in terms of economy. Over thousand people worked in the industrial sector in Tuv aimag.

3.7.1. Light and Food Industries

Agricultural raw material processing industry

Tanneries and leather industry. Tanneries sector produced 8% of GDP and constituted 15% of total jobs in 1992. However, in 2001, the production reduced and the employment decreased to 1% of total employees.

In 2001, in order to support tanneries sector and increase processed products' export The Government of Mongolia approved "Leather" program by the resolution number 114. As result of the program is tanneries manufactured some MNT 360.7 million products in Ulaanbaatar city and MNT 140.8 million products at constant prices of 2005 in Tuv aimag in 2010.

In tanneries sector, there are some 40 industries which have a capacity of processing 9.2 million skins a year and some 200 small industries are operating that manufacture end products. Only three of them are located in rural area and the rest is in Ulaanbaatar. Some 35 industries do first processing; 5 industries for deep processing; 4 industries for processing furry skins; 8 industries for leather boot manufacturing; 180 industries for leather products and clothes; 4 industries for leather and furry clothes; research center and one technological wastewater treatment plant.[5]

Tanneries and raw material processing industries use some 30 kinds of chemical substances for the technology, which have become one of the causes of water pollution. The tanneries in Ulaanbaatar city are supplied from the central network and their wastewater is treated by "Khargia" wastewater treatment plant. The "Khargia" wastewater treatment plant was established in 1972. The capacity of the wastewater treatment plant is 13000 cubic meter per day. At present, the wastewater treatment plant treats 7000-8000 cubic meter water per day. Due to old equipments, the WWTP supplies high-level wastewater to the central pipelines since it is not capable of doing it. It increases the Central wastewater treatment plant's load. Also it is one of the sources that pollutes Tuul River.

5 "Social economic development of Mongolia in 2009" NDIC, UNs population fund

In order to reduce pollution in tanneries' industrial wastewater, first processing industries participated in the assessment of environmental impact. In addition, nature friendly technology and equipment are being introduced. "Mongol Shevro" and "Darkhan nekhii" companies' tanneries involved in the project "Introducing clean industrial method". In result of these their industrial waste decreased 2-5 times.

In the framework of "Program for great construction and mid-term goals" from 2011, detailed survey will be conducted in industries that cause environmental pollution. Some of the industries will be moved from Ulaanbaatar city. Also, it is necessary to include in the IWRM plan that new technologies need to be introduced which treat wastewater.

Wool and cashmere processing industries. This sector is one of the main sectors which produce export products. Mongolia is capable of processing 32.4 thousand tons of wool and cashmere a year. Some 68.2% is sheep wool; 20.5% is cashmere and 11.3% is camel wool and other stuff.

The wool and cashmere production is developing rapidly due to high global demand. The wool and cashmere sector produced MNT 169.2 billion products or 3.6% of industrial sector in 2010. MNT 135.6 billion products were made in Ulaanbaatar city. MNT 42.1 million products were made in Tuv aimag.

At present, some 54 industries are operating in the sector. 6 of them have domestic investment and remaining 48 are joint venture companies with foreign investment. Some 9 of the industries are textile ndustries and 44 are first processing industries. Some 5 of the industries are in rural areas and 48 are in Ulaanbaatar city. Some 4.2 thousand people are working in this sector. The big industries of the sector are as follows: "Govi" company, "Goyo" Co, Ltd, "Altai cashmere" Co, Ltd, "Sor cashmere" Co, Ltd and "Buyan" company. Some small industries of the sector closed due to the 2008-2009 global economic crisis. The following big industries are also operating in Ulaanbaatar city: "Monmyandas" Co, Ltd; "JJ Khuvsgul Knitting" Co, Ltd; "Selenge Knitting" Co, Ltd; "Cashmere fine-Asia" Co, Ltd; "Monnoos" company; "Eermel" company; "Novanooluur" Co, Ltd and "Ulaanbaatar Carpet" company.

According to monitoring by GASI, the wool-washing industries discharge its wastewater to the central sewerage network. In addition, the industries used different type's water filters with small capacity. There was no solution which equipment to use in which industry. Some 70-80% of the industries did not meet the industrial wastewater requirement to supply to the central pipelines. The pollution level is 5-8 times higher than standard level. As for the IWRM plan, attention should be paid to introduce nature-friendly technology, which treats wastewater to the standard level and reuse water in the raw material processing industries. Moreover, the introduction of financial and economic incentive is important.

Other sectors of the light industry

Garment industries: Garment industry is one of the biggest industrial sectors of Mongolia. It produced 35% of industrial sector's GDP and constituted 55% of employees in 2001.

The Government of Mongolia approved the program and started implementation of the program "Developing production of garment products" in 2003 in order to increase the production of sewn products; increase export volume and supply population needs by domestic products. The sector's export amount was USD 17.9 million in 2008. In 2010, the amount was reduced 30 times and reached USD 589.6 thousand. As for the sector's employees, there were 4.7 thousand employees in 2007, which decreased 3.1 times and reached 1.9 thousand in 2010. They produce and supply following things in domestic market: labor clothes, uniforms of police officers and firefighters, yurt cover and student

uniforms. There is a large demand in domestic market, but production not increased due to financial possibilities and lack of material availability.

There are some big industries in Ulaanbaatar: "IKOS" Co, Ltd; "Temujin mench" Co, Ltd; "Anar Teks" Co, Ltd; "Suljee" company and "Borte". In 2010, Ulaanbaatar's industries produced MNT 2718.2 million garment products at current prices and MNT 154.5 million garment products produced in Tuv aimag.

Wood working industries. This sector produced MNT 6605.5 million products in Ulaanbaatar MNT410.0 million products produced in Tuv aimag at current prices in 2010. The sector supplies construction door, window, floor, furniture, yurt wooden frames and furniture to the domestic market.

Some 300 entities are operating in the sector of wood preparing and processing industries. Of which 90 are located in Ulaanbaatar and about 3 thousand people work there. Mongolia's furniture import amount has increased in recent years and reached USD 20 million in 2008 and USD 17.7 million in 2010, which shows domestic industries can increase their production.

The Government of Mongolia approved and started to implement action program of "Restoring wood processing sector and solving unemployment and social problems of the sector" in 2000.

Paper, paper production and publishing industries: Some 220 entities have been registered, from which over 90% are located in Ulaanbaatar and some 4 thousand people are working there. About 20% of them are fully equipped big industries.

Some 30% of the publishing products are textbooks; 20% are newspapers and magazines; 15% are commercials and 10% are packages and labels. In 2010, there were produced MNT 15.8 billion products in Ulaanbaatar city. The production of paper products reached MNT 8.8 billion at current prices in 2010.

Other productions: In recent years, the tobacco industry is developing in Mongolia. In 2010, MNT 36.5 billion products were produced in Ulaanbaatar city. It increased by 2.9% compared to the previous year and covers 5.4% of manufacturing.

In current year, the liquid fuel, chemical, coke and rubber industries produced MNT 30.9 billion products at current prices, this was 50.8% of the manufacturing.

Food industries

As of 2010, there were manufactured MNT 398.7 billion products by food industries in Ulaanbaatar city and MNT 0.3 billion products in Tuv aimag.

Ulaanbaatar: In 2010, from total food products manufactured by Ulaanbaatar some 7.3% or MNT 29.0 billion of milk dairy production; 7.8% or MNT 31.2 billion of meat production; 19.4% or MNT 77.5 billion of flour and pastry production; 54.2% or MNT 215.9 billion beverage production and 11.3% or MNT 45.0 billion products in other food production (See Table 43).

Table 43. Food production of Ulaanbaatar city in MNT million, at current prices

Products	2006	2007	2008	2009	2010
Milk, dairy products	2 689.7	5 722.1	14 281.8	20 087.3	29 026.7
Meat products	7 584.2	8 749.4	24 665.6	33 339.7	31 240.0
Flour	16 216.6	32 183.0	50 708.7	67 116.0	77 514.8
Beverage /including alcohol/	29 592.1	51 652.1	86 080.0	131 597.6	215 943.6
Other food products	25 260.2	28 038.2	43 305.4	46 126.0	45 031.5
Total	**81 342.8**	**126 344.8**	**219 041.5**	**298 266.6**	**398 756.6**

Flour and flour products are playing an important role in the food consumption of the Mongolians. In 2010, 127.1 thousand tons of flour and 26.9 thousand tons of flour products were produced in Ulaanbaatar city. Some 70 industries are operating in Mongolia with a capacity of manufacturing 380 thousand tons of flour. They include "Altan taria" company, "Ulaanbaatar flour" Co, Ltd, "Dornod flour" Co, Ltd, "Atar urguu", "Uguuj chikher boov" and "Talkh chikher" Co, Ltd. In addition, there are some 300 small and medium industries that manufacture flour products.

In 2010, 11.3 thousand tons of meat and meat products processed in Ulaanbaatar city. There were registered 32 slaughter industries with a capacity of processing 85 thousand tons of meat a year on average. Some 18 of them are operating regularly. Some 1.3 thousand people are working there. There are some big industries in Ulaanbaatar. They include "Makh impex" Co, Ltd; "Dorniin govi" Co, Ltd and "Just" group. In addition, 100 small and medium industries are operating in Ulaanbaatar city. The sector exports beef, mutton, horsemeat, pet food and canned meat products.

In 2010, there were produced 16.9 million liter milk and dairy products in Ulaanbaatar city that was increased by 69% from previous year. There are 90 industries in Mongolia with a capacity of processing 220 thousand tons of milk per day. About 20 of them operate regularly and use 40% of the capacity. The biggest industry is "Milk" Co, Ltd with 350 employees. Some 60 small and medium industries are operating.

In 2010, 16.8 million liter of alcohol and 67.6 million liter of bottled water and beverage were produced in Ulaanbaatar city. Most aimags have beverage industries. There are 15 alky, 93 alcohol, 21 beer and 14 wine industries with special permission in our country. About 40 alcohol and alky industries are located in Ulaanbaatar city. The following industries have more than 100 employees. They include "APU" company; "Mon-Erdene" Co, Ltd; "UFC" Co, Ltd and "MCS Coca Cola" Co, Ltd. 100 small and medium industries operate in Ulaanbaatar city.

Tuv aimag. In 2010, there were produced MNT 257.8 million of food products at current prices in Tuv aimag. From total food production some 13.2% or MNT 33.9 billion milk and dairy products, 0.6% or MNT 1.5 million flour and flour products, 15.6% or MNT 40.1 million beverages, water and beer products and 70.7% or MNT 182.3 million other food products.

As of 2010, there were produced 183.2 tons of bread, 8.7 million liter of alcohol and MNT 17.5 million of milk (at constant prices of 2005). The beverage industry of the aimag did not function since 2009. In addition, alcohol production declined due to poor competitiveness in the market.

Future Trend of Light and Food Industry

The Mongolian MDG-based Comprehensive National Development Strategy aims to develop economy of Mongolia based on nanotechnology, transit transport, logistic networks, and mining and agricultural product industry. The Government of Mongolia approved "Industrialization program of Mongolia" by the 299th resolution in 2009. The main objective of the program is: to increase competitiveness of Mongolia through developing processing industry with high-tech equipment that is based on domestic raw materials and sources.

The Government of Mongolia approved the policy document "The trend to develop industries in local areas" in June 2009 by the 178th resolution. By implementing this project, 900 industries and factories will be constructed in aimags between 2009-2012 and about 9.9 thousand people will be employed (see Table 44).

Table 44. Planned major industries at local area

Industry	Bulgan	Uvurkhangai	Tuv	Ulaanbaatar
Fatten livestock	+		+	
High breeding livestock farm	+		+	
Milk processing plant (per soum)	+	+	+	
Milk cooling center, point	+	+	+	+
Milk farm with 50 cows	+	+	+	
Fodder farm and plant		+	+	
Greenhouses (in all soums)	+	+	+	
Vegetable processing plant			+	
Warehouse for keeping potatoes and vegetables				+
Greenhouse center				+
Fruits and berries processing plant			+	
Salt factory			+	+
Starch plant			+	
Poultry farm (construct and expand)	+	+	+	+
Service center (aimag, soum center)	+	+	+	
Wool washing and felt plant	+	+	+	

Source: Government resolution number 178, 2009

The Mongolian policy on food sector focuses on increasing productions and improving food products' quality and safety in the framework of regional development of economy. The Government of Mongolia started developing "National Food security programme" since 2009. By the year of 2012, the products of food processing industries will be increased by 30% than that of 2007. The processed meat production will be increased by 35% or will reach to 50.0 thousand tons and meat export will reach to 20.0 thousand tons. By the year of 2016, the milk amount that processed by industry will be increased 2 times than that of 2012 and the meat export will reach to 38.0 thousand tons. More than 60% of meat products for the population will be processed by the industry. The following things will be produced in Mongolia: eggs a 100%, 20% of butter; 25% of fish; 15% of the fruits; 5% of rice and less than 40% of vegetable oil. The implementation period of the program is 8 years and it will cost USD 780.98 million. From sum some 39.5% is from state and local government budgets; 45.7% is from private sectors and 14.8% is from foreign aid and loans.

The following will be done in surrounding towns and villages of Ulaanbaatar and TRB: support the establishment of small and medium industries that process vegetables; constructing industries that process skins and manufactures knitted products; improving technologies and equipment of cashmere industries. The Tuv aimag's development program planned following: every single household will be a manufacturer; start the movements "1 household-1 product", "1 bag-1 product" and "1 soum-1 product" for the purpose of creating a brand product for each soum.

The objectives of the Tuv aimag's development program are: start the movements of "One Household-One Product", "One Bag-One Product" and "One Soum-One Product" in order to create brand products for each soum; support projects and programs in order to expand production of aimag brand product.

Table 45. Planned industries in the regional and aimags' development program

Capital, aimag and soums	Planned industries
Arkhangai	
Khashaat	Create competitiveness brand production; Establish meat, wool, cashmere and skin processing small and medium enterprises; Develop mining, light and food industry, tourism and irrigated crops in Ugii region
Bulgan	
Buregkhangai	Small industry of flour; milk processing plant
Bayannuur	Food industry and vegetable, fruits and berries processing plant, sea-buckthorn processing plant and patent fuel
Gurvanbulag	Milk processing plant; patent fuel; service' center; salt plant
Dashinchilen	Model-meat industry, fatten livestock, meat processing complex; milk processing plant; Food industry and vegetable, fruits and berries processing plant; patent fuel; service' center
Rashaant	patent fuel; water bottling plant
Uvurkhangai	
Burd	Creation brand product related to One town-one product program; support small and medium industry
Selenge	
Orkhontuul	Support small and medium industry; agricultural raw material processing plants
Tuv	
Argalant Bayantsogt Bayankhangai Bayan-Unjuul Zaamar, Lun Undurshireet Ugtaal, Sergelen Erdenesant	Develop small and medium industry: - Agricultural raw material processing plants with new technology, - Shoes, fur and felt factory, garment factory, and support small and medium light industries - Creation brand product - Food industry - Service' center
Zuunmod	"Zuunmod" development complex: - Factory for processing cosmetics, perfume and enzyme products from animals raw material; - Information technology; - Biotechnology; - High quality leather, cashmere and garment production industry
Ulaanbaatar	
Districts	Patent fuel plant; support garment industry and improve technology; in towns and villages develop vegetable, fruits and berries processing plants, first processing industries of wool and cashmere, garment factory, to move tanneries and iron factories from center of Ulaanbaatar to Baganuur and Bagakhangai, develop food and light industries with high technology
Nalaikh	"Nalaikh" Business complex: milk processing, flour and pastry factories, slaughter house, meat processing plant, fish and vegetable processing plant, patent fuel, iron casting factory, support small coal plants of Nalaikh; expand brick plant
Emeelt-Argalant	First processing factories for wool, cashmere, leather and skin, logistic, trading, small and medium industries for food
Tuul-Shuvuu	Poultry and pig farms, greenhouses, small and medium industries for food, сав, packing industry, service
Bio-Songino	Livestock medicine factory, sanatorium, nano-biotechnology
Ulziit	Potatoes, vegetable cropping and vegetable, fruit and berries greenhouses
Gachuurt	Recreation
Aero-city	Airport, information technology, trade service, business center, logistic
Student city	Universities and colleges, services

3.7.2. Heavy industry

In Mongolia, mining is developing rapidly, but the number of heavy industries is low. There are some 10 metal processing and maintenance industries in Mongolia. There are

also 50 factories and plants and 314 service centers related to the metal and automobile maintenance. In Ulaanbaatar, there are some maintenance factories. As of 2010, metal processing sector produced MNT 1580.7 million of products in Ulaanbaatar city and 61.4 million MNT of production in the Tuv aimag.

3.7.3. Mining and quarrying

The mining sector is one of the rapidly developing economic sectors of Mongolia. As of 2009, 170 research and 120 use licenses were delivered in the basin. Some 220 licenses were delivered in Ulaanbaatar city. Recently in the TRB located about 30 gold mines, 36 gravel and asphalt plants, 19 brick factories. About location of the licensed area please see Figure 44.

Tourism and agriculture are the basic economic activities of the Gorkhi-Terelj natural park. It is located in Erdene soum area of Tuv aimag. Most part of the territory belongs to the Khan Khentii protected area and mining activities do not exist there. There is one chalkpit in the territory of Erdene soum. The Nalaikh coalmine is located in Erdene soum as well.

There are many sandpits and pebblepits in the territory of Altanbulag soum of Tuv aimag and, they have huge negative impact on environment. For example, green area is decreasing and high dusting.

The gold mines are located in Zaamar soum of Tuv aimag and Buregkhangai soum of Bulgan aimag. The Zaamar area mines are having a negative impact on Tuul River and pollute the river. As of 2009, about 30 organizations and entities were operating in the gold-mining sector. The entities and organizations except Monpolimet did not do rehabilitation at the required level (see Figure 44).

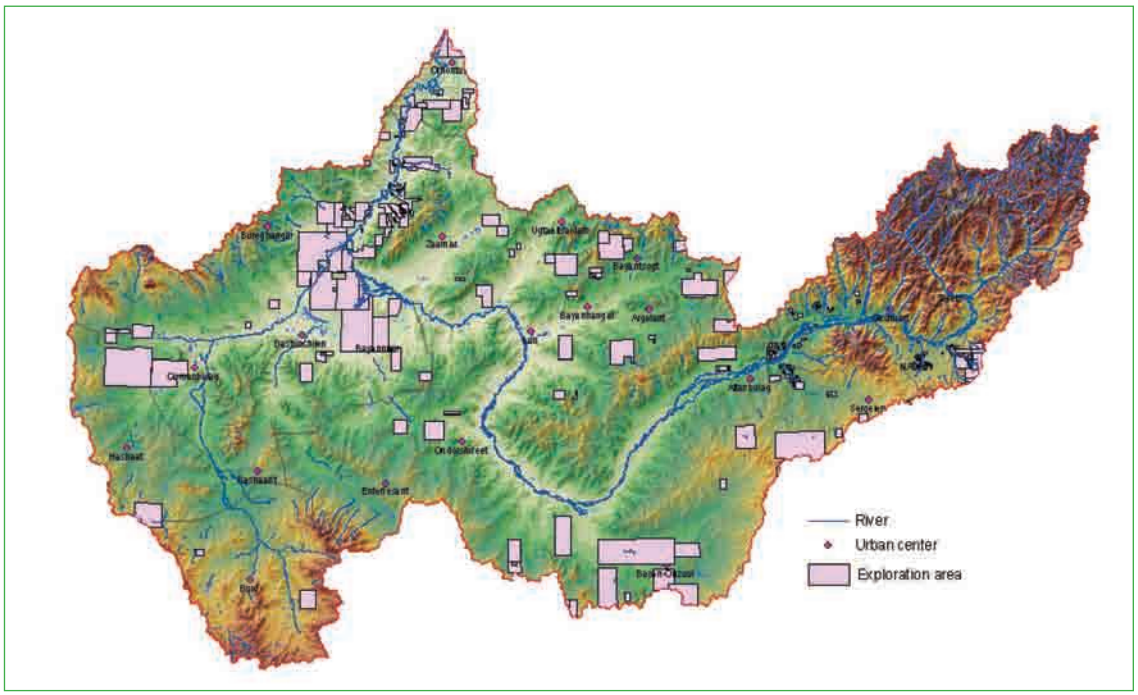

Figure 44. Exploration area in Tuul RB

The mining production occupies some 20% of Tuv aimag's industrial products and over 50% of Ulaanbaatar city productions. The mining sector employed about 50% of industrial employees. The sector's production statistic information include by entity's belonging not by location.

In Mongolia, mining is developing rapidly, but the number of heavy industries is low. There are some 10 metal processing and maintenance industries in Mongolia. There are also 50 factories and plants and 314 service centers related to the metal and automobile maintenance. In Ulaanbaatar, there are some maintenance factories. As of 2010, metal processing sector produced MNT 1580.7 million of products in Ulaanbaatar city.

The following is planned in Tuv aimag's development program: to use natural resources mines without implicating heavy damage; increase citizens' participation; constructing entities by local area investment; developing heavy industrial sector; developing master plan to renew the structures of aimag's mineral resources sector and keep the growth of mining production. The Ulaanbaatar regional development program planned to establish an iron melting factory and the Bulgan aimag development program planned to prepare feasibility study of the oil shale deposit of Zuunbulag of the Khashaat soum.

3.7.4. Energy

In 2010, some MNT 169.0 billion electricity and thermal energy were produced at current prices in Ulaanbaatar city and it was increased by 15.2% compared to 2009. It distributed 3173.9 million KWh electricity and 5.1 million Gcal thermal energy. Ulaanbaatar city has good energy supply and energy demand is increasing due to migration and increasing services and industries.

Table 46 shows the central region energy and electricity supply and demand. In Ulaanbaatar, sometimes energy transmitting capacity lacks in ger districts and city center. In terms of technical capacity, it is getting difficult to supply big energy consumers in the city center. It means that consumers need to be supplied with nature-friendly, cheap and reliable energy. The concession list includes the projected fifth thermal energy station with 450 MW capacity.

Table 46. Electricity and thermal energy

Products	unit	2006	2007	2008	2009	2010
Electricity energy	mill.KWh	2518.9	2678.3	2924.5	3381.8	3650.2
Thermal energy	thous. Gcal	4654.8	4771.8	5024.1	6365.9	6435.8
Electricity and heat production	MNT mill. at current prices	95945.9	102509.2	127317.8	146267.9	168994.8

The soum centers of the basin are connected to the energy network. Ugtaal, Argalant and Zaamar soums have a connection to central heating pipelines. Other soums' entities supply from small size heating stoves. In total 50% of nomadic families use solar and wind energy. It is important to expand the renewable energy use in our country.

The thermal power plants use much water and technical water is used for technology, cooling and auxiliary facilities. The thermal power plant number 4 is the main energy producer of the central region energy system. In 2009, it used 10.4 million cubic meter water and water loss was 14.4% in 2000. The water loss was 6.5% in 2009

The fourth thermal power plant is decreasing its water loss according to the survey. The influencing factors of water loss are old pipelines and it is not fully metered (water use is not fully connected to water meter). New technologies need to be introduced in order to decrease water loss of thermal power plants.

3.7.5. Construction and construction materials

As of 2010, the construction sector produced 1.7% of GDP and MNT 350.8 billion of construction works and major maintenance works were done. Some 308 entities of Ulaanbaatar city constructed MNT 239.9 billion of buildings and houses. 34.4% of total

construction works are apartment blocks; 28.1% are other-purpose buildings and 37.5% are engineering constructions. About 130 apartments for 42.0 thousand households were constructed between 2000 and 2010. Moreover, 7 industrial-purpose buildings; 32 trade and service buildings; 70 office, hospital, education and cultural buildings; 67 engineering and 27 other-purpose buildings were constructed.

Some 17 entities and organizations of Tuv aimag did 7372.3 million MNT worth of construction works in 2010. 154 apartments; 15 trade, service and industrial buildings; 89 kiosks/boreholes; 10 farmer houses and 29 other buildings were constructed. There are 72 entities with permission to manufacture construction materials. About 50 of them are in Ulaanbaatar city. There is a steel wire industry in Altanbulag soum of Tuv aimag.[6]

The following construction materials were produced in Ulaanbaatar city in 2010: 1.5 thousand tons of chalk; 42.9 thousand tons of cement; 33.0 thousand cubic meter concrete mix; 1.7 thousand cubic meter concrete; 18.4 million pieces of bricks; 17.4 tons of hardware and 68.1 thousand pieces concrete materials. 100.5 thousand tugrugs worth of iron materials were produced in Tuv aimag.

3.8. Services and Public Utilities

3.8.1. Housing and Public Utilities

The Ulaanbaatar Water and Sewerage Authority and the Housing and Communal Service Authority are responsible for the Ulaanbaatar city water supply and sewerage. There are 3 companies and 17 kontors in the Housing and Communal Service Authority. In addition, 33 private companies with special permission operate in the field.

According to the report of USUG of 2010, 52.1 million cubic meter water was extracted and 43.1 million cubic meter water was distributed in Ulaanbaatar city. In 2006, water loss was 27.1% and it was 17.2% in 2010. The volume of water extracted decreased by 3 million cubic meter and water distribution decreased by 0.1 million cubic meter compared to 2008 (Table 47).

Table 47. Extracted and distributed water and treated wastewater in million m^3/year

Types	2006	2007	2008	2009	2010	2010/2009, %
Extracted water	55.4	56.3	55.1	52.9	52.1	98.5
Distributed water	40.4	41.9	43.2	43.8	43.1	98.4
Water loss %	27.1	25.6	21.6	17.2	17.2	100.3
Waste water treated by central WWTP	55.9	55.2	54.9	53.7	54.0	100.6
Supplied waste water by pipelines	39.1	41.0	42.6	41.3	42.1	101.9
Waste water calculation loss %	30.05	25.72	22.40	23.12	22.08	95.5

Source: Report of USUG-2010 and 2011

Of the water supplied by the Ulaanbaatar Water and Sewerage Authority 77.3% is used for population drinking water and 22.7% for organizations and entities. The number of people who live in apartments increased in the last few years. But, water demand did not change much which is due to installation of water meters and increased water price. The ger district water demand did not increase due to unsolved wastewater issues, water carrying time and population water-keeping capacity.

In 2010, the Ulaanbaatar Water and Sewerage Authority increased the water price by 35% (VAT included). Due to this, the amount of water used by one person decreased from 261 liter to 230.8 liter. The water price sensitivity was -0.33 (Figure 45).

6 Data from ALACGC

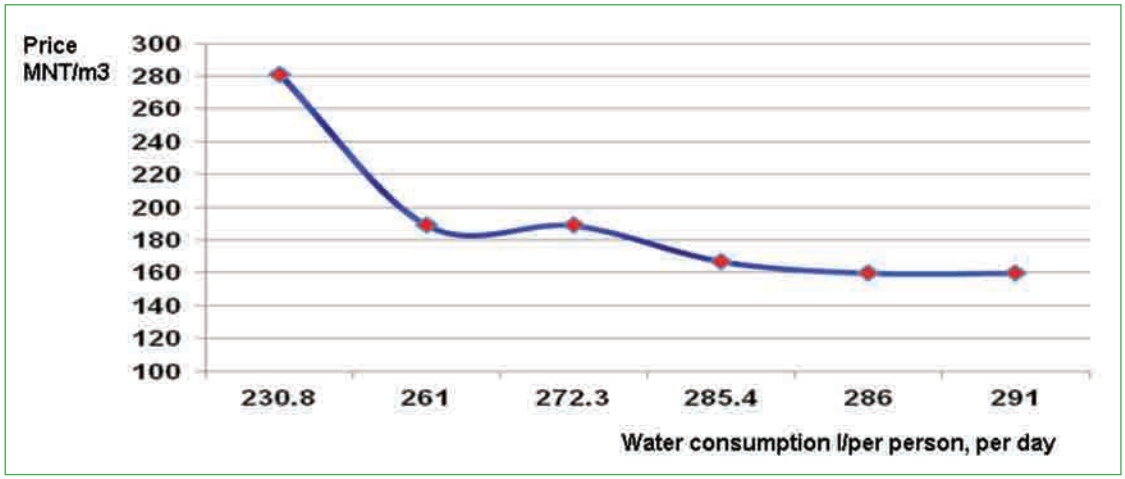

Figure 45. Drinking water demand of apartment households

The Ulaanbaatar Water and Sewerage Authority and Housing & Communal Service Authorities are operating at a loss although the Government has taken some measures on water supply and sewerage. One of the reasons is water cost and tariff system. It should be renewed.

As for basin aimags and soums, Zuunmod, Erdenesant, Rashaant, Orkhontuul and Khailaast towns have water supply and sewerage central systems. Moreover, following companies are operating in the field of water supply and sewerage services: Tuv chandmani in Zuunmod soum; Tuuliin Khishig in Orkhontuul; "Mongol alt" Co, Ltd in Khailaast village of Zaamar soum. Those places have central system of water supply and sewerage. However, wastewater treatment level is too low.

Some 37% of the population living in the Tuul river basin is connected to a central water supply and sewerage system as of 2008. It was 37.7% in 2010. 99.0% of them live in Ulaanbaatar city. As of 2010, 62.5% of Ulaanbaatar population and 60.5% of the Tuul RB population are connected to a central system. The Tuul River basin drinking water supply connection is presented in Table 48.

Table 48. Population connection to the drinking water supply in the TRB

Drinking water supply source		2008		2010	
		thous. people	Percentage,%	thous. people	Percentage, %
Connected to central system	Apartments	407.1	37.1	448.8	37.7
	Kiosks	233.6	21.3	271.5	22.8
Kiosks by transport		208.7	19.0	229.2	19.2
Protected boreholes and springs		12.3	1.1	15.2	1.3
Other sources		236.6	21.5	226.6	19.0
Total		**1098.5**	**100**	**1191.3**	**100**

Public bathhouse: There were 336 public bathhouses in basin aimags and soums which have a capacity to serve 2.1 thousand people in one session as of 2010. If they use current capacity, they are able to serve 12.1 million people a year.

According to the survey of Health Department of Ulaanbaatar, 20% of Ulaanbaatar city ger districts inhabitants take a shower once a week; 12% once in 1-2 weeks time and 81% of households takes shower over a week. On average, ger district person takes a shower once in 2 weeks. The bathhouses of the basin aimags and soums supply only 50-60% of the population sanitation needs.

According to some survey about shower, per person uses 60-180 l water when takes once shower and if they using water safety technology 27-99 l once per person. Based on these results the Mongolian norm needs to be renewed since many technologies that decrease water loss are being introduced.

Future development trend of sector

The Government of Mongolia approved "Millennium Development Goals based-Comprehensive National Development strategy" by the 12th resolution of 2008. According to the third strategic objective of the 5th propriety strategy of Mongolia's development; "Water National Program" will be developed and implemented. In 2010, the Government of Mongolia approved "Water National Program" and started its implementation in 2010. If the program is implemented successfully, we will have possibility to implement some 50 complex measures and invest MNT 2 trillions.

As reflected in the "100000 apartment blocks" program, 75-80 thousand household-apartment blocks will be built in Ulaanbaatar; 25 thousand household-apartment blocks will be built in aimag centers and main cities of the regions. Some 22 ger districts of Ulaanbaatar city will be involved in the program "Turning ger districts into apartment districts". If this program and objectives reflected in Ulaanbaatar city Master plan are achieved successfully, 80% of Ulaanbaatar city population will be living in apartments by the year of 2020.

There are 33 projects related to water supply and sewerage sector in the concession list. It will increase the private sector participation. 26 projects out of 33 will be implemented in Tuul river basin.

Services

200 entities are operating in this sector and 1.2 thousand people are employed there. According to the 2007 survey, some 60 thousand people are working in the service sector. In addition, about 98% of the sector's activities belong to the informal sector.

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

There are some 60 laundries and dry cleaning in Ulaanbaatar. The laundry services and dry cleaning places mostly connected to central water supply and sewerage networks.

Beauty and hairdressing services: Beauty and hairdressing services occupy most of the service organizations. There are some 500-beauty and hairdressing service places in Ulaanbaatar. There are some 89-service spots in Zuunmod soum and 84 of them are private.

Car wash: The car wash is one of the services that pollute water a lot. For the last few years, living standard of the Mongolians is growing and number of cars has rapidly increased. As of 2010, there were 254.5 thousand cars in whole country and 64.0% or 162.7 thousand is in Ulaanbaatar city. For the basin aimags, there were 3.3 thousand cars. Total number of the cars in the basin aimags is 166.0 thousand cars.

Some 40 car washing centers officially operate in Ulaanbaatar. The car maintenance centers do car washing as well. The registered car washing centers are generally connected to central systems and have water meters. However, some people are illegally washing car and do not use the water meter and discharge wastewater directly to the soil, which is become one of pollution sources of environment.

It is difficult to define water use for car washing and there is no water use norm. It was defined as follows based on surveys in Ulaanbaatar. 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 small size car. Some 80-100 liter water is used for big car. According to the survey conducted in United States in 2002, 28-38 liter water is used for small size car; 57-76 liter for medium size cars and 95-114 liter water for big cars. The results are close to each other. In warm season, car is washed 2-4 times a month on average and 1-2 times in winter. In 2010, 159.3 thousand cubic meter water a year has used in the basin, if the calculation is as follows: 40 l water is used for per car on average and it is washed 2 times a month. Although the use is low, polluting level is high.

Shops, hotel and restaurant services: Some 370 thousand people employed. It is one of the important economic sectors. As of 2010, there were 15.0 thousand shopping centers and 800 hotels and restaurants in Ulaanbaatar. As for basin aimags, there are 100 shopping centers, hotels and restaurant services. The hotels and restaurants in aimag centers are connected to central network, but in soum centers, they are supplied from kiosks and boreholes.

Public administration organizations: There are some 300 organizations and 76.0 thousand people work there.

3.9. Green area

According to Ulaanbaatar statistic data, there was 7139.3 thousand square meter gardens and 3625.9 thousand square meter lawn area and 2828.1 thousand trees in Ulaanbaatar. There was 2.5 hectares green area in Zuunmod soum in 2008. In 2010, there was no registered green area in the area. Some parts of the gardens and lawn area are watered by special systems and some parts are watered by some kind of equipment of the organizations.

3.10. Tourism

The tourism sector is developing intensively in the Tuul River Basin and it is the main place where the tourists pass through. As of 2010 data of MNET, some 70 tourism organizations were in business of which 67% is located in the Khan Khentii special protected area. The capacity of the tourist camps is receiving 4000 people a day. 90% of the tourist camps operate in a seasonal cycle.

The following tourist attractions are located in the basin, they include: Bogdkhan mountain, Gorkhi, Terelj, Janchivlan, Elsen tasarkhai, Khugnukhan mountain, Khustai, Rock paintings of Ikh tengeriin am, Hun-era tombs of Belkh area, Tombs of Songino mountain, Rock paintings of Gachuurt, Rock paintings of Nukht, Palace ruin of Tooril khan of Khereid, Bogd Khaan Palace museum, Choijin lama temple, Geser temple, Dambadarjaa monastery, Megjid Janraisag monastery and Gandan monastery. These are the basis of tourism development.

A survey of tourism organizations located in the basin has been conducted in 2009. The drinking water supply and sewerage facilities are important for sustaining the comfort of the tourists. Most tourist camps in the basin have their own boreholes and use pit latrines. As of 2010, Terelj hotel had water supply and sewerage networks and WWTP built by Canadian technology. The big tourist camps like UB2, Tiara resorts and Saran travel, they all have boreholes and a sewage pit. Their waste water is treated by Nalaikh WWTP. The Khustai national park has its own WWTP. It is important to supply tourist camps with a reliable source of drinking water and introducing small size WWTPs.

Sanatorium: Mongolia has about totally 100 spas and sanatoriums, from which only 27 were accredited in 2010. In the TRB located following accredited sanatoriums:

- "Ar Janchivlan" sanatorium and "Takhilt" rehabilitation therapy of Tuv aimag
- Ulaanbaatar: "Orgil" and "Ulaanbaatar" sanatorium and spa center, "Arga bileg", "Amarsanaa gunj", "Saikhan gazar", "EMJJ", "Erdenet khun", "Enkh-Undarga", "Unu-Ekh", "Jargalan" and " Khasu khandgait sanatoriums.

Development trends of the sector

The Government of Mongolia has set goals in the Millennium Development Goals-based Comprehensive National Development Strategy as follows:

- develop the necessary tourism infrastructure,
- build large complexes,
- receive some 1 million tourists by 2015,
- intensify development of the tourism sector and
- improve service quality, and increasing tourist number close to that of Mongolian population in the year of 2021.

The Ministry of Nature, Environment and Tourism has developed a project of program "Tourism" in 2011 to elevate the tourism sector into a leading economic sector by way of developing stable tourism.

The Ulaanbaatar Region Development program aimed to develop tourism to the global market scale and to support sustainable growth GDP of the sector. In the framework of these objectives planned to improve services in the tourist camps and centers, establish high level hotels in the main tourist zones, include Ulaanbaatar region to the international tourism network and develop the national scale tourist center.

The Tuv aimags development program planned to develop tourism to the one main economic sector of the aimag, to set up hotel and tourist camp network, to establish National complex in Manzushir, construct central regions culture and sport center in Zuunmod and to develop tourism to the international level.

To achieve these objectives it is necessary to improve water supply and sanitation situation in the tourist camps and centers.

3.11. Water pricing system

3.11.1. Drinking water and waste water tariffs

In total 30.5 percent of our country's total population is supplied with water from central networks, 35.8 percent is supplied from transported water, 24.6 percent is supplied from kiosks and 9.1 percent is supplied from springs, ponds, rivers, ice and snow water.

According to the survey, a person who lives in a ger district of an urban area uses 8-10 liter water a day on average. This is 2.5-4 times lower than the WHO norm. As for some urban consumers that have a central water system connection, their water use exceeds that of developed countries. This is due to unwise use of water and pipeline leakages.

Urban area water supply, waste water discharge service: A 4-member ger district household uses 30-40 liter drinking water a day. Some 40% is used for cooking, 30% for laundry, 10% for washing bowls and dishes and other needs and the remaining 20% is used for washing hands, face and hair. By installing water meters in apartments, water use is decreasing and getting closer to the developed countries level.

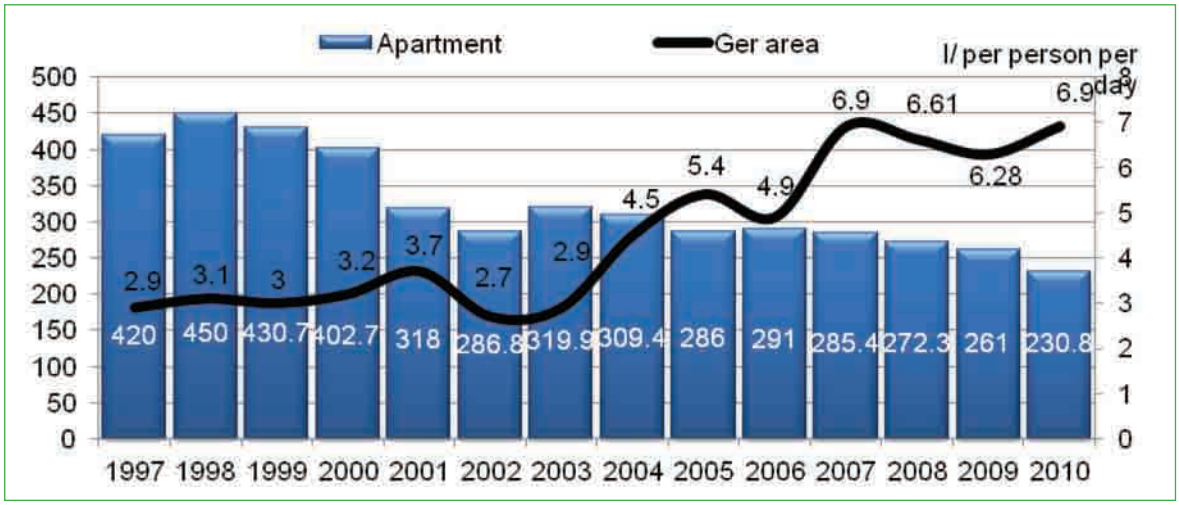

Figure 46. Drinking water consumption per person in Ulaanbaatar City

In 2010, USUG distributed 33.3 million m^3 fresh water to the Ulaanbaatar city population and 9.8 million m^3 water to entities and organizations. In total 732.8 thousand m^3 water per year was supplied to some 293,400 Ulaanbaatar city ger district residents by 60 water trucks and 256 not-connected kiosks; 620.4 thousand m^3 water per year was distributed to 234,000 residents through 301 kiosks connected to the central networks (Table 54). As of 2010, an apartment resident used 230.8 l water per day on average and a ger district resident used 7.9 l water per day on average.

Table 49. Water tariffs of USUG in Ulaanbaatar

Consumer types	Water tariff, *MNT/m^3*				
	2005	2007	2008	2009	2010
Water distributed to industries and service shops by central system	315	329	610	610	882
Water distributed to budget organizations by central system	315	329	610	610	882
Water distributed to domestic needs by central system	160	167	189	189	250.91
Water distributed to apartments with water meters	160	167	189	189	319.78
Water truck- water distribution to organizations that are 10kms away	2435	2435	2435	2435	2435
Water truck-water distribution to organizations that are farther than 10km	2609	2609	2609	2609	2609
Water truck-water distributed to camp area households	2000	2727.27	2727.27	2727.27	2727.27
Water sold at water kiosks	500	909.09	909.09	909.09	909.09
Water transportation to the households	1000	1818.18	1818.18	1818.18	1818.18

Remark: Water price does not include VAT.

The USUG (Ulaanbaatar Water and Sewerage Authority) total sales were MNT 20,719.1 million in 2010. The sales increased by 8.1% or MNT 1,560.5 million compared to the previous year. The water supply earning is MNT 11,644.5 million or 56.2%; wastewater earning is MNT 7,260.74 million or 35%; transported water revenue is MNT 1,255.5 million or 6% and other activity revenue constitutes 2.8% from total sales. The Ulaanbaatar City-owned 21 companies worked at a loss of MNT 1,701.1 million in 2009. In 2010, the loss was MNT 1,938.9 million, an increase of 13.9% compared to the previous year loss.

The water resource use fee is collected from industries and organizations by USUG and OSNAAG's with water service charge. Those fees are collected into the Ulaanbaatar

City State Fund. In 2008, some MNT 239.4 million was collected from industries and entities. Some MNT 50 million of that amount was used for protecting water resources and quality. In 2010, some MNT 458.4 million was collected as water resource use fee. MNT Some 243.0 million was spent on protecting water resources and quality as well as restoration.

The water supply organizations functioning in urban areas outside Ulaanbaatar are:

- ''Tuv Chandmani'' communal services, Tuv aimag;
- ''Chandmani-Nalaikh'' communal services, Nalaikh district of Ulaanbaatar City and
- ''Tuuliin khishig'' in Orkhontuul soum.

These organizations and their water supply boreholes belong to the municipal administration. Table 50 presents the above organizations water tariffs.

Table 50. Public Urban Service Organizations tariffs in 2010

Type of service		Unit	''Tuv Chandmani'', Tuv aimag	''Chandmani-Nalaikh'', Nalaikh	USUG	OSNAAG
Connected to the central system						
Apartment	drinking water (meter)	MNT/m³	650	304	250.91	319.78
	drinking water *(without meter)*	MNT/per person	700	2101	3201.6	3201.6
	waste water *(meter)*	MNT/m³		121	147.0	183.48
	waste water *(without meter)*	MNT/per person	410	897	1465.91	1465.91
Organizations	water	MNT/m³	850	220	852.00	852.00
	wastewater	MNT/m³	690	670	462.00	462.00
Kiosks	to organizations	MNT/m³	-	920	1565.2	-
	to population	MNT/m³	1000	3000	909.09	-
Water transportation						
Water supply (to organizations)		MNT/m³	4500	4000	2609	-
Water supply (to population)		MNT/m³	1500	3000	1000	-
Transporting sewage by vehicle		MNT/m³	-	4400	300	-

Source: ALACGC, www.nc-cudpu.gov.mn

In recent years, water meters are being installed at organizations and apartment households in order to decrease water losses and water wasting. New apartment blocks and other buildings are installed with water meters with the financial aid from state and local budget, private investment and foreign aid. The Ulaanbaatar drinking water and waste water tariffs are much lower compared to other aimags in this region. This is the main factor for the unwise use of water.

Rural population drinking water tariffs: For the soum centers population water supply 1-2 boreholes are used. Some soum center households and companies have boreholes and dug wells within their fences.

According to a survey conducted in 21 soum centers, some 64 kiosks and boreholes are used for drinking water supply of the population. About 20% of the boreholes is operated by salary-paid workers. The monthly salary is between 120 and 150 thousand MNT. The others are rented out. The water distributors' income of the rented-boreholes is between 34 and 280 thousand MNT. Some 60.5% of the distributors have an income lower than the minimum standard of salary due to the low water tariff and less customers. 1 liter water costs between 0.5 and 5 MNT. The most expensive is in Dashinchilen soum of Bulgan aimag where 1 liter water costs 5 MNT for soum population. The reason for the high fee is that water is transported from a long distance due to the small quantity of water resources in the area.

Livestock watering water tariffs: The livestock water demand temporary norm is followed in some soums based on order №153 ''Temporary Norm Approval'' of Nature and Environment minister which was issued in1995.

Table 51. Soum centers livestock water supply tariff

No	Aimag	Soum	Water supply source	Tariff, *MNT/head*	
				Cattle	Goat and sheep
1	Tuv	Argalant	well and river	1-1.5 MNT/liter	
2		Bayankhangai	well and river	6	3
3		Bayantsogt	well and river	20	5
4		Zuunmod	well and river	100	50
5		Undurshireet	well and river	By agreement	
6		Tseel	well	400 MNT/month	100 MNT/month
7		Ugtaaltsaidam	well and river	1 MNT/liter	
8		Erdenesant	well and river	20	2
9	Bulgan	Buregkhangai	well and river	By agreement	
10		Dashinchilen	well	30	10
11		Rashaant	well and river	10	5
12		Khishig-Undur	well and river	7	3

* *Other soums use surface water for livestock watering.*

The livestock water supply source and water tariff are presented in the above table. The livestock water tariffs are different due to surface water scarcity and pasture well abundance. The pasture wells are municipal property and some people can be in charge of these pasture wells within the framework of an owner agreement. The renter is fully responsible for recurrent expenses. The water tariff is established by the resolution of Local Representatives Khural. The standard price for cattle and goat-sheep is set in the soums. It is not possible to estimate the revenues.

The reason is that it works as a discussion among herders. The water tariff is low in areas where there is much surface water. In some areas, the water tariff is not established.

3.11.2. Current situation

The water price in Mongolia consists of a water resource use fee, a 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 charge and water users' are paying a water resource use fee. The water pricing system of Mongolia is presented in Table 52.

Table 52. Water price types and water pricing principles

Type of price	Scope	Principle	Payer
Water and wastewater tariff	Water supply service	Based on costs	Consumers
Water resource use fee	Water use	Pays for the used amount	Users
Water pollution compensation fee	Water quality	Pollution level and quantity (if more than standard)	Users, who discharge wastewater to the environment (more than standard)
Subsides	Water supply service, investment and others	If water supply organizations work with losses or do not have sufficient funds	State budget or 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 the 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 compensate 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 herders' 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% or more must be spent in order to protect and rehabilitate water resources. The local area administration should allocate some amount of money for the activities to protect water and rehabilitate resources. But, that amount of money is not spent in a useful way.

For example: water resource use fee income reached MNT 4.72 billion in 2010 and MNT 1.1 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 2012-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, mainly the direct subsidy principles are used.

3.11.3. Possibility to change the 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 53.

Table 53. Water fee and tariff types and principles which can be used further

Type of price	Scope	Main principle	Payer
Water and wastewater tariff	Water supply service	Consumer cost pricing	Consumer
Water resource use fee	Water use amount	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.

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 should 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; GASI; 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 authority 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 needs to be locally and differential. The water tax has to cover following two 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 covered 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 the 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 the amount of compensation will at least be equivalent to the expenses 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.

3.12. Recommendations

1. The Tuul river basin covers only 3% of the territory of Mongolia, but holds over 40% of the country population. About 60% GDP of Mongolia is produced in the TRB and it is an economically important region.
2. The infrastructure development in the TRB is sufficient, but needs improvement related to the rapid growth of population and economy.
3. The population water supply is the top-priority issue for the TRB management plan. It includes:
   - Need to rebuilt and expand the central water supply and sewerage systems of Ulaanbaatar and Zuunmod in coherence with "Water National Program";
   - Need to improve water supply sources capacity and study of a dam and reservoir in the Tuul River to regulate flow according to water demand estimation, which shows possibility of future water shortages in Ulaanbaatar;
   - To plan measures to support the wise use of water and to reduce water losses;
   - To pay more attention to the water supply and sanitation of ger area population and of herders and to plan measures to implement modern technologies suitable for Mongolian conditions;
   - To introduce modern, new technologies into the water supply and sewerage system that protect human health;

- To increase per person water consumption in ger and rural areas by improving water supply and sanitation conditions and review of water tariffs etc.
- To improve drinking water quality in some soums (Bayan-Unguul of Tuv, Dashinchilen of Bulgan) by installing water softener etc.;
- To plan information campaign for wise water use by population;

4. To pay attention to the agricultural water supply, especially livestock water supply; to strengthen current success of farming, especially irrigation; to expand food production in coherence with population food demand.
   - To plan measures to build ponds and boreholes in order to increase the pasture water supply level; the measure will be reflected in the IWRM measures in coherence with state policies and programs like "Water National Program";
   - To plan improvement measures of investment efficiency in pasture water supply;
   - To plan activities for rehabilitating and building irrigation systems;
   - To develop mechanisms for increasing investment efficiency of irrigation systems;
   - To support development of greenhouses near Ulaanbaatar;
5. To support tourism sector development; to plan activities to introduce new technology, small-capacity water supply and sewerage facilities:
6. For the industrial water supply:
   - To use water wisely and introduce nature-friendly technology;
   - To pay attention to wastewater treatment facilities of wool, cashmere and tannery industries which pollute water a lot;
   - To improve water use efficiency of the energy sector;
7. To improve mining water supply:
   - To develop and stimulate the introduction of nature-friendly technology into the mining sector;
   - To develop measures to decrease damage of water resources caused by mining;
   - To define methodologies to calculate results of measures and programs oriented to mining water supply;
8. To organize the rehabilitation and construction of flood protections and drainage works of Ulaanbaatar, Zuunmod city and other settlement areas;
9. To study changes in surface water runoff and groundwater levels due to increasing water consumption and use at Ulaanbaatar and to take measures to identify the cause and reduce the negative impacts.
10. To plan measures for reducing water pollution and to study options to clean the Tuul River bed.

4. WATER SUPPLY, WATER CONSUMPTION– USE AND WATER DEMAND, HYDRO– CONSTRUCTIONS

4.1. Population water supply, water consumption and water demand

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

Ulaanbaatar city

The Ulaanbaatar city water supply is currently handled by the Water Supply and Sewerage Authority (USUG), 21 offices (under management agreement) of Housing and Public Utility Authority (OSNAAG) and 22 private companies. The water demand is increasing due to the growth of the population and the number of organizations in Ulaanbaatar city. The capital city is supplied from 4 groundwater sources (Central, Upper, Industrial and Meat factory) in the Tuul River valley from near Nalaikh in the upstream part to the Songino Bridge. Of the total 176 wells in the 4 water sources of Ulaanbaatar about 110-130 are frequently used everyday.

The main drinking water supply sources of Ulaanbaatar are:

- **Central source**: located in the south-east of the city, the largest source, current water abstraction ranges from 87-90 thousand m^3 from 70-80 wells per day on average. Water is supplied for water consumers in east, central and north parts of the city.
- **Industrial source**: located in Khan-Uul district and used to supply factories, economic entities and apartments. A total of 25-28 thousand m^3 water is abstracted daily through 4 pump stations and 16 boreholes. This source is used for drinking water and technical water supply but due to risk of pollution, the source should be used for technical water supply only in the future.
- **Meat factory source**: 15-19 thousand m^3 water is abstracted from 11 wells through 4 pump stations per day on average and it supplies drinking water to factories, economic entities and apartments in Tolgoit area. The meat factory source pipelines are not separated from other pipelines. This source is important in the supply of the current water demand of the city but as the groundwater at this source is in pollution risk in the future, the source should be used for technical water supply only in the future.
- **Upper source**: 45 thousand m^3 water is abstracted from 55 wells through 5 pump stations and distributed to supply the increasing water consumption-use of the central part of the capital city. In 2010, USUG abstracted 52.4 million m^3 water from this water source.

The water is distributed to industries, organizations, apartments which have a connection to the central network and water is also distributed through 300 kiosks that have a connection to the ger district central network. USUG also supplies the urban ger district population by water truck through 260 not connected kiosks (Table 54).

Table 54. Ulaanbaatar city 2010 and 2011 water abstraction and distribution by USUG

Abstraction and distribution types		2010	2011
Abstracted water, *thous. m^3/year*		52 400.0	54 800.0
Sold/distributed water, *thous. m^3/year*		41 800.0	40 800.0
Water distribution, *thous. m^3/year*	Kiosks connected to the central network	620.4	752.7
	Kiosks supplied by water truck	732.8	598.8
Number of kiosks	Ger district kiosks connected to the central network	301	310
	Ger district kiosks without connection to the central network	256	250
Population supplied from kiosks *thous. people*	Kiosks connected to the central network	234.0	233.2
	Kiosks without connection to the central network	293.4	232.4
Average daily water demand per person, l/day	Apartment resident	237	204
	Person supplied by kiosk connected to the central network	8.8	8.4
	Person supplied by kiosk not connected to the central network	6.9	7.0

Source: Ulaanbaatar city USUG integrated report of 2010 and 2011.

According to the 2010 Ulaanbaatar city USUG report, water use by apartment residents was 237 l/day water, by ger district residents using connected kiosks 8.8 l/day and by ger district residents using not connected kiosks 6.9 l/day (Table 54). When comparing this to the "Temporary norm for population drinking water" approved by Annex 3 of resolution number 153 on "Approval of Temporary Norm" of Environmental minister, 1995, daily water demand of apartment resident is close to the norm (230 l/day) and daily water demand of ger district residents' using kiosks is lower than the norm (25 l/day).

Since 2003, along with land privatization, citizens, industries and entities started drilling boreholes on their private land. The Institute of Geoecology conducted a research in 2009 and according to this research, in Ulaanbaatar city, except USUG- and power plant-owned boreholes, some 1600 boreholes were drilled by industries and private entities and some 90 thousand m^3 groundwater was abstracted. The water is used without any registration or permission. The water demand is likely to be increased along with the basin's socio-economic development and according to research by the project "Second Ulaanbaatar Services Improvement Project", current water sources are not able to supply Ulaanbaatar city water demand starting from 2015. It is presented in Figure 47. Please note that water abstracted from 32 wells established for technological demand of thermo-power plants and 800 wells established for private water demand of people and economic entities in Ulaanbaatar is not included in this calculation.

Source: Second Ulaanbaatar Services Improvement Project, 2008.

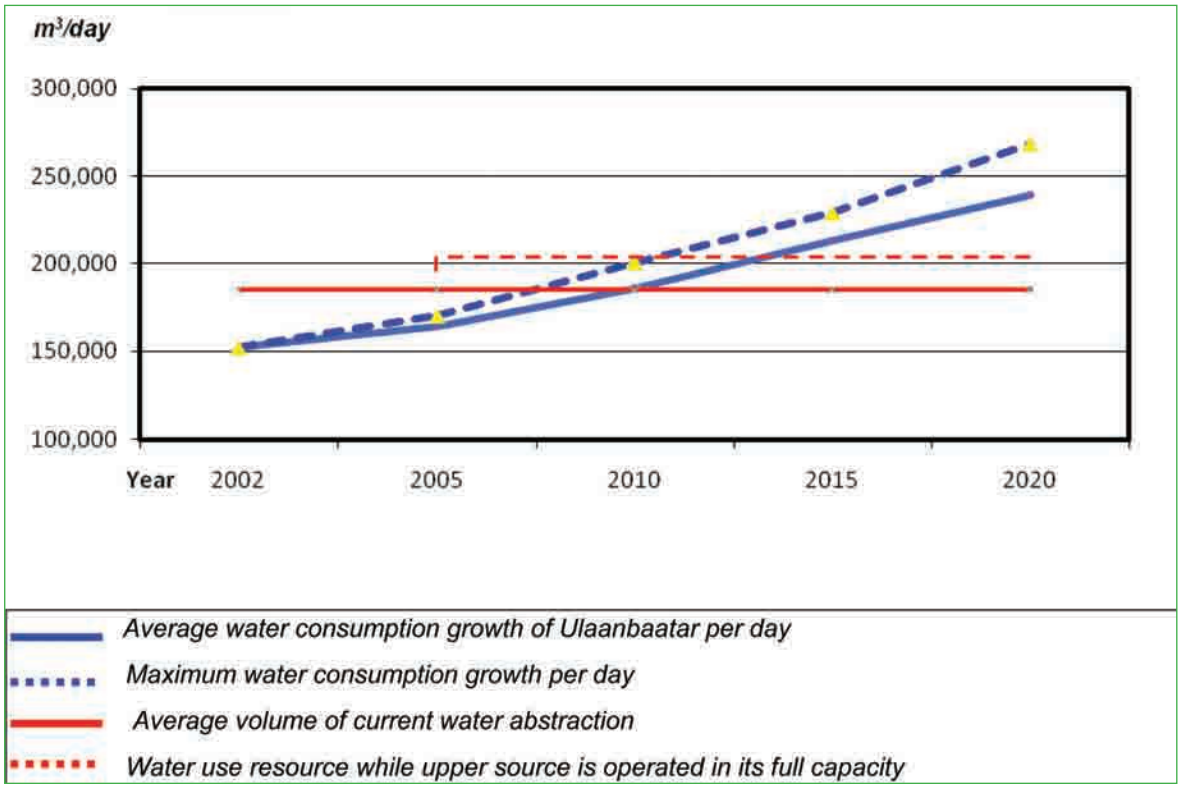

Figure 47. Potential exploitable water resource of water sources in Ulaanbaatar, its water consumption and water demand

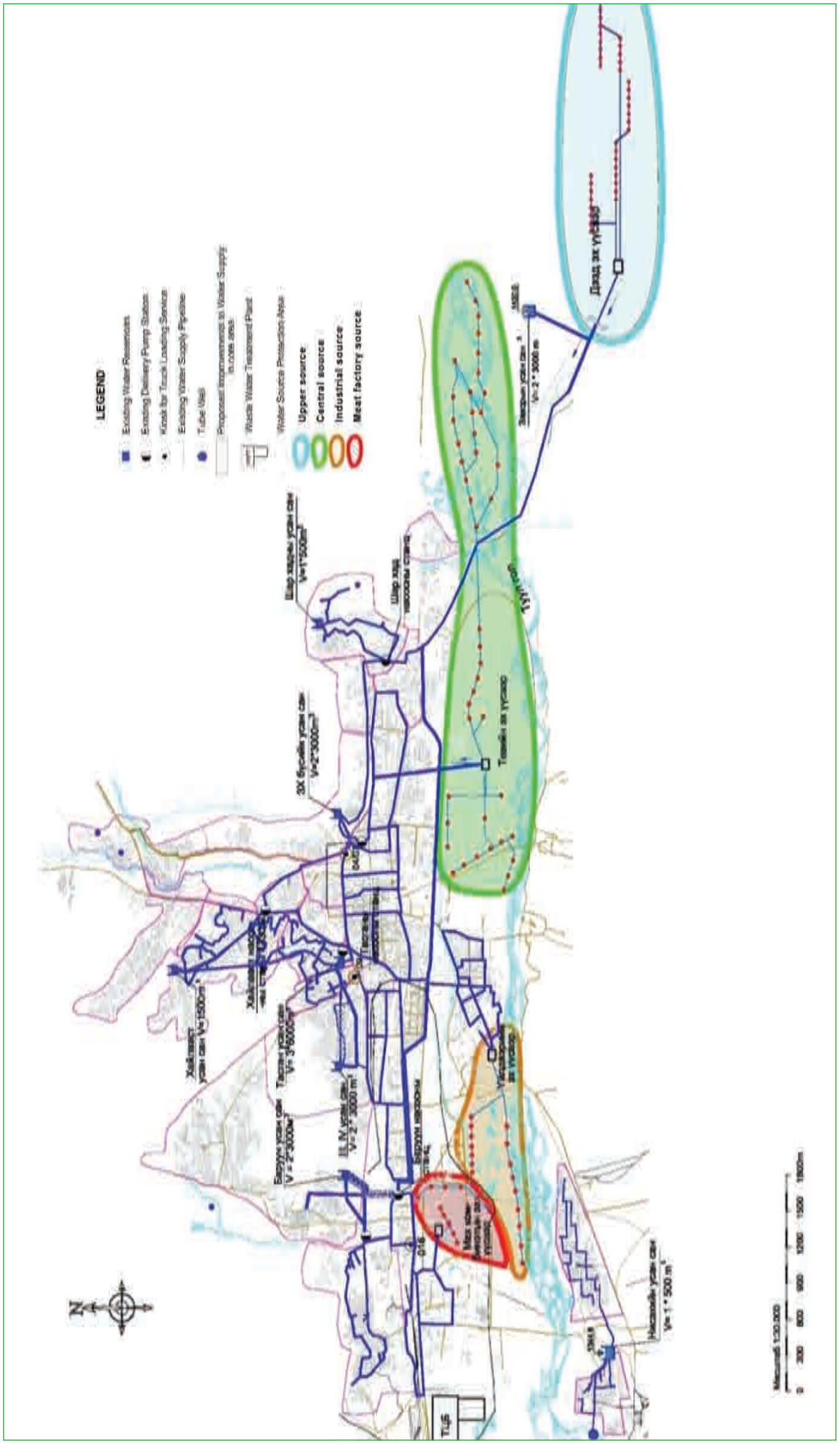

Figure 48. Layout of water supply sources in Ulaanbaatar city

The coverage of Ulaanbaatar residents divided in apartments connected to the central water supply network and ger areas not connected to the network was determined in 2008 within the framework of the 'Water Supply and Sanitation' project implemented by UNICEF and WHO in Mongolia.

Table 55. Coverage of Ulaanbaatar citizens by water supply sources

№	Water supply source	Coverage, %
1	Apartment residents connected to the central water supply network both hot and cold water	37.7
2	Apartment residents connected to the central water supply network, only cold water	-
3	Residents supplied by water kiosk connected to the central water supply network	21.4
4	Residents supplied by water kiosk not connected to the central water supply network	21.2
5	Residents supplied from protected water sources	19.7
6	Residents supplied from unprotected water sources	-
7	Other	-
Total		100.0

Water is delivered to residents of apartments connected to the central water supply network through 'Water and Heat Transmission Center' of Housing and Public Utility Authorities. Water and heat transmission centers have water meters installed in water distribution pipelines and consumer-households. Consequently, there has been some results as citizens are able to control their water consumption, reduction of losses and unproductive expenses.

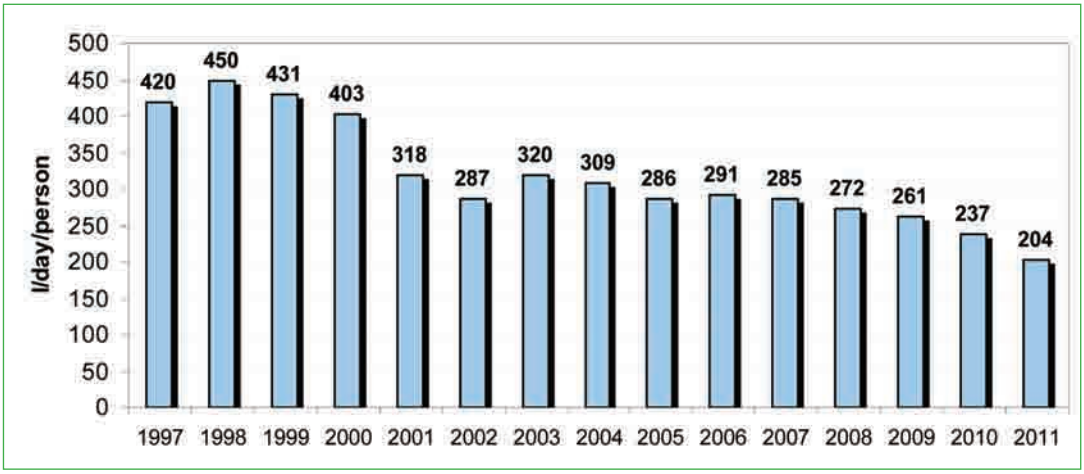

Figure 49. Average daily actual water demand for one resident in apartment

According to a study by the Geoecological Institute, water meters have been installed in some 5% or 20,000 of overall households connected to the central water supply network. As a result, it's been concluded that water consumers with a water meter use 100 l water per day.

The water demand of the Ulaanbaatar population has been calculated for 2008 and 2010 and for 2015 and 2021 and it is shown in Table 56. The water demand of 2008 and 2010 is based on census conducted by the Metropolitan Statistics Authority in 2008 and 2010, result of state census of population and apartments conducted by the National Statistics Committee in 2010 and indicators of water supply and sanitation facilities included in the Millennium Development Goals released by the Ministry of Road, Transportation, Construction and Urban Development (MRTCUD). The projection of the Ulaanbaatar population in 2015 and 2021 has been calculated using the population growth 2010-2040 by the National Statistics Committee.

Within the framework of the project for '40000 and 100000 households apartments' and the direction of the 'Comprehensive National Development Policy based Millennium Development Goals' approved by the State Great Khural (Congress) in 2008, many households will be enabled to move to an apartment and will have access to the central water supply that meets standard requirements.

One objective of integrated water management is to improve the access to water, to coordinate the availability of the water resources and to consider whether or not providing consumers' demand.

Table 56. Water consumption and water demand of Ulaanbaatar population

№	Water supply source and status of supply		Population, *thous. person*				Water consumption, *thous. m³ /year*			
			2008	2010	2015	2021	2008	2010	2015	2021
1	Central water supply	With hot and cold water	389.0	431.1	636.9	762.7	32653.9	36190.0	46490.9	44541.3
		With cold water	-	-	-	-	-	-	-	-
		From water kiosk	220.6	251.0	318.7	370.3	644.3	916.0	2908.3	4055.2
2	Non-central water supply	From water kiosk	219.3	243.4	213.3	305.2	480.3	710.7	1167.9	2227.8
3	From protected source		-	-	-	-	-	-	-	-
4	From non-protected source		203.4	200.0	153.4	47.5	445.5	583.9	559.9	260.3
5	From other sources		-	-	-	-	-	-	-	-
Total			**1032.3**	**1125.5**	**1322.3**	**1485.7**	**34223.9**	**38400.7**	**51126.9**	**51084.6**

According to data of the city public administrative authorities, approximately 20000 people migrate to Ulaanbaatar every year increasing the population growth. Considering actual and mechanical population growth of the capital city, several international and national supported projects have been implemented in order to supply safe drinking water to the people:

- Project for Urgent Maintenance of Equipments for Water Supply in Ulaanbaatar 1997-1999 (with grant aid from Japan),
- Project for Innovation of Equipments for Meat Factory Source 2000 (Denmark),
- Project for Innovation of Equipment for Industrial Source 2001 (China),
- Project for Automation of Equipments for Tasgan Transmission and Pump station in 3rd and 4th Districts 2004 (Russian Sinetik LLC),
- Project for Innovation of Equipments for Upper Source 2005-2007 /with grant aid from Japan/,
- Project for Improving Public Utility Services in Ulaanbaatar 2008 (World Bank)

Zuunmod city of Tuv aimag

As of 2010, the central water supply source of Zuunmod is groundwater and water is abstracted and distributed from the Khushig Valley 12 km to the south-west of the aimag center. In total 600-680 m^3 water is abstracted and distributed per day. The state-owned Tuv Chandmani thermo-power plant is responsible for water and heating supply of Zuunmod.

As of 2008, there have been 14,805 inhabitants of 4100 households in Zuunmod. Of these, some 33.4% or 4944 inhabitants live in apartments connected to the central water supply network and 66.6% or 9861 inhabitants live in ger areas.

According to the national census of population and apartments in 2010, in total 15295 inhabitants have been registered in Zuunmod. In terms of water supply network, inhabitants supplied from the central water supply network reached 34.1% and increased by 0.7% since 2008.

In recent years, a newly built house area is being connected to the central water supply network. There is a thermo-station in Zuunmod for heat supply for factories and public administrative authorities in winter. But as of 2008, the station didn't operate in its full capacity. Therefore, apartments and offices were supplied from heating stoves with a small capacity.

Annual water consumption of Zuunmod in 2008 and 2010 determined by each water supply source is shown in Table 57 based on population numbers using 'Temporary water consumption norm' which was approved by the 153rd order of Minister of Nature and Environment in 1995.

Table 57. Water consumption and water demand of Zuunmod

№	Water supply source and status of its supply		Population, *thous. person*				Water consumption, *thous. m³/year*			
			2008	2010	2015	2021	2008	2010	2015	2021
1	Central water supply	Hot and cold water	-	-	-	-	-	-	-	-
		Cold water	4.9	5.2	8.8	11.1	315.8	333.1	547.1	649.1
		From water kiosk	5.5	8.4	6.3	4.3	16.0	30.6	57.1	47.5
2	Non-central water supply	From water kiosk	4.4	1.7	-	-	9.6	4.9	-	-
3	From protected source			-	-	-	-	-	-	-
4	From unprotected source			-	-	-	-	-	-	-
5	From other sources			-	-	-	-	-	-	-
Total			**14.8**	**15.3**	**15.1**	**15.4**	**341.4**	**368.7**	**604.2**	**696.6**

The water demand in 2015 and 2021 has been calculated based on the projection of the Zuunmod population in 2015 and 2021 included in the Projection of Mongolia's Population 2010-2040 released by the National Statistics Committee.

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

Soum center population

There are central water supply networks in some soum centers, but these are not used. The water source is groundwater from the floodplain of the Tuul River and its tributaries. There are differences according soum location and surface water and groundwater conditions.

The population of most soum centers take their water from 2-5 boreholes with an average yield of 0.9-3.0 l/sec. In some soum centers, water is delivered to public service establishments by water truck and horse-cart, but this is not on a regular basis throughout the year.

Wells in soum centers are not only used for water supply for people, but are also used for domestic activities such as livestock watering or vegetable irrigation, etc.

Actions for sterilization and treatment of drinking water are not taken. A general chemical analysis of the water is usually carried out when boreholes are put into operation, but regular monitoring of the water quality during use of the well is not carried out to compare the quality to the drinking water requirements and national standards.

Citizens of soum centers and rural areas are included as rural population according to the classification of the National Statistics Committee. They are divided in: consumers of soum center and consumers of rural areas depending on their different water consumption norm and their water consumption has been calculated separately. The water consumption of the soum centers in the basin has been determined based on Mongolia's statistics book in 2008 and 2010 and the summary results of the national census on population and apartments in 2010 (Table 58).

Table 58. Water consumption and water demand of population in soum centers

№	Aimag	№	Soum	Population, *thous. person*				Water consumption, *thous. m³/year*			
				2008	2010	2015	2021	2008	2010	2015	2021
1	Arkhangai	1	Khashaat	0.8	1.1	1.1	1.2	2.2	4.0	4.8	7.3
2	Bulgan	2	Bayannuur	0.7	0.7	0.7	0.7	1.9	2.5	2.9	4.4
		3	Buregkhangai	0.9	0.8	0.8	0.8	2.4	3.0	3.5	5.3
		4	Gurvanbulag	1.1	1.2	1.2	1.3	3.2	4.4	5.2	7.9
		5	Dashinchilen	0.9	1.1	1.1	1.1	2.6	3.8	4.5	6.8
		6	Rashaant	0.9	1.7	1.7	1.7	2.6	6.0	7.0	10.7
3	Selenge	7	Orkhontuul	0.9	1.3	1.3	1.4	2.6	4.7	5.6	8.6
4	Tuv	8	Altanbulag	1.0	0.9	0.9	0.9	2.8	3.1	3.6	5.5
		9	Argalant	0.8	0.8	0.8	0.8	2.1	2.8	3.3	5.0
		10	Bayan-Unjuul	0.4	0.7	0.7	0.7	1.2	2.5	2.9	4.4
		11	Bayankhangai	0.8	0.8	0.8	0.8	2.1	2.8	3.3	5.0
		12	Bayantsogt	0.9	0.8	0.8	0.9	2.7	3.0	3.5	5.4
		13	Zaamar	4.2	3.8	3.7	3.8	11.9	13.4	15.8	24.0
		14	Lun	1.3	0.9	0.9	0.9	3.5	3.2	3.8	5.7
		15	Undurshireet	0.6	0.4	0.4	0.4	1.7	1.3	1.5	2.3
		16	Sergelen	0.3	0.5	0.5	0.5	0.8	1.7	2.0	3.1
		17	Ugtaaltsaidam	1.4	1.4	1.4	1.4	3.9	5.0	5.9	8.9
		18	Erdenesant	1.5	1.4	1.4	1.5	4.3	5.1	6.1	9.2
5	Uvurkhangai	19	Burd	0.5	0.5	0.5	0.6	1.5	1.9	2.3	3.5
Total				**20.0**	**20.9**	**20.6**	**21.1**	**56.0**	**74.1**	**87.4**	**132.7**

The local administration has set a sanitation zone of 25 m around the wells used for water supply in soum centers, and wells in some soums are fenced and protected against building construction and apartment for the purpose of industry and service. Some water treatment and softening equipments have been installed in wells with highly mineralized drinking water in Bayan-Unjuul soum of Tuv aimag and Dashinchilen soum of Bulgan aimag. But these equipments were frozen in winter and are no longer used.

Rural area population

Wells for livestock watering are established as water supply sources for rural people (herdsmen and farmers) but also dug wells, rivers, streams and springs are used and sometimes water from ice and snow is used in winter. In other words, both people and livestock are supplied from the same source. But in some Gobi and steppe regions, due to high mineralization, groundwater can not be used for drinking purposes. In this case, local people select fresh water source on their own and fetch water from there. They may call it 'Drinking water'.

Due to occurrence of natural phenomena such as drought of small rivers and disruption of runoff, herder families usually concentrate in areas where runoff occurs. As a result, water is polluted by dung and does not meet the drinking water requirement. Therefore, it is necessary to treat this water before consumption.

Rural people of 29 soums of Arkhangai, Uvurkhangai, Bulgan, Tuv and Selenge aimags are included in the Tuul River Basin. These comprise inhabitants of bag (sub-soum) centers separated from soum centers, people at small mining and farming activities, herdsmen who use livestock productivity as their own income source, and permanent rural population. The number of water consumers and water consumption have been determined by each soum in the basin based on Mongolia's Statistics Book 2008 and 2010, summary result of the national census on population and apartments in 2010, and temporary water consumption norm (Table 59).

Table 59. Water consumption and water demand of rural people

№	Aimag	№	Soum	Population, *thous. person*				Water consumption, *thous. m³/year*			
				2008	2010	2015	2021	2008	2010	2015	2021
1	Arkhangai	1	Ugiinuur	0.4	0.4	0.4	0.4	1.0	1.3	1.5	2.4
		2	Khashaat	2.1	1.8	1.8	1.8	4.6	5.3	6.5	10.1
	Bulgan	3	Bayannuur	0.7	1.0	0.9	1.0	1.6	2.8	3.4	5.3
		4	Buregkhangai	0.9	1.0	1.0	1.0	2.0	3.0	3.7	5.7
		5	Gurvanbulag	1.9	1.9	1.9	1.9	4.2	5.5	6.8	10.4
		6	Dashinchilen	1.4	1.3	1.3	1.3	3.1	3.8	4.6	7.1
		7	Mogod	0.5	0.5	0.5	0.6	1.2	1.6	2.0	3.0
		8	Rashaant	2.1	1.5	1.5	1.5	4.7	4.3	5.3	8.2
		9	Khishig Undur	0.8	0.8	0.8	0.9	1.9	2.5	3.0	4.7
2	Selenge	10	Orkhontuul	0.6	0.6	0.6	0.7	1.2	1.9	2.4	3.7
3	Tuv	11	Altanbulag	1.9	1.9	1.9	2.0	4.3	5.7	7.0	10.7
		12	Argalant	1.0	0.7	0.7	0.7	2.2	2.0	2.4	3.8
		13	Bayandelger	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3
		14	Bayan-Unjuul	0.9	0.6	0.6	0.7	1.9	1.9	2.3	3.6
		15	Bayankhangai	0.7	0.6	0.6	0.7	1.5	1.9	2.3	3.6
		16	Bayantsogt	1.0	0.9	0.9	0.9	2.1	2.7	3.3	5.1
		17	Buren	0.5	0.5	0.4	0.5	1.0	1.3	1.6	2.5
		18	Zaamar	1.6	1.3	1.3	1.3	3.6	3.8	4.7	7.2
		19	Lun	1.2	1.7	1.7	1.7	2.7	5.0	6.1	9.4
		20	Undurshireet	1.4	1.5	1.4	1.5	3.0	4.3	5.2	8.1
		21	Sergelen	0.5	0.4	0.4	0.4	1.0	1.3	1.5	2.4
		22	Ugtaal	0.8	0.9	0.9	0.9	1.8	2.7	6.4	9.8
		23	Tseel	0.2	0.4	0.4	0.4	0.4	1.2	1.5	2.3
		24	Erdene	1.4	1.4	1.4	1.5	3.1	4.2	5.2	8.0
		25	Erdenesant	2.2	2.2	2.1	2.2	4.8	6.3	7.8	12.0
4	Uvurkhangai	26	Bayanundur	0.6	0.4	0.4	0.4	1.3	1.1	1.4	2.1
		27	Burd	2.4	2.3	2.3	2.4	5.3	6.8	8.4	13.0
		28	Zuil	0.5	0.4	0.4	0.4	1.0	1.3	1.6	2.4
		29	Kharkhorin	0.5	0.5	0.5	0.5	1.1	1.5	1.9	2.9
Total				**30.7**	**29.4**	**29.8**	**31.1**	**67.6**	**86.9**	**107.0**	**164.9**

In the event a soum territory is divided by the basin boundary, soum population has been determined by correlating the rural population density of the relevant soum with the size of the pasture area included in the basin. Compared to 2008, the rural population decreased in 2010 by 3.5%. This is due to the migration to soum centers and urban areas as well as due to the 2009/2010 dzud.

4.1.3. Conclusion on population water supply, water consumption and water demand

- In Ulaanbaatar the actual drinking water consumption per day per apartment resident was reduced by 35 liter in 2010 (237 l/day) compared to 2008 (272 l/day)

and closely approached the water consumption norm approved by the Ministry of Nature and Environment. However the actual drinking water consumption by ger area residents did not increase, but kept the same level in 2010 as in 2008 and remained at less than three times the related water consumption norm.

- According to a study covering apartments where water meters are installed, the average water consumption per person per day is 110-120 liter. Therefore, it's possible to reduce the water consumption of the Ulaanbaatar population two times if water consumption of apartment households is measured by water meter.
- The capacity of a toilet tank installed in toilet of apartments connected to the central water supply network ranges from 8 to 15 litres. If one person uses the toilet 4-5 times a day, some 25% of daily water consumption is used in the toilet. It is important to consume fresh water as efficient as possible and especially to install /plumbing/ devices in water tap and showers, etc of hotels, schools and entertainment places for efficient water consumption.
- There is experience in China and Germany to reuse water called 'Grey water' to flush toilets by collecting, treating and purifying washing and shower water in the basement or first floor area of buildings. It is necessary to test this experience.
- The water resource of Zuunmod water supply sources is 6480 m3 per day in terms of A+B class. Currently 1090 m3 water or some 16.8% of its capacity is being used and it is expected that 30.0% is used by 2012. It is necessary to study the possibility to supply the new international airport and satellite town of Ulaanbaatar from the water resources in Khushig valley on the ground of a complete calculation of the future Zuunmod water consumption.
- It is necessary to install water freshening and softening equipment at wells with a high mineralization and hardness used for drinking water purpose in Bayan-Unjuul and Undurshireet soums centers of Tuv aimag and Dashinchilen soum center of Bulgan aimag.
- As rural herdsman families and their livestock use the same water supply source, herdsmen can't be supplied by drinking water that meets the standard. Therefore, it is necessary to protect the source from pollution by livestock.
- It is necessary to connect public service organisations such as schools and dormitories, hospitals, kindergartens, government offices, etc to a piped water supply network and to establish partial (at the water consumer) or integral wastewater treatment plant.

4.2. Municipal service sector water supply, water consumption-use and water demand

4.2.1. Public services: education, culture and health sectors

The capital city of Ulaanbaatar, the center of public administration, science, culture, education and etc, is located in the Tuul River Basin. As of 2010, there have been over 100 universities, colleges and professional education centers, 230 general education schools and 260 pre-school education organisations.

As of 2010, there were more than 800 health organisations in the cities of Zuunmod and Ulaanbaatar that included in the basin. There are approximately 300 public administrative organizations and 300 drug stores in the basin. Public service organisations located in Ulaanbaatar and Zuunmod are connected to the central water supply pipelines network whereas organisations in soum centers are supplied from own wells and by transported water.

In connection with the increasing number of people involved in public services, expansion and new establishment of public service infrastructure is being performed by the state budget on an annual basis.

The number of people receiving service from public service organisations and their water consumption as of 2010 are shown in Table 60.

Table 60. Water consumption by public services in the cities (2010)

City	Education organisation, *thous. children*				Health organisation, *thous. children*			Offices	Water consumption, *thous. m³/year*			
	Kindergarten	General education school	University	Vocational training center	Employees	Outpatient	Inpatient		Education organization	Health organization	Office	Total
Ulaanbaatar	54.2	184.6	181.0	19.0	18.3	676.1	313.6	72.1	2116.3	7764.0	349.0	3241.7
Zuunmod	3.6	14.3	1.0	1.3	1.1	19.2	15.7	3.9	58.4	21.9	18.9	99.2
Total	**57.8**	**198.9**	**182.0**	**20.3**	**19.4**	**695.3**	**329.3**	**76.0**	**2174.7**	**7983.0**	**367.9**	**3340.9**

In calculating water consumption of public service organisations, the water consumption norm approved by the resolution No.153 of Environmental minister in 1995, data and information on admission for academic year 2010-2011 by the Ministry of Education, Culture and Science (MECS), result of data and information on population disease and mortality by the end of 2010 by the Ministry of Health (MH) have been used. The water demand of the public service sector has been calculated based on population growth and is shown in Table 61.

Table 61. Water consumption and water demand by public services in the cities

City	Water consumption, *thous. m³/year*			
	2008	2010	2015	2021
Ulaanbaatar	3079.9	3241.7	3475.0	3777.3
Zuunmod	94.2	99.2	106.3	115.5
Total	**3174.1**	**3340.9**	**3581.3**	**3892.8**

The water consumption of public services located in soum centers in the Tuul River Basin has not been calculated due to incomplete data and information of those who are involved.

4.2.2. Commercial services

Commercial services include shops, restaurants, hotels, baths, hairdressers, laundry services, etc. Water consumption of these has been included in water consumption of the commercial service sector.

According to the "Temporary water use norm" which was approved by the order 153rd of the Minister of Nature and Environment in 1995, water consumption of the commercial service sector in the basin amounted to 3591.7 thousand m^3 in 2010. According to a service sector production growth of 6.9% on average annually in the future as it included in the regional development programme for Ulaanbaatar, water consumption is projected to be 5180.4 thousand m^3 in 2015 and 8039.6 thousand m^3 in 2021 (Table 62).

Table 62. Water consumption and water demand for commercial services in the cities

City	Water consumption, m^3/year			
	2008	2010	2015	2021
Ulaanbaatar	3410.6	3590.1	5178.1	8036.0
Zuunmod	1.5	1.6	2.3	3.6
Total	**3412.1**	**3591.7**	**5180.4**	**8039.6**

4.3. Tourism and green areas water supply, water consumption-use and water demand

4.3.1. Tourism

According to registration of tourists passing the passport control of the General Authority of Border Troops, the number of inbound tourists visiting Mongolia has been increasing year by year and tends to increase in the future (Figure 50).

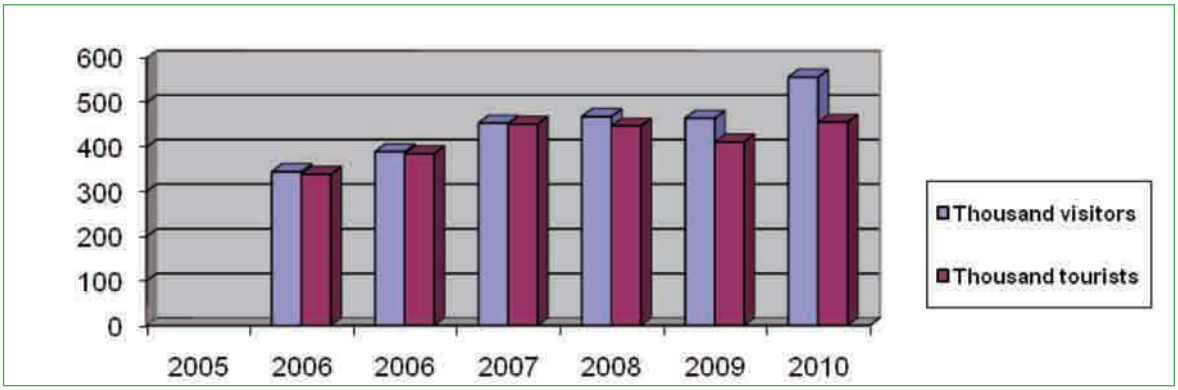

Figure 50. Visitors and tourists visiting Mongolia

Transit passengers and visitors stay temporarily in Mongolia for 5 days and tourists stay for 8-12 days. The number of tourists visiting Ulaanbaatar amounts to half the population of Ulaanbaatar. Tourists mostly visit during warm seasons.

Tourist camps are based in historical monument areas and special natural areas. According to data and information of MNET from 2010, there were around 70 tourist camps in the basin.

One of the main services to tourists is drinking water supply and sanitation. Most camps establish their own wells and use water by delivering it to kitchen and sanitation facilities in a closed network.

The water consumption for tourist camps which is based on capacity, service period, number of tourists visiting the camps in the basin and water consumption norm was calculated at 43.9 thousand m^3 in 2010. Assuming a tourism sector growth of 6.9% annually according to regional development programmes, projection of water consumption will amount to 90.8 thousand m^3 in 2015 and 209.8 thousand m^3 in 2021, respectively.

4.3.2. Green areas

Green areas in the capital city are supplied from the same drinking water sources for people as there is no specific water source for green areas. At present, some parts of gardens, parks and lawn areas are irrigated by irrigation system. Some organisations use

mini-portable sprinkling irrigation equipment by using domestic water or they manually irrigate their lawns and green areas. Tsetserlegjilt LLC is responsible for service of green areas in Ulaanbaatar while Tokhijilt service LLC is responsible for service of green areas in Zuunmod.

According to calculation of 'Temporary irrigation norm for lawn areas' approved by the resolution No.153 of the Environmental minister in 1995, lawn and garden irrigation norm amounts to 4 l/m^3 for one supply. If areas are irrigated on 50 days during the warm season, it would amount to 2000 m^3/ha per year. Based on the above, calculation of water consumption for green areas irrigation in 2010 amounted to 2153.0 thousand m^3.

According to the "New Development" mid-term objective program, which specifies the green areas to be established per year (growth on average per year, 4900 m^2), basin green area water demand will be 2160.1 thousand m^3 in 2015 and 2169.6 thousand m^3 in 2021 (Table 63).

Table 63. Irrigated green areas in the cities

Indicator	2008		2010	
	Green area, *ha*	Irrigated forest area, *ha*	Green area, *ha*	Irrigated forest area, *ha*
Ulaanbaatar	706.7	335.6	713.9	362.6
Zuunmod	0	2.5	0	0
Total area	706.7	338.1	713.9	362.6
Water consumption *(thousand m3 /year)*	1413.4	676.2	1427.8	725.2

4.4. Agricultural sector water supply, water consumption-use and water demand

4.4.1. Pastoral farming

Water supply for livestock is directly associated with pasture use. The way of dealing with animal husbandry is changed in recent years due to socio-economic conditions and climate change, etc. In this connection, the state policy and trend of activities are being changed, too. There has been a growth in the number of livestock, and that's why the products of animal origin and food industry have increased in recent years.

Overall livestock owned by citizens in 29 soums of Arkhangai, Uvurkhangai, Bulgan, Tuv, Selenge aimags and 7 districts of Ulaanbaatar and Zuunmod of Tuv aimag has been included in the basin. Burd soum of Uvurkhangai aimag, Mogod and Khishig-Undur soum of Bulgan aimag, Orkhontuul soum of Selenge aimag are subject to forest steppe zone and others are subject to steppe zone. Water supply and water availability for Buren, Bayankhangai and Argalant soums of Tuv aimag are dependent on only groundwater resources as they do not have surface water.

As of 2010, there were 355 rivers, 389 springs, 3897 wells (1519 boreholes, 584 short-tube wells, 1314 wells with a concrete ring, 480 hand dug wells) and 3 ponds in use for water supply of people and livestock in the pasture area of the basin. Open water bodies are frozen in winter causing difficulties with livestock water supply and livestock is watered from snow. Pasture use is limited due to water supply condition and livestock is concentrated near surface water bodies and wells in the warm season. These are leading to a loss of vegetation growth, grazing intensity and domination of stipa (feather grass), santonica (wormseed), wild leek and ramson.

According to researchers, vegetation is able to restore if 50% is used by livestock, but use of 70% leads to degradation. The number of livestock in Ulaanbaatar, Zaamar, Lun

and Altanbulag soums of Tuv aimag exceeds 3-4 times the standard grazing capacity. Livestock density in the Tuul River Basin is more than in other basins due to its relatively well developed infrastructure and close location to the capital city.

According to the socio-economic study of the Tuul River Basin, the average number of livestock in terms of sheep head amounted to 114 livestock in the Tuul River Basin which is as much as two times the national average number of livestock per 100 ha of 49 livestock.

It has been recently noted by researchers that animal husbandry and livestock breeding conditions are changing due to the increasing number of livestock, the reduction in number and size of water bodies, the strong dependence of pasture use on water availability, the loss of herdsmen's traditional nomadic-habits, the permanent settlement at one location such as winter and summer camps and the impact on water forming conditions in watersheds.

Livestock population around rivers, streams, springs and surface water bodies exceeds the ecological grazing capacity and water pollution is being detected. Livestock breeding and selection must be done in harmony with the regional ecological conditions. However, livestock has been privatized and the numbers are increasing. Cattle, as marketable livestock, merely comprises 5.2-5.9% of the total livestock in the basin and this is a very low indicator.

The number of cattle increased with 0.7% and sheep increased with 2.3%, while the number of goats decreased with 3.2% at the basin level in 2010 compared to 2008 (Figure 51).

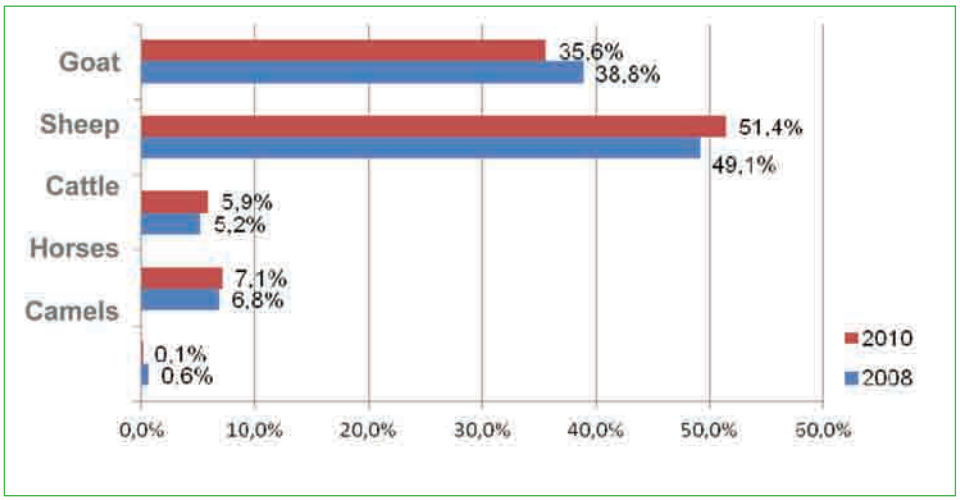

Figure 51. Livestock composition in the basin as of 2008 and 2010

It has been calculated to increase large cattle by 3.1-6.3% and decrease sheep and goat by 0.3-3.9% at the end of 2015 and 2021. This is according to, on one hand, a necessity to develop marketable livestock as a priority and to have intensified animal husbandry, and on the other hand, according to projects and programmes approved by the government.

The number of livestock in soums in the Tuul River Basin has been calculated based on the result of national census on livestock conducted by the National Statistics Committee in 2008 and 2010, and the projection of livestock numbers in 2015 and 2021. The water consumption has been calculated using the livestock water consumption norm applying an average depending on average age of livestock and duration of cold and warm seasons as their water consumption depends on age and season of the year.

In total, 2951.2 thousand livestock were registered in the Tuul River Basin in 2008 and their water consumption amounted to 6407.5 thousand m^3. This number decreased by 97.7 thousand to 2853.5 thousand in 2010 and water consumption also decreased at 6389.5 thousand m^3, respectively. In 2021, the number of large cattle tends to increase and the water consumption also increases by 17%. However, the total number of livestock in the basin is expected to decrease by 1% in 2021 (Table 64).

Table 64. Number of livestock, water consumption and water demand in the Tuul River Basin

Livestock population, *thousand heads*				Water consumption, *thous. m^3/year*			
2008	2010	2015	2021	2008	2010	2015	2021
2951.7	2853.3	3329.4	3297.5	6407.5	6390.0	8805.9	10315.4

Other livestock in the Tuul River basin includes 12 thousand pigs and 300 thousand chickens as well as rabbit and pets and the interest of breeding such animals amongst the community in the future is increasing.

As of 2010, some 48 non-functioning wells have been restored and 54 new wells have been established as a result of restoration work of old wells since 1998 and the establishment of new wells since 2004 within the framework of a policy of the Ministry of Food, Agriculture and Light Industry (MFALI) on improvement of water supply for herdsmen and pasture on their request in recent years.

According to a study carried out by the Institute of Geoecology between 2008 and 2010 to determine potential areas for pastoral farming, an area of 2081.6 thousand ha or 48.4% of the total pasture area in the basin is found possible to be covered by water supply points. Currently, 32.5% or 1396.9 thousand ha pasture area is covered by water supply points. Pasture area is added when new wells are established in pasture areas without water points and not when new wells are established near non-functioning wells. Hydrogeological investigations need to be carried out to determine locations of pasture water points.

It is said that many projects and programmes are implemented regarding improvement of water supply for herdsmen and their livestock, and new wells are established with the financial support from the state budget, international organisations, foreign loans and grant aids. But there is no data and information on the name of the related aimag, soum and area, the address of the economic entities conducted performance, the hand over receipt of wells, and the technical specification of the wells, etc.

4.4.2. Farming

Due to necessity of providing urban people with safe foods, the government of Mongolia has been significantly focusing on the development of intensified animal husbandry. In this connection, the number of farmers in the field of meat and milk livestock is increasing in recent years.

According to data of the Small-Medium Enterprise Development Fund of MFALI, bidding for projects of breeding meat and milk livestock, pig and poultry, production of animal feeds and animal feed planting has been carried out. As of 2010, loans amounting to MNT 705 million have been granted to some 90 economic entities and people. And 13.6% of the farms are based around Ulaanbaatar. As of the end of 2010, there were 211 dairy cattle farms in Ulaanbaatar with some 259 cattle of pure breed and 14,000 cattle of crossbred.

Farms have their own supply of water from boreholes. The water consumption of livestock farms is included in the water consumption of pastoral farming, as they have own wells and there is no different water consumption norm.

4.4.3. Irrigated areas

The upstream part of the basin is surrounded by high mountains and the climate characteristics are: a big difference between air temperatures of day and night, relatively long cold season and short summer and most precipitation falls during the warm season. Average annual precipitation is 233.8 mm as the basin is located in the insufficient moisture zone in terms of natural moisture provision. Some parts of the basin are included in the steppe zone and lack water resources; therefore it is considered that the possibility is limited of establishing irrigated areas. The duration of the period with air temperatures above 10 degrees lasts about 110 days on average. For agriculture and water melioration, the Tuul River Basin and its tributaries are part of the central zone or the 2nd zone with insufficient natural moisture. Therefore, the basin necessarily requires irrigation in crop farming.

Some irrigation schemes have been established in the basin since 1990 such as Daliin Bulag (57 ha) in Bayannuur soum of Bulgan aimag, Guna (70 ha) and Dund Urt (57 ha) in Bayantsogt soum, Ar-Urt (125 ha) in Zaamar soum, Uubulan (36 ha) in Erdenetsogt soum of Tuv aimag, Uvurbayan (74 ha), Khar Usan Tokhoi (95 ha) and Uliastai Am (240 ha) in Bayanzurkh district, and Bukhug-1 (150 ha) and Bukhug-2 (189 ha) in Khan-Uul district of Ulaanbaatar, etc. In total 10 irrigation schemes with engineering design in 1135 ha area are financed from the state budget. And 50 irrigation schemes with normal design in 1300 ha area are financed from former soum commune/cooperative budget. Of these irrigation schemes, Guna, Dund-Urt, Khar Usan Tokhoi and Bukhug-2 have been restored between 2005 and 2009 with the support of investments by the state budget.

Since 2005 26 new irrigation schemes with 1339.2 ha area have been established with support of the state budget. Of these systems, some 87% use groundwater. The surface water source used in these irrigation schemes is from the Bukhug and Turgen Rivers, tributaries of the Tuul River. However, the source is recently changed into wells established in the river floodplain due to interruption of river runoff.

The main crops planted in irrigated areas are vegetables, animal feeds, seabuckthorn and fruit bushes. In recent years, economic entities and people plant tomato, cucumber and leaf-vegetables in protected soil and it leads to the development of green-house industry.

In implementing goals/objectives included in the State Policy on Food and Agriculture and Water National Programme, old irrigation schemes need to be restored and new irrigation schemes need to be established in potential areas.

Water use and water demand for irrigated areas have been calculated by irrigation norm (Table 65).

Table 65. Water use and water demand for Irrigation

Irrigated area, *ha*				Water use, *thousand.m³ /year*			
2008	2010	2015	2021	2008	2010	2015	2021
1132.6	1346.0	2149.0	3296.0	2992.1	3535.7	6083.4	9341.6

Irrigation norm and quantity is determined for irrigated areas depending on structure and soil moisture, type of crops, air temperature and precipitation.

In the scope of "Atar-3" campaign, new irrigation schemes have been established and put into operation in Danikhuu Hill and Shar Usnii (Yellow Water) Channel in Orkhontuul soum of Selenge aimag. The water source for these irrigation schemes is groundwater and this violates the National Security Concept which states that groundwater use for irrigation should be limited. However, this groundwater-based irrigation scheme is a good activity aimed at improving food supply for people.

Therefore, it would be appropriate to adapt the clause of 'limitation of groundwater use in irrigated areas' of the National Security Concept.

The only way to harvest constantly by reducing the impact of the continental climate and the extreme difference between day and night temperatures in Mongolia is to develop green-houses as well as to improve marketing of vegetables in urban areas. The number of entities and people in this field is increasing from year to year. The best irrigation method in green-house is drip irrigation and fog irrigation. Green house vegetables are irrigated from groundwater that is warmed by solar energy. The main green house crops are tomatoes, cucumbers and leaf-plants that grow in a short period of time.

According to study of Metropolitan Agricultural Authority in 2010, there were 33 organisations and citizens that have planted vegetables in greenhouses with 21.2 ha area and took regular harvest.

Water use for greenhouse has been calculated by irrigation norm for greenhouse seedlings (Table 66).

Table 66. Greenhouse water use and water demand

Year	Greenhouse				Water use, *thous. m³/year*	
	Summer		Winter			
	Qty	Area, *ha*	Qty	Area, *ha*	Summer	Winter
2008	27	8.7	11	10.8	22.3	24.5
2010	27	9.0	15	12.2	23.1	30.0
2015	-	10.6	-	14.4	27,0	36.7
2021	-	12.2	-	19.5	31.1	49.7

4.4.4. Recommendations on agricultural water supply and water demand

- It is necessary to identify locations of new wells to use pasture in areas where pasture is not used due to non-functioning wells established prior to 1990, based on protection of pasture area, on recommendations of herder groups and contribution in costs by herders, and to assign ownership and ownership of wells to them,
- As the number of livestock per 100 ha area in the Tuul River Basin is as much as twice the national average, it is necessary to implement a policy change the livestock structure and to maintain livestock with a high productivity corresponding with the grazing capacity,
- To establish large irrigation schemes using surface water and to completely use the potential irrigated areas based on rivers with permanent runoff,
- To take measures to enable farmers in irrigated areas to make the correct selection of crops and to protect soil from erosion, salt accumulation and becoming marshy,
- In the event of groundwater use it is necessary in irrigated areas to execute a complete hydrogeological investigation of the recharge regime and the water resource,
- To teach household farmers the method of how to establish green houses by using synthetic plastic and glass material to create a warm and humid environment, how to plant vegetables using synthetic plastic soil covers and how to regularly take a good harvest by keeping proper temperature and soil moisture and protection from weeds.

4.5. Industries water supply, water use and water demand

4.5.1. Food industry

As the capital city of Ulaanbaatar is located in the Tuul River Basin, it becomes the largest consumer of products of the food industry. Much water is used for production. Water use by food industries has been calculated based on data and information by the Metropolitan Statistics Authority on production by the factories in Ulaanbaatar and the water use norm per unit product (Table 67).

Table 67. Water use by food industry

№	Product	Measuring unit	Product quantity		Water use, *thous. m³/year*	
			2008	2010	2008	2010
1	Milk and dairy products	*mil l*	7.1	27.6	57.5	232.3
2	Meat	*thous. ton*	9.4	9.8	203.0	211.2
3	Canned meat product	*ton*	22.1	25.6	0.3	0.3
4	Sausage	*ton*	1500.0	1521.4	57.8	58.6
5	Spirit	*thous. ton*	1127.7	1337.5	16.9	20.1
6	Vodka and wine	*thous. l*	7800.0	16754.4	170.0	365.2
7	Beer	thous. l	32444.1	44878.5	275.8	381.5
8	Beverage drinks	thous. l	25080.2	67551.0	175.6	773.9
9	Flour	*thous. ton*	55.1	128.6	259.0	604.6
10	Noodle	*ton*	2314.2	2001.5	5.1	4.4
11	Bread	thous. ton	21.1	16.7	67.5	53.4
12	Bakeries	thous. ton	10.0	9.5	28.0	26.7
13	Biscuits/cookies	thous. ton	0.6	0.7	1.6	1.9
14	Confetti/candy	thous. ton	0.1	0.1	0.9	0.9
Total			-	-	**1319.0**	**2735.0**

Soum centers and urban areas in the Tuul River Basin produce bread, beverages, milk and dairy products and supply the local demand as well as the lunch of school children and kindergartens. Due to the absence of data and information on the number of small factories running local activities and the quantity of their products and due to their operation is not permanent, this is not included in water use by the industries.

4.5.2. Light industry

After 1990, factories have been privatized and divided into many number of factories such as initial stage leather, wool and cashmere processing factories, spinning/yarn mill, knitting factory, etc. Light industries not only receive water from the central water supply, but use groundwater as additional water source through wells established nearby.

There are some individuals, cooperatives and small workshops in soum centers included in the Tuul River Basin which produce sewn, knitted, felt and hand-crafted products. But no data and information related to quantity of their products and also their operation is not permanent. Therefore, this is not included in water use by the industries.

Table 68. Water use by light industry

№	Product	Unit	Product quantity		Water use, *thous. m³/year*	
			2008	2010	2008	2010
1	Combed cashmere	*ton*	752.7	824.7	45.2	49.5
2	Washed cashmere	*thous. ton*	0.5	1.6	0.0	0.1
3	Yarn	*ton*	120.2	123.3	15.0	15.4
4	Carpet	*Thous. m²*	108.8	42.2	25.0	9.7
5	Felt	*thous. m*	20.5	40.4	1.7	3.4
6	Knitted wool and cashmere products	*thous. pc*	1139.7	795.8	33.0	23.1
7	Shevro*	*thous. pc*	812.0	588.8	224.1	159.0
Total			-	-	**344.1**	**260.2**

According regional economic development programmes light and food industries are to grow by 6.9% and the water use and water demand has been calculated as follows (Table 69).

Table 69. Total water use and water demand of food and light industries

Industry	2008	2010	2015	2021
Food industry	1319.0	2735.0	3810.8	5687.0
Light industry	344.1	260.2	370.5	553.0
Total water use, thous. m³/year	**1663.1**	**2995.2**	**4181.3**	**6240.0**

4.5.3. Construction and construction material industries

Before 1990, construction factories used to produce and assemble construction structure/ frame and other parts by using industrial method on construction site. The Remicon industry intensively started in Mongolia since 2007. Remicon is produced in the factory, transported by mixer truck, delivered to the construction site and moulded into construction columns, cross backbones, ceilings and walls reinforced by steel.

There are some 30 remicon companies such as Remicon LLC, JKS LLC, MKI LLC, Premium Concrete LLC, Arga Baril LLC, San Industrial LLC, West LLC, CFC LLC, Someone Dreamwork LLC, Ulaanbaatar Management LLC, etc in Ulaanbaatar (capacity to produce 70-120 m³ remicon per hour). Also many companies such as Bluestarlit LLC, Baiguulamj Od LLC, Gungervaa LLC, etc produce concrete, ferro-concrete, brick and block. These companies mainly use groundwater through their own wells established along the floodplain of the Tuul River in producing construction materials and Remicon. Within the framework of '100,000 household apartments' programme approved by the government in 2010, it is planned to build 75,000 household apartments in Ulaanbaatar until the end of 2016. It means construction sector industry is growing and it will increase the water demand for both construction industry and people.

Water use by construction and construction material industries has been calculated based on data and information of the Metropolitan Statistics Authority on production by construction companies and water use norm per unit product (Table 70).

In the event that the measuring unit for products included in the statistics book did not match the measuring unit for water use norm, the water use has been calculated by converting the unit to the unit of the water use norm.

Table 70. Water use of construction material industry

№	Product	Measuring unit	Product quantity		Water use, *thous. m3/year*	
			2008	2010	2008	2010
1	Cement	*thous. ton*	27.8	32.9	69.5	82.3
2	Lime	*thous. ton*	0.3	1.5	0.2	0.8
3	Concrete product	*thous. m³*	43.7	46.6	183.5	195.7
4	Gravel and sand	*thous. m³*	12.1	16.5	8.5	11.6
5	Rock debris	*thous. m³*	123.4	101.1	86.4	70.8
6	Red brick	*Million. pc*	16.9	18.4	30.6	33.3
Total					**378.7**	**394.5**

The water demand of the construction industry in 2015 and 2021 was calculated based on the water use in 2008 and 2010, and the industry sector growth and development programmes (Table 71).

Table 71. Water use and water demand of construction industry

Year	2008	2010	2015	2021
Water use, *thous. m³/year*	**378.6**	**394.3**	**550.3**	**821.3**

In suburban areas of Ulaanbaatar and soum centers, some citizens and cooperatives produce concrete products such as blocks, bricks, curbs, etc on their own site. As there is no data and information on water use for producing remicon that is required for construction, this is not included in the calculation.

Due to the unclear amount of construction materials such as gravel and sand which are being mined widespread, water volume for washing such materials is not included in this calculation.

In connection with the construction and housing process for citizens of the capital city, many clauses of Mongolian Laws on Nature Conservation are violated by the increase in the number and the capacity of the construction material industry, and the mining of gravel and sand for producing remicon, concrete and ferro concrete. Therefore it is necessary to:

- Establish quarries that use eco-friendly technologies and does not pollute environment for mining gravel and sand which are main materials for construction industry in areas not less than 500 m from river bank as permitted by local administrative authority,
- Use rock debris instead of gravel which is a filling material of concrete product,
- Use surface water or treated grey water in producing concrete and remicon as this is produced in warm seasons.
- Prohibit drinking water use in caretaking and other cleaning work of concrete moulded on construction sites.

4.5.4. Mining and processing industries

Within the government approved and implemented 'Gold' programme, many national and international companies have been involved in gold mining. In total 14 gold mining companies operate in the Tuul river valley in the territory of Zaamar soum of Tuv aimag. According to data and information of the Ministry of Natural Resources and Energy in 2010, gold mining activities occurred in some 40 deposit areas in the Tuul River Basin. For mining industry, only gold mining and gravel and sand quarries are now operating in the Tuul River Basin. Water used for gold mining is supplied from the

Tuul River, its small tributaries and streams, and the drinking water consumption is supplied from wells that are established in the floodplains of above rivers and streams.

In the Tuul River Basin, gold is mostly abstracted from placer deposit. Gold-contained sand is washed by highly pressured water and wastewater is collected in ponds for reuse. It is estimated that 30% of the water for washing gold is replaced from rivers, streams and groundwater. Water use by the mining industry has been calculated according to the annual mining work plan of mining entities based on 'Conclusion on water use' by the Water Authority (Table 72, Table 73).

In order to enforce the 'Law on prohibiting exploration and mining of natural resources in river runoff-forming areas, protection zone of reservoir areas and forest resource areas' approved by the State Great Khural (Congress) in 2009, the Water Authority organized the determination of protection boundaries in 2010 in collaboration with local administrative authorities according to the powers specified in clause 22 of Mongolian Law on Water. The government of Mongolia verified this by resolution 'Partially Setting the Boundaries' which will result in suspending exploration licenses of 246 companies included in protection zones. Consequently, some 43 licenses of 26 companies which were running gold mining activities in the Tuul River Basin have been suspended.

Table 72. Water use by mining industries in 2008

№	Aimag	Soum	Natural resource	Deposit	Water use, thous. m³/year
1	Bulgan	Buregkhangai	gold	Baruun /west/ Zakhtsag	276.0
2		Buregkhangai	gold	Baruun /west/ Zakhtsag	56.5
3	Tuv	Zaamar	gold	Bayangoliin Golidrol	1476.0
4		Zaamar	gold	Tosongiin Golidrol	1328.3
5		Zaamar	gold	Ar Naimgan	720.8
6		Zaamar	gold	Dund Arnaimgan	462.5
7		Zaamar	gold	Baga Khailaast	429.3
8		Zaamar	gold	Tuul Goliin Zuun Denj /east embankment/	336.7
9		Zaamar	gold	Bayangoliin Altnii Uusmel Ord /Derivative gold deposit in Bayangol/	187.0
10		Zaamar	gold	Zaamariin Ekh	172.2
11		Zaamar	gold	Tuul Denj	123.0
12		Zaamar	gold	Tsagaan Chuluut	87.8
13		Zaamar	tin /Sn/	Avdrantiin Tsagaan Tugalga /tin deposit/	59.0
14		Zaamar	gold	Urd Delengiin	50.1
15		Zaamar	gold	Tuuliin Zuun Denj /east embankment/	27.9
16		Zaamar	gold	Tosongiin Zuun Denj	3.0
17		Zaamar	gold	Tuuliin Khundii /valley/	2550.0
Total					**8346.1**

Table 73. Water use by mining industries in 2010

№	Aimag	Soum	Deposit	Water use, thous. m³/year
1	Bulgan	Buregkhangai	Baruun /west/ Zakhtsag	98.4
2		Zaamar	Zaamariin Ekh	239.0
3	Tuv	Zaamar	Toson River downstream	25.6
4		Zaamar	Khadat Tolgoi /hill/	162.6
5		Zaamar	Bayangoliin Denj	31.6
6		Zaamar	Urd /south/ Delen	49.2
7		Zaamar	Zuun Shand Burkhantiin Am /valley/	32.6
8		Zaamar	Toson River-1	35.1

№	Aimag	Soum	Deposit	Water use, thous. m³/year
9		Zaamar	Tuul east embankment-1	17.1
10		Zaamar	Tuul Valley	2706.0
11		Zaamar	Dund Galt	24.8
12		Zaamar	Baga Khailaast valley	175.7
13		Zaamar	Bayangol Denj-6	46.6
14		Zaamar	Toson embankment	65.2
15		Zaamar	Ulaan Mountain	147.6
16		Zaamar	Toson Golidrol /channel/	1878.7
Total				**5735.8**

Compared to 2008, water use by mining industries in 2010 has decreased by 31.3%. This is not due to decrease of mining, but enforcement of the related legislation issued by the government over natural conservation.

Due to the trend of many mining licenses to be suspended, the amount of mining production is going to decrease and water use by the mining industry will not increase much in the future (Table 74).

Table 74. Water use and water demand of mining industry

Year	2008	2010	2015	2021
Water use, *thous. m³/year*	8346.0	5735.8	7396.4	6952.3

It is necessary to take the following measures which are included in the Comprehensive National Development Policy and the State Policy on Ecology to eliminate negative impacts on the environment from gold mining industry based on the Mongolia's Millennium Development Goals.

- To suspend special mining licenses of mining industries based in placer deposit areas with a small gold resource and protection of watershed zones, basins and forest resource areas, and to completely stop mining activities,
- To enforce restoration by mining companies in the Tuul River Basin based on economic assessment of damages caused by them on the environment,
- To improve the quality and result of the detailed environmental impact assessment, to control its performance and to increase participation of public control,
- To take measures for the purpose of improving the living condition of citizens based on principle in which complete and efficient use and restoration of natural resources and equal sharing/distribution of their benefits for people,
- Mining companies to take measures such as tight enforcement of a technological regime in extracting gold from placer deposit, reduction of negative impacts on the environment and restoration of the environment on a regular basis,
- To use wastewater collection and recycling systems in gold washing, to discharge excessive wastewater into the river after treatment and to treat sediments before starting mining operation in spring.

4.5.5. Energy and heat industries

Population growth and intensive increase of building in Ulaanbaatar is followed by increase of energy and heat use. As the city rapidly expands and many industrial, social and apartment buildings are built, energy and heat demand is increasing and it is solved by increasing capacity of thermo-power plants. Water supply for technological demand

of the existing thermo-power plants is from some 44 wells in the alluvial aquifer of the Tuul River floodplain. In 1980, the Industrial and Scientific Institute for Civil Engineering Investigation of the Construction Committee of Soviet Union (former name) carried out investigations on water in the Tuul River Basin required for energy and heat production by thermo-power plants in Ulaanbaatar. According to the Natural Resources Commission of the two countries, the related water resource was verified amounting to 70.6 thousand m^3 per day.

Thermo-power plants not only re-use their excessive steam through facilities to cool and liquefy steam after energy production. The government of Mongolia has planned to establish a new thermo-power plant and to increase energy and heat supply in Ulaanbaatar by 2015.

Energy and heat produced throughout the year and water use have been calculated based on data and information of the National Statistics Committee of Mongolia and thermo-power plants in Ulaanbaatar (Table 75).

Table 75. Water use by energy and heat industries in the Tuul River Basin

City	Product	Measuring unit	Product quantity		Water use, *thous. m^3/year*	
			2008	2010	2008	2010
Ulaanbaatar	energy	mil kwt. hour	2 924.5	3 650.3	11.5	14.3
	heat	thous. Gkal	5 024.1	435.8	25 100.0	22 500.0
Zuunmod	heat	thous. Gkal	255.0	279.5	256.0	279.5

In Zuunmod, heat is supplied from a boiler/steam generator for offices, school, kindergarten and apartments in winter. Based on perspective of energy sector, energy and heat demand, the projection of water use is as follows (Table 76).

Table 76. Water use and water demand of energy and heat industries in the Tuul River Basin

Year	2008	2010	2015	2021
Water use, *thous. m^3/year*	25355.0	22779.5	30484.1	43242.3

Heat for administration buildings, schools, hospitals and cultural centers in soum centers are supplied from wood and coal burning stoves while some others use low pressure stoves.

4.6. Total water consumption-use and water demand in the Tuul river basin

Compared to the water consumption-use in the reference year 2010, which is the first year of the Integrated Water Resource Management (IWRM) plan of the Tuul River Basin, water consumption-use in 2021, the final year of the IWRM plan is increased by 53%.

Water management is not only about existence of water resources, but also about the appropriate organisation of issues how to efficiently use the water resources and protect from scarcity and pollution. This is the policy with a technical and technological view. Water security can be achieved in the future for Ulaanbaatar if the of urban expansion complies with the available water resources. It is necessary to protect the upstream part of the Tuul River by limiting economic activities and to manage and control the water use in the midstream and downstream to reduce water shortages and pollution.

Water consumption-use and water demand in the Tuul River Basin has been calculated and is shown in Table 77 and Figure 52.

Table 77. Water consumption-use and water demand in the Tuul River Basin

№	Water consuming and using sector	Water consumption-use and water demand							
		2008		2010		2015		2021	
		thous. m³/ year	%	thous. m³/ year	%	thous. m³/ year	%	thous. m³/ year	%
1	Ulaanbaatar population	34,223.9	38.6	38,400.7	42.7	51,126.9	42.5	51,084.6	35.6
2	Zuunmod population	341.4	0.4	368.7	0.4	604.2	0.5	696.6	0.5
3	Soum center population	56.0	0.1	74.1	0.1	87.4	0.1	132.7	0.1
4	Rural population	67.6	0.1	86.9	0.1	107.0	0.1	164.9	0.1
5	Public services	3,174.1	3.6	3,340.9	3.7	3,581.3	3.0	3,892.8	2.7
6	Commercial services	3,412.1	3.9	3,591.7	4.0	5,180.4	4.3	8,039.6	5.6
7	Food industry	1,319.0	1.5	2,735.0	3.0	3,810.8	3.2	5,687.0	4.0
8	Light industry	344.1	0.4	260.2	0.3	370.5	0.3	553.0	0.4
9	Construction and construction material	378.6	0.4	394.3	0.4	550.3	0.5	821.3	0.6
10	Mining	8,346.0	9.4	5,735.8	6.4	7,396.4	6.1	6,952.3	4.9
11	Energy and heat	25,355.0	28.6	22,779.5	25.3	30,484.1	25.3	43,242.3	30.2
12	Livestock	6,407.5	7.2	6,390.0	7.1	8,805.9	7.3	10,315.4	7.2
13	Irrigation	2,992.1	3.4	3,535.7	3.9	6,083.4	5.1	9,341.6	6.5
14	Tourism	38.8	0.0	43.9	0.0	90.8	0.1	209.8	0.1
15	Green area	2,150.6	2.4	2,153.0	2.4	2,160.1	1.8	2,169.6	1.5
Total		88,606.8	100.0	89,890.4	100.0	120,439.5	100.0	143,303.5	100.0

Now it's time to take measures step by step such as setting boundaries of the Tuul River runoff-forming upstream part and water source recharge area, enforcement of protection procedure, bringing the runoff-forming part under protection, complete wastewater treatment, strict enforcement of the standard for discharging treated wastewater into environment, moving tanneries/wool washing factories from drinking water source area if they don't properly treat wastewater, river flow regulation, and increase surface and groundwater sources, etc.

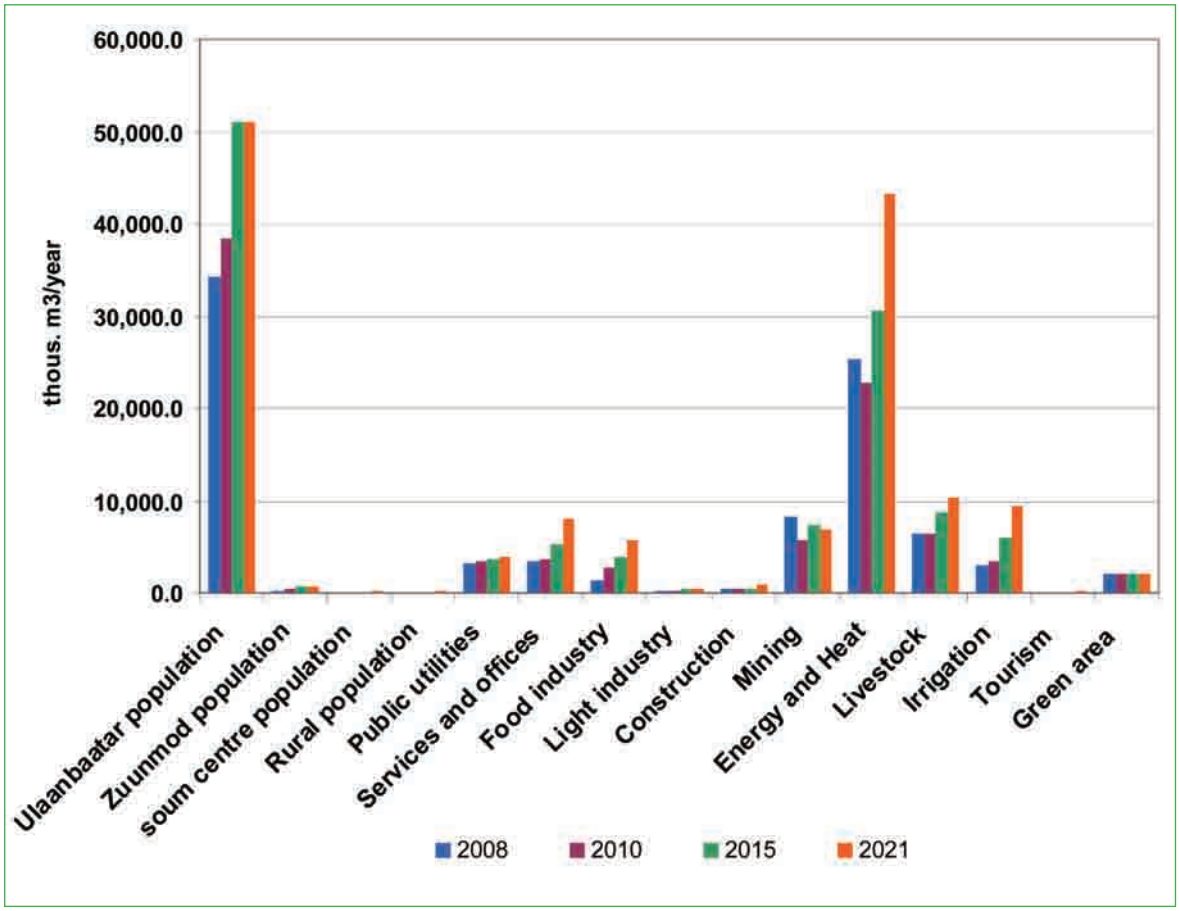

Figure 52. Total water consumption-use and water demand of the basin

4.7. Hydro-constructions

It is stated in the Mongolian Law on Water that hydro-constructions include ordinary and engineering constructions to regulate water discharge, water collection, water storage, water transfer, water distribution, provision, sterilization, purification and water treatment, exploration of ground water and protection from water disasters.

There are all kind of types of hydro-constructions in the Tuul River Basin and especially, large water supply and sewerage facilities and flood protection dykes in Ulaanbaatar. Wells and irrigation schemes are playing a significant role in the existing hydro-constructions.

Water supply and sewerage facilities in rural and urban areas of the basin, agricultural water supply facilities as well as flood protection system, etc are briefly mentioned in this chapter.

4.7.1. Hydro-constructions for water supply

Hydro-constructions for water supply in Ulaanbaatar city

The Ulaanbaatar water supply system consists of hydro-constructions that abstract, lift, collect and transmit water from water sources and of auxiliary water lifting and transmission pump stations, reservoirs, and main and branch pipelines.

As of 2010, the Ulaanbaatar water supply system included 176 boreholes from 4 main water abstraction sources, 6 transmission and pump stations, 4 pressure-regulating reservoirs, 350.3 km fresh water pipeline, 301 water kiosks connected to the central pipeline and 256 water kiosks not connected to the central pipeline. Also the system partially used some 29 boreholes from water supply sources at the Airport and Bio-combinat area for the city's thermo-power plants. The Water Supply and Sewerage Company (USUG) of Ulaanbaatar is responsible for the water supply system that supplies water to the Water and Heat Transmission Centers of the House and Public Utilities Company (HPUC) as well as industrial and office water consumers in urban areas of the city. USUG also supplies water to inhabitants in Ulaanbaatar ger areas through the central network and not-connected water kiosks.

In connection with land privatization, citizens and economic entities have established and are using a number of wells on their own land. It's been reported that in recent years inhabitants in Ulaanbaatar suburban areas have established 800 new wells within their own fences for their own consumption.

Water supply sources: There are 4 water sources: Central, Upper, Meat Factory and Industrial which are being used for water supply in urban areas of Ulaanbaatar (Figure 3). Also there are water sources for water supply of thermo-power plants and a new water source is recently started in Gachuurt village with the support of the government of Japan and one in Yarmag by aid of the government of Korea.

Structure and operation of all the sources are similar. Water is supplied to primary reservoirs by pumps and the city is supplied by water through auxiliary water pumps and pipelines.

Central source: the largest source located in a wide area south-east of the city's constructed area consisting of 82 boreholes (22 wells in east part or between Gachuurt village and Khujirbulan, 45 wells in central part or between Khujirbulan and Central pump station, and 15 wells in west part or between Central pump station and central stadium). Of these, some 78-80 wells are functioning on a regular basis. These wells were established by renovation programmes of Russia, Mongolia and Japan during certain phases since 1961. The most recent renovation has been carried out and was completed in 1999 by project of JICA, Japan. Some installation of new pumps, control system and chlorination equipment and system maintenance were carried out under this project. Water is delivered from the central source to the city center and Tasgan reservoir through 3 main pipelines and it supplies the 3rd and 4th sub-districts and east part of the pipelines.

Industrial source: established in 1964 for the purpose of water supply to the industrial area located in south-west constructed area of the city and expanded in 1973 and 1976, respectively. This source is located 8 km to the west from the central source. There are 16 wells and 4 water pump stations: 2 of them non-function and 11-14 wells are functioning on a regular basis. USUG carried out an innovation on water pump station of industrial source in 2001. A new pump, control equipment of variable-speed engine (frequency converter) and discharge measurer and chlorination system were installed.

Meat factory source: was established in 1964 for the purpose of water supply to the meat factory and military compounds in the west of the city. It is located 1.5 km in downstream direction of the industrial source. There are in total 11 wells. In the scope of a project implemented with a grant aid from the government of Denmark, all the new wells of the auxiliary water pump stations, well sites, the auxiliary pump and discharge measurers have been updated in 2002.

Upper source: is the second largest water source located 47 km to the east of the city. The well field is located in a stretch with a length of 20 km and occupies 45 km^2 area.

There are in total 39 boreholes in this source. Water is delivered to the equalizing reservoir located 7 km from the city's built-up area through two main pipelines with a length of 50 km and with a diameter of 600 and 800 mm. These pipelines were established for the water supply of the main pipelines and reducing the pressure.

The Upper source was put into operation in 1989 and went through innovation in 2004 and 2005 with the support of the government of Japan.

Thermo-power plant sources: three sources established for the purpose of water supply for thermo-power plants No.2, 3 and 4 are located in south-east of the city. These sources are under the control of the Energy Authority and are established based on groundwater in the alluvial aquifer of the Tuul River floodplain.

Reservoirs: The Ulaanbaatar main pipeline has five large reservoirs. These are West District, the 3rd and 4th Sub-District, Tasganii Ovoo, North-East Regional and the Equalizing reservoirs. In the framework of 'Project-1 for Improvement of Ulaanbaatar Utility Service' in 2009, one reservoir with a capacity of 1500 m3 was established in Khailaast for the purpose of water supply for people in Khailaast and Denjiin Myanga areas (water supply is available for people in Chingeltei and Dambadarjaa areas in the future). The reservoir was built by ferro-concrete and covered by soil in order to prevent from freezing during winter. The location of the Ulaanbaatar water supply sources, main pipelines and reservoirs is shown in Table 78.

Table 78. Main reservoirs in Ulaanbaatar city

№	Reservoir	Quantity	Capacity of each reservoir, *thous. m³*	Total capacity, *thous. m³*
1	North-East Regional	2	3.0	6.0
2	Tasganii Ovoo (hill)	3	6.0	18.0
3	III, IY Sub-Districts	2	3.0	6.0
4	West District	2	3.0	6.0
5	Equalizing	2	3.0	6.0
Total		**11**		**42.0**

Pump stations:

Figure 53. Pump station

West districts' pump station: is aimed at increasing the pressure in west part of Ulaanbaatar pipeline. Therefore, the West District reservoir is enabled to be filled with water. The station was established in 1990 for the purpose of increasing the pressure of water received from the Central source. Although now it is being used for transmitting water from the Upper source to the West District pipeline through the South pipeline by using the West District pump station. There has been neither innovation nor improvement since the West District pump station was established. Currently, only one of four pump stations is in use. This station is going to be used in water delivery to Tolgoit and Bayankhoshuu ger areas through the central water supply network in the future.

Tasgan pump station: was established in 1972 for the purpose of water supply for 3rd and 4th sub-districts and water delivery to the 4th sub-district reservoir from the Tasgan Ovoo reservoir. The station consists of some 4 pumps which are all functioned.

Circle/Ring (Road) pump station: is a mini-pump station and established for the purpose of increasing the pressure in water supply for apartments in the 12th sub-district.

Branch pipeline: branch pipeline of central part of the city started to establish since 1959 and completed at certain phases. The pipeline had undergone maintenance and few additional pipelines have been installed since 1992. But so far, expansion and improvement haven't been carried out on a large scale. All New Creation works are being carried out in the scope of or in the vicinity of the currently used pipeline network.

Pipeline network consists of 83.3 km cast-iron and 241.7 km steel pipes, respectively. Cast iron used in relatively earlier established pipelines with a diameter of 250-600 mm and without any internal layer. Most cast-iron pipelines need maintenance as their joints have been depreciated and their pressure capacity has been decreased. Steel pipes have 150-900 mm diameter.

New water supply source of Ulaanbaatar or Tuul Complex:

The Ulaanbaatar city water demand is supplied from above mentioned water supply sources, but this is increasing rapidly. New water supply sources are required. In the near future it will not be possible to use the Industrial and the Meat Factory sources for drinking water. An option is to collect and use surface water by carrying out flow regulation in the Tuul River as a new water supply source of Ulaanbaatar.

A feasibility study for a new water supply source of Ulaanbaatar was executed in 1981-1983 with the assistance of then-Soviet Union's experts. This feasibility study suggested a scenario to use 11 sites with groundwater resources in a 200 km circle around Ulaanbaatar: 6 in the Tuul River valley, 2 in the Kharaa River valley, 2 in the Orkhon River valley and 1 in the Kherlen River valley. Also 5 dam sites: 3 in the Tuul River and 2 in the Terelj River have been studied. And according to comparison of these sources, one scenario to establish a dam 2.5 km upstream of the Gachuurt village and to supply water to Ulaanbaatar from open reservoir was selected as the most beneficial one. Therefore, investigations and designs have been carried out in 1989. Monhydroconstruction LLC implemented a 'pre-investigation work for formulating the feasibility study to establish hydro-construction on the Tuul River' between November 2007 and April 2008 upon request of the Ministry of Nature, Environment and Tourism and the Water Authority (Figure 54). Under this project some three dam sites have been selected. The 1st dam site selected to be in Khar Us, bend of the river in Gachuurt and it overlaps with the dam site which was previously selected by the Soviet Union's experts (this is considered the most convenient site to construct dam for tackling Ulaanbaatar water supply issue). The 2nd dam site has been selected to be 2 km downstream of the 2nd site previously selected by Soviet Union's experts. The 3rd one selected to locate 70 km upstream of Ulaanbaatar or 4km downstream of Tuul-Terelj confluence. Also Prestige Engineering LLC studied the Tuul Water Complex in 2010-2011 for the purpose of regulating the Tuul River runoff, safe water supply for Ulaanbaatar in the future, hydro-power production, establishing complex hydro-construction including water refreshing facilities, solution of water supply for large factories and objects, and creating a convenient ecosystem environment in the Tuul River Basin. A preliminary feasibility study has been carried out and 4 dam sites were selected (Figure 55).

In the initial stage 2 sites have been proposed to build a dam. The 1st one is located 80 km upstream of Ulaanbaatar and 4.3 km downstream of Bosgiin bridge (river valley is 1367 m wide according to the standard level of reservoir, average annual discharge is Q_0=9.6 m^3/sec, discharge is W=305.8 mil.m^3, watershed area is F=2253 km^2, the basin is 2037 m high on average, flood discharge with 1% probability is $Q_{1\%}$=1107 m^3/sec). And the 2nd dam site is located 63 km upstream of Ulaanbaatar and selected to overlap with the 3rd dam site selected by Monhydroconstruction LLC or downstream of Tuul-Terelj confluence in lower boundary where brushwood, aspen, larch and spruce forest is the most widespread (river valley is 1667 m wide according to the standard level of reservoir, average annual discharge is Q_0=27.4 m^3/sec, discharge is W=872.83 mil.m^3, watershed area F=4164 km^2, the basin is 1778 m high on average, and flood discharge with 1% probability is $Q_{1\%}$=1548 m^3/sec) (Figure 55). The preliminary feasibility study considered that one or both dams are possible to be constructed and used at the same time. The 1st scenario is a single reservoir used until 2030 and the second one to be used after 2030, additionally.

The Tuul River Water Complex is intended to become an important multifunctional project creating a reliable water supply source for Ulaanbaatar, hydro-power use of Tuul River water, flood protection, river ecology conservation, condition for aquatic sports, tourism and aquatic animal breeding, etc.

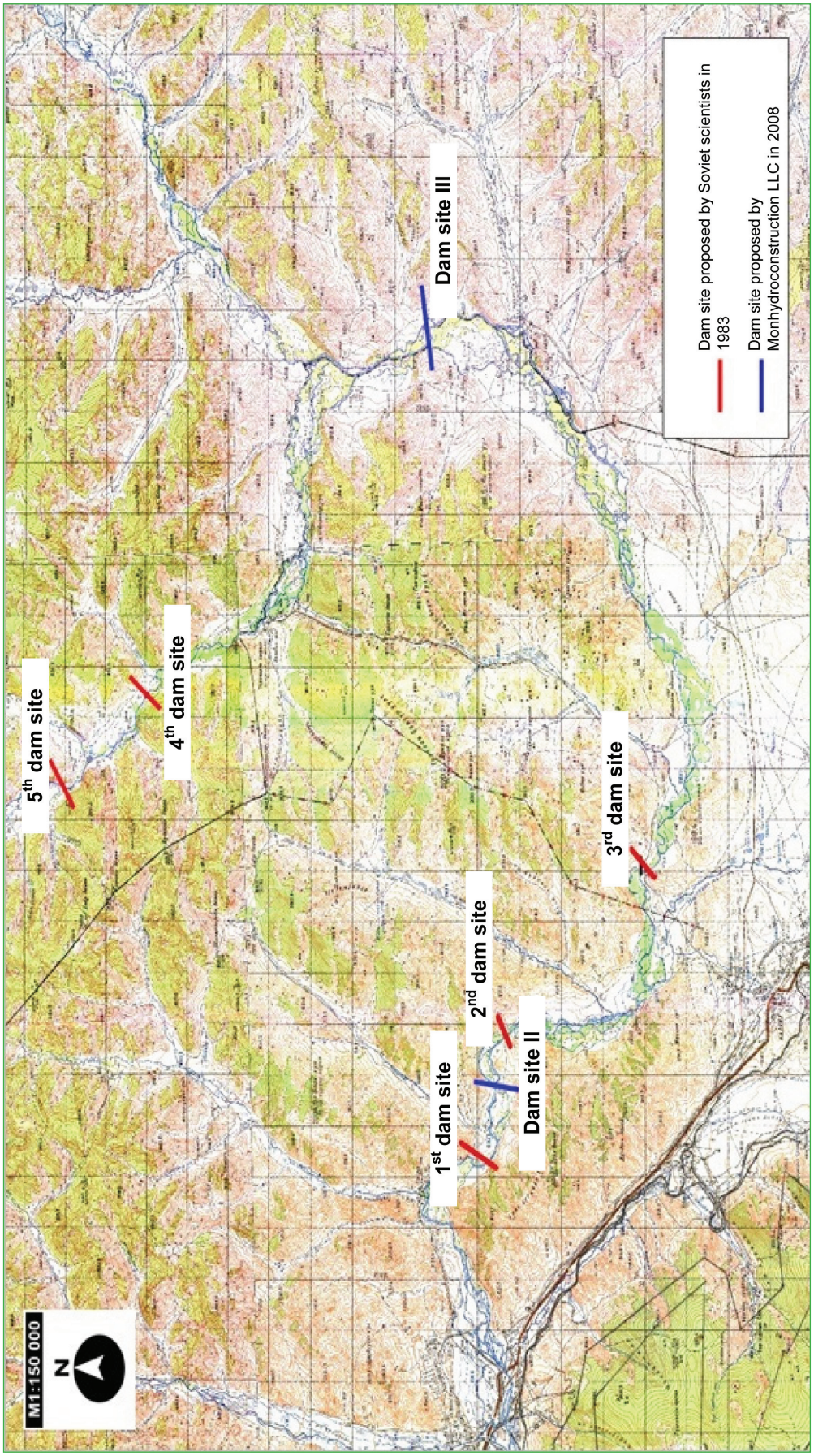

Figure 54. Dam sites selected by Soviet Union's experts in 1983 and by Monhydroconstruction LLC in 2008 on the Tuul River

Figure 55. Dam sites selected by Prestige Engineering LLC in 2010 on the Tuul river basin

Hydro-constructions for water supply in Zuunmod city

The water source of the central water supply of Zuunmod is groundwater. It uses a hydro-construction consisting of 3 wells, 2 pump stations and water transmission pipeline with a length of 15 km in Khushig Valley. Water supply for residents in ger districts is delivered through 2 water kiosks connected to the central water supply network and 15 water kiosks supplied by water truck.

Service centers and citizens in Zuunmod established some 11 wells and are using them for their own drinking water demand.

Hydro-constructions for water supply in soum centers

The Tuul River Basin includes in total 19 soum centers of 5 aimags: Sergelen, Altanbulag, Erdenesant, Undurshireet, Lun, Argalant, Bayantsogt, Zaamar, Ugtaal, Bayankhangai, Bayan-Unjuul soum centers of Tuv aimag, Burd soum center of Uvurkhangai aimag, Khashaat soum center of Arkhangai aimag, Rashaant, Bayannuur, Dashinchilen, Gurvanbulag, Buregkhangai soum centers of Bulgan aimag, and Orkhontuul soum center of Selenge aimag. In total 70 boreholes are used. There is no central water supply network in soum centers in the basin (except piped connections of some soum center wells with boiler, school, hospital and administration building). Instead, 2-3 boreholes are being used. Design of this well is similar to the design of a pastoral well. Electric water pumps may be used in wells in soum centers connected to the mains.

Hydro-constructions for water supply in rural area (pasture)

Rural wells are not specifically established for the purpose of water supply for rural people (herdsmen and farmers), but mainly established for irrigation and livestock watering. Drilled (borehole), short tube, concrete ring and hand dug wells are being used in water supply.

On one hand, there is no detailed study of well construction, reservoir and status of their use and on the other hand, the basin boundary crosses the territories of soums. Therefore, it's difficult to come up with clear numbers of wells. But there is 2010 data and information that 355 rivers, 389 springs and 3897 wells are used for livestock water supply. Of the wells, some 1519 boreholes, 584 short tube wells, 480 hand dug wells and 3 ponds.

Wells are divided into two types: wells with traditional design and wells with engineering design (drilled, concrete ring and short tube).

Boreholes: Groundwater resources in artesian and pressureless aquifers are investigated by geophysical and drilling methods. URB-2A, URB-3AM and 1BA-15B rotary drilling rigs, etc and UKS-22 percussion drilling rig drilled 30-300 m deep. A 6-10 inch tube was installed inside the well, filter installed adapting to aquifer, VL-3M pump installed in combination with T-62 mini-power generator with one cylinder. A small building is built to protect these equipments of the well with a water tank. A 12 m trough was built outside the construction.

The drilling rigs, pumps and engines were manufactured in the former Soviet Union.

Above pumps and engines are rarely found in recent years and their operating cost is too high. And in establishing new borehole and restoring old wells, some pumps: DBZ, QGD, QDX, QJ manufactured in China, VRD, UQN manufactured in German Democratic Republic, electric pump manufactured in Grundfoss LLC of Denmark, some power generators: ET-950, EF-1600 manufactured in Yamaha and Honda LLC of Japan, and X170F, 5EF, R185 manufactured in China, etc have been installed.

Figure 56. Design and appearance of a borehole

Since 2000, many boreholes have been established in pasture areas by loan and grant aid from the state budget, foreign countries and international financial organisations, and various models of water lifting devices /pumps/ and power generators have been installed. Consequently, technical policy has been lost, making it very difficult to provide maintenance.

Irrigation schemes: a complex system established for the purpose of irrigating hay, crop and pasture areas consisting of hydro-constructions and equipments for collection, transmission, distribution and allocation of groundwater and drainage of excess water.

Figure 57. Main channel and sprinklers of an irrigation scheme

In the Tuul River basin, some 4 old irrigation schemes (Guna, Dund-Urt, Khar Usan Tokhoi and Bukhug-2) with engineering design and a projected initial capacity of 411 ha have been restored for irrigation of 284.7 ha area since 2005. And 26 new irrigation schemes with 1339.2 ha area have been established.

4.7.2. Conclusion on hydro-constructions for water supply

- Some parts of hydro-constructions and equipments such as central water supply pipelines in the cities of Ulaanbaatar and Zuunmod, and soum centers are largely in bad condition and outdated. Therefore, maintenance and expansion are really needed.

- A technical policy is not implemented at national level on standardization of water lifting equipment /pumps/ and power generators as a variety of types is being installed on boreholes located in soum centers and pasture area.
- Groundwater at urban areas is used locally to the limit of the available resources and abstraction of groundwater can not increase much more.
- As the NV-3M pump installed in concrete ring and short tube wells in pasture area is often damaged and cannot be replaced as it is not longer manufactured, this sort of well is no longer used. New boreholes are established by the side of such wells but this does not increase the pasture water supply area.
- In recent years, there is special support from the state budget in establishing ponds. But ownership and use of the ponds are still unclear.
- It is necessary to carry out detailed studies in areas where irrigated crop is possible to establish new irrigation schemes. Therefore, it is necessary to introduce water-efficient equipment which limits groundwater use in crop irrigation.

4.7.3. Sewerage and wastewater treatment

In Mongolia, urban areas' wastewater treatment was generally started in 1964 by introducing science-based advanced technologies and operating control systems on a regular basis with the assistance from developed countries. It was an important measure to prevent negative impacts on environment and ecology.

In this scope, all the factories and service units in the basin that used to produce wastewater were supplied by large and mini wastewater treatment plants /WTTP/ and the related systems were put into operation. After the transition period of Mongolia's new economic and social system, many WWTPs were out of service, abandoned and unused. There are 27 WWPTs in 7 districts of Ulaanbaatar, Zuunmod city and 9 soum centers of Bulgan, Selenge and Tuv aimags. There is one WWTP in Rashaant soum of Bulgan aimag, Orkhontuul soum of Selenge aimag, Erdenesant, Bayantsogt, Zuunmod, Bayankhangai, Sergelen and Ugtaal soums of Tuv aimag, 2 WWTPs in Zaamar soum, 6 WWTPs in Songinokhairkhan district, 3 WWTPs in Bayanzurkh district, 6 WWTPs in Khan-Uul district and 2 WWTPs in Nalaikh district. Of these 27 WWTPs, 13 plants are operating normally, 4 are operating not normally and 10 are non-operating. Amongst the above WWTPs, there are 18 domestic WWTPs and 9 hospital and industrial wastewater pre-treatment plants. And 5 plants of each are non-operating, respectively.

Table 79. Type of wastewater treatment plants in the basin

Type of wastewater	Wastewater treatment plant	Wastewater pre-treatment plant
Domestic wastewater	15	-
Hospital wastewater	-	2
Mining camp domestic wastewater	1	-
Tannery, wool and cashmere industrial wastewater	-	5
Meat processing industrial wastewater	-	2
Skiing camp domestic wastewater	1	-
Children's camp domestic wastewater	1	-
Total	18	9

A list of currently used domestic WWTPs in the Tuul River Basin as of 2010 is shown in Table 80.

Table 80. Domestic wastewater treatment plants operating in the basin

№	City and aimag	Soum and district	Wastewater treatment plant	Type of treated wastewater	Type of WWTP	Date put into operation	operation	Type of treatment	Capacity, m³/day		Where to discharge waste-water	Owner	Geographic coordinates	
									Projected	Current				
1	Ulaanbaatar	Songino-Khairkhan	Central wastewater treatment plant	domestic		1963	normal	mechanic, biological	230000	160000	Tuul River	UB Water Supply and Sewerage Company	47.9036	106.763
2			Bayangol WWTP / Nairamdal/	domestic		1978	normal	mechanic, biological	200	200	Bayangol	UBUSUG	48.0063	106.7298
3		Khan-Uul	Airport WWTP	domestic		1985	normal	mechanic, biological	1000	2200	Tuul River	UBUSUG	47.8578	106.7523
4		Bayanzurkh	National Center of Contagious Disease WWTP	domestic	pre-treatment	1986	normal	mechanic, chemical	3000	600	Central Pipeline	Ministry of Health	47.9144	106.9486
5			Psychiatric Clinic WWTP	domestic	pre-treatment	1986	normal	mechanic, chemical	280	280	Central WWTP	Ministry of Health	47.9343	107.0153
6			MCS Sky resort WWTP	domestic		2009	normal	mechanic, biological, chemical	30	30	reused	MCS LLC		
7		Nalaikh	Nalaikh WWTP	domestic		1976	normal	mechanic	2000	4500	Tuul River	Chandmani Nalaikh	47.779	107.2648
8		Khan-Uul	Bio WWTP	domestic		1989	normal	mechanic, biological	700	1300	Tuul River	UBUSUG	47.8388	106.6774
9	Tuv	Zuunmod	Soum WWTP	domestic		1995	not normal	mechanic, biological	2700	2100	soil	Tuv Chandmani	47.6859	106.9423
10		Erdenesant	Soum WWTP	domestic		1971	not normal	mechanic	200	200	soil		47.3134	104.4935
11		Zaamar	Shijir Alt LLC WWTP	domestic		2006	normal	mechanic, biological	100	100	Tuul River	Shijir Alt LLC	49.2969	104.4098

Domestic wastewater treatment plants:

There are in total 18 domestic WWTPs in the Tuul River Basin. Of these, some 8 plants are located in Ulaanbaatar, 4 in Tuv aimag and 1 in Selenge aimag, respectively. And 5 plants are completely out of service.

Ulaanbaatar city DWWTP: in Ulaanbaatar ger areas 61% of the households reside in houses and 38% reside in gers. And 92.8% of the households in ger areas have their own pit latrine within their fences. Most pit latrines can not be used from the last months of the winter due to full of solid and liquid wastes. As of 2010, 42% of Ulaanbaatar population are connected to the central network or have an access to improved sanitation.

Table 81. Sanitation availability of Ulaanbaatar population

Coverage	Population	Remark
Population have an access to the central sewage network	411 062	Subject to people who have an access to flush toilet connected to sewage system and WWTP.
Population have an access to improved sanitation	50 000	Subject to people who have an access to septic tank, flush toilet, improved pit latrine with air conditioner and eco-toilet.
Population have an access to non-improved sanitation	600 000	Subject to people who have an access to pit latrine, borehole, public toilet and open field.

Source: *Ulaanbaatar Water Supply and Sewerage Authority, 2010*

***Ulaanbaatar city central WWTP*:** receives pre-treated domestic and industrial wastewater from Ulaanbaatar and treats the wastewater through mechanical and biological treatment. The plant was established in 1964 according to a design prepared by Hydrocommunvodacanal Institute of Soviet Union based on the mission of Mongolian side. Its capacity is to receive normally 45,000 m^3 wastewater per day and to treat up to 50% by using mechanical treatment. In connection with the capital city's development, the Central WWTP was expanded in 1979 and 1986 with a capacity to receive 200,000 m^3 wastewater per day and to treat the pollution up to 90-92%. In principle, the current wastewater treatment method hasn't been changed since it was initially planned. Sludge is drained in its sludge bed by natural method without processing. This is because the sludge and residue processing system wasn't built according to plan. In order to improve land use and accelarate the sludge drainage process a sludge bed has been reconstructed as a sludge thickening area. Today the CWWTP receives 155-165 thousand m^3 wastewater per day, treats it by mechanical and biological treatment and delivers it into the Tuul River. Wastes, fat, oil, sand and sludge in wastewater are treated by mechanical treatment. And organic pollution is treated by biological treatment with the support of air and activated sludge by fermenting and mineralizing it, and disinfecting it by ultraviolet radiation. From 600 to 700 m^3 sludge is pumped into 44 small fields with a total area of 14.7 ha per day and drained by natural method. And 14-15 thousand m^3 drained sludge is collected and loaded on trucks, then transported and dumped into specifically prepared landfill areas. Liquid chlorine is poured into the channel of treated wastewater with the support of a weight measurer.

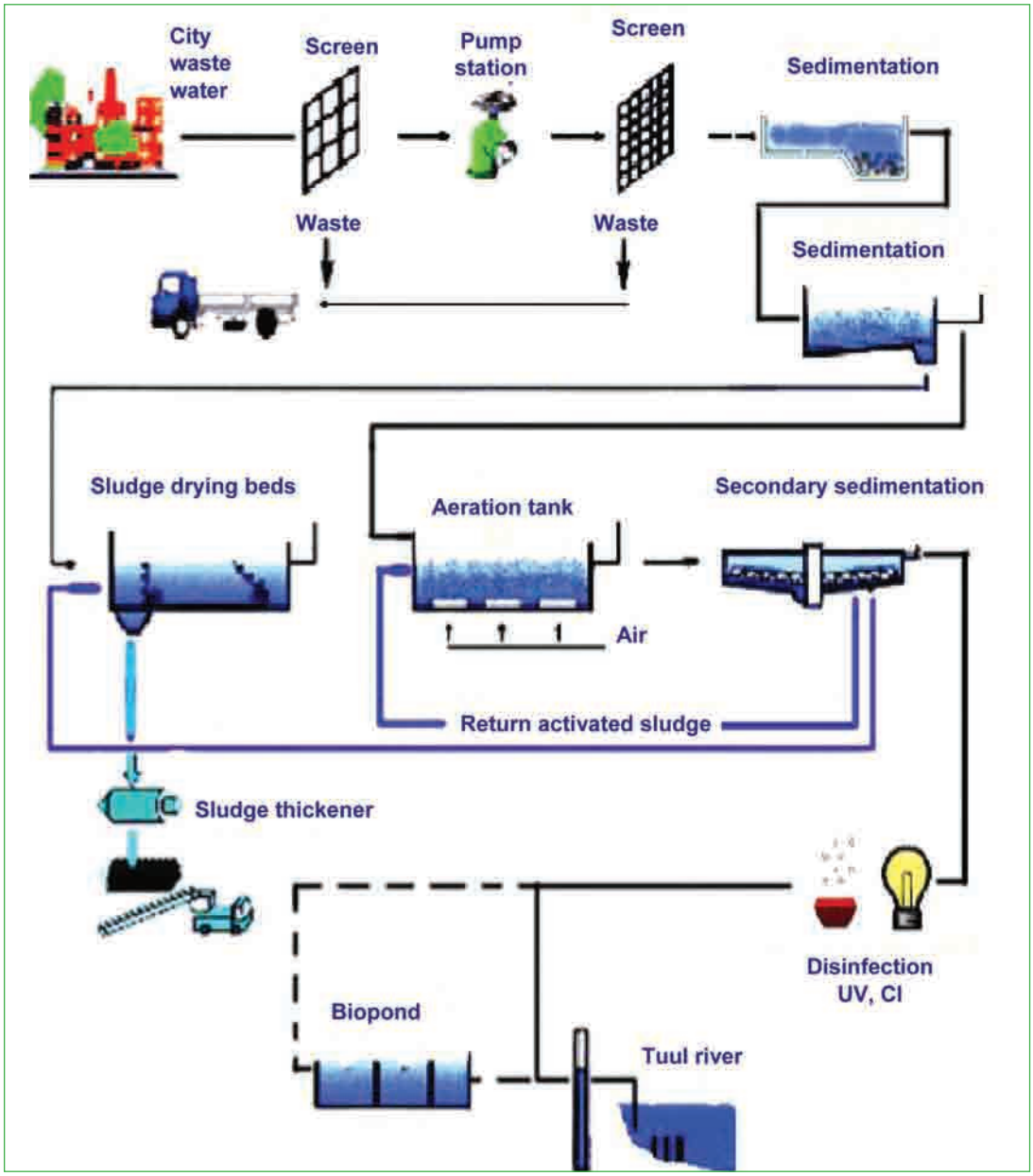

Figure 58. WWTP's technological conveyer

Pump station: when the pump station was firstly put into operation to receive wastewater from industrial region/district, there were only 5 SDV-2700/23.5 pumps and 3 RMU-4 screens. The pump station was additionally equipped with 5 AFP 5004 pumps and 3 ER screens. Today the station receives over 100 thousand m^3 wastewater per day and pumps it into the screens.

Pump station that receives domestic wastewater: firstly started its operation with GrUL-12 pump, 2 10F12 pumps and 2 MG-8 screens. Now it operates with 4 Cornell pumps and 2 ER screens. The station currently receives over 50 thousand m^3 wastewater per day and pumps it into the screens.

Screen: was put into operation with 4 MG-10 screens and 1 comminutor. During the operation, the comminutor was out of service and 2 screens were replaced with different screens manufactured in Mongolia. Currently, the screening is operating with 4 ER screens and a waste pump.

Grit chamber: there are four chambers in use. Each chamber has a hydro-elevator for delivering sand into sand field/site. Previously, water level in Parshall channel used to be measured by rake and received water here was determined by normal calculation. But now it is measured by Ultrasonic automatic measurer with a high accuracy.

Grit chamber

Discharge measurer /ultrasonic/

Figure 59. Grit chamber

Primary clarifier or raw residue pump station: 2 5F12 pumps (40 kW) and 1 SD-250/22.5 pump (37 kW) have been installed for the purpose of pumping sludge and raw residue into sludge bed. Also 4 radiation clarifiers (Sh40m) with 8Sh12 pump (55kWt) are being operated to empty the clarifier. Automation work has been carried out in pump station for pumping raw residues such as sludge, fat, grease and oil. And this is considered as a technical and technological innovation in a mechanical treatment conveyer. Consequently, it not only enabled to control, to regulate and to change operation of the station, but mechanical treatment level has been improved and safe operation has been provided.

Primary clarifier

Pump station for raw residue

Figure 60. Primary clarifier and pump station for raw residue

Aeration tank: 5 aeration tanks are being operating in four chambers. Previously, air used to be delivered to each chamber of aeration tanks with the support of grid boards. During the operation, these boards were cracked and air was largely lost. But now each aeration tank has been equipped with membrane diffuser and aeration has been improved.

Aeration tank

Aeration tank diffuser

Figure 61. Aeration tank construction

Aeration station: started operation in 1979 with 3 N-750-23 compressors and 2 K45/30 pumps for pumping water used in machines and equipments. In 1984 the station was additionally equipped with 3 N-750-23 pumps at 2nd expansion level. Since 1992, the operation started with 5 pumps. Now the station is operating with 3 KA22S compressors and 3 N-750-23 compressors.

Secondary clarifier and return sludge pump: there are 5 radiation clarifiers with a diameter of 40 m in operation. Pump station for activated sludge was firstly started with 5 10F12 pumps for pumping activated sludge into aeration tank, 1 5F12 pump for pumping excessive sludge, 2 D320/50 pumps for pumping water used in machine and equipments and 1 8F12 pump to empty the aeration tank and clarifier. Currently, 4 KX and CM pumps are being operated.

Return sludge pump

Second clarifier

Figure 62. Second clarifier and return sludge pump station

Disinfection: UV/Air disinfection system of DOOHAP LLC, Korea has been installed in 2010. It aerates wastewater and rays/beams it with UV lamp. That's why this system is cost-efficient and can kill bacteria without large facilities.

Figure 63. Disinfection facilities

Central WWTP sludge processing equipment: its location was determined in connection with Ulaanbaatar population density, development and settlement in 1960-1970. As the city expanded, now the location is almost in the middle of the city. And gas and odour emission from sludge which drained on open field might negatively affect the human health and hygiene. As the drained sludge is dumped into landfill, there is a risky condition of pollution in soil and water of that area. Therefore, it is necessary to launch a technology that completely processes the sludge from the WWTP.

There were 2 old clarifiers with a diameter of 28 m in 2008. But they have been newly equipped and now used as the sludge thickening equipment. Also 2 BS-25 filter-presses have been installed within the framework of a project implemented by the government of Spain. The sludge thickening equipment pumps 3122 m^3 sludge and raw residue mix with 98.5% moisture from the primary clarifier per day according to its operation mode. Sludge pump station has been restored and two pumps have been installed, additionally. Then thickened sludge is dehydrated by 2 BS-25 filter-presses. In the result, sludge moisture becomes less than 80%, volume becomes 234 m^3 and the treated sludge is enabled to be directly transported and dumped into landfill.

Figure 64. Sludge thickening equipment

Bayangol WWTP /Nairamdal children's camp/: was established in 1979 under UBUSUG for the purpose of carrying out mechanical and biological treatment by technology of the Soviet Union. In 1996 the plant was expanded and 2 KU-100 equipments were installed. Now it is consisting of pump station, currently used KU-100 equipment as well as sludge bed. Treatment capacity is 400m^3 domestic wastewater. The plant receives 350-450 m^3 wastewater per day or 140,000 m^3 per year wastewater from Nairamdal international children's camp and premises for treatment and discharges

the treated wastewater into environment. According to data and information from accredited Central Water Laboratory analyses of USUG, treatment level is 88%.

Airport WWTP: established in 1971 for the purpose of filter area under UBUSUG and innovated in 1973 for the purpose of carrying out mechanical and biological treatment by equipments and technology of Soviet Union. In 1989, the plant was expanded by installing 3 KU-200 equipments and establishing 3 sludge beds. Treatment capacity per day is 1000 m^3, but the plant currently receives 2000-2200 m^3 wastewater which is as much twice and treats wastewater by mechanical and biological treatment and delivers the treated wastewater into the Tuul River. According to data and information of the Central Water Laboratory analysis of USUG, treatment level is 86.4%.

***National center of contagious disease (NCCD) pre-treatment plant*:** was established in 1986 with a projected treatment capacity 3000 m^3 wastewater per day and treats 600 m^3 wastewater from the hospital and 219,000 m^3 per year. It carries out mechanical and chemical treatment in the wastewater and delivers it to the central wastewater pipeline. The plant has 5 technicians. Sludge from the WWTP is treated once a year and 42 ton sludge is discharged and dumped into the sludge bed of the Central WWTP. In 2008, technical innovation has been carried out and now the plant is being normally operated.

***Psychiatric hospital wastewater pre-treatment plant*:** was established in 1986 under the Ministry of Health within the scope of cooperation between Mongolia-Czechoslovakia. Mechanical treatment is daily carried out in 280 m^3 wastewater per day and in total 102,200 m^3 wastewater is treated per year. Some 60 m^3 wastewater is transported 12 times a day and delivered to the central wastewater pipeline. Sludge from the WWPT is treated and discharged once a year and dumped into the sludge bed of the Central WWTP.

Nalaikh district WWTP: was established in 1976 with a projected treatment capacity of 2000 m^3 wastewater per day. Currently, mechanical and biological treatment is carried out in 1450 m^3 wastewater and the treated wastewater is delivered to the Tuul River. Owner of this plant is Chandmani Nalaikh state owned company. The plant construction has a monitoring laboratory inside. Chemical analysis is carried out in raw and treated wastewater to/from the plant once a week.

Bio factory WWTP: was established in 1990 under UBUSUG for the purpose of carrying out a mechanical and biological treatment using equipments and technology of Soviet Union with a treatment capacity of 600m^3 per day. As of today, the plant receives and treats 290-320 m^3 wastewater per day from buildings with 60, 52 and 48 apartments, schools and kindergartens located in the territory of Khoroo 12 of Khan-Uul district, and the plant delivers the treated wastewater into the Tuul River. Treatment level was 50-76% in 2007, 54-82% in 2008 and 78-87% in 2009, respectively. Buildings of 60, 52 and 68 apartments in Khoroo 12 of Khan-Uul district don't have an access to hot water supply and it causes difficulties in operation of WWTP in winter and makes it impossible to carry out a biological treatment.

Figure 65. Bio factory WWTP clarifiers

"Sky Resort" skiing camp WWTP: Sky Resort was established in 2009 by MCS LTD and its domestic WWTP was built. The plant treats 30 m^3 wastewater per day by using mechanic, biological and chemical methods and reuses the treated wastewater as an artificial snow.

Zuunmod WWTP: was established in 1995 with a capacity of carrying out a mechanical and biological treatment in 2700 m^3 wastewater per day. During its normal operation, 2100 m^3 wastewater is treated per day. A technical innovation has been carried out in 2010-2011 and equipments manufactured in Poland have been installed. And 1 OZ-B/500/2 automatic screen installed in screening part, 1 OH 1/N9 manual screen installed for use while maintenance and treatment are carried out, and automatic discharge measurer, grit chamber and old hydro-elevator have been replaced and 2 MF404D underwater-operating grit pumps installed in water measuring channel, a new sludge stabilizer installed in old sludge mineralizing facilities, 2 IFRA 1F2 100T pumps installed for improving operation of primary clarifier, aeration system with a special aeration nozzle /254 pieces/ and 2 LDO Lange light sensors to determine oxygen content and 2 temperature sensors installed in aeration tank, AFP 1032.IM60/40 pump installed in the secondary clarifier, 70*70*1.9 m sized 4 bio ponds with soil dam and other auxiliary equipments, and fresh and wastewater and heating systems have been newly established. Also Russian Lonii-100 disinfection equipment has been replaced with CMP10-TEKNA disinfection equipment manufactured in Poland.

Shijir Alt LLC WWTP: the company runs gold mining activity in Zaamar soum of Tuv aimag and established mini-WWTP in 2003. The plant carries out mechanical and biological treatment in 150-200 m^3 domestic wastewater from mining camp and dumps the treated wastewater into the Tuul River.

Other domestic WWTPs

There are approximately 20 mini-WWTPs for the purpose of carrying out mechanical treatment with a capacity 15~2500 m^3 in the basin. General status for wastewater treatment technologies of such plants are shown in Table 82.

Table 82. Technology used in domestic WWTPs

Capacity, m^3/day	Total	Qty	Technology used in domestic WWTP
10 ~ 200	11	2	Mechanical screen to filter wastes, wastewater pipeline and wastewater is delivered to the Central WWTP in Ulaanbaatar.
		6	Mechanical screen to filter wastes, wastewater pipeline and wastewater is dumped into soil.
		3	Mechanical screen to filter wastes, comminutor, grit chamber, primary clarifier, aeration tank, secondary clarifier, wastewater is dumped into nature.
200 ~ 500	4	1	Mechanical screen to filter wastes, wastewater pipeline and wastewater is delivered to the Central WWTP.
		1	Mechanical screen to filter wastes, wastewater pipeline and wastewater is delivered into nature and soil.
		1	Mechanical screen to filter wastes, comminutor, grit chamber, primary clarifier aeration tank, secondary clarifier, chlorine disinfection equipment and wastewater is delivered into the Central WWTP.
		1	Mechanical screen to filter wastes, comminutor, grit chamber, primary clarifier, aeration tank, secondary clarifier and wastewater is dumped into nature.
500 ~ 1000	2	1	Mechanical screen to filter wastes, wastewater pipeline and wastewater is dumped into nature and soil.
		1	Mechanical screen to filter wastes, comminutor, grit chamber, primary clarifier, aeration tank, secondary clarifier, chlorine disinfection equipment and wastewater is delivered into the Central WWTP.
1000 ~ 5000	3	3	Mechanical screen to filter wastes, comminutor, grit chamber, primary clarifier, aeration tank, secondary clarifier, chlorine disinfection equipment and wastewater is dumped into nature.
> 300000	1	1	Mechanical screen to filter wastes, comminutor, grit chamber, primary clarifier, aeration tank, secondary clarifier, disinfection equipment with ultraviolet radiation and wastewater is dumped into nature.

Industrial WWTPs

Wool and cashmere processing factories and tanneries are concentrated in the floodplain of the Tuul River or in the territory of Khan-Uul district of Ulaanbaatar. These factories produce a significant amount of heavy metals and toxic substances. However, some of these factories have WWTPs but their operation is not normal. Industrial WWTPs in the Tuul River Basin are shown in Table 83.

Table 83. Large industrial WWTPs in the Tuul river basin

№	City	District	WWTP	Date put in operation	Capacity, m^3/day	Current capacity, m^3/day
1	Ulaanbaatar	Songinokhairkhan	Makh Impex shareholding company	1968	7000	7000
2			Mon Noos LLC	1982	1200	1200
3			Cashmere Holding LLC	1978	3000	3000
4		Khan-Uul	Gobi shareholding company	2009	50	50
5			Goyo LLC	2001	10	10
6			Khargia Ulaanbaatar-owned company	1972	13000	5300

Makh Impex shareholding company wastewater pre-treatment plant: Makh Impex LLC was established in 1972. And the pre-treatment plant's equipments and technology are now outdated and damaged. Nowadays 164 m^3 wastewater from the sausage factory and butchering factory is treated per day and treated wastewater is delivered to the Central WWTP. Oil Parshall equipments are already outdated and damaged and factory operation is deficient.

Mon Noos LLC wastewater pre-treatment plant: was established in 1979 and used to carry out pre-treatment in industrial wastewater from the factory and deliver it into the Khargia pre-treatment plant. But now wool factory operation is completely out of service. And domestic wastewater from Orkhon University and Kherchsen Guril (chomped/prepared noodles) Factory is delivered to the Central WTTP through this pre-treatment plant.

Cashmere Holding LLC wastewater pre-treatment plant: established in 1980 and previously owned by Eermel shareholding company. Mechanical treatment is carried out in 60-75 m^3 industrial wastewater from wool processing, washing and dying factory and the treated wastewater is delivered into the Central WWTP. Its clarifier capacity is 6.6 m^3. Sludge after treatment is treated on weekly basis and 18 ton sludge is dumped into landfill monthly. The company has the plant's technological innovation project formulated by Us Borgio LLC and is preparing for its implementation in the future.

Goyo LLC wastewater pre-treatment plant: established in 2001 and located in the territory of Khan-Uul district of Ulaanbaatar. It treats industrial wastewater produced during the operation of wool and cashmere processing factory and delivers it into the Central WWTP. And its treatment capacity is 50 m^3 per day. There are two separate pre-treatment plants to treat industrial wastewater from washing and dying workshops. The wastewater is analysed by the industrial wastewater laboratory of the Central WWTP on regular basis.

Gobi shareholding company wastewater pre-treatment plant: established in 2009 and located in Khan-Uul district. Pre-treatment is carried out in industrial wastewater from washing and dying workshops of wool and cashmere processing factory and the treated wastewater is delivered into the central wastewater pipeline. Its treatment capacity is 10 m^3 per day. Before the pre-treatment plant was established, industrial wastewater used to be delivered into the Central WWTP. At that time, industrial wastewater exceeded than the treated wastewater standard. Since the pre-treatment plant was established, it has been normally operating.

Khargia wastewater pre-treatment plant (Ulaanbaatar-owned company): established in 1972 as a part of manufacturing factories with main function to pre-treat industrial wastewater from tanneries up to a particular composition content and deliver the treated wastewater into the Central WWTP.

The plant was expanded in 1975 with neutralizing station, reservoir to receive wastewater with a chemical composition, stabilizing reservoir, pump station and horizontal clarifier for wastewater contains both chrome and other chemical composition, respectively. The plant has been updated with a capacity of 13865 m^3 wastewater.

Figure 66. Khargia industrial wastewater pre-treatment plant

There are over 20 factories and economic entities which are connected to the plant through 2 special pipelines with a diameter of 300-500 mm. Depending on old and depreciated equipments and outdated technology used in chemical treatment of the plant, wastewater treatment operation basically stopped. And it was negatively affecting treatment level of the Central WWTP. Technology to neutralize trivalent chrome by calcimine has been used and wastewater contains alkali and chrome has been received in two separate pipelines. Khargia wastewater pre-treatment plant has been restructured as Khargia shareholding company according to the resolution No.43 of the Privatization Commission of the Government of Mongolia in 1993. Due to deficiency in its operation, the plant has been also restructured as the Pre-treatment plant Ulaanbaatar-owned company according to the resolution by the Citizens' Representatives' Khural (City Council) in 2010. The plant has been renovated by the investment of MNT1.5 billion from the state budget and put into operation in April 2011. Currently, the plant treats 5400 m3 industrial wastewater from 4 tanneries and delivers to the Central WWTP.

Mini-industrial WWTPs

There are over 50 mini-industrial WWTPs in the basin which established by economic entities for the purpose of industrial wastewater treatment. It's good that these companies treat their industrial wastewater on their own costs. It has been considered that it is necessary to put non-operating treatment plants back into operation, to renovate and improve them and to stabilize their operation. It is necessary to make analysis on the current situation of treatment plants except plants of Arildii LLC, Future LLC, Lora Piana Mongolia LLC and Ikh Ergelt LLC. And to take certain measures which might suitable for their own technologies over improvement of wastewater treatment level.

Figure 67. Newly established wastewater pre-treatment plant of Future Holding LLC

Figure 68. Newly established wastewater pre-treatment plant of Arildii LLC

Non-operating WWTPs

As of 2010, there were 9 non-operating domestic WWTPs and 1 non-operating industrial WWTP in the Tuul River Basin (Table 84).

Table 84. Non-operating wastewater treatment plants in the basin

№	City and aimag	Soum and district	WWTP	Date put into operation	Type of treatment	Projected capacity, m^3/day	Geographical coordinates		Measure to take in the future
1	Ulaanbaatar	Khan-Uul	Poultry farm WWTP	1981	Mechanical and biological	500	47.77	106.65	To put into operation
2		Nalaikh	Gorodok area WWTP	1989	Mechanical and biological	2800	47.79	107.41	To put into operation
3		Songino-Khairkhan	Pig farm WWTP	1980	Mechanical	270	47.91	106.80	To study and use
4	Tuv	Bayantsogt	Soum WWTP	1973	Mechanical	200	48.12	105.81	To put into operation and renovate
5		Zaamar	Soum WWTP	1968	Mechanical	240	48.21	104.77	To put into operation and renovate
6		Bayan Khangai	Soum WWTP	1989	Mechanical and biological	200	47.95	105.54	To put into operation
7		Ugtaal	Soum WWTP	1983	Mechanical and biological	200	48.07	105.44	To put into operation
8		Sergelen	Soum WWTP	1973	Mechanical and biological	560	48.32	107.71	To put into operation
9	Selenge	Orkhontuul	Soum WWTP	1974	Mechanical	450	48.83	104.80	To put into operation and renovate
10	Bulgan	Bayannuur	Soum WWTP	1976	Mechanical	100	47.37	105.95	To put into operation and renovate

Sanitation in sanatorium and spa resorts

Table 85. Sanitation in sanatorium and spa resorts that have been involved in the study

№	Sanatorium and spa resorts and their owners	Type of treatment / waste water handling
1	Ar Janchivlan (of Administration of Livestock Fattening Area in Erdene soum)	Mechanical and biological treatment is carried out and wastewater is dumped into soil.
2	Terelj Saran Travel hotel (in Nalaikh district)	Wastewater is stored in ferro-concrete tank with capacity of 200 ton and dumped by carrying it.
3	Ulaanbaatar-2 camp (of Ulaanbaatar hotel)	Wastewater is stored in ferro-concrete tank with capacity of 40 ton and dumped by carrying it.
4	Terelj Suikh camp (of Gachuurt LLC)	Mechanical and biological treatment is carried out in summer and wastewater is dumped into soil; Wastewater is pumped into pit with capacity of 24 ton in winter
5	Gorkhi Melkhii Khad camp (of Customs General Authority)	Wastewater is stored in ferro-concrete tank with capacity of 100 ton and dumped by carrying it.
6	Gorkhi camp of (of the government)	Wastewater is pumped into pit with capacity of 10 ton
7	Ar Khuvch camp (of Ulaanbaatar hotel)	Wastewater is pumped into pit of Ulaanbaatar-2 camp
8	Other camps and children's camps	Public toilet

4.7.4. Recommendations on sanitation and WWTPs

- To pay attention to following issues: On average, 160-170 thous.m^3 waste water is discharged into Tuul river daily, from WWTPs operating in the Tuul river basin. It

deteriorates the self-treating process of river water and it has negative impacts on water bodies. It disrupts the possibilities of people and livestock to live in healthy and safe environment.

- Develop layout to renovate, maintain and conduct detailed research in non-operating WWTPs in basin's soum centers and Ulaanbaatar city including Poultry farm, Pig farm and Gorodok. To renovate facilities and put them back into normal operation.
- To renovate WWTP equipments, to improve monitoring activities on treatment level of treated wastewater and to make it constant;
- To make amendment and alteration in the relevant legislation having a condition which will grant a permission for running production in case of industrial wastewater meets the standard level, doesn't have a negative impact on the nature and ecology, and meets the hygienic requirements;
- To enforce Mongolian Law on Water Pollution Fee;
- To improve operation and use of Khargia pre-treatment plant;
- To enable biological treatment
- To create opportunity to collect the treated wastewater in specifically designed ponds and reuse it for industrial purpose without delivering it into the Tuul River and the Central WWTP
- To process sludge from WWTP and to put it into domestic circle. To take systematic measures: abstract flammable gas and energy from sludge pumped by conveyer and use it in producing fertilizer, curbs, etc;
- To launch a technology that collects the treated wastewater in ponds for reuse without dumping it into natural water sources and soil;
- To draw up and enforce a general technical requirement standard and instruction for using a septic and mini WWTPs for the purpose of domestic wastewater treatment;
- To bring the wastewater pipeline closer to ger area and to establish a new one;
- To carry out an inventory on pollution point sources of the Tuul River and to precisely determine boundaries of the river's self purification;
- To organize framework to protect the Tuul River from pollution and scarcity in the scope of activities of the Tuul River Basin Council;
- To draw up and enforce a technological solution for wastewater treatment which is suitable for Mongolian natural and climate conditions, households, organizations, soum and settled areas;
- To train professional personnel and familiarize with imported sanitation equipment and technology in providing normal operation of the equipments that carries out treatment, disinfection and processing and monitoring of wastewater and its sludge. And to properly deal with the financial sources for carrying out investigations.

4.7.5. Flood protection systems

The Tuul River Basin includes large factories, economic entities and important state objects in Ulaanbaatar city and Zuunmod city which are important for the country's economy. Therefore, over 100 km dam and drainage channels and 70 km underground pipelines with 18 collectors and 40 water drainage constructions to drain rain and soil

water have been established and are being used for the purpose of protecting the important objects from flash floods in dry channels and rivers.

Figure 69. During flood in Ulaanbaatar in 2009

In order to make an assessment and conclusions on the current situation of flood protection constructions, some flood protection systems in Ulaanbaatar have been considered.

After flooding took place in Ulaanbaatar in 1966, first investigations on flood protection systems were started, design work was formulated and construction started. Flood protection structures were additionally built after the flash flood disaster due to heavy shower in August 1982 near Chingeltei Mountain of Ulaanbaatar. Hydro-construction Ulaanbaatar-owned company is responsible for improving Ulaanbaatar city infrastructure engineering facility, renovating flood protection facilities and pipelines, watering/irrigating lawn and trees by using soil water, constructing/establishing parks consisted of irrigation systems, fountains and ponds, managing its maintenance, service and use.

Flood protection systems in the vicinity of Ulaanbaatar which are independent from one another can be considered as follows:

Flood protection system of West Mountain: involves flood protection channels in Denjiin Myanga, channel from 32 circle and Nogoon Lake to Dund River, flood protection systems in the 3rd and 4th sub-districts and Tolgoit River. Flood protection channel was built in 1965 with a length of 23.7 km in order to protect central Ulaanbaatar from flood from south and south-west ravines of the Chingeltei Mountain. This channel was built not only for protecting Ulaanbaatar from flood but for the purpose of improving water environment in downstream part of Nogoon Lake and creating micro climate. This channel collects flood water from all channels and ravines of Denjiin Myanga and the West Mountain, rain water from the 3rd and 4th sub-districts, water from flood protection channel and all the channels and ravines of north hill of the 1st sub-district. Then the channel joins with flood protection channel of Tolgoit River and flows into Dund River.

The West Mountain channel not only delivers flood water but represents a channel which drains /shallow/ groundwater or spring, water loss from heavy and engineering pipelines and wastewater from ger area, etc. Therefore, under-road water drainage facilities are full of ice and frozen in winter and large amount of ice coverage appears along the channel. It makes the channel incapable to carry spring flood.

As the flood protection channel and trench are filled with ice and frozen, spring snow and ice water overflows the channel and flood disaster strikes the city's roads, squares

and buildings. Except that, ice significantly degrades the quality of concrete products. Due to this situation, city of Ulaanbaatar suffers from melt snow and ice runoff or spring flood and it caused huge damage repeatedly in both direct and indirect ways. Considerable amount of sediment is collected in the West Mountain channel by flood water from the roads, squares and side channels during summer rain. After flood, some 20-30% of cross section in some parts is covered by mud and sometimes the West Mountain channel is completely covered by gravels (sediments) transported by flood water from the side channels, channels and ravines. It causes flood disaster surrounding area. For instance, considerable amount of waste, gravel and sand are transported by flood water through the 3rd channel of Denjiin Myanga and deposited in confluence of the West Mountain channel. As it encloses the channel and flood water overflows, city of Ulaanbaatar is suffered from flood disaster. Another important part of flood protection systems of the West Mountain is a channel with internal prefabricated ferro-concrete layer and with a length of 4.36 km located in the 3rd and 4th districts.

People dump their wastes into the channel and some fences were built very close to the connection construction in the end of ravine which joins the channel. And it makes unable to clarify and collect solid wastes transported by flood water before entering the channel. In other words, gravels and stones transported by flood water along the channels directly enter and deposit in the channel. It not only reduces the channel's capability of water drainage, but also covers/clogs main channel (which water flowed through) by gravels and stones in several events. And there have been two flood disasters nearby.

It is necessary to build a clarifier to screen solid runoff in the beginning of constructions connected to channel in the end of dry channels and to clean the clarifier on regular basis. It is impossible to maintain a normal operation of the flood protection system in the 3rd and 4th sub-districts without establishing such clarifier.

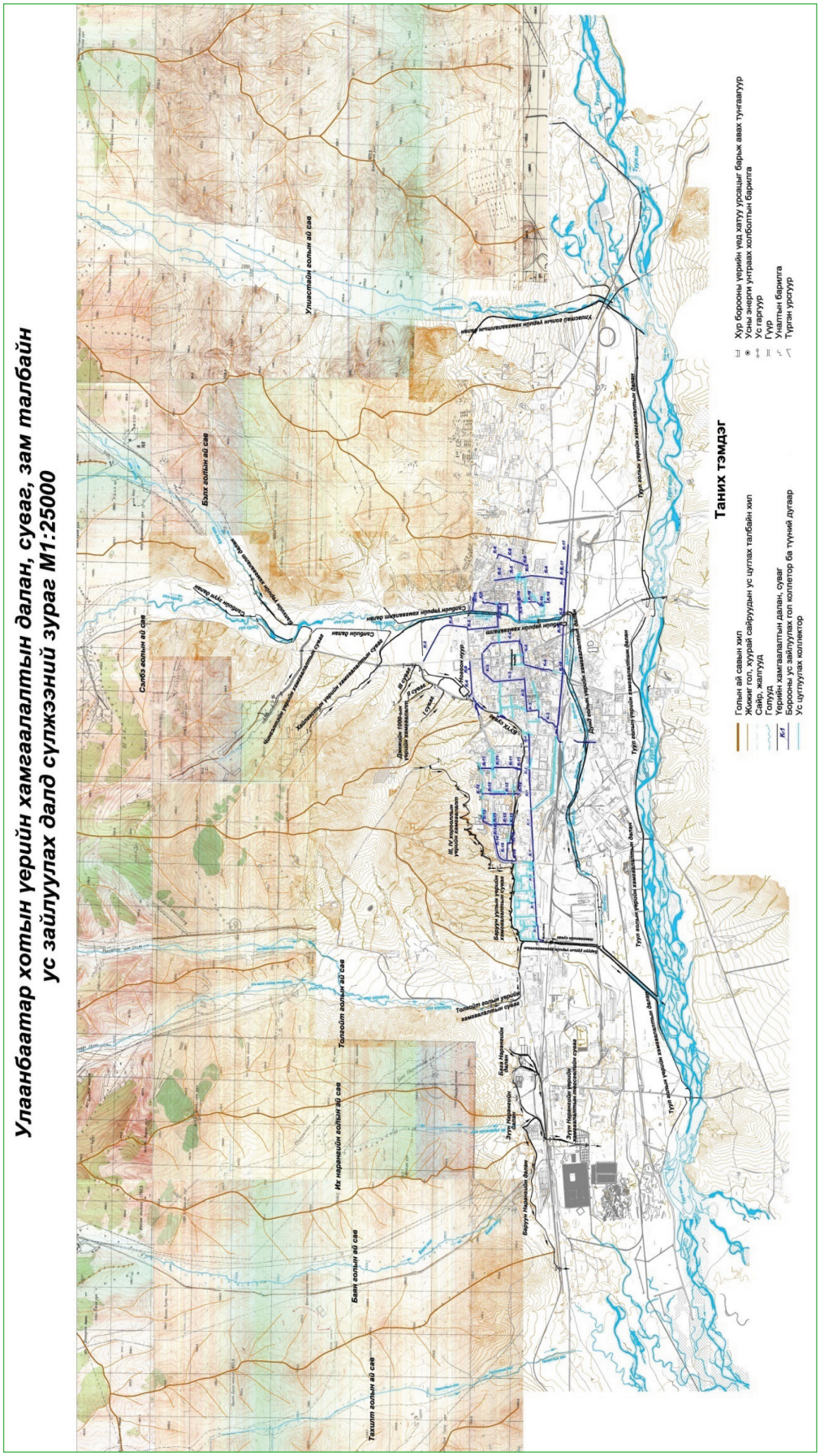

Figure 70. Layout of flood protection systems in Ulaanbaatar

As we can see from the study, this main channel was built with a drainage capacity of 5.7 m^3/sec flood water in its upstream part. But flood discharge in 2003 and July 2009 was 7.5-9.5 m^3/sec which is two times more than the channel capacity. During the floods, flood water overflowed the dam which collects sediment and flood disaster has been caused. In the West Mountain flood protection, number of hydro-technical constructions such as dyke, channel, tunnel, trough channel, clarifier, underground water transmission pipeline, water inertia-reducing well, sediment Parshall, chute, etc are used in combination. This can possible lead to a loss of normal operation and flood disaster if waste is dumped there and they are clogged by construction wastes, etc. So it is necessary to provide citizens with awareness in this regard.

Flood protection system in Selbe river: involves flood protections of Chingeltei, Khailaast and Belkh rivers, the tributaries of the Selbe River. It was planned to build the combined system of a dam and channel along the Selbe River channel from the Dund River upstream part to the Khailaast River downstream part or the bus station II. The channel's inside wall was built with stones mixed with remicon. This construction still existing upstream of the bridge on the Selbe River of Ikh Toiruu (big ring) and has been used for more that 4 decades. But recently the stones have been peeled off and used for other purposes. Consequently, there is a condition that brittles the dam and to be washed by water runoff.

Improving the water environment within the city of Ulaanbaatar by using Selbe River water has a multi-functional importance such as creation of a micro-climate and improvement of the city's appearance, etc. Systems in the Selbe River really can't meet current demand in terms of its design suitability, appearance and damage. Along the river channel, weir collects 40-50 cm sediments in thickness and decreases the river's flood passing capacity. In some parts of the river, flood water with 1% probability is incapable to be passed. It is necessary to update the design of flood protection systems in the Selbe River and to increase the bridge's capacity to pass river water and to remove currently damaged concrete weir.

Figure 71. Flood protection channel in the Selbe River

Flood protection system of East Mountain: collects snow and rain water through open natural channel near Tsagaan Davaa and Shar Khad areas and the water flows through

underground pipelines. It is connected to ravine that protected by soil dam located in the west of Police Department of Bayanzurkh district through water inertia-reducing well. Then it is delivered into the Tuul River through tunnels under Narnii Zam /road/ and railway. Currently, ger area and buildings are being built on watershed area of dry channels. This leads to tricky situation which causes flood disaster.

***Flood protection system in the Tuul river*:** involves the west flood protection dykes in Uliastai and Tuul Rivers. Dam in west bank of Uliastai River was established continuously as a soil dam 24.5 km in length with internal stone layer along the north bank of the Tuul River until the Sonsgolon Bridge. Due to human activities, the flood protection dyke was cracked and partially damaged in several parts during the long period of use and became unable to pass the flood water through it. Even an apartment block was built in the flood protection dyke of the Tuul River.

***Zuun Naran flood protection system*:** involves soil/ channel dug in the west and east of the existing oil base and the channel located in the end of Baga /small/ Naran dry channel.

***Baruun Naran flood protection system*:** involves soil dam which directs the flood water from Ikh Naran and Bayangol valley and drainage pipes under railway and the roads.

4.7.6. Conclusions on flood protection systems

- It is necessary to successfully pass and protect from possible flash floods in Ulaanbaatar. Location and number of engineering construction is lacking and unprepared to operate in summer.
- Complex measures to protect Ulaanbaatar from flash floods, river floods, soil water and rain water have been planned in the general development plan for Ulaanbaatar until 2020. But its implementation is insufficient. Re-planning of Zuun and Baruun Naran flood protection systems included in the general development plan, but implementation of measures became not possible due to settlement of population in the watershed area and land has been privatized.
- During the flood, flood protection channel and clarifying lake near Denjin Myanga and Nogoon Lake is full of sludge and wastes from ger area. As fly, mosquito and pests are bred here, it leads to a condition of contagious disease which has a negative impact on social hygiene.
- Due to low drainage capacity of flood water passing channel, it can't pass a particular part of the flood water. And this may lead to condition in which Ulaanbaatar suffers from flash flood. Renovation is required in the flood protection dyke and channels in Khailaast and Chingeltei areas.
- As there is no flood protection system in the vicinity of Yarmag, Airport and Bio factory, it is necessary to be newly established.
- If it rains near Dari-Ekh and Maakhuur Tolgoi /hill/ flood water flows towards the 13th and 14th sub-districts and blocked by road and railway. As a result, puddle is created and soil is polluted. This possibly has a negative impact on social health. Therefore, it is necessary to take measure on flood water drainage.
- It is necessary to clearly determine the maximum runoff of unstudied small rivers, springs and dry channels which have small watershed area in the vicinity of the city center, and to build a robust hydro-construction with a high quality which will survive for 100 years, by design with the most rational technical solution. This is for the purpose of a successful pass of the largest flood which possibly can occur once-in-hundred years and safe protection of the city from the flood disaster.

- Tuul River dam urgently needs a complete renovation and maintenance.
- Large amount of flood water is unable to pass by the Arslantai Bridge on the Selbe River, but only 70% of a flood with 1% probability is able. Therefore, it is necessary to renovate the Arslantai Bridge, flood protection dyke and channel in the Selbe River.
- Migrants from rural areas settle down on ravine mouth and dry channels without permission and disregard the resolution of local administration. Consequently, they may largely suffer from flood disaster and it causes big damage during the flood. Therefore, it is necessary to create a legal system to completely stop old practice in which sufferers receive the state grant and aid.
- Hydro-Construction Ulaanbaatar-owned company in charge of operation and maintenance of the flood protection and snow/rain water drainage systems in Ulaanbaatar needs to focus on taking measures for protection from the flood disasters mentioned in this report.

4.7.7. Rain and snow water drainage systems

Due to global warming and degradation of the ecological condition of the Ulaanbaatar environment, annual precipitation and its in-year distribution have significantly changed. Rainfall in and around the city has been likely turned into type of heavy shower in recent years and risk of flood disaster is being increased. Meanwhile, paved roads and squares in the city have a low drainage capacity and are clogged in some parts. Consequently, the city streets and squares are likely to suffer repeatedly from flood disaster.

There are currently 18 collectors consisting of ferro-concrete pipelines with a length of 30 km (with a diameter of Ш500, Ш600, Ш800, Ш1000 and Ш1500) for rain and snow water drainage in Ulaanbaatar. Each collector consists of own water collection pipeline. Total length of water collection pipeline is more then 50 km. These water collecting pipelines are the underground network with a special function to drain water from rain/snow and water filtrated from groundwater in the territory of 6 districts of Ulaanbaatar. The drainage capacity of these collectors' pipelines ranges between 0.1-4.0 m^3/sec.

Figure 72. Clogging of rain water drainage pipeline during the flood

A pump station was put into operation in 1987 for underground pipelines to drain rain/snow water from surface of paved roads and squares. Capacity is 14000 m^3/hour

(Q=3500 m^3/hour per pump). This station is located in the west of Kharkhorin market in Songinokhairkhan district.

4.7.8. Soil water level drainage systems

As Ulaanbaatar is located in the floodplain and slopes of the Tuul River and its tributaries, soil water levels are often high depending on changes in groundwater levels and precipitation amounts. This situation still continues as soil water lowering constructions were not built in Ulaanbaatar so far.

There are a number of cases with damages caused by water such as erosion of construction basement, the basement and cellar suffer from flood water, subsidence of the construction basement and cracking of construction wall, and damage in electric cable and other underground engineering pipeline networks in some parts with a high soil water fluctuation such as central part of Ulaanbaatar (along the old West Selbe River channel), Bayankhoshuu, Khaniin /wall/ material ger area, ger area from school No.17 to the east of Doloon Buudal /bus station 7/, Gandangiin Khur, 16th sub-district, Dari-Ekh ger area and Dambadarjaa ger area, etc.

There are cracks in walls and damages to floors of the first floor of some 20 buildings such as building No.14, 44, 16 and 13 in the city center and Baga Toiruu, some buildings of the 1st Duchin Myangat /40,000/ and Tavan Myangat /50,000/, the State Palace, Property Authority building, expansion of National History Museum, Art Museum, etc. It has a negative impact on working and living conditions of citizens. Also moisture in the basement/cellar of some buildings in both summer and winter creates a humid environment. As a result, flies, mosquitoes and pests are breeding leading to outbreak of contagious diseases. One of two Gandan children's hospital buildings is completely collapsed, and Tolgoit road is damaged and it is unavailable for cars. Except that, some 40% of buildings in the central part of Ulaanbaatar suffer from the impact of soil water to some extent.

The first project for protecting Ulaanbaatar from the impact of /shallow/ groundwater in the northern and central parts of Ulaanbaatar and measures to be taken to protect from this impact was formulated by Gyprocommunstroi institute of Soviet Union in 1959. Ever since this first project, several Mongolia's Investigation and Design Institutes carried out investigations, formulated projects and made proposals. However, it wasn't implemented. A system to provide safe flood protection in Ulaanbaatar, to lower impact of soil water and to drain rain water from the road and squares will support the city's sustainable development and will protect the citizens' peaceful life and their properties.

5. WATER USE BALANCE OF THE TUUL RIVER BASIN

As of 2010, the Tuul River Basin comprised 43% of Mongolia's population or 1.19 million people and 2.72 million livestock. In Mongolia, the basin has the highest water demand, the most economic activities including thousands of economic entities, light industries, food processing industries, construction activities, building material industries, quarries and crop production, etc. The basin is very important by its socio-economic development.

To calculate the 'water balance' or water use balance of the Tuul River Basin, it is divided into 3 parts:

Upstream part: includes the river runoff forming area which requires protection or 4084.4 km^2 watershed area of several soums of Tuv aimag and small part of Nalaikh and Bayanzurkh districts of Ulaanbaatar city;

Midstream part: includes 5242.2 km^2 watershed area of 7 districts of Ulaanbaatar city and several soums of Tuv aimag considering socio-economic importance, perspective development, water consumption-use and hydrological monitoring location, etc;

Downstream part: includes 40447.7 km^2 watershed area of soums of Arkhangai, Bulgan, Uvurkhangai, Selenge and Tuv aimags considering water consumption-use, water pollution, flood risk and hydrological monitoring location, etc. (Figure 73 and Table 86).

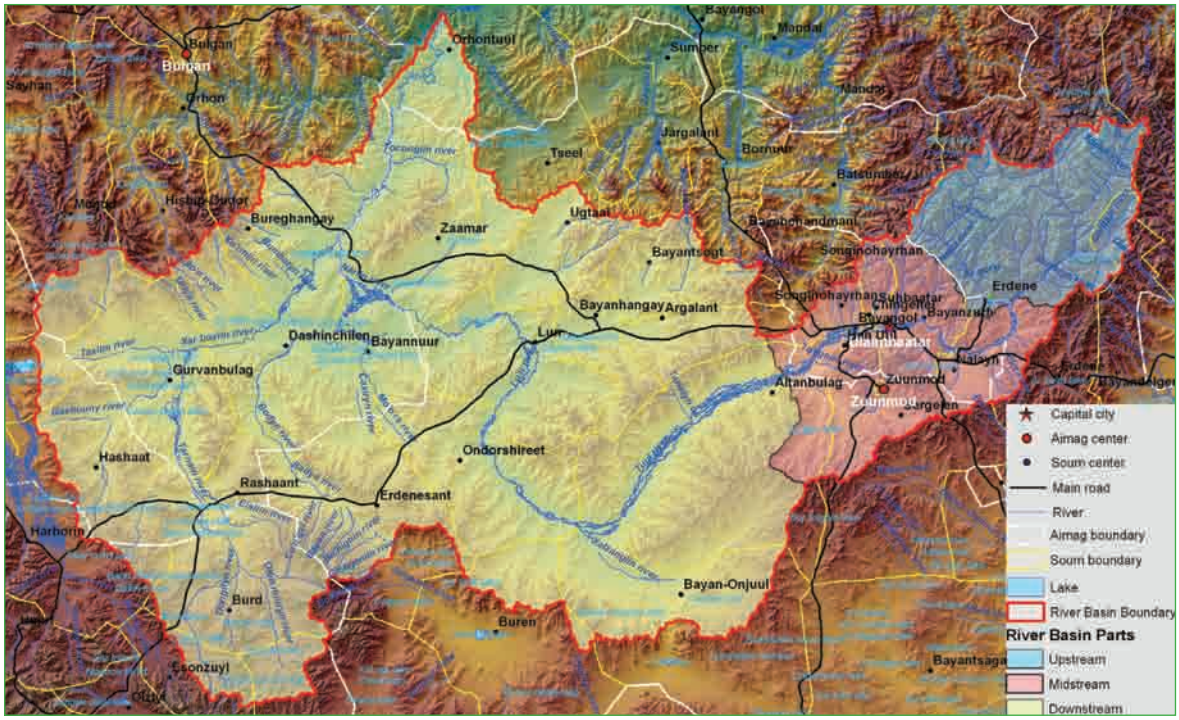

Figure 73. Tuul River Basin balance parts

The basin water resources consist of surface water and groundwater. The surface water resources mainly comprise the Tuul River and its tributaries while the main groundwater resources are composed of the alluvial aquifer groundwater in the Tuul River valley.

Table 86. The basin water use balance parts and its area

The basin parts	Included aimag and city	№	Included soum and district	Soum or district area in the basin part (km²)	Percentage of area inside the basin part (%)
Upstream part	Tuv	1	Batsumber*	7.9	0.3
		2	Mungunmorit*	27.8	0.4
		3	Erdene***	3 681.3	45.4
		4	Bayandelger	285.1	13.1
	Ulaanbaatar	5	Nalaikh***	69.3	10.0
		6	Bayanzurkh*	13.0	1.1
	Total of upstream part			4 084.4	
Midstream part	Ulaanbaatar	1	Bayanzurkh	1 215.9	98.8
		2	Nalaikh***	624.0	89.9
		3	Sukhbaatar	207.4	99.9
		4	Chingeltei	89.0	98.6
		5	Bayangol	23.6	100.0
		6	Khan-Uul	510.0	100.0
		7	Songinokhairkhan	373.6	31.0
	Total of Ulaanbaatar			**3 043.5**	
	Tuv	8	Batsumber*	1.7	0.1
		9	Erdene***	428.3	5.3
		10	Sergelen	1 101.2	29.0
		11	Zuunmod**	19.3	100.0
		12	Altanbulag***	617.4	10.9
		13	Argalant***	30.8	2.7
	Total of midstream part			**5 242.2**	
Downstream part	Tuv	1	Argalant***	943.4	83.9
		2	Altanbulag***	4 710.4	83.1
		3	Bayan-Unjuul	2 244.6	46.8
		4	Bayanchandmani	34.5	5.6
		5	Bornuur*	3.7	0.3
		6	Jargalant*	2.8	0.2
		7	Bayantsogt	1 330.3	90.2
		8	Bayankhangai	998.8	100.0
		9	Ugtaaltsaidam	1 403.0	90.4
		10	Tseel	385.8	23.5
		11	Zaamar	2 802.1	99.9
		12	Lun	2 541.4	100.0
		13	Undurshireet	2 623.5	39.2
		14	Buren	756.7	20.2
		15	Delgerkhaan*	2.4	0.1
		16	Erdenesant	2 510.3	74.0
	Selenge	17	Orkhontuul	824.7	28.0
	Bulgan	18	Buregkhangai	2 019.5	57.9
		19	Bayannuur	1 010.5	100.0
		20	Dashinchilen	2 309.7	100.0
		21	Rashaant	612.9	100.0
		22	Gurvanbulag	2 681.2	100.0
		23	Khishigundur	960.8	39.4
		24	Mogod	620.9	22.0
	Uvurkhangai	25	Bayanundur	508.1	14.4
		26	Burd	2 447.5	92.7
		27	Yesunzuil	428.2	21.8
		28	Kharkhorin	258.5	11.2
	Arkhangai	29	Khashaat	2 175.6	83.6
		30	Ugiinuur	295.7	17.6
		31	Ulziit*	0.3	0.0
	Total of downstream part			**40 447.8**	
Total of the basin				**49 774.4**	

Remark: * *Soum not included in the balance calculation because watershed area is less than 3% of soum area;*

** *Aimag centre-city;* *** *Soum in two basin parts.*

5.1. Water resources

5.1.1. Surface water resources

There were 287 rivers, 47 small lakes and 167 springs and streams at the basin level as of 2009.

The Tuul River runoff consists on average of 25% contribution by groundwater, 6% by snow and ice and 69% by spring, summer and autumn rain water. In terms of water regime type, the river is subject to a spring and summer flood regime. The spring flood volume is always smaller than the summer and autumn flood volume.

The basin annual average precipitation amounts to 246.7 mm (in the vicinity of Ulaanbaatar city) and 90% falls during the warm season from June to September. A significant part of the precipitation occurs in heavy showers.

It is estimated that 48.4% of annual average precipitation becomes evapotranspiration and 51.6% becomes surface water and groundwater recharge. The total annual runoff varies between 25.1 to 327.1 mm and amounts to 127.5 mm on average.

In general the Tuul river runoff increases in the upstream and midstream parts of the basin due to the inflow of groundwater and decreases in the downstream part of the basin due to evaporation of water and flooding in old river channels. The Tuul river runoff is reduced in the vicinity of Ulaanbaatar due to infiltration of surface water caused by the abstraction of groundwater by the cities water supply boreholes. The reduction in runoff is on average about 2 m^3/sec which is about 10% of the average annual flow.

The Tuul River freezes from the end of October to the end of April and the thickest ice coverage reaches more than one meter in February.

The Tuul river runoff is observed at several monitoring stations. In the upstream part of the basin the long term mean annual runoff as observed at Tuul-Bosgiin Bridge is 9.1 m^3/s and at Terelj-Terelj is 12.8 m^3/s. In the midstream part the long term mean annual runoff as observed at Tuul-Gachuurt is 23.2 m^3/s (observations have been terminated) and at Ulaanbaatar is 26.1 m^3/s. In the downstream part the runoff is observed at Altanbulag and at Tuul-Lun but records are too short to allow calculation of a mean. Observations have been done in the past at Undurshireet (21.1 m^3/s) and at Zaamar (22.2 m^3/s), respectively.

The Tuul River runoff shows periods of low and high flow. In general it was low between 1945-1957, high between 1958-1975, low between 1976-1981, high between 1982-1995 and low until 2010.

The average annual surface water resources in the basin are calculated by aimag, soum and Ulaanbaatar city in the upstream, midstream and downstream parts of the basin by using the specific runoff map (see Figure 8 of Chapter 2). The map indicates the mean quantity of surface water expressed in l/s·km^2 generated upstream of each location in the basin.

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 Tuul River specific runoff ranges from 6 to 7 l/s·km^2 in the upstream part, it ranges from 0.5 to 2 l/s·km^2 in the midstream part and decreases to 0.2-0.3 l/s·km^2 in the downstream part of the basin.

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, 90-93% in the midstream part and 93-95% in the downstream part, respectively.

The calculation of the 50% probability mean annual surface water resources in the basin indicates a total amount of 1,073.2 million m^3/year and a usable amount of 63.1 million m^3/year. According to the 90% probability, the surface water resources amount to 528.9 million m^3/year and a usable amount of 30.5 million m^3/year (Table 88).

A seasonal scarcity is observed in recent years in the Tuul River runoff near Ulaanbaatar city. The river water level decreases at the end of April and the river is dry in the vicinity of Ulaanbaatar water supply sources and further downstream until the inflow from the Central Wastewater Treatment Plant. This is due to the infiltration of surface water which recharges the groundwater abstracted by the water supply boreholes during the winter months (Dec, Jan, Feb and Mar). The river water infiltration is the highest in April with the largest infiltration rate at the Central source (Figure 74, calculation of monthly surface water infiltration by IWRM project based on a total groundwater abstraction of 178,375 m^3/day, which includes abstraction from private wells).

Source: *groundwater level data and infiltration estimate from IWRM project*
Abstraction data from USUG, 2010 (http://www.mne.mn/mn/)

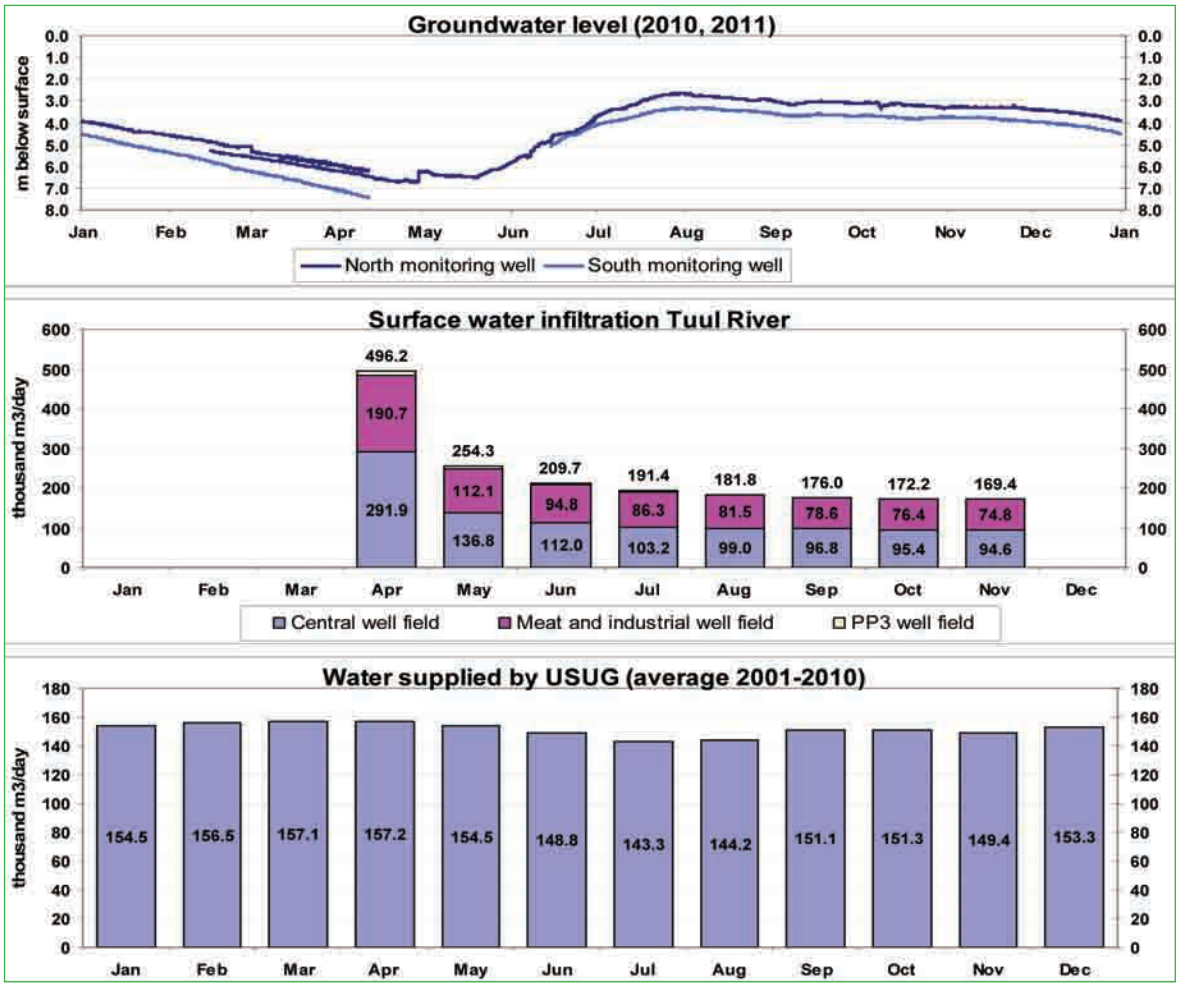

Figure 74. Groundwater level variation, river water infiltration and water abstraction in the vicinity of Ulaanbaatar city

5.1.2. Groundwater resources

In the Tuul river basin there are two main aquifer types: granular and fissured. The granular aquifers consist of Lower Cretaceous, Neogene and Quaternary deposits and the fissured aquifers are sedimentary, metamorphic rocks formed within the Cambrian, Devonian, Carboniferous, Jurassic and Triassic ages, respectively. The aquifer with the relatively largest groundwater resources is the Quaternary granular alluvial aquifer of the Tuul River. Aquifers with smaller quantities of groundwater resources are the granular aquifers in side valleys, terraces and slopes of the river basin and the fissured aquifers in the mountainous areas of the basin.

The total renewable groundwater resources in the basin have been calculated at 960 million m^3/year. This quantity is based on the average groundwater recharge in the basin derived from infiltration of precipitation and river water (see Table 16 of Chapter 2).

The renewable groundwater resources are 0-5 mm/year km^2 in Khashaat soum centre of Arkhangai aimag, Buregkhangai and Rashaant soum centres of Bulgan aimag, Burd soum centre of Uvurkhangai aimag, Argalant, Bayan-Unjuul, Bayantsogt, Undurshireet, Sergelen, Ugtaaltsaidam and Erdenesant soum centres of Tuv aimag and Orkhontuul soum centre of Selenge aimag. They are 5-10 mm/year km^2 at Zuunmod city and Altanbulag soum centre of Tuv aimag, 20-50 mm/year km^2 at Erdene soum centre of Tuv aimag and 40-80 mm/year km^2 at 6 soum centres including Bayannuur, Gurvanbulag and Dashinchilen of Bulgan aimag, Bayankhangai and Lun of Tuv aimag.

The highest renewable groundwater resources are found in the upstream part at 160 mm/year km^2 and along the river valley at 40-100 mm/year km^2.

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 637.7 million m^3/year of which 94.4% is located in 19.7% of the total area (this is less than the 640 million m^3/year presented in Table 17 of Chapter 2 because soums with less than 5% area inside the Tuul basin have been excluded in the water balance).

Investigations were carried out on groundwater resources and the exploitable resources were determined for water supply of the urban areas in the basin, viz. Ulaanbaatar city, Zuunmod city, Sergelen soum centre of Tuv aimag, Rashaant and Dashinchilen soum centres of Bulgan aimag and Khashaat soum centre of Arkhangai aimag. Also groundwater resource investigations were carried out and the potential exploitable resources were determined for new water supply sources in recent years in the Uvur Gorkhiin Khundii valley area, from the Tuul-Terelj confluence to the Kharztain tourist camp, and at Yarmag, Buyant-Ukhaa and Khui Doloon Khudag (this is located in the Kharaa River Basin, but close to the Emeelt area) (see Table 87).

Table 87. Exploitable groundwater resources in the vicinity of Ulaanbaatar and Zuunmod cities

№	Source	Resource, m^3/day		Remark
		Exploitable groundwater resource	Resources excluding C degree	
1	Central source	90,300 (A+B) + 34,800 (C1) = **125,100**	**90,300**	*Ulaanbaatar city water supply source. Its resource was determined in 1980 and it's been in use for years. C degree is removed from the resource because re-evaluation hasn't been carried out.*
2	Upper source	**89,700**	**89,700**	*Ulaanbaatar city and Nalaikh district water supply source. Its resource was determined in 1980.*
3	Industrial area source	30,300	**30,300**	*Khan-Uul district industrial and drinking water supply source. The resource was determined in 1980. Its water might be polluted and no longer used in drinking water.*
4	Thermo-power plant (No. 2, 3, 4) source	52,300	**52,300**	*Thermo-power plant No.3 and 4 sources. The resource was determined in 1980.*
5	Meat factory source	8,600	**8,600**	*West Ulaanbaatar city industrial and drinking water supply source. The resource was determined in 1980.*
Currently used resource		**360,000**	**271,200**	***This is the current approved exploitable resource that can be used per day.***
6	From Tuul-Terelj confluence to Kharztain tourist camp	17,193 (A) + 17,183.6 (B) + 5,685.1 (C1) = **40,061.9**	**40,061.9**	*New Ulaanbaatar city water supply source. The resource was determined in 2006 and currently unused.*
7	Uvur Gorkhiin Valley source	**11,750.4**	**11,750.4**	*New Ulaanbaatar city water supply source. The resource was determined in 2003 and currently unused.*
8	Yarmag source	**26,201.0**	**26,201.0**	*Its resource was determined in 2011 and is currently under construction for the purpose of using as drinking water supply source in new sub-districts of Airport and Yarmag.*
9	Buyant-Ukhaa source	**22,550.0**	**22,550.0**	*New airport sub-district drinking water supply source. The resource was determined in 2010 and hasn't been used as yet.*
10	Khusigiin Valley source	6,356.2 (Zuunmod) + 3,921.5 (new airport) = **10,277.7**	**10,277.7**	*The resources were determined as 6356.2 m^3/day for Zuunmod city drinking water supply in 2007 and as 3921.5 m^3/day for International Airport in 2010, respectively.*
11	Khui Doloon Khudag source	1,771.2 (B) + 2,073.6 (C1) = **3,844.8**	-	*The resource was determined in 2006. It can be used as Emeelt water supply source. However, it is located in the Kharaa River Basin.*
12	Additional Gachuurt source*	**25,000.0**	-	*Additional east Ulaanbaatar city and Gachuurt water supply source. The resource is not approved by the Water Authority because it is already included in the Upper and Central source resources. Therefore not included in total resources.*
Determined, but unused resource		**139,685.5**	**110,841.0**	***This is the additional exploitable resource that can be used per day.***
Total resources		**474,685.8**	**382,041.0**	***Annual water resources amount to 139,445 thousand m^3/year.***

*Remark: * It was determined to abstract 25,000 m^3 water from the Gachuurt source per day and its water abstraction facility is currently under construction with the support of the government of Japan.*

The exploitable groundwater resources for the Upper, Central, Meat Factory, Industrial and Thermo-power plant (No. 2, 3 and 4) water supply sources which are used as Ulaanbaatar city water supply sources were determined as 271.2 thousand m^3 per day. Groundwater investigation was carried out in some 6 areas (including Khui Doloon Khudag which is outside the basin) for the future use and total exploitable resources

were determined to be 114.7 thousand m^3, but these are unused so far. With the support of the government of Japan, a water abstraction facility is now under construction at Gachuurt for the purpose of 25.0 thousand m^3 groundwater resource use per day. But this resource wasn't approved by the Water Authority as a new additional source. This is because the volume is already included in the estimate of the Central and Upper sources.

Investigations carried out in 1980 revealed that it is possible to include 34.8 thousand m^3/day in the Central source resource in terms of C degree. But in view of a high risk of groundwater pollution in the aquifer in the downstream part of the Selbe River, it was considered that this quantity should not be included in the Central source groundwater resources. This was confirmed by pollution found in some boreholes near the Narantuul market. Therefore, the C degree exploitable resources are not included in the total resources.

Investigations in 2007 and 2010 in the alluvial-proluvial aquifer in the Khushigiin Valley which is the water supply source for Zuunmod city and Sergelen soum of Tuv aimag and the new international airport determined the exploitable groundwater resources to be 10277.7 m^3/day of which 6356.2 m^3/day is to be used for Zuunmod city and Sergelen soum water supply, and 3921.5 m^3/day for the new international airport water supply.

Monitoring of groundwater levels in the Tuul aquifer at Ulaanbaatar indicates an increase of the groundwater drawdown from 2-3 m observed in 1979-1980 to 3-4 meter at present days. The groundwater is abstracted in an area which is growing in size which means that the groundwater drawdown is experienced in an ever increasing area in April of every year.

The potential exploitable and exploitable resources are calculated for the upstream, midstream and downstream parts of the basin on an annual basis. Please see the results in Table 88 below.

Table 88. Surface and ground water resources of the Tuul River Basin

Basin part	Included aimag and Ulaanbaatar city	№	Included soum and district	Water resources, *million m³/year*							
				Surface water						Ground water	
				Surface water resources		Ecological resources		Possible usable resources			
				Probability P=50%	Probability P=90%	Probability P=50%	Probability P=90%	Probability P=50%	Probability P=90%	Potential exploitable resources	Exploitable resources
1	2	3	4	5	6	7	8	9	10	11	12
Upstream part	Tuv	1	Batsumber*	-	-	-	-	-	-	-	-
		2	Mungunmorit*	-	-	-	-	-	-	-	-
		3	Erdene	414.00	240.12	393.30	228.11	20.70	12.01	36.00	-
		4	Bayandelger	27.00	15.66	25.65	14.88	1.35	0.78	6.00	-
	Ulaanbaatar	5	Nalaikh	9.00	5.22	8.55	4.96	0.45	0.26	2.00	-
		6	Bayanzurkh*	-	-	-	-	-	-	-	-
Total of upstream				450.00	261.00	427.50	247.95	22.50	13.05	44.00	-
Midstream part	Ulaanbaatar	1	Bayanzurkh	30.82	13.25	28.20	12.13	2.62	1.13	34.00	138.3
		2	Nalaikh	16.08	6.91	14.71	6.33	1.37	0.59	11.00	
		3	Sukhbaatar	5.36	2.30	4.90	2.11	0.46	0.20	0.30	
		4	Chingeltei	2.01	0.86	1.84	0.79	0.17	0.07	0.30	
		5	Bayangol	0.67	0.29	0.61	0.26	0.06	0.02	2.00	
		6	Khan-Uul	12.73	5.47	11.65	5.01	1.08	0.47	22.00	
		7	Songino Khairkhan	9.10	3.91	8.33	3.58	0.77	0.33	7.00	
		Total of Ulaanbaatar		76.77	32.99	70.24	30.21	6.53	2.81	76.60	**138.3**
	Tuv	8	Batsumber*	-	-	-	-	-	-	-	-
		9	Erdene	10.05	4.32	9.20	3.95	0.85	0.37	1.00	
		10	Sergelen	24.12	10.37	22.07	9.49	2.05	0.88	6.00	3.75
		11	Zuunmod	0.67	0.29	0.61	0.26	0.06	0.02	0.06	
		12	Altanbulag	18.09	7.78	16.55	7.12	1.54	0.66	5.00	
		13	Argalant	-	-	-	-	-	-	-	-
Total of midstream				**129.70**	**55.77**	**118.67**	51.03	11.03	4.74	88.66	142.0

1	2	3	4	5	6	7	8	9	10	11	12
Downstream part	Tuv	1	Argalant	11.40	4.90	10.72	4.61	0.68	0.29	8.00	
		2	Altanbulag	58.20	25.03	54.71	23.52	3.49	1.50	58.00	
		3	Bayan-Unjuul	27.00	11.61	25.38	10.91	1.62	0.70	4.00	
		4	Bayanchandmani	0.30	0.13	0.28	0.12	0.02	0.01	0.01	
		5	Bornuur*	-	-	-	-	-	-	-	-
		6	Jargalant*	-	-	-	-	-	-	-	-
		7	Bayantsogt	16.20	6.97	15.23	6.55	0.97	0.42	7.00	
		8	Bayankhangai	12.60	5.42	11.84	5.09	0.76	0.33	8.00	
		9	Ugtaaltsaidam	16.80	7.22	15.79	6.79	1.01	0.43	13.00	
		10	Tseel	4.80	2.06	4.51	1.94	0.29	0.12	1.00	
		11	Zaamar	34.80	14.96	32.71	14.07	2.09	0.90	17.00	
		12	Lun	31.20	13.42	29.33	12.61	1.87	0.80	44.00	
		13	Undurshireet	32.40	13.93	30.46	13.10	1.94	0.84	48.00	
		14	Buren	9.60	4.13	9.02	3.88	0.58	0.25	1.00	
		15	Delgerkhaan*	-	-	-	-	-	-	-	-
		16	Erdenesant	29.40	12.64	27.64	11.88	1.76	0.76	16.00	
	Selenge	17	Orkhontuul	9.60	4.13	9.02	3.88	0.58	0.25	14.00	
	Bulgan	18	Buregkhangai	24.60	10.58	23.12	9.94	1.48	0.63	44.00	
		19	Bayannuur	12.60	5.42	11.84	5.09	0.76	0.33	18.00	
		20	Dashinchilen	28.80	12.38	27.07	11.64	1.73	0.74	35.00	0.24
		21	Rashaant	7.80	3.35	7.33	3.15	0.47	0.20	10.00	0.25
		22	Gurvanbulag	33.00	14.19	31.02	13.34	1.98	0.85	54.00	
		23	Khishig-Undur	12.00	5.16	11.28	4.85	0.72	0.31	16.00	
		24	Mogod	6.60	2.84	6.20	2.67	0.40	0.17	6.00	
	Uvurkhangai	25	Bayan-Undur	5.40	2.32	5.08	2.18	0.32	0.14	5.00	
		26	Burd	29.40	12.64	27.64	11.88	1.76	0.76	47.00	
		27	Yesunzuil	6.60	2.84	6.20	2.67	0.40	0.17	5.00	
		28	Kharkhorin	3.00	1.29	2.82	1.21	0.18	0.08	1.00	
	Arkhangai	29	Khashaat	26.40	11.35	24.82	10.67	1.58	0.68	23.00	0.28
		30	Ugiinuur	3.00	1.29	2.82	1.21	0.18	0.08	2.00	
		31	Ulziit*	-	-	-	-	-	-	-	-
Total of downstream part				493.50	212.20	463.88	199.45	29.62	12.74	505.0	0.76
Total of the basin				1 073.20	528.97	1 010.05	498.43	63.15	30.53	637.7	141.8

Remark: *1. Evaporation and infiltration loss included in surface water resources calculation.*
*2. * Surface water and groundwater resources are not calculated because soum area inside the basin is small.*

5.2. Water consumption-use in the Tuul River Basin

5.2.1. Water consumption-use in 2010

The water consumption-use in Ulaanbaatar city and its districts is increasing on a regular basis due to population growth, migration, urban expansion and construction activities in recent years. At the same time the apartment residents' water consumption is decreasing as a result of water meter installation in the apartments.

As of 2010, Ulaanbaatar Water Supply and Sewerage Company (USUG) abstracted for the Ulaanbaatar water supply 52.4 million m^3 water from 175 boreholes of 4 main sources: the Central, Upper, Industrial and Meat Factory water sources. Population, industries, economic entities and organisations are supplied through the centralized water supply network through individual connections and 301 water kiosks and through 256 water kiosks not connected to the centralized water supply (Table 89).

Table 89. Water abstraction and distribution by USUG as of 2010 and 2011

Year		2010	2011
Abstracted water, *thousand m³/year*		52 400.0	54 800.0
Sold water, *thousand m³/year*		41 800.0	40 800.0
Water supply, *thousand m³/year*	to water kiosk connected to the centralized water supply	620.4	752.7
	by water truck to not-connected water kiosk	732.8	598.8
Number of water kiosks in ger areas	connected to the centralized water supply	301	310
	not connected to the centralized water supply	256	250
Number of ger area residents using water from kiosk, *thousand person*	water kiosk connected to the centralized water supply	234.0	233.2
	water kiosk not connected to the centralized water supply	293.4	232.4
Average water consumption per person per day, *l/day*	Apartment resident	237	204
	from water kiosk connected to the centralized water supply	8.8	8.4
	from water kiosk not connected to the centralized water supply	6.9	7.0

Source: *Consolidated report 2010 and 2011 by Ulaanbaatar Water Supply and Sewerage Company*

Remark: *Apartments and other private connections are not supplied by USUG but by PUSO's*

According to the USUG 2010 report, apartment residents consumed 237 l/day while ger area residents supplied from water kiosks connected to the centralized water supply consumed 8.8 l/day and supplied from water kiosks not connected to the centralized water supply consumed 6.9 l/day, respectively (Table 89). Compared to the Temporary Drinking Water Consumption Norm approved by Appendix No.3 of the Resolution No.153 by the Ministry of Nature and Environment in 1995, the apartment residents' water consumption is very close to the norm (230 l/day) and water consumption by ger area residents supplied from water kiosks either connected or not connected to the centralized water supply is lower than the norm (25 l/day) (Figure 75).

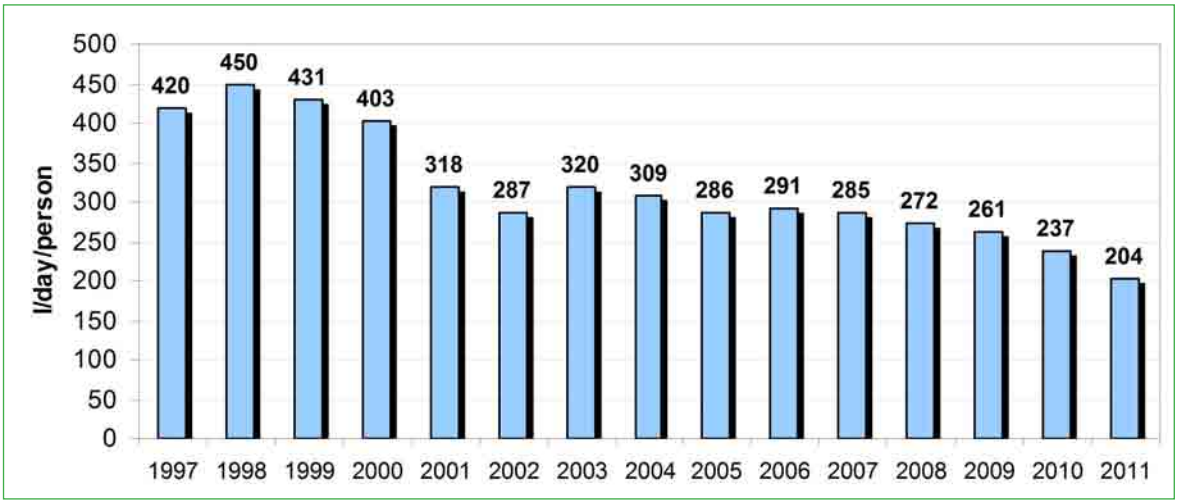

Figure 75. Actual water consumption per apartment resident per day

In connection with the land privatization which is on-going since 2003, the number of privately drilled wells has increased within private land-fences. According to a study carried out by the Water Authority in 2010 and recent studies by researchers, 800 wells have been established and were financed by individuals, economic entities and organisations and an estimated 339.7 thousand m³ groundwater is abstracted and consumed per day additional to the abstraction from the wells owned by USUG.

As of 2010, some 680 m³ water was abstracted and consumed per day from the Khushigiin Valley water supply source of Zuunmod city and Sergelen soum of Tuv aimag.

In most soum centres, 1-3 drilled wells with a 0.9-3.0 l/s yield are being used for drinking and domestic water supply as well as hospitals, schools and offices' water supply. Soum centre ger area and rural area (herdsmen and farmers) people use wells, springs and river water for their drinking and domestic water supply. This water consumption varies depending on the soum's geographical location and the exploration of surface and groundwater.

The surface and groundwater consumption-use by each sector in 2010 is calculated at the basin level in the upstream, midstream and downstream parts on an annual basis and shown in Table 93 and Table 94.

In total 90.2 million m^3 water was consumed and used in 2010 at the basin level. Of this, 7.9 million m^3/year is from surface water and 82.3 million m^3/year or 91.3% is from groundwater.

The Ulaanbaatar drinking and domestic water consumption (37.3 million m^3/year) and the Ulaanbaatar energy and industrial water use (22.5 million m^3/year) are the largest water consumers-users in the basin (2010 total water consumption-use is shown in Table 93 of the water use balance).

5.2.2. Water demand in 2015 and 2021

The parliament and the government of Mongolia approved a number of policies and programmes on economic and social development and the implementation of these policies and programmes will lead to an expected sharp increase in the water demand. According to the calculation of the water demand which is required for the One Hundred Thousand Household Apartments programme only (75,000 apartments are planned to be built in Ulaanbaatar) to be implemented until the end of 2016, approximately 50,000 m^3 water per day shall be required additionally for Ulaanbaatar city (on the basis of 1 household has 4 members and 200 l water per person).

Water consumption-use is being decreased by installing water meter in apartments, industries, economic entities and offices. Therefore the water demand is calculated assuming a decrease in the water consumption norm level for apartment residents. The low water consumption of ger area residents (8 l/day) is assumed to increase up to the norm level (25 l/day) in 2015 and 2021 (Table 90).

Table 90. Drinking water consumption norm

Type of water source	Water consumption norm, *person l/day*		
	2010*	2015	2021
Apartment with hot and cold water connected to the centralized water supply: Ulaanbaatar city	230.0	200.0	160.0
Apartment with cold water connected to the centralized water supply: Zuunmod	175.0	170.0	160.0
Water kiosk connected to the centralized water supply: Ger area	10.0	25.0	30.0
Portable water kiosk not connected to the centralized water supply: Ger area	8.0	15.0	20.0
Protected source: well, spring and stream	8.0	15.0	20.0
Unprotected source: well, spring and stream	8.0	10.0	15.0
Other sources	8.0	-	-

*Remark: * Actual water consumption*

The water demand is calculated for three scenarios: high, medium and low, in the upstream, midstream and downstream parts of the basin for the years of 2015 and 2021 and shown in Table 919.

As of 2010, 35.6% of the Ulaanbaatar population was connected to the centralized water supply. It is stated in the Millennium Development Goals that 44.9% is to be connected to the centralized water supply by 2015 and 47.7% by 2021, respectively. The water demand for 2015 and 2021 is calculated using a population growth based on the Mongolian population projection 2010-2040 carried out by the National Statistics Committee as well as using the sectors' economical growth based on the regional development programmes.

Table 91. The sectors' annual growth

Sector		Annual growth percentage, %					
		Low scenario		Medium scenario		High scenario	
		2010-2015	2015-2021	2010-2015	2015-2021	2010-2015	2015-2021
Drinking and domestic water	Urban population Rural population	5.45 4.00	-0.16 4.90	7.20 4.21	-0.04 5.08	10.16 4.35	-0.10 5.16
Manufacturing industries	Light and food industry Construction and building material Energy and heat Mining industry	4.0 4.0 1.5 3.0	4.0 4.0 1.5 3.0	6.9 6.9 2.5 10.5	6.9 6.9 2.5 10.5	12.6 12.6 6.0 23.0	12.6 12.6 6.0 23.0
Irrigated crop		2.0	2.0	7.8	2.4	15.0	15.0
Livestock	Camel Horse Cattle Sheep Goat	0.4 4.0 8.7 1.5 -1.5	1.7 2.9 6.0 -0.4 -2.8	1.4 5.1 9.8 2.5 -0.5	1.7 2.9 6.0 -0.4 -2.8	0.0 6.2 7.4 6.8 10.5	0.9 0.7 1.6 1.6 0.8
Services	Municipal services Commercial services	0.7 4.5	0.7 4.5	1.4 7.6	1.4 7.6	4.0 14.5	4.0 14.5

The total Ulaanbaatar water use amounted to 75.8 million m^3 (207.7 thousand m^3 per day on average) in 2010. According to the medium scenario, the total Ulaanbaatar water use is expected to increase to 100.9 million m^3 (276.6 thousand m^3 per day on average) in 2015 and to 121.1 million m^3 (331.8 thousand m^3 per day on average) in 2021, respectively.

At the basin level, 93.5% of the total water consumption-use is supplied from groundwater in 2010. And this percentage increases to 94.0% in 2015 and to 95.0% in 2021, respectively.

5.3. Water use balance of the basin

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 for 2010, 2015 and 2021 using the following indicators by aimag and city in the upstream, midstream and downstream parts as:

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 calculated by 50% probability to the total surface water consumption-use,

4. By comparing the possible usable surface water resources calculated by 90% probability to the total surface water consumption-use,

Finally, by comparing the potential exploitable groundwater resources and the possible usable surface water resources (p=50%) to the total water consumption-use (Table 93).

5.3.1. Water use balance of the basin upstream part

The Khan Khentii protected area and Gorkhi-Terelj national park cover more than three fourth of the area of the Tuul River Basin upstream part. The natural resources in this part are under protection according to the related legislation and procedures, and it is prohibited to run businesses in this part. There are approximately 2600 inhabitants and 50,000 livestock in the upstream part. About 180 hotels and tourist camps are located in this part and receive 130,000 national and international tourists every year. In the future, the number of tourists visiting the upstream part is expected to increase.

When calculating the water balance by potential exploitable groundwater resource and possible usable surface water resource (p=90%), the water resource is to be sufficient in 2015 and 2021 (Table 93).

The upstream part includes the area from the Tuul-Terelj confluence to the Kharztain tourist camp and the Uvur Gorkhiin Valley water source of which its groundwater resource has been determined to be used for the midstream part or Ulaanbaatar water supply. Also water complex with a multi-purpose dam (water supply, energy, tourism and flood regulation) is planned to be established on a dam site in the upstream part by 2020 to supply the increasing water demand of Ulaanbaatar city. The water storage provided by this water complex is not included in the balance calculation as it was considered that the benefits of this complex need to be investigated in detail during a feasibility study.

5.3.2. Water use balance of the basin midstream part

The water consumption-use is the highest in the midstream part. This part is encountering difficulties to tackle the water supply issues of the 1.2 million inhabitants of Ulaanbaatar city's 7 districts as well as the 20,000 industries and economic entities, 400 ha irrigated crop area, 330,000 livestock, 3 large thermo-power plants (a new thermo-power plant No.5 is being planned to be established), Zuunmod city of Tuv aimag and a new international airport which will be established at Khushigiin Valley.

As quickly as the population is growing in this part, at the same time the city's construction area is expanding and the building material industry (remicon, concrete products, sand and gravel mining) is increasing from year to year. Uncontrolled drilling of wells/boreholes by large industries, economic entities and individuals of Ulaanbaatar city on private land is causing trouble in determining how much water is being used and will be used in the future.

It is stated in the General Development Plan for Ulaanbaatar City, which is being newly formulated by the city's Governor's Office, to establish 15 satellite towns and new settlement areas, and the Plan also includes the number of residents to live in these towns. Please see Table 92 below. It is possible to include the water demand from these plans in the water balance of the midstream part. However this was not possible for industrial demand because of uncertainty over what type of industries will be established and where they will be located.

Table 92. Population of the satellite towns and villages of Ulaanbaatar city

№	Town	Definition	Location	Population, *thousand*				
				2008	2009	2010	2015	2021
1	Nalaikh	satellite town	Nalaikh district	27.9	28.9	30.2	34.3	40.0
2	Emeelt-Argalant	satellite town	Songinokhairkhan district. khoroo 20	9.9	10.0	9.3	11.1	13.6
3	Tuul-Shuvuu	village	Khan-Uul district. khoroo 13	3.5	2.6	3.7	4.6	5.9
4	Gavijiin Shand	new settlement area						
5	Bio-Songino	satellite settlement	Khan-Uul dist. khoroo 12	5.6	5.8	5.8	7.2	9.3
6	Ulziit	satellite settlement	Khan-Uul dist. khoroo 14	2.5	2.8	3.1	3.8	4.9
7	Gachuurt	satellite settlement	Bayanzurkh dist. khoroo 20	6.6	6.2	6.1	7.8	10.3
8	Aero city (new airport)	newly established city	Khushigiin Valley	-	-	-		100.0
9	Terelj	village	Nalaikh district. khoroo 6	1.2	1.3	1.3	1.5	1.7
10	Airport	village	Khan-Uul district. khoroo 9, 10 and 16	20.3	21.1	22.3	27.6	35.6
11	Yarmag	Khan-Uul district, khoroo	Khan-Uul district. khoroo 7 and 8	14.7	14.9	15.7	19.5	25.2
12	Nukht	Khan-Uul district, khoroo	Khan-Uul dis. khoroo 6	7.8	7.9	7.9	9.8	12.7
13	Uliastai	village	Bayanzurkh dist. khoroo 10	10.0	10.5	10.9	13.9	18.5
14	Khonkhor	village	Bayanzurkh district. khoroo 11	4.2	4.8	5.5	7.0	9.3
15	Nairamdal	village	Songinokhairkhan district. khoroo 22	10.5	11.9	12.9	15.3	18.9

It is necessary to carry out investigations on groundwater at the new satellite towns and settlement areas, in the vicinity of Tuul-Shuvuu, Gavijiin Shand, Bio-Songino, Ulziit, Terelj, Nukht, Khonkhor and Nairamdal, etc.

The Emeelt-Argalant satellite town water supply source at Khui Doloon Khudag is located outside the Tuul River Basin and it has a determined exploitable groundwater resource. If the town's population reaches over 13,600 in 2021, then 2,176 m^3 water (13,600 person x 160 l/day = 2,176 m^3/day) is expected to be required for only drinking water supply, but Khui Doloon Khudag's exploitable resource (3,844.8 m^3/day) is sufficient.

A new international airport will be established at the Khushigiin Valley and a new city with a population of 100,000 is planned to be established there by 2021. The water consumption by 100,000 people will amount to 16,000 m^3/day. According to investigations carried out for the new airport at the Khushigiin Valley, the exploitable groundwater resources are 3921.5 m^3/day which is not sufficient. As the water demand of the new airport was not included in the demand calculation this resource was not included in the water balance.

In the midstream part, the calculated potential exploitable groundwater resource (76.6 million m^3/year) of Ulaanbaatar city is lower than the approved exploitable resource (138.3 million m^3/year).

The explanation is that in general the potential exploitable groundwater resources are estimated conservatively to prevent an estimate of the groundwater resources which is too high. Detailed investigations in an area will provide a more accurate estimate of the exploitable groundwater resources. Such investigations have been done at Ulaanbaatar, therefore when calculating the balance the determined and approved exploitable resource should be used only.

According to the water balance calculation of Ulaanbaatar (using the total exploitable resources of the Central, Upper, Industrial, Meat Factory and Thermo-power plants which are 271.2 thousand m^3/day or 99.0 million m^3/year according to investigations of 1980), water shortages are expected to amount to 2.0 million m^3/year by 2015 and

22.1 million m^3/year by 2021 according to the medium water demand scenario, and 18.6 million m^3/year by 2015 and 67.7 million m^3/year by 2021 according to the high water demand scenario, respectively.

It is planned to establish new additional sources (110.8 thousand m^3/day or 40.4 million m^3/year) in 2021 from newly determined exploitable resources for Ulaanbaatar water supply use. When calculating the Ulaanbaatar city water balance by total exploitable groundwater resources (138.3 million m^3/year) and water consumption-use by population, services and industries (light, food, energy, construction, etc), (total groundwater consumption-use is 101.0 million m^3/year in 2015 and 121.1 million m^3/year in 2021 according to medium scenario) the medium scenario shows a positive indicator. However, according to the high scenario, a water shortage will occur in 2021 of 18.8 million m^3/year or 51.5 thousand m3/day (see Figure 76).

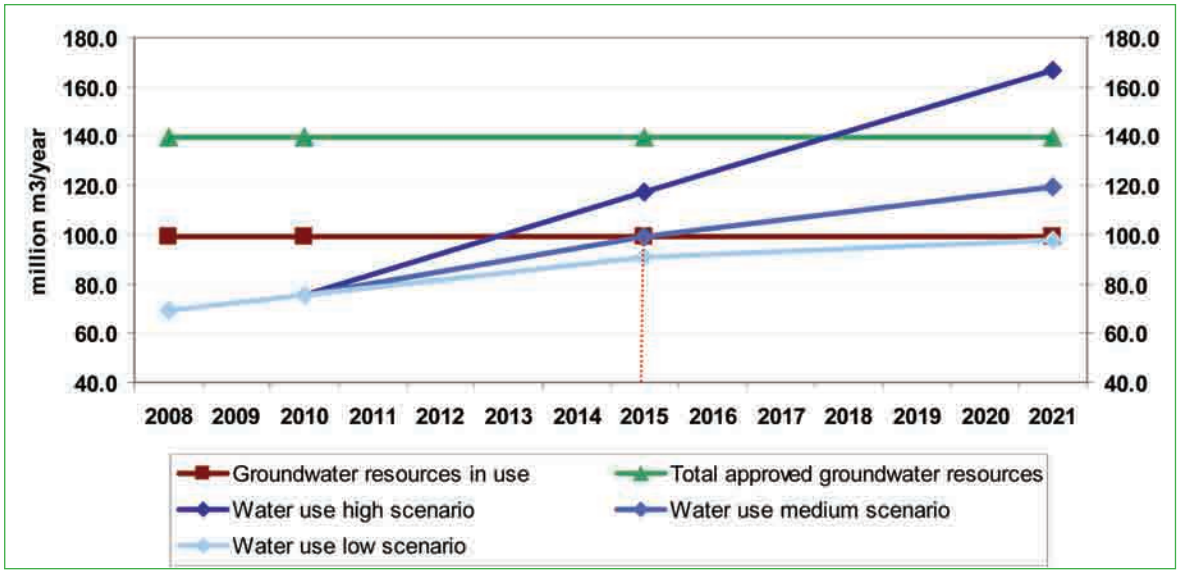

Figure 76. Groundwater use balance of Ulaanbaatar city

The surface water of the Tuul River is not directly used in water supply due to significant pollution and the river water recharges groundwater at large amount. The Tuul River is dry in some years from Zaisan to the Central WWTP in April. According to calculations made by the project groundwater expert, 496.2 thousand m^3 water recharges the groundwater from the Tuul River per day on average in April (see Figure 74). This high infiltration rate is due to the water abstraction for water supply from November to April and the absence of groundwater recharge during this period due to the river freezing. When the soils and river melt in spring the recharge of groundwater will start.

An average infiltration rate of 496.2 thousand m^3/day corresponds with a river runoff of 5.75 m^3/s. This runoff is available in most years during April and May. However it may not be reached in some years especially after winters with little snow in the Tuul watershed or in years with little precipitation in May. When runoff is insufficient then Tuul river runoff will infiltrate completely and the river may be dry along the section between Zaisan and Biocombinat. Drying of the Tuul River in this section was observed in 2012. Although ecological effects are probably minimal such a situation should be avoided.

The shortage in resources as described above, shows that it is necessary to establish new exploitable groundwater resources or to create and use a new water source in a way of collecting surface water. Depending on the increase in water use this may be as early as

2017. New groundwater resources already under development are:

- at Gachuurt where the Ministry of Road, Transport, Construction and Urban Development and Ulaanbaatar Water Supply and Sewerage Company are establishing an additional water supply source (25 thousand m^3/day) with grant aid of the government of Japan in 2012-2014. However according to the WA this groundwater resource is already included in the resources of the Central and Upper sources and therefore, the source is not approved as a new source.
- at Yarmag where investigations were carried out on a new source (26.2 thousand m^3/day) in 2011-2012 with the grant aid of the government of Republic of Korea and it is planned to complete it by 2015.

5.3.3. Water use balance of the basin downstream part

The downstream part covers most of the basin territory (40 774.4 km^2) of which the majority consists of pasture area. As of 2010, livestock water consumption (5.6 million m^3/year) and mining water use (5.7 million m^3/year) comprised the largest part of the total basin water consumption-use (12.7 million m^3/year) was. In irrigation, groundwater is dominantly consumed. Comparing the water consumption-use to the water resources, the water use is low and except when calculating the water use balance of soum centres.

Only herdsmen and farmers in Altanbulag, Undurshireet and Lun soums of Tuv aimag are able to use the Tuul River water according to their geographic location. But locals complain about unavailability of the river water use for livestock due to pollution of the river from Ulaanbaatar to Lun soum of Tuv aimag.

The channel is damaged and the river water is significantly polluted due to exploitation of placer gold deposits at Zaamar soum of Tuv aimag. It is estimated that 70% of the water used by the mines is reused by establishing reservoirs. In the future, it is planned to close the gold mines at Zaamar according to the state policy and the law.

When precipitation is low, the Tuul River water in the downstream part is recharged by groundwater and it increases runoff. But when precipitation is high, the river water recharges the groundwater and the runoff is tended to decrease along the downstream.

There is almost no surface water resource such as lake and large river other than the Tuul River. The 90% probability possible usable surface water resources amount to 12.7 million m^3/year and the potential exploitable groundwater resources amount to 505.0 million m^3/year. The exploitable groundwater resources at Dashinchilen and Rashaant soum centres of Bulgan aimag and Khashaat soum of Arkhangai aimag amount to 0.76 million m^3/year.

As of 2010, total water consumption-use of this part amounted to 12.7 million m^3/year and surface water consisted of 5.7 million m^3/year. In the future, total water demand expected to reach 17.4 million m^3/year by 2015 and 19.5 million m^3/year by 2021 according to medium scenario. According to the total amount, the water use balance shows a positive indicator.

As there is a surface water scarcity in the downstream part, irrigated crop activities are limited. It will be required to use groundwater in the event of running irrigated crop activities in this part.

Table 93. Water use balance of aimags, soums and Ulaanbaatar city of the Tuul River Basin, 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: Surface water resource P=90%	Surface water: Ecological resource P=50%	Surface water: Ecological resource P=90%	Surface water: Possible use of resource P=50%	Surface water: Possible use of resource P=90%	Groundwater: Potential exploitable resource for use	Groundwater: Exploitable resource for use	Water consumption and use (thousand m3/year): Surface water: Drinking and domestic water for population: Urban settlement, town and aimag centre	Drinking and domestic water for population: Soum centre	Drinking and domestic water for population: Rural area	Drinking and domestic water for population: Total	Municipal services (hospital, school, office and commercial service)	Industries: Food industry	Industries: Light industry	Industries: Heavy industries	Industries: Energy	Industries: Construction and its material industry	Industries: Road and transport	Industries: Total	Mining (mine and processing)	Livestock (pastoral and farming)	Irrigated area	Tourism	Green area	Grand total
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
Calculation																															
Upstream part	Tuv	1	Batsumber	7,9	0,3												0,0							0,0	0,0				0,0	0,0	0,0
		2	Mungunmorit	27,8	0,4												0,0							0,0	0,0				0,0	0,0	0,0
		3	Erdene	3 681,3	45,4	414 000	240 120	393 300	228 114	20 700	12 006	36 000					0,0							0,0	0,0		101,6		0,0	0,0	101,6
		4	Bayandelger	285,1	13,1	27 000	15 660	25 650	14 877	1 350	783	6 000					0,0							0,0	0,0		1,8		0,0	0,0	1,8
	Ulaanbaatar	5	Nalaikh	69,3	10,0	9 000	5 220	8 550	4 959	450	261	2 000					0,0							0,0	0,0				0,0	0,0	0,0
		6	Bayanzurkh	13,0	1,1												0,0							0,0	0,0				0,0	0,0	0,0
Total				**4 084,4**		**450 000**	**261 000**	**427 500**	**247 950**	**22 500**	**13 050**	**44 000**	**0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**103**	**0,0**	**0,0**	**0,0**	**103,4**
Midstream part	Ulaanbaatar	1	Nalaikh	624,0	89,9	16 080	6 914	14 713	6 327	1 367	588	11 000	5 000				0							0,0	0,0		13,1		0,0	0,0	13,1
		2	Bayanzurkh	1 215,9	98,8	30 820	13 253	28 200	12 126	2 620	1 126	34 000																			
		3	Sukhbaatar	207,4	99,9	5 360	2 305	4 904	2 109	456	196	300																			
		4	Chingeltei	89,0	98,6	2 010	864	1 839	791	171	73	300	133 300				0							0,0	0,0		32,1	0	0,0	0,0	32,1
		5	Bayangol	23,6	100,0	670	288	613	264	57	24	2 000																			
		6	Khan-Uul	510,0	100,0	12 730	5 474	11 648	5 009	1 082	465	22 000																			
		7	Songinokhairkhan	373,6	31,0	9 100	3 913	8 327	3 580	774	333	7 000																			
			sub-total	3 043,5		**76 770**	**33 011**	**70 245**	**30 205**	**6 525**	**2 806**	**76 600**	**138 300**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**45,2**	**0**	**0,0**	**0,0**	**45,2**
	Tuv	8	Batsumber	1,7	0,1												0,0							0,0	0,0				0,0	0,0	0,0
		9	Erdene	428,3	5,3	10 050	4 322	9 196	3 954	854	367	1 000					0,0							0,0	0,0		11,3		0,0	0,0	11,3
		10	Sergelen	1 101,2	29,0	24 120	10 372	22 070	9 490	2 050	882	4 000					0,0							0,0	0,0		4,7	0,0	0,0	0,0	4,7
		11	Zuunmod	19,3	100,0	670	288	613	264	57	24	2 060	3 751				0,0							0,0	0,0		0,0		0,0	0,0	0,0
		12	Altanbulag	617,4	10,9	18 090	7 779	16 552	7 118	1 538	661	5 000					0,0							0,0	0,0				0,0	0,0	0,0
		13	Argalant	30,8	2,7												0,0							0,0	0,0				0,0	0,0	0,0
Total				**5 242,2**		**129 700**	**55 771**	**118 676**	**51 030**	**11 025**	**4 741**	**88 660**	**142 051**	**0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**61,1**	**0**	**0,0**	**0,0**	**61,1**
Downstream part	Tuv	1	Argalant	943,4	83,9	11 400	4 902	10 716	4 608	684	294	8 000					0,0							0,0	0,0		0,0	0,0	0,0	0,0	0,0
		2	Altanbulag	4 710,4	83,1	58 200	25 026	54 708	23 524	3 492	1 502	58 000					0,0							0,0	0,0		92,6	0,0	0,0	0,0	92,6
		3	Bayan-Unjuul	2 244,6	46,8	27 000	11 610	25 380	10 913	1 620	697	4 000					0,0							0,0	0,0		29,7		0,0	0,0	29,7
		4	Bayanchandmani	34,5	5,6	300	129	282	121	18	8	10					0,0							0,0	0,0				0,0	0,0	0,0
		5	Bornuur	3,7	0,3												0,0							0,0	0,0				0,0	0,0	0,0
		6	Jargalant	2,8	0,2												0,0							0,0	0,0				0,0	0,0	0,0
		7	Bayantsogt	1 330,3	90,2	16 200	6 966	15 228	6 548	972	418	7 000					0,0							0,0	0,0		15,8	0,0	0,0	0,0	15,8
		8	Bayankhangai	998,8	100,0	12 600	5 418	11 844	5 093	756	325	8 000					0,0							0,0	0,0		15,5		0,0	0,0	15,5
		9	Ugtaaltsaidam	1 403,0	90,4	16 800	7 224	15 792	6 791	1 008	433	13 000					0,0							0,0	0,0		63,4	0,0	0,0	0,0	63,4
		10	Tseel	385,8	23,5	4 800	2 064	4 512	1 940	288	124	1 000					0,0							0,0	0,0		5,0		0,0	0,0	5,0
		11	Zaamar	2 802,1	99,9	34 800	14 964	32 712	14 066	2 088	898	17 000					0,0							0,0	0,0	5 637	107,0		0,0	0,0	5 744
		12	Lun	2 541,4	100,0	31 200	13 416	29 328	12 611	1 872	805	44 000					0,0							0,0	0,0		200,1		0,0	0,0	200,1
		13	Undurshireet	2 623,5	39,2	32 400	13 932	30 456	13 096	1 944	836	48 000					0,0							0,0	0,0		125,3		0,0	0,0	125,3
		14	Buren	756,7	20,2	9 600	4 128	9 024	3 880	576	248	1 000					0,0							0,0	0,0		6,3		0,0	0,0	6,3
		15	Delgerkhaan	2,4	0,1												0,0							0,0	0,0				0,0	0,0	0,0
		16	Erdenesant	2 510,3	74,0	29 400	12 642	27 636	11 883	1 764	759	16 000					0,0							0,0	0,0		114,9		0,0	0,0	114,9
	Selenge	17	Orkhontuul	824,7	28,0	9 600	4 128	9 024	3 880	576	248	14 000					0,0							0,0	0,0		49,1		0,0	0,0	49,1
	Bulgan	18	Buregkhangai	2 019,5	57,9	24 600	10 578	23 124	9 943	1 476	635	44 000					0,0							0,0	0,0	98,4	109,5		0,0	0,0	207,9
		19	Bayannuur	1 010,5	100,0	12 600	5 418	11 844	5 093	756	325	18 000					0,0							0,0	0,0		93,1		0,0	0,0	93,1
		20	Dashinchilen	2 309,7	100,0	28 800	12 384	27 072	11 641	1 728	743	35 000	230				0,0							0,0	0,0		195,2		0,0	0,0	195,2
		21	Rashaant	612,9	100,0	7 800	3 354	7 332	3 153	468	201	10 000	250				0,0							0,0	0,0		48,8		0,0	0,0	48,8
		22	Gurvanbulag	2 681,2	100,0	33 000	14 190	31 020	13 339	1 980	851	54 000					0,0							0,0	0,0		264,3		0,0	0,0	264,3
		23	Khishig-Undur	960,8	39,4	12 000	5 160	11 280	4 850	720	310	16 000					0,0							0,0	0,0		81,9		0,0	0,0	81,9
		24	Mogod	620,9	22,0	6 600	2 838	6 204	2 668	396	170	6 000					0,0							0,0	0,0		25,0		0,0	0,0	25,0
	Uvurkhangai	25	Bayan-Undur	508,1	14,4	5 400	2 322	5 076	2 183	324	139	5 000					0,0							0,0	0,0		10,8		0,0	0,0	10,8
		26	Burd	2 447,5	92,7	29 400	12 642	27 636	11 883	1 764	759	47 000					0,0							0,0	0,0		165,6		0,0	0,0	165,6
		27	Yusunzuil	428,2	21,8	6 600	2 838	6 204	2 668	396	170	5 000					0,0							0,0	0,0		13,5		0,0	0,0	13,5
		28	Kharkhorin	258,5	11,2	3 000	1 290	2 820	1 213	180	77	1 000					0,0							0,0	0,0		4,5		0,0	0,0	4,5
	Arkhangai	29	Khashaat	2 175,6	83,6	26 400	11 352	24 816	10 671	1 584	681	23 000	280				0,0							0,0	0,0		147,9		0,0	0,0	147,9
		30	Ugiinuur	295,7	17,6	3 000	1 290	2 820	1 213	180	77	2 000					0,0							0,0	0,0		5,9		0,0	0,0	5,9
		31	Ulziit	0,3	0,0												0,0							0,0	0,0				0,0	0,0	0,0
Total				**40 447,8**		**493 500**	**212 205**	**463 890**	**199 473**	**29 610**	**12 732**	**505 010**	**760**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**5 736**	**1 991**	**0,0**	**0,0**	**0,0**	**7 726**
Grand total				**49 774,4**		**1 073 200**	**528 976**	**1 010 066**	**498 453**	**63 135**	**30 523**	**637 670**	**142 811**	**0**	**0,0**	**0,0**	**0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**5 736**	**2 155**	**0,0**	**0,0**	**0,0**	**7 891**

Parts of basin	Name of aimag	№	Name of soum	Water consumption and use (thousand m3/year): Groundwater: Drinking and domestic water for population: Urban settlement, town and aimag centre	Drinking and domestic water for population: Soum centre	Drinking and domestic water for population: Rural area	Drinking and domestic water for population: Total	Municipal services (hospital, school, office and commercial service)	Industries: Food industry	Industries: Light industry	Industries: Heavy industries	Industries: Energy	Industries: Construction and its material industry	Industries: Road and transport	Industries: 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 resources	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%) resources	According to calculation of balance by surface water (90%) resources	According to calculation of balance by surface water (50%) and potential exploitable groundwater resources
A	B	C	D	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD
Calculation																						AF+AX	M-AX	N-AJ-AK-AR	K-AF	L-AF	M+K-AY
Upstream part	Tuv	1	Batsumber				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
		2	Mungunmorit				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
		3	Erdene	0,0	0,0	4,2	**4,2**							0,0	**0,0**		101,6		30,7	0,0	**137**	**238**	**35 863**	-	**20 598**	**11 904**	**56 462**
		4	Bayandelger	0,0	0,0	0,1	**0,1**							0,0	**0,0**		15,8		0,0	0,0	**16**	**18**	**5 984**	-	**1 348**	**781**	**7 332**
	Ulaanbaatar	5	Nalaikh				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**	**2 000**	-	**450**	**261**	**2 450**
		6	Bayanzurkh				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
Total				**0,0**	**0,0**	**4,4**	**4,4**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**117**	**0,0**	**30,7**	**0,0**	**153**	**256**	**43 847**	**0**	**22 397**	**12 947**	**66 244**
Midstream part	Ulaanbaatar	1	Nalaikh	1 067,9	0,0	0,0	**1 068**	198						0,0	**0,0**		118,0		13,2	0,0	**1 397**	**1 410**		**3 932**	**1 354**	**575**	**10 957**
		2	Bayanzurkh																								
		3	Sukhbaatar																								
		4	Chingeltei	37 333	0,0	0,0	**37 333**	6 634	2 729	260	300	22 500	394	0,0	**26 183**		288,8	1 781	0,0	2 153	**74 372**	**74 404**		**63 151**	**2 588**	**1 094**	**64 055**
		5	Bayangol																								
		6	Khan-Uul																								
		7	Songinokhairkhan																								
			sub-total	**38 401**	**0,0**	**0,0**	**38 401**	**6 832**	**2 729**	**260**	**300**	**22 500**	**394**	**0**	**26 183**	**0**	**406,8**	**1 781**	**13,2**	**2 153**	**75 769**	**75 814**	**0**	**67 083**	**3 941**	**1 669**	**75 011**
	Tuv	8	Batsumber				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
		9	Erdene				**0,0**							0,0	**0,0**		11,3		0,0	0,0	**11**	**23**	**989**	-	**843**	**356**	**1 832**
		10	Sergelen	0,0	1,7	1,3	**3,0**							0,0	**0,0**		41,9	487,5	0,0	0,0	**532**	**537**	**3 468**	-	**2 046**	**877**	**5 513**
		11	Zuunmod	368,7	0,0	0,0	**369**	100,7	1,0	5,3	0,0	279,5	0,7	0,0	**286,4**		85,0		0,0	0,0	**841**	**841**		**2 995**	**57**	**24**	**1 276**
		12	Altanbulag				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**	**5 000**	-	**1 538**	**661**	**6 538**
		13	Argalant				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
Total				**38 769**	**1,7**	**1,3**	**38 772**	**6 932**	**2 730**	**265**	**300**	**22 780**	**394**	**0**	**26 469**	**0**	**544,9**	**2 268**	**13,2**	**2 153**	**77 153**	**77 214**	**9 456**	**70 078**	**8 424**	**3 588**	**90 170**
Downstream part	Tuv	1	Argalant	0,0	2,8	2,0	**4,8**							0,0	**0,0**		112,4	159,5	0,0	0,0	**277**	**277**	**7 723**	-	**684**	**294**	**8 407**
		2	Altanbulag	0,0	3,1	5,7	**8,7**							0,0	**0,0**		216,1	54,5	0,0	0,0	**279**	**372**	**57 721**	-	**3 399**	**1 409**	**61 120**
		3	Bayan-Unjuul	0,0	2,5	1,9	**4,4**							0,0	**0,0**		118,7		0,0	0,0	**123**	**153**	**3 877**	-	**1 590**	**667**	**5 467**
		4	Bayanchandmani				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
		5	Bornuur				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
		6	Jargalant				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
		7	Bayantsogt	0,0	3,0	2,7	**5,7**							0,0	**0,0**		142,0	623,2	0,0	0,0	**771**	**787**	**6 229**	-	**956**	**402**	**7 185**
		8	Bayankhangai	0,0	2,8	1,9	**4,7**							0,0	**0,0**		139,6		0,0	0,0	**144**	**160**	**7 856**	-	**740**	**310**	**8 596**
		9	Ugtaaltsaidam	0,0	5,0	2,7	**7,7**							0,0	**0,0**		147,9	430,2	0,0	0,0	**586**	**649**	**12 414**	-	**945**	**370**	**13 359**
		10	Tseel	0,0	0,0	1,2	**1,2**							0,0	**0,0**		45,4		0,0	0,0	**47**	**52**	**953**	-	**283**	**119**	**1 236**
		11	Zaamar	0,0	13,4	3,8	**17,2**							0,0	**0,0**		249,6		0,0	0,0	**267**	**6 011**	**16 733**	-			**13 077**
		12	Lun	0,0	3,2	5,0	**8,2**							0,0	**0,0**		200,1		0,0	0,0	**208**	**408**	**43 792**	-	**1 672**	**605**	**45 464**
		13	Undurshireet	0,0	1,3	4,3	**5,5**							0,0	**0,0**		187,9		0,0	0,0	**193**	**319**	**47 807**	-	**1 819**	**711**	**49 625**
		14	Buren	0,0	0,0	1,3	**1,3**							0,0	**0,0**		56,9		0,0	0,0	**58**	**65**	**942**	-	**570**	**241**	**1 511**
		15	Delgerkhaan				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
		16	Erdenesant	0,0	5,1	6,3	**11,5**							0,0	**0,0**		268,1		0,0	0,0	**280**	**394**	**15 720**	-	**1 649**	**644**	**17 370**
	Selenge	17	Orkhontuul	0,0	4,7	1,9	**6,5**							0,0	**0,0**		49,1		0,0	0,0	**56**	**105**	**13 944**	-	**527**	**199**	**14 471**
	Bulgan	18	Buregkhangai	0,0	3,0	3,0	**6,0**							0,0	**0,0**		164,2		0,0	0,0	**170**	**378**	**43 830**	-	**1 268**	**427**	**45 098**
		19	Bayannuur	0,0	2,5	2,8	**5,3**							0,0	**0,0**		93,1		0,0	0,0	**98**	**192**	**17 902**	-	**663**	**232**	**18 564**
		20	Dashinchilen	0,0	3,8	3,8	**7,6**							0,0	**0,0**		195,2		0,0	0,0	**203**	**398**	**34 797**		**1 533**	**548**	**36 330**
		21	Rashaant	0,0	6,0	4,3	**10,3**							0,0	**0,0**		195,4		0,0	0,0	**206**	**255**	**9 794**		**419**	**152**	**10 213**
		22	Gurvanbulag	0,0	4,4	5,5	**9,9**							0,0	**0,0**		264,3		0,0	0,0	**274**	**539**	**53 726**	-	**1 716**	**587**	**55 441**
		23	Khishig-Undur	0,0	0,0	2,5	**2,5**							0,0	**0,0**		81,9		0,0	0,0	**84**	**166**	**15 916**	-	**638**	**228**	**16 554**
		24	Mogod	0,0	0,0	1,6	**1,6**							0,0	**0,0**		100,1		0,0	0,0	**102**	**127**	**5 898**	-	**371**	**145**	**6 269**
	Uvurkhangai	25	Bayan-Undur	0,0	0,0	1,1	**1,1**							0,0	**0,0**		43,1		0,0	0,0	**44**	**55**	**4 956**	-	**313**	**129**	**5 269**
		26	Burd	0,0	1,9	6,8	**8,7**							0,0	**0,0**		165,6		0,0	0,0	**174**	**340**	**46 826**	-	**1 598**	**593**	**48 424**
		27	Yusunzuil	0,0	0,0	1,3	**1,3**							0,0	**0,0**		20,3		0,0	0,0	**22**	**35**	**4 978**	-	**382**	**157**	**5 361**
		28	Kharkhorin	0,0	0,0	1,5	**1,5**							0,0	**0,0**		40,8		0,0	0,0	**42**	**47**	**958**	-	**175**	**73**	**1 133**
	Arkhangai	29	Khashaat	0,0	4,0	5,3	**9,4**							0,0	**0,0**		221,8		0,0	0,0	**231**	**379**	**22 769**		**1 436**	**533**	**24 205**
		30	Ugiinuur	0,0	0,0	1,3	**1,3**							0,0	**0,0**		52,9		0,0	0,0	**54**	**60**	**1 946**	-	**174**	**72**	**2 120**
		31	Ulziit				**0,0**							0,0	**0,0**				0,0	0,0	**0**	**0**					
Total				**0,0**	**72,4**	**81,3**	**153,7**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**3 572**	**1 267**	**0,0**	**0,0**	**4 993**	**12 720**	**500 007**	**0**	**25 522**	**9 845**	**521 872**
Grand total				**38 769**	**74,1**	**86,9**	**38 930**	**6 932**	**2 730**	**265**	**300**	**22 780**	**394,3**	**0,0**	**26 469**	**0**	**4 235**	**3 536**	**43,9**	**2 153**	**82 299**	**90 190**	**553 310**	**70 078**	**56 343**	**26 379**	**678 286**

Remark: *1. Water volume which can be withdrawn and used from Tuul River: 4-6% in upstream part, 7-10% in midstream part and 5-7% in downstream part ["Surface water in Mongolia" 1999]*

Correction: *Groundwater resources from Sergelen soum to Zuunmod 2 000 thousand m3/year*

Explanation:

1 *Surface water resources: the estimate is derived from the specific runoff map.*
The specific runoff map provides an estimate of the mean runoff.
Based on a ratio derived from the observed runoff data, the median (50%) and the low runoff (90%) are calculated.
The inflow of runoff from upstream soums is not included
The possible use of river runoff is calculated using percentage obtained from monograph: ["Surface water in Mongolia" 1999]

2 *Potential exploitable groundwater resources are derived from the potential exploitable groundwater map.*
Exploitable resources are based on detailed investigations of groundwater deposits.
Potential exploitable groundwater resources are valid for the whole soum.
Exploitable resources are valid only for the area of the detailed investigations of the groundwater deposits.
Exploitable resources do not cover the whole soum except for the districts of Ulaanbaatar.

3 *Ulaanbaatar districts are added as sub-total because some of the demand estimates are available for the whole Ulaanbaatar only*

4 *The water demand is primarily supplied from groundwater. In general only mines and irrigation use surface water.*

5 *The water balance is calculated for:*
- *difference between potential exploitable groundwater resource and demand from groundwater*
- *difference between exploitable groundwater resource and demand from groundwater for drinking water and industry*
- *difference between median (50%) surface water resource and demand from surface water*
- *difference between low (90%) surface water resource and demand from surface water*
- *difference between total surface and groundwater resource and total demand*

6 *If the balance is negative then the number will be shown in red*

Explanation of balance result:

1 *Negative balance at Zaamar because river runoff from upper parts not included*
This runoff covers the demand (from mining) completely

2 *Demand from mining in 2 soums: Burekhangai and Zaamar; assumed to be supplied from surface water*

3 *Demand from irrigation in 5 soums: Argalant (1), Altanbulag (2), Bayantsogt (3), Sergelen (3), Ugtaal (1)*
Demand from irrigation in 3 UB districts: Songinokhairkhan (6), Khan Uul (3), Bayanzurkh (1), Bayangol (1)
Total demand of 2,992 mil m3/year divided by number of irrigation schemes. Total number is 21.
Demand assumed to come from groundwater in all irrigation schemes.

Table 94. Water use balance of the Tuul River Basin (2010, 2015, 2021)

[million m3/year]

Part of basin	Catchment area (km2)	Aimag	Scenario	Year	Water resource				Water consumption and use (million m3/year)																	Balance difference				
									Surface water									Groundwater								Total consumption and use					
					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	Domestic water for population	Municipal supply (hospital, school, offices and commercial services)	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 services (hospital, school, offices and commercial services)	Industry, energy, construction, road and transport	Mining (mine and processing)	Livestock (pastoral and farming)	Irrigated area	Tourism	Green area	Total		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
																											R+AA	H-AA	I-S-T-U	F-R	G-R	AC+AE
Upstream part	4084,4	Tuv		2010	22,5	13,1	44,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	**0,1**	0,00	0,0	0,0	0,0	0,1	0,0	0,0	0,0	**0,2**	**0,3**	43,8	**0,0**	22,4	12,9	66,2
			High	2015					0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	**0,2**	0,01	0,0	0,0	0,0	0,2	0,0	0,1	0,0	**0,3**	**0,5**	43,7	**0,0**	22,3	12,9	66,0
			Medium	2015					0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	**0,2**	0,01	0,0	0,0	0,0	0,2	0,0	0,1	0,0	**0,3**	**0,4**	43,7	**0,0**	22,3	12,9	66,1
			Low	2015					0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	**0,2**	0,01	0,0	0,0	0,0	0,2	0,0	0,1	0,0	**0,2**	**0,4**	43,8	**0,0**	22,3	12,9	66,1
			High	2021					0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	**0,2**	0,01	0,0	0,0	0,0	0,2	0,0	0,1	0,0	**0,4**	**0,6**	43,6	**0,0**	22,3	12,9	65,9
			Medium	2021					0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	**0,2**	0,01	0,0	0,0	0,0	0,2	0,0	0,1	0,0	**0,4**	**0,6**	43,6	**0,0**	22,3	12,9	65,9
			Low	2021					0,0	0,0	0,0	0,0	0,2	0,0	0,0	0,0	**0,2**	0,01	0,0	0,0	0,0	0,2	0,0	0,1	0,0	**0,4**	**0,6**	43,6	**0,0**	22,3	12,9	65,9
Midstream part	5242,2	Ulaanbaatar		2010	6,5	2,8	76,6	138,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	38,4	6,8	26,2	0,0	0,4	1,8	0,0	2,2	**75,8**	**75,8**		**66,9**	6,5	2,8	73,4
			High	2015					0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	**0,1**	56,9	11,0	43,2	0,0	0,7	3,7	0,0	2,2	**117,6**	**117,7**		**27,3**	6,4	2,7	33,7
			Medium	2015					0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	**0,1**	51,1	8,7	35,3	0,0	0,6	3,1	0,0	2,2	**100,9**	**101,0**		**43,3**	6,5	2,7	49,7
			Low	2015					0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	**0,1**	47,8	7,8	29,9	0,0	0,6	2,3	0,0	2,2	**90,6**	**90,7**		**52,7**	6,5	2,7	59,2
			High	2021					0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	**0,1**	57,4	20,9	78,8	0,0	0,8	6,5	0,1	2,2	**166,6**	**166,7**		**-18,8**	6,4	2,7	-12,3
			Medium	2021					0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	**0,1**	51,1	11,8	50,4	0,0	0,8	4,7	0,1	2,2	**121,0**	**121,1**		**25,0**	6,4	2,7	31,4
			Low	2021					0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	**0,1**	47,0	9,3	35,2	0,0	0,7	3,0	0,1	2,2	**97,5**	**97,6**		**46,7**	6,4	2,7	53,2
		Tuv		2010	4,5	1,9	12,1	3,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	0,4	0,1	0,3	0,0	0,1	0,5	0,0	0,0	**1,4**	**1,4**	**10,7**	**3,0**	4,5	1,9	15,2
			High	2015					0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	0,7	0,1	0,5	0,0	0,2	1,0	0,0	0,0	**2,4**	**2,5**	**9,6**	**2,5**	4,5	1,9	14,1
			Medium	2015					0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	0,6	0,1	0,4	0,0	0,2	0,8	0,0	0,0	**2,1**	**2,1**	**10,0**	**2,7**	4,5	1,9	14,5
			Low	2015					0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	0,6	0,1	0,3	0,0	0,1	0,6	0,0	0,0	**1,8**	**1,8**	**10,3**	**2,8**	4,5	1,9	14,8
			High	2021					0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	0,8	0,2	0,8	0,0	0,2	1,8	0,0	0,0	**3,7**	**3,8**	**8,3**	**2,0**	4,5	1,9	12,8
			Medium	2021					0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	0,7	0,1	0,5	0,0	0,2	1,3	0,0	0,0	**2,8**	**2,8**	**9,2**	**2,4**	4,5	1,9	13,7
			Low	2021					0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**	0,6	0,1	0,4	0,0	0,2	0,8	0,0	0,0	**2,1**	**2,1**	**9,9**	**2,6**	4,5	1,9	14,4
Downstream part	40447,7	Tuv, Selenge, Bulgan, Uvurkhangai and Arkhangai		2010	29,6	12,7	505,0	0,8	0,0	0,0	0,0	5,7	2,0	0,0	0,0	0,0	**7,7**	0,2	0,0	0,0	0,0	3,6	1,3	0,0	0,0	**5,0**	**12,7**	**500,0**		21,9	5,0	521,9
			High	2015					0,0	0,0	0,0	10,0	3,1	0,0	0,0	0,0	**13,1**	0,2	0,0	0,0	0,0	5,6	2,6	0,0	0,0	**8,4**	**21,5**	**496,6**		16,5	-0,4	513,1
			Medium	2015					0,0	0,0	0,0	7,4	2,7	0,0	0,0	0,0	**10,1**	0,2	0,0	0,0	0,0	4,9	2,2	0,0	0,0	**7,3**	**17,4**	**497,8**		19,5	2,6	517,2
			Low	2015					0,0	0,0	0,0	4,1	2,6	0,0	0,0	0,0	**6,7**	0,2	0,0	0,0	0,0	4,6	1,6	0,0	0,0	**6,4**	**13,1**	**498,6**		22,9	6,0	521,5
			High	2021					0,0	0,0	0,0	15,5	3,3	0,0	0,0	0,0	**18,8**	0,3	0,0	0,0	0,0	6,0	4,6	0,0	0,0	**10,9**	**29,7**	**494,1**		10,8	-6,1	504,9
			Medium	2021					0,0	0,0	0,0	7,0	3,2	0,0	0,0	0,0	**10,2**	0,3	0,0	0,0	0,0	5,7	3,3	0,0	0,0	**9,3**	**19,5**	**495,7**		19,5	2,6	515,2
			Low	2021					0,0	0,0	0,0	3,3	3,0	0,0	0,0	0,0	**6,3**	0,3	0,0	0,0	0,0	5,4	2,1	0,0	0,0	**7,8**	**14,1**	**497,2**		23,3	6,4	520,5
Total basin	49774,3			2010	63,1	30,5	637,7	142,8	0,0	0,0	0,0	5,7	2,2	0,0	0,0	0,0	**7,9**	38,9	6,9	26,5	0,0	4,2	3,5	0,0	2,2	**82,3**	**90,2**	**554,5**	**69,9**	55,2	22,6	676,7
			High	2015					0,0	0,0	0,0	10,0	3,4	0,0	0,0	0,0	**13,4**	57,7	11,1	43,6	0,0	6,7	7,3	0,1	2,2	**128,7**	**142,1**	**550,0**	**29,8**	49,7	17,1	627,0
			Medium	2015					0,0	0,0	0,0	7,4	3,0	0,0	0,0	0,0	**10,4**	51,9	8,8	35,6	0,0	5,8	6,1	0,1	2,2	**110,5**	**120,9**	**551,5**	**45,9**	52,8	20,1	647,5
			Low	2015					0,0	0,0	0,0	4,1	2,8	0,0	0,0	0,0	**6,9**	48,6	7,9	30,3	0,0	5,5	4,5	0,1	2,2	**99,1**	**106,0**	**552,6**	**55,4**	56,2	23,6	661,5
			High	2021					0,0	0,0	0,0	15,5	3,6	0,0	0,0	0,0	**19,1**	58,5	21,1	79,6	0,0	7,2	12,9	0,2	2,2	**181,7**	**200,8**	**546,0**	**-16,8**	44,0	11,4	571,3
			Medium	2021					0,0	0,0	0,0	7,0	3,5	0,0	0,0	0,0	**10,5**	52,1	11,9	50,9	0,0	6,9	9,3	0,2	2,2	**133,5**	**144,0**	**548,6**	**27,4**	52,7	20,1	626,2
			Low	2021					0,0	0,0	0,0	3,3	3,3	0,0	0,0	0,0	**6,6**	48,0	9,4	35,6	0,0	6,5	5,9	0,2	2,2	**107,8**	**114,4**	**550,8**	**49,3**	56,5	23,9	654,1

5.4. Tuul River Basin water balance viewer

The IWRM Water Balance Viewer (Figure 77) 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.

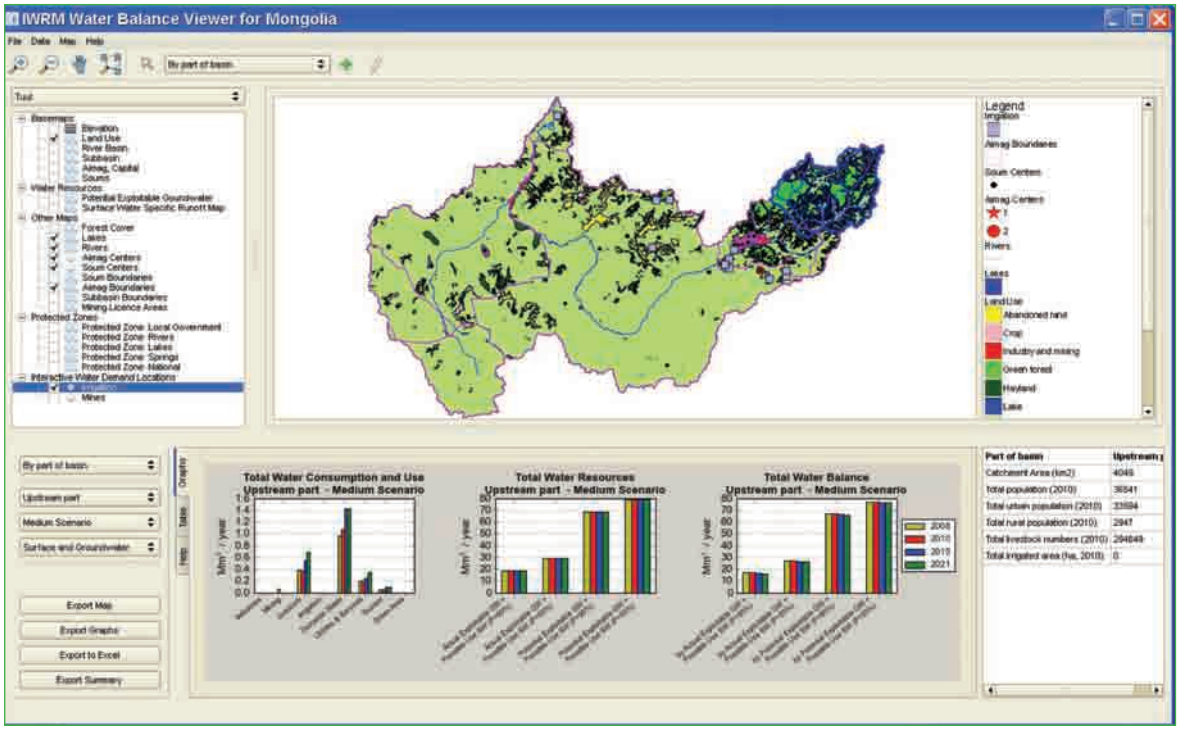

Figure 77. Appearance of the Tuul River Basin water balance viewer

The results of the water balance calculations are shown for each basin part and each scenario in Figure 78Figure 77, Figure 79 and Figure 80.

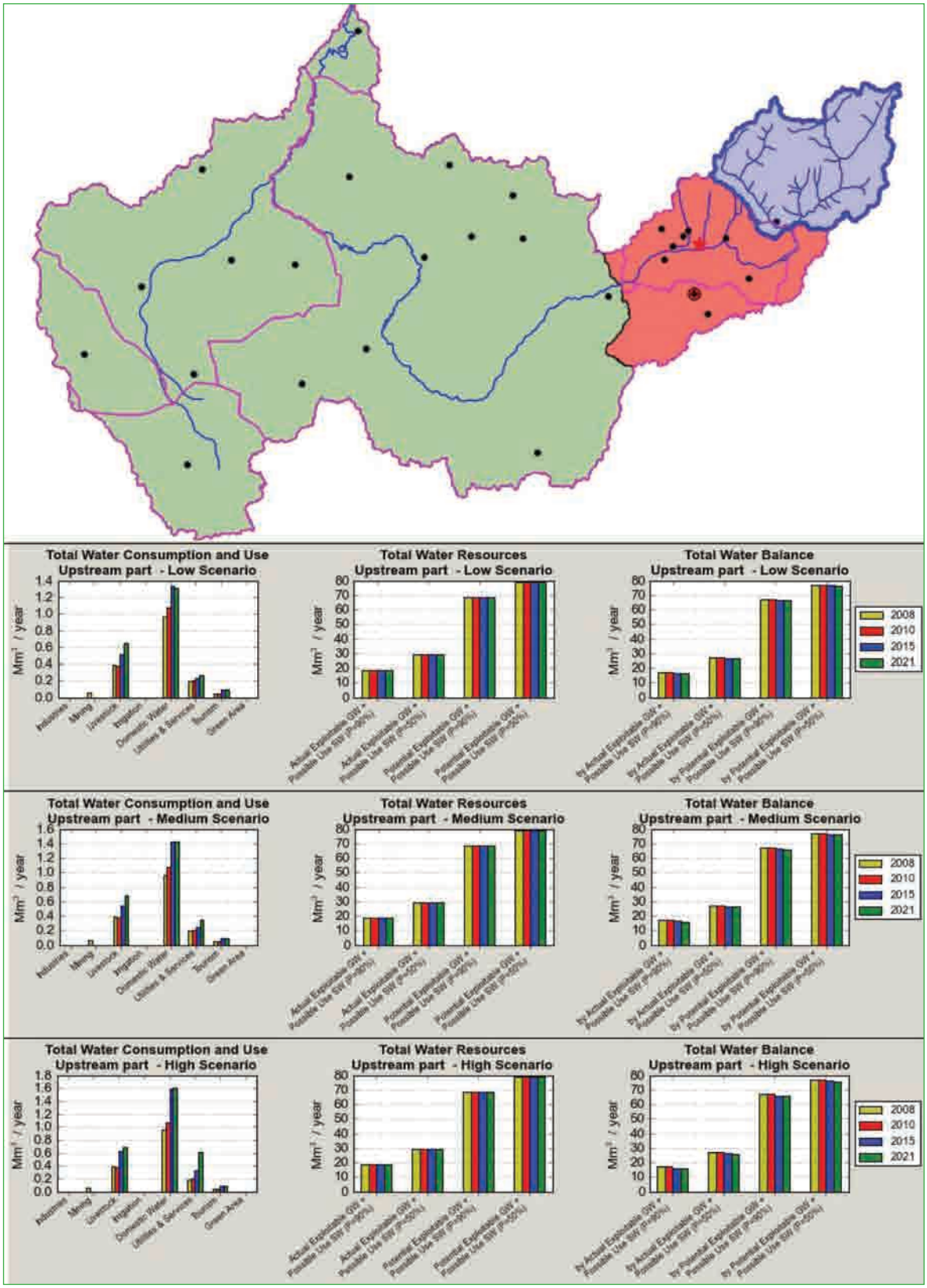

Figure 78. Water balance results upstream part Tuul River Basin

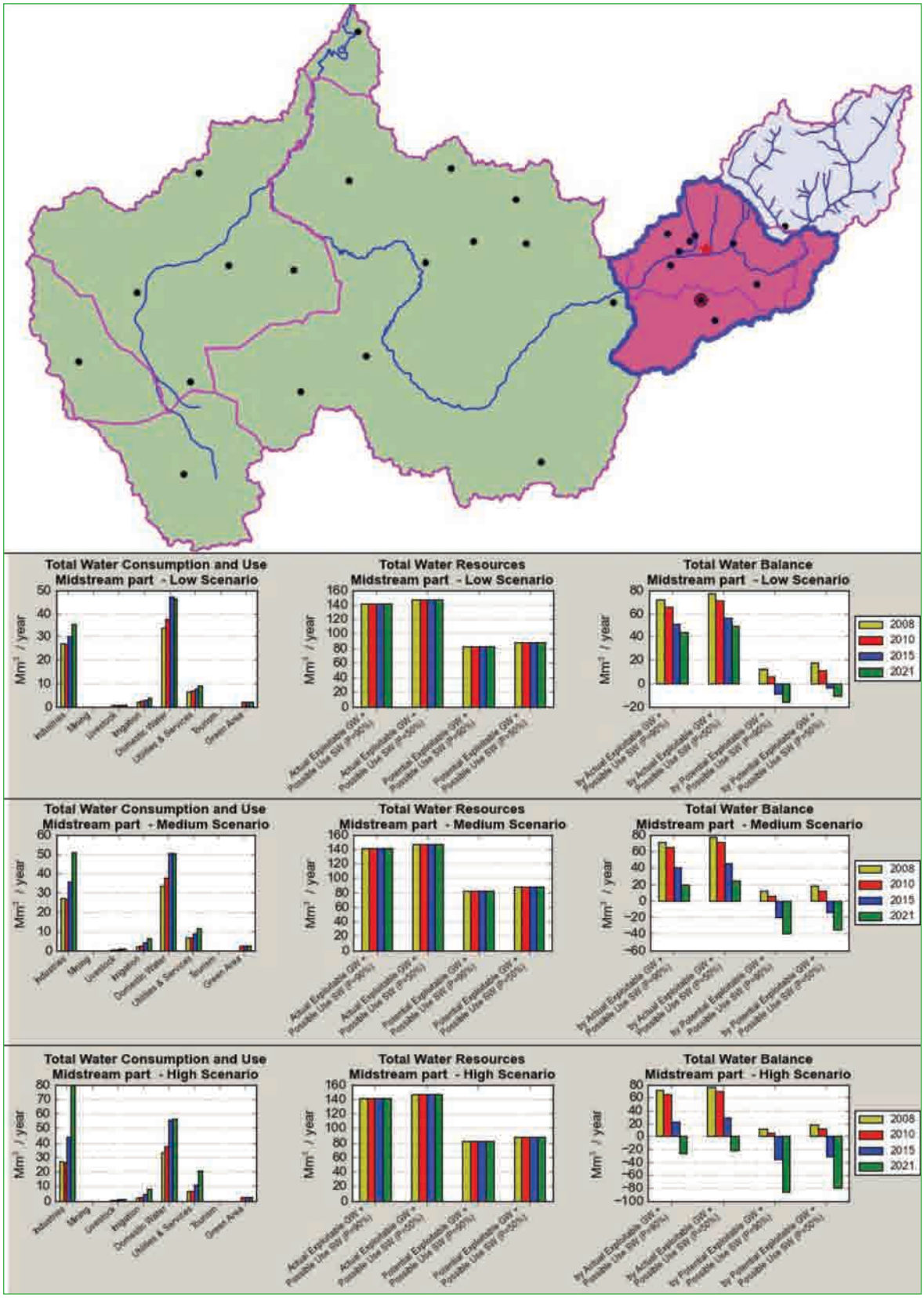

Figure 79. Water balance results midstream part Tuul River Basin

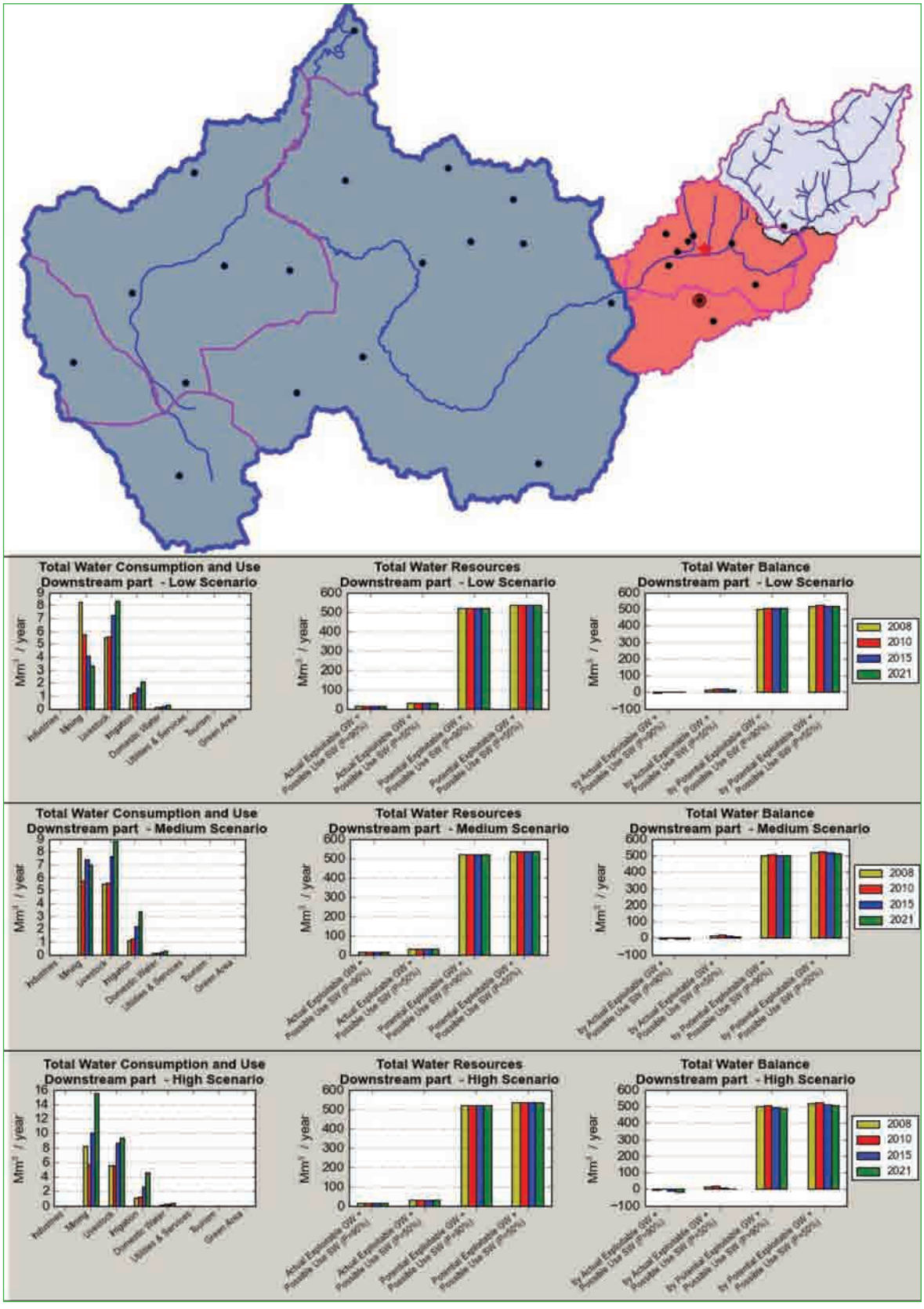

Figure 80. Water balance results downstream part Tuul River Basin

5.5. Conclusions on water use balance of the Tuul River Basin

- The Tuul River Basin water balance of 2010 was calculated by aimag, capital city, soum and district in the upstream, midstream and downstream parts of the basin. It provides an indication whether the current and future water demand of population, industries and agriculture can be supplied. Analysis of the relative location of the water demand and the water resources is required to deal with the issue of water consumption-use and water demand and to plan the water supply.
- As of 2010, in total 90.1 million m^3/year water was consumed and used in the Tuul River Basin. Compared to the water consumption-use in other basins, this represents the highest consumption-use. The total water consumption-use in this basin is supplied for 91.3% by groundwater and for 8.7% by surface water
- The water balance as established for the years 2010, 2015 and 2021 indicates that potentially the Tuul River Basin has sufficient water resources to supply the water demand of the low and medium scenario projections for 2015 and 2021 in all parts of the basin. The water demand of the high scenario projection for 2021 shows a shortage in Ulaanbaatar. However, some groundwater resources, of which the exploitable resources were determined, were not included in the available water resources.
- The projected water demand by energy is expected to amount to 85% of the total industrial water demand. This demand is based on an annual growth percentage of 6% of the energy water demand. A detailed study of the expected energy water demand in 2021 is required to calculate the energy water demand in detail as it does not include the water demand of the new power plant number 5.
- The surface water is mainly used in gold mines in the downstream part of the basin. If gold production is considered to increase in the future, its water demand is expected to be 15.5 million m^3/year according to the high scenario for 2021 and shortages are likely to occur in the river. This problem is unlikely to happen if measures to shut down the gold mines are taken according to the Law on prohibition of natural resources exploration and mining activities in river runoff forming areas, protection zones of reservoir areas and forest resource areas.
- Economic activities other than tourism should be prohibited and the number of permanent inhabitants should not be increased in the upstream part of the Tuul River Basin. The number of tourists visiting the upstream part is likely to increase in the future and this may have a negative impact on the natural ecosystem and the water quality of the related zone.
- The protection of the upstream part ecosystem, water resources and water quality, etc, by not allowing herdsmen to settle in water protection zones is the basis of the socio-economic development and the people wellbeing in the midstream and downstream parts of the basin.
- The protection of the ecosystem of the upstream part of the Tuul River Basin is expected to prevent significant changes in the river runoff and groundwater situation in the midstream part of the basin.
- The water situation in the Tuul river basin is affected by economical activities and climate change. Economical activities increase the water abstraction and pollute the water resources. Climate change causes higher temperatures which increase the potential evaporation and reduce permafrost occurrences. These processes have a critical impact on the Tuul River water regime causing a deterioration of the available water resources in quantity and quality.

- The exploitable groundwater resources of the currently used water sources for the Ulaanbaatar water supply were determined in 1980s and the resources have not been confirmed so far. Also there has not been adequate monitoring carried out on these resources so far. Therefore, re-determination, re-confirmation and constant monitoring are required.
- The four sources which supply Ulaanbaatar city with groundwater need to be extended by new sources (area from Tuul-Terelj confluence to Kharztain tourist camp and Uvur Gorkhiin Valley, Yarmag and Buyant-Ukhaa sources) of which the resources were already identified to avoid incapability of the city's water supply. The four sources are expected to be inadequate in 2014 according the high scenario and in 2015 according the medium scenario.
- The increase in groundwater abstraction at Ulaanbaatar by using new groundwater sources at Gachuurt and at other locations will increase the infiltration of surface water from the Tuul River. As a result river runoff will decrease causing a dry river bed possibly every year in April and May near Ulaanbaatar city.
- Due to the ongoing growth in groundwater abstraction at Ulaanbaatar groundwater drawdown occurs in an increasing area. This enlarges the danger of groundwater pollution of the resources by polluted groundwater flows until it becomes unable to be purified. Therefore, detailed investigations studying the groundwater regime of the Tuul aquifer are urgently needed.
- In view of the analysis carried out on the Ulaanbaatar water supply, it is necessary to consider and study the usable surface water resources and the exploitable groundwater resources in the upstream and midstream parts of the basin in an integrated manner.

- The water demand of the new international airport and Aero City, the new satellite town which will be established at Khushigiin Valley can't be supplied from the determined exploitable groundwater resources if the population is expected to be 100,000. Therefore, it is necessary to reassess the exploitable groundwater resources in this area and to find additional resources to supply the increase in water demand.
- It is necessary to carry out investigations on water supply sources for satellite towns and new settlement areas of Ulaanbaatar and to calculate the water use balance in detail as related to the expected population numbers and the industries to be established there.
- The water balance calculation shows that it is necessary in the future to increase the available water resources. The plan to build for the purpose of increasing Ulaanbaatar city's water supply by 2020 a multi-purpose dam complex at least on one dam site, but possibly on two or three other dam sites, needs to be investigated in detail soon, to determine the feasibility technically, socially, environmentally and economically. The effect of the dam on both the surface water and groundwater resources has to be investigated in an integrated manner.
- The water resources allocation is unlikely to be the same everywhere, not alone at national level, but also at the basin level. In the Tuul river basin groundwater is used in crop irrigation by almost 100% due to a lack of areas where irrigation areas are close to surface water. This contradicts the National Security Policy which limits groundwater use in crop agriculture.
- As of 2010, groundwater contributed 91.3% of the total water consumption-use at the basin level. Taking into consideration an increasing trend in groundwater

consumption-use in the future, it is necessary to investigate the possibility of using more surface water in the future.

- The Tuul River water is polluted starting from the point at Nalaikh where treated wastewater discharges into the Tuul River from Nalaikh WWTP and is significantly polluted from the point where treated wastewater is discharged into the river from the Ulaanbaatar Central WWTP until the point where the river passes through Lun soum centre of Tuv aimag. As according to study the river water in this section was determined as impossible to be consumed as drinking water, it is inappropriate to consider the surface water in this part as a possible usable water resource. If professional organisation carries out the detailed study and makes a conclusion that the water 'doesn't meet the drinking water requirements', it would be appropriate to prohibit using the river water for drinking and livestock purposes until the WWTP activities are improved and to remove the related part's surface water and groundwater resources from the total exploitable or usable resources. But such a resolution hasn't been made so far. That's why it wasn't removed from the exploitable and usable resources. If the groundwater in the midstream part was found to be polluted, there will be no way other than removing the Industrial and Meat Factory sources from the drinking water consumption-use. At the same time, a new additional drinking water source will be required by the same amount.
- It is necessary to take measures in the near future to remove pollution sources in the basin midstream part, to improve the WWTP treatment level, to protect the river from dumping of solid wastes and to reduce pollution in the river channel, etc.
- It is necessary to carry out an inventory of the uncontrolled boreholes established by individuals and companies in Ulaanbaatar and Zuunmod cities' areas for domestic and industrial purposes to assess the additional water consumption-use from these boreholes.
- It is necessary to execute continuous monitoring of groundwater levels in selected boreholes to manage the related groundwater regime and groundwater use and to study the long term development of the groundwater situation.
- It is necessary to make an assessment and a conclusion on water consumption-use by each sector's water users and consumers in the basin and to make the detailed planning of the measures to take in the future.
- The installation of water meters in apartments, industries, economic entities and organisations improves the efficiency of water consumption-use and water consumption-use will decrease. According to data and information from the Ulaanbaatar Water Supply and Sewerage Company, there is a large difference between the amount of abstracted and sold water, showing a significant loss of water from the supply system. Getting rid of this loss should be an objective of the water supply companies which provide and distribute fresh water.

6. NEGATIVE IMPACTS ON BASIN WATER RESOURCES

6.1. Natural impact

6.1.1. Climate impact

Air temperature: Temperatures are increasing in the Tuul river basin. For example: according to the data of weather stations in the basin, the temperature increased by 0.043 ˚C/year between 1940 and 2008. Since 2000, this increase became even higher. It was 0.14˚C/year between 1991 and 2008. The annual average temperature of weather stations in the Orkhon-Tuul basin increased by 0.8-1.3˚C. It was warmer in elevated areas. The thermal resources are enough in the basin. Thermal resources main indicators are presented in the table below.

Table 95. Thermal resources indicators

Weather station	Cold period			Total temperature		
	Final	Beginning	Duration of warm period, (days)	> 0°°C	> 5°°C	> 10°°C
Zuunmod	VI.5	IX.4	91	1868.5	1753.7	1411.1
Erdenesant	VI.2	IX.7	96	2122.1	2014.1	1706.4

The land elevation and the latitude affect the thermal resources. The thermal resources accumulating during the plant growing period are increasing due to climate warming. The useful temperature resources of the plant growth period are increasing. It is good for plants that require much heat. But the water that evaporates from the land and water surface is increasing. It increases the water deficiency of rivers, lakes and reservoirs.

The number of extremely hot days is increasing. The average number of hot days over 30.0˚C between 1961-1990 and 1991-2007 is presented in the table below.

Table 96. Average number of hot days over 30.0˚C in the basin

Weather station name	1961-1990	1991-2007
Erdenesant	4.8	12.7
Zuunmod	1.6	6.0
Buyant-Ukhaa	5.3	16.9
Ulaanbaatar	4.0	11.8

According to the table, the number of hot days is increasing in recent years (L.Natsagdorj).

Aridity: For the last 10 years, many rivers, ponds, springs and lakes have disappeared. The river runoff is decreasing. As for the Selenge River, 7 out of 10 years with the lowest flow of the last 60 years happened since 1996. Many factors have impacted it 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.

The surface evaporation increased by 153 mm between 1961 and 2008. The warm season precipitation amount 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 Tuul river basin.

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 the summer, fluctuation is low. The fluctuation is no more than 4.5°C and it will increase by 2.4°C. In winter, temperature is likely to increase more than in summer. The average winter precipitation will increase by 23 percent in 100 years. The average summer temperature will increase by 3 percent in 100 years.

Winter precipitation is likely to increase more than that of summer. This growth will continue until 2070 and it will stabilize after 2070. As for other elements, they will be increase 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 compared 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 results of the ecosystem productivity decreases in semi-arid area under natural factors and industrial impacts".

In 1996, Mongolia joined 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 Tuul river basin covers a total of 28,877 km^2 of land or 57.0 percent of the total territory of the river basin. About 8.5 percent or 4,293.2 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 of each category of desertification are presented in Table 97.

Table 97. Assessment of areas where desertification appeared in the Tuul river basin

Desertification rate	Area, km^2	Percentage,%
Slightly	13379.9	26.9
Moderately	11203.9	22.1
Severely	4293.2	8.5

6.2. Negative impacts of human activities

There are some key processes that affect the water resources and the regime of the Tuul River basin as following.

6.2.1. Urban area waste water treatment

Studies on the Tuul River pollution and water quality were conducted by many organizations like the Ecological Department of the Geo-ecology Institute, the Central Environmental Laboratory and the Laboratory of the State Implementation Agency. As mentioned in their research the main polluters are the waste water from the central treatment plants. Consequently water becomes polluted, loses its clarity and transparency and its self- purifying distance increases (Ch, Javzan). The water pollution problem needs to be addressed urgently before irreparable damage occurs, affecting the river ecology and human health (Natasha Roza B, IGE, 2005). The main polluters are the waste water and dry waste of Ulaanbaatar city, Zuunmod and 20 soum centers. None of the Waste Water Treatment Plants work properly.

6.2.2. Commonly distributed solid wastes in creeks and dry beds

Solid waste is another source of pollution in the Tuul River basin. During floods they wash away with water and add pollution affecting the water quality.

6.2.3. Unmanaged mining activities

The main mining activities concentrate along the Tuul River at Altanbulag and Zaamar soum. Studies by the Geo-ecology Institute show total destruction of terrain terraces at Tsagaan Bulag (4.8 km), Toson River (3.3 km), Bayangol River (5.5 km), Ar Naimgan (6.5 km), Khailaast (10.7 km) basins and destruction of natural pasture along the Tuul River (40 km), of 31,380.2 ha topsoil and 5,761.3 ha plant cover in the floodplain. The largest effect was from river channel changes during the development of gold mines. The construction of 1.05 km artificial channel destroyed around 5000 willows and plant cover. While using dredgers in Zagas kharaikh 1.55 natural channels changed to 0.85 reproductive channels and 34 ha area with 6292 shrubs and natural plant cover were changed and destroyed.

Mining also causes a high level of air born dust and artisanal miners (“ninjas”) cause additional environmental problems in the mining areas.

6.2.4. Land cover degradation (overgrazing)

In the Tuul River basin lives 50 percent of the total population of Mongolia and the large number of livestock lead to 28.8 percent highly degraded area and 3.7 percent of area infested by rodents.

In the basin, people and entities are conducting mining activities and the exploration area is 4,656.4 km^2 or 9.4 percent of the total territory of the basin. The mining exploitation area size is 339.3 km^2 or 0.7 percent of the total basin territory. Much land is degraded due to these activities. The other factor of land degradation and erosion are dirt roads in urban and rural areas.

6.2.5. Forest area change, soil and plant cover degradation

One of the key reasons for the decline in runoff in the Tuul River basin is deforestation and the consequent loss of runoff regulating capacity by forest. The total forest area in the Tuul basin was around 5,000 km^2, but now it has decreased by 35 percent. It is the primary reason for the changing hydrological regime of rivers (D. Enkhsaikhan, G. Davaa). Pasture in the Tuul River basin is considered as overgrazed and the soil surface layer is much degraded (soil compaction) and hydro-physical properties of the soil cover are changed. This situation certainly affects the change of the flow regime.

The plant cover near Ulaanbaatar city and along the Tuul River is used a lot for pasture and it is much degraded due to human activities and technical impacts. The percentage of many types of plants in the forest steppe and the steppe plant cover is decreasing and 1-year old plants increase which are not tolerant for pasturing of livestock. This phenomenon is observed in steppe and meadow pasture along the Tuul river. In this case, the surface soil moisture decreases and it gets harder. It lacks nutritious substances. The permeability of rain water decreases, evaporation increases and direct flow of surface water increases.

The basin residents cut wood in the forest for their every day life and it is also a kind of income. This action needs to be limited. So forestation and basin forest management are an integral component of the Tuul river basin integrated management.

6.2.6. Ecological degradation

Negative impacts of human activities are causing more degradation in the basin than natural and ecological conditions along with climate change results. Ecological conditions are changed in most of the basin territory which is related to the negative impacts of human activities.

6.3. Providing ecosystem balance

There is no land on the earth, which is located outside of river basins. The river basin is the most appropriate unit for implementing integrated water management considering the hydrology and the physical properties (boundaries). The stream network is a hierarchical system (stream order) and this systematic property can serve as bases for arrangement of other natural and socio-economical systems within the river basin.

Surface water mainly feeds by rainfall and forms in the vadose zone. Therefore all human and natural processes and activities which occur within the river basin express through changes of physical, chemical and biological properties of river water. Land use, desertification, degradation of pasture and plant cover, water quality and surface water source changes occurring in the Tuul basin were taken as reference conditions by the research studies by comparing with the undisturbed, natural conditions and these conditions or status were applied to the 16 sub-basins of the Tuul basin to classify and determine the present ecological status.

According to the classification Nomin, Kherkheluur, Khiid, Ikh Songino, Dulaankhaan, Khag, Galttai, Zuun Bayan, Baruun Bayan river basins in the upper Tuul are classified as close to natural condition; Terelj, upper Tarnai River basin are largely natural with few modifications and other sub-basins are considered to be moderately to seriously modified (Figure 81).

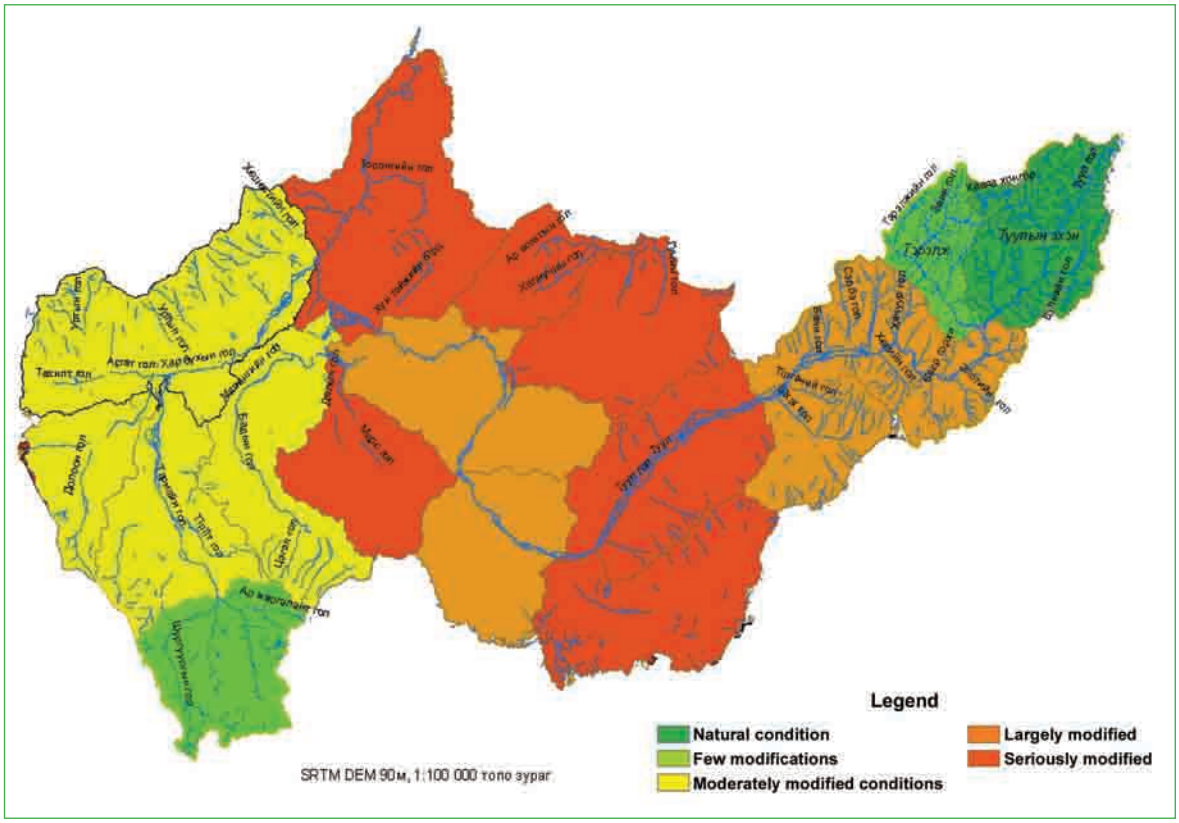

Figure 81. Ecological conditions of Tuul river sub-basins

Only 5.5 percent of the Tuul basin area has close to natural condition, 7.0 percent has largely natural condition with few modifications, 26.8 percent has moderately modified conditions, 22.8 percent largely modified conditions and 37.9 percent has seriously modified conditions. More than 60 percent of the total basin area is disturbed to some degree with as main reason human induced activities.

To assess the ecosystem integrity only few data is available within the Tuul basin, however research studies are going on to determine the ecological changes in this basin.

In the upper Tuul above Ulaanbaatar city 16-31 species of macroinvertebrates were registered at sample points and 61.9-85.0 percent is occupied by organisms of organic enrichment such as Hydrosyche ornatula. There are 12-25 types of aquatic macroinvertebrate in the river between the Ulaanbaatar city central WWTP waste water outflow area and the Orkhon-Tuul confluence. Most of them are pollution-tolerant Tubifex tubifex.

There is blue-green algae (cyanobacteria) in the waste water of the CWWTP and the river bed sediment which is black as coal represents a deficiency of oxygen in the water. The water temperature is high in this environment at all seasons, so it constitutes a comfortable environment for the distribution of aquatic micro-organisms.

Eristalis sp (Syrphidae) is found in the waste water of the CWWTP. It is an indicator for a higher environment of organic pollution. Below the area where the CWWTP's waste water is discharged into the river, the following insects dominate: *Tubifex tubifex, Chironomus sp, Brachycercus sp, Hydropsyche sp, and Cheumatopsyche sp.*

Indicator organisms of organic enrichment such as Hydrosyche ornatula which is distributed by 15-80 percent and Chironomus sp., Tubifex are counted at 71-93 or 40-

80 percent of all organisms in 0.1 m^2. If these were collected in 1 m^2, the number of individuals would range from 710 to 930.

Water resources are polluted due to domestic and industrial pollution sources. It has a direct and indirect impact on aquatic plants and animals. Some species of animals and plants die due to the impact. It will take much time and effort to rehabilitate the local fauna and flora when a secure living environment is restored once again or maybe it is totally impossible (J.Enkhtsetseg, 1997).

Soil, forest, vegetation cover changes are key reasons of ecological degradation in the basin. Compared to 1992 data, 42 percent of the steppe class area shifted to dry steppe area. That shows desertification is ongoing in Tuul basin and it's expressed by the topsoil and plant cover changes and increased soil erosion. Pasture growth decreased and plant species number decreased as well. Soil is degraded. Due to these reasons, it was not able to fulfil its ecological duty (D.Avaadorj, 2008).

The river basin land cover and its changes in 1992, 2002 and 2008 are presented in Figure 82.

Even though the upper part of the Tuul River has a close to natural ecological condition, some degradation is started to be observed in the area because of intense and growing pressure by tourist camps and local herders. Therefore preventive measures are taken such as control of wood exploitation and fire, to ensure no decrease in availability of land and water resources over time. If the continuing gradual degradation of the upper watershed lasts over 25 years than it will correspond to the expense of 400-655 billion MNT to the Mongolian economy. In the Terelj and upper Tarnai River sub-basins, which are largely in natural conditions with few modifications, it is necessary to protect the runoff forming area by stopping any human induced activities leading to changes of topsoil and plant cover. Ecological conditions in the upper watershed have a direct link to the availability of surface water and groundwater downstream.

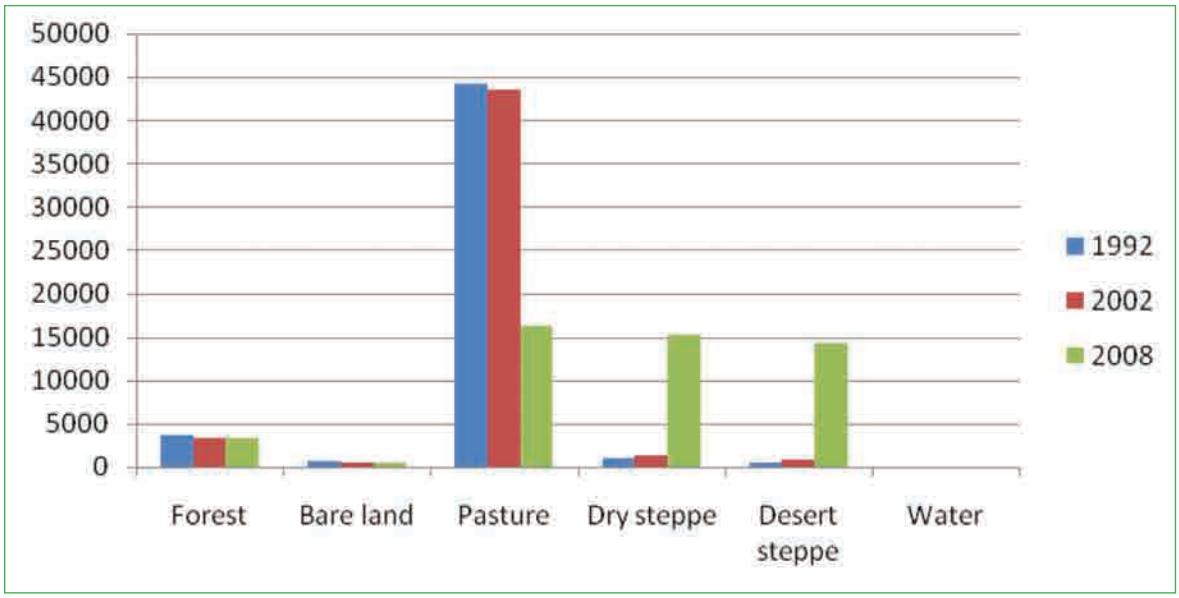

Figure 82. Land cover change (1992, 2002, 2008)

In the Kharbukh, Bad, Doloon and Tarnai River sub-basins, which belong to the moderately changed land class, pasture management has to improve as natural vegetation is particularly critical, as it influences interception, runoff and discharge.

In the Selbe, Uliastai, Gachuurt, Khul and Bukhug River sub-basins, 50 percent of the area is destroyed and many small rivers and springs have dried up,. So, topsoil protection and measures to restore river runoff are required in these basins.

In the Khalzan, Guna, Khaliuch, Zaamar sub-basins, 70 percent of the area is degraded and many rivers dried up.

Land and water conservation measures need to be done within the sub-basin in cooperation with national desertification, climate change adaptation and water program.

7. MAIN CHALLENGES AND STRATEGIC OBJECTIVES OF THE RIVER BASIN WATER MANAGEMENT PLAN

7.1. Main challenges of the management plan

The water related main challenges in the basin are:

1. Water for people
2. Water for agriculture
3. Water for industry, mining and energy
4. Water for environment
5. Comfortable environment of river basin water management

The following are the issues to be solved in the basin within the framework of the above mentioned main challenges:

Main challenge		Issues to be solved
1	Water for people	Improving the urban and rural area population safe drinking water supply and domestic waste water treatment level
		Improving rural population water supply and sanitation
		Developing tourism and sanatorium water supply and sanitation
2	Water for agriculture	Improving livestock water supply
		Expanding crop irrigation
3	Water for industry, mining and energy	Industry water supply (light, food, construction, building material etc)
		Developing mining water supply technology
		Renewing energy and thermal water supply technology
4	Water for environment	Preventing water resources from scarcity; protection and expansion
		Protecting water resources from pollution, decreasing pollution
		Keeping ecosystem balance
		Rehabilitating water resources
		Neutralizing damages of flood, drought, famine and other natural disasters
5	Enabling setting of water management	Water management legislation
		Water sector administrative structure
		Water sector financing
		Water management human resources
		Water resources monitoring, research, survey
		Data, data management, public awareness

7.1.1. Challenges related to population drinking water supply and sanitation

A) Improving urban area population safe water supply and domestic waste water treatment

Issues related to urban area population drinking water quality, waste water treatment and sanitation:

Population drinking water needs to meet the drinking water standard requirements at each water source in terms of quality.

- The main sources of the Ulaanbaatar city water supply are the Tuul River and groundwater which is recharged by precipitation. Tuul river valley groundwater meets the standard requirement in terms of chemical composition. Some groundwater quality parameters of some affluent river valleys and valley slopes do not meet the standard requirements in terms of chemical composition. Pollution indicators are observed in borehole water in districts where population and industries are concentrated;
- Structures are built inside the water supply sources and protection zones along the Tuul river and water is polluted;
- From the point where the treated waste water from the central waste water treatment plant joins the Tuul river to the Altanbulag bridge of Tuv aimag, the river water quality does not meet the population and livestock drinking water standard;
- There are 27 facilities that treat waste water in the basin: 13 of them are operating normal and 4 of them are operating not normal; 10 facilities are not operating. There are 18 facilities that treat domestic waste water and 5 of them are not operating. There are 9 facilities that pre-treats industrial and hospital waste water and 5 of them are not operating;
- Issues related to the treatment technology renovation, expansion and technology of the "Khargia" industrial waste water pre-treatment facility and the central waste water treatment plant, need to be solved urgently;
- As of 2010, only 42 percent of Ulaanbaatar city population was provided with improved sanitation;
- 61 percent of Ulaanbaatar city ger district households live in houses and 38 percent live in gers. 92.8 percent of total households has toilets inside their fences. Many toilets are filled in the last months of winter and during floods. Waste flows in the streets;
- The groundwater monitoring network data is insufficient and there are few monitoring boreholes;

Issues related to urban population drinking water availability:

- The main sources of Ulaanbaatar city water supply are groundwater and their potential exploitable resources have not been reapproved since 1970;
- According to the surveyed resources of currently used 4 sources, water demand can not be supplied after 2015;
- Extra groundwater and surface water sources need to be constructed for Ulaanbaatar city water supply;
- Water resources research and survey have not been conducted at areas where new settlement areas are constructed;
- Only 38.3 percent of Ulaanbaatar city population and only 34.0 percent of Zuunmod city population have connection to central water supply and sewerage networks;
- 22.3 percent of Ulaanbaatar city ger district population and 54.9 percent of Zuunmod city population are supplied from kiosks which have a connection to central networks. They do not have connection to sewerage networks;
- Suburb ger district residents of Ulaanbaatar and Zuunmod cities are supplied from not-connected kiosks, but availability is low and distance is far;

- Many residents and entities drill boreholes in their fences without any permission and they use water without fee and monitoring;
- Most of Ulaanbaatar and Zuunmod cities' ger district households use simple pit latrines and waste water hole/pit, these are the source of soil and water pollution;
- Soum center water supply and sewerage use management is insufficient and it needs to be included in the plan to be solved.

B) Improving rural area population safe water supply and domestic waste water treatment

Issues related to soum center and rural population (herders and farmers) drinking water quality:

- Soum center boreholes and ponds protection is not enough and there is a possibility of infectious disease outbreak;
- Groundwater in the Tuul river basin soum territories is mostly fresh and soft but in some places, some boreholes' water has a high mineralization and hardness, especially in Gurvanbulag, Khishig-Undur, Bayannuur, and Rashaant soums of Bulgan aimag;
- Water-softening and purifying equipment is installed at some soum center boreholes which have high mineralization and hardness; but usage is not enough;
- There is no hygienic protection at rivers, ponds and boreholes that are used for population drinking water. It is polluted by livestock dung;
- There are WWTPs only in 10 soum centers in the basin, but most of them are not operating (Bayannuur of Bulgan aimag; Bayankhangai, Ugtaaltsaidam, Bayantsogt, and Sergelen soums of Tuv aimag).

C) Developing tourism and sanatorium water supply and sanitation

- The number of tourists is increasing each year and it is important to improve tourist camps' water supply and sanitation facilities;
- Most of the basin's tourist camps are located in Khan Khentii SPA and Gorkhi-Terelj national park, and sanitation facility is not enough. Waste water treatment technology is weak and there is a risk to pollute natural water;
- Sanatoriums are based on water body areas including national parks and spas; there is no protection of the drinking water and spa source;
- The use of spa and mud is private sector-oriented. There is a risk of natural regime loss and it needs to be solved.

7.1.2. Challenges related to agricultural water

A) Improving livestock husbandry water supply

- The basin livestock number is increased and pasture capacity is 4 times exceeded on average;
- Engineering designed water points in pasture are broken and water availability is lowered, pasture capacity is exceeded and pasture is degraded;
- There were no surveys on pasture water resources. In recent years, boreholes funded by state budget, foreign loan and aid are drilled next to short tube borehole and concrete fence borehole which are broken. State budget assets are spent in a useless way;

- Construction of new boreholes is not conducted on the basis of pasture management plan and capacity;
- Not suitable pumps and engines are installed at recently-drilled boreholes and technical policy is lost;
- State budget asset-funded boreholes and ponds' maintenance, ownership and use are in bad condition and they are in a state of breakdowns;
- The inventory of water points in pasture is not detailed and registered. Data on their usage and ownership is rare;
- There are many livestock farms near urban areas. Their water supply is insufficient and there is a requirement that livestock fodder needs to be planted with irrigation.

B) Expanding agricultural irrigation

- The state budget gives support for the agricultural units to rehabilitate irrigation systems and construct new ones. The system is not constructed according to the layout and in some places irrigation systems are not constructed while the financial support is provided;
- There is no detailed research on possibility to conduct irrigation field and water resources availability of areas where irrigation system is constructed;
- In the basin, groundwater source is used a lot for irrigation field;
- Old irrigation systems' maintenance, use and agro-technological adherence are not good. The operational management is weak and the irrigation norm is not adhered to;
- As for irrigation, surface irrigation method is used which has much water loss. Methods that save water need to be introduced;
- Large field, multi-user irrigation system head constructions and main channels are required to be financed by state budget.

7.1.3. Challenges related to industries, mining and energy water

A) Improving industrial water supply (light, food, building material)

Issues related to the light industry water supply and WWTP:

- Light industry water supply is provided from central drinking water networks. It needs to be separated and we should conduct survey on possibilities to use surface water;
- Solving industries' water supply to be constructed in new settlement areas and satellite town of Ulaanbaatar;
- Most of Ulaanbaatar city light industries do not have facilities that pre-treat waste water. Some industries' WWTPs are old and their technologies are lost. Some of them are not operating.
- To stop activities to discharge waste water and half-treated waste water into Tuul river and to strengthen monitoring on it;
- Introducing technology that reuses treated waste water in industries and entities and supporting water saving policy. To prevent river source from pollution and to move industries that discharge much polluted water out of city;

- Ulaanbaatar city tanneries have technology that uses chrome. The river water is polluted by 6 and 3 valent chrome and there is a risk to pollute groundwater;
- WWTPs in the basin are not designed to eliminate heavy metal pollution in the waste water;
- In order to prevent from heavy metal flow into river, suitable WWTP for this kind of heavy metal discharging industry, needs to be constructed;
- Data and survey on light industry water use are rare;

Issues related to food industry water supply:

- Monitoring on food industry water quality standard requirement needs to be strengthened;
- All food industries are connected to central source of population drinking water and water use will be metered and monitored;
- To survey possibilities to reuse food industry waste water at tanneries and wool-cashmere washing industries;
- Data and survey on food industries' water use are rare;

Issues related to construction and building material water supply:

- As urban constructions expand, construction material (sands, gravel) extraction is conducted in river flood channel and it pollutes river water and leads to its scarcity;
- Building material production is seasonal. The material producers (who produce concrete and concrete materials) use water from their own drilled boreholes without any regime and they discharge construction wastes onto soil;
- It is required to study possibilities to use surface water in the building material production;
- To stop activity to use fresh drinking water for maintenance of concrete on construction site;

B) Developing mining water supply technology

- There are ecological negative impacts caused by gold, sand and gravel extraction. They include: decrease of river flow, damage of river channel, soil and plant degradation near river banks;
- To revoke special use permissions of gold mines that operate in the protection zone of water sources, river basin and forest fund areas; to stop the production activities;
- Gold mining companies' damage inflicted on environment in the basin, will be calculated on the basis of economic evaluation and rehabilitation work will be conducted;
- To improve detailed environmental impact assessment quality and results; to increase public participation in the monitoring on the execution/performance;
- Gold mining companies in Zaamar constructed bad-designed "septic-pond" in order to reuse water and its turbid water spills over its dam and it pollutes river water. It causes much amount of sediments in the river;
- To stop illegal activities of gold mining and there will be legalized organization/ structure;

- It is required to stop the activity that uses hazardous chemical substances for gold separation;

C) Renovating energy and thermal water supply technology

- 86.1 percent of total industrial water use in the basin is energy and thermal water use. If energy demand increases, water demand will increase as well. To study possibility to solve this demand by surface water sources;
- Thermal power plants in Ulaanbaatar reuse water and they are supplied from sources that meet drinking water requirements, it has negative impacts on fresh water resources;
- If ash removing activity is conducted by hydraulic method, treated waste water and water that meets technical requirements will be used and ash removing paired methods will be studied and introduced;
- If still using current fresh water sources in the future, observation will be made in borehole regime. Attention will be paid on keeping groundwater natural regime;
- Examining and proving groundwater resources in water supply source area;
- Establishing hygienic and protection zones in water supply facilities and regime will be complied;
- Water resources survey will be conducted in the territory where new thermal power plant 5 is constructed; safe water resources will be determined;
- To study and implement possibility to use treated waste water of CWWTP for the energy production;
- To renovate some parts of thermal pipelines and decrease water loss;
- To study possibility to use water energy and land heat in the basin;

7.1.4. Challenges related to the water for environment

Issues related to protection, expansion and prevention of water resources from scarcity:

- Establishing protection zones in Tuul and its affluent rivers' flow-forming source and water body areas and regime will be complied and this activity will be intensified according to the law;
- To stop following activities: drilling borehole without permission; extract much water that exceeded the amount; extract construction materials in the flood channel; construct facilities in the protection zone;
- Groundwater is used a lot for Ulaanbaatar city water supply in winter and in Aril of each year, Tuul river water disappears near the area close to Ulaanbaatar and area below Ulaanbaatar;
- To strengthen state and public control on prevention from forest fires, destruction and cutting of wood; decreasing wood cutting level to appropriate level;
- As for Mongolia, warming is intensified for the last 30-40 years and air temperature was increased by 2-3 degrees. It increased water amount that evaporates from land surface and water surface. It has become 110-140 times more than annual precipitation growth and aridity is likely to be increased as a result;
- To prevent from pasture degradation by coordinating water point location and pasture distribution (winter, summer, springs and autumn) with livestock number (in relation to pasture capacity);

- In order to decrease natural scarcity of water resources, water regulation should be conducted at each possible section of the river;
- Groundwater and surface water regime survey will be expanded and water demand and use will be regulated according to seasonal regime;

Issues related to water resources pollution:

- Tuul river pollution used to be self-purified at 100 km. Now it does not purify itself at this distance. It has negative impacts on river water quality, ecological condition and hydrobiological regime;
- CWWTP's waste water flows into river and river water mineralization increases 5.4-12.4 times more than "very polluted" norm. At other points, ammonium ion goes to "very polluted" category from "polluted" norm. It is not treated and it is joined with Zaamar pollution and is flowed into Orkhon River. Industries' and entities' preliminary treatment of waste water is not sufficient. CWWTP's technologies are not suitable for treatment. The treatment performance is no more than 60-70 percent;
- Tuul river water is impacted with chemical and domestic pollution near Ulaanbaatar city. It is likely to have impact on groundwater quality near flood channel;
- Wastes are thrown into flood channel and it is carried away by rain water and snow water. It pollutes river water;
- Cars and materials are washed in river water and it should be stopped;
- The WWTPs operating in the Tuul river basin discharge 160-170 thousand m3 waste water into Tuul river per day on average;
- Gold is mined in flood channel in summer time and it has obstacles for fish migration route to upper section of the river. It has negative impact on fish breeding and it even causes extinction of species;
- If forest is destroyed, soil permeability is decreased and fine dust is carried away by rain water and flows into river. It increases rivers' organic substances. Eutrophication is increased in the deep part of the water;

7.1.5. Challenges related to the establishment of an enabling river basin water management environment

Water management legal aspects:

- Water sector issues are divided between many ministries and many duties on water are given to local area administrations. Implementation of integrated water management faces obstacles;
- On water law, it is approved that RBC is established under RBA. But RBC's status is not certain;
- On Water Law, National Water Committee and RBA will conduct inter-sectoral management on water issues and it is not certain how management is conducted;

Water organization structure:

- To define the structure of new RBA and define its duties and responsibilities; To train employees;
- To establish possibilities for RBA to directly cooperate with relevant ministries, agencies and local area administrations;

- Inter-sectoral management on water issues will be certain when implementing river basin management plan;
- Coordination of activities of "Mongol-Us" state property industry and RBA will be certain;
- In order to improve monitoring on water resources use and pollution, monitoring organization will conduct activities under central state administration organization;
- Employees who are responsible for river basin administration water use, will be given state inspector rights;

Water sector finance:

- Expenses related to implementation of measures on water resources use and determination of finance related to measures to be implemented within the framework of river basin water management plan, will be centered on central state administration organization in charge of water resources issues;
- Public and private sector partnership will be used wisely in the wise use of water resources;

Water management human resources:

- Recent years, water sector employees' coherence of employment, profession, studies and policy is lost and water sector lacks experts;
- Experts required for water sector will be educated, trained by state budget;
- Training structure and environment will be developed and strengthened;

Water resources, quality monitoring, researches and surveys:

- To expand network of water resources and quality monitoring; to improve data processing;
- Scientific institute of water resources survey, research and layout will be established under central state administration organization in charge of water resources issues;

Data management and advertisements:

- Using modern technology and program for the establishment of river basin water information networks and database;
- Data on water resources and use will be advertised to the public by the use of media;

7.2. Management plan goals and strategic objectives

7.2.1. Management plan main objective

The objective of the Tuul river basin integrated water resources management is to use water resources wisely and protect from pollution and scarcity, plan ecosystem balance issues in an integrated way for the support of happy life of the people.

7.2.2. Management plan strategic objectives

Within the framework of the issues and objectives, strategic objectives of the management plan will be defined and the strategic objectives are based on the: MDG-based Comprehensive National Development strategy; "Water" national program;

regions' and sectors' development policy; natural conditions and features of the basin; research on groundwater and surface water resources; natural and human impacts on water resources; water resources pollution and scarcity; current development of aimags, soums and urban areas in the basin; trend of country's socio-economic development.

7.2.3. Objectives of the management plan

The strategic objectives of the challenges are:

1st challenge: To supply the population with safe drinking water, improve treatment level of domestic waste water and improve sanitation.

2nd challenge: To improve agricultural water supply.

3rd challenge: To solve water supply and waste water treatment of industry, mining and energy.

4th challenge: To keep river basin ecosystem balance.

5th challenge: To establish comfortable environment of river basin water management.

The goals of the river basin water management plan strategic objectives are:

1. Within the framework of the strategic objective to supply the population with safe drinking water, to improve the treatment level of domestic waste water and to improve sanitation:

   Goal 1. To supply the urban area population with safe drinking water, increase availability of sewerage and sanitation;

   Goal 2. To improve rural population water supply and sanitation;

   Goal 3. To improve water supply and sanitation of tourist camps and sanatoriums.

2. Within the framework of strategic objective to improve agricultural water supply:

   Goal 1. To improve animal husbandry water supply;

   Goal 2. To support sustainable development of irrigation field.

3. Within the framework of strategic objective to solve water supply and waste water treatment of industry, mining and energy:

   Goal 1. To solve industrial water supply (light, food, building material);

   Goal 2. To solve mining water supply based on water resources;

   Goal 3. To solve energy and thermal water supply based on water resources regime.

4. Within the framework of strategic objective to keep river basin ecosystem balance:

   Goal 1. To protect and expand water resources;

   Goal 2. To protect water resources from pollution and to decrease pollution;

   Goal 3. To define environmental flow and regime of Tuul river and its affluent rivers and protect biological species;

   Goal 4. To rehabilitate damaged water sources;

   Goal 5. To establish condition that neutralizes floods, drought, famine and other natural disasters;

5. Within the framework of strategic objective to establish comfortable environment of river basin water management:

   Goal 1. To develop legal environment of activities in the basin;

   Goal 2. To have appropriate structures of river basin water organizations;

   Goal 3. To develop financial structures of river basin water management;

Goal 4. To establish capacity to implement water management in the basin;

Goal 5. To improve water resources, quality monitoring-research and level of surveys;

Goal 6. To develop river basin data management and expand advertisements;

7.3. River basin water management condition

7.3.1. General introduction

The water organization structure and relations in the basin will be managed according to article 10, 17-21 of Mongolian law on water.

In August 2012, the state administration organization in charge of water issues was disbanded. The following was amended in the law on water: disbanded organization's activities, duties and rights will be transferred to the Ministry of Environment and Green Development.

Figure 83. New structure of the Ministry of Environment and Green Development (as of September, 2012)

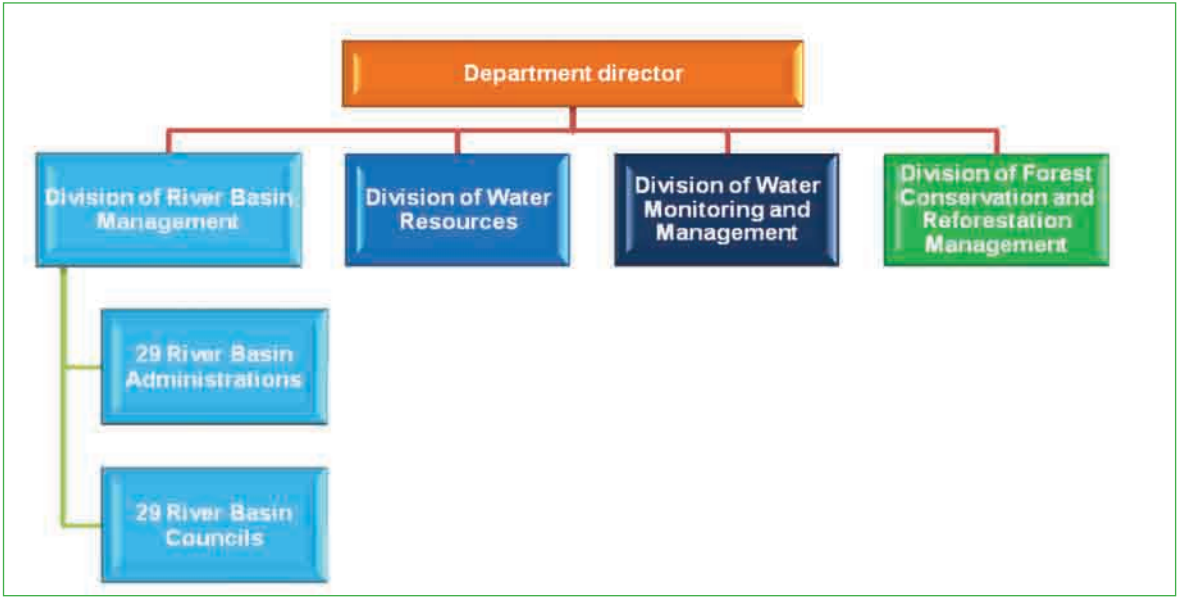

Figure 84. The structure of the Department of Policy Implementation of the Ministry of Environment and Green Development

River Basin Authorities (RBA) and River Basin Councils (RBC) are to be established according to the law on water and these will develop and implement the river basin water resources management plan. According to article 17 of the law on water, RBA rights and duties are defined. According to the article 20, RBC activities are defined. In order to define RBC status, 2nd sub chapter of 4th chapter of the civil law needs to be considered. In the sub chapter, types of organizations and entities are defined in a detailed way. The organizations for benefits are companies and non benefit organizations are unions, funds and partnerships. So RBC activities and financial issues are solved based on clauses of civil law and law on water. RBA activities need to be organized according to the article 17 of the law on water. The Khovd and Buyant RBC were established by order 59 of the Minister of Nature, Environment and Tourism in 2009. It is funded by WWF. Participation of stakeholders in the RBC is weak and the state dominates in the direction of activities. Article 20 of the law on water needs to be the basis.

7.3.2. Development of river basin water organization structures

According to the international experiences, river basin organizations conduct their activities in three ways. First, state; second, public and private partnerships; third, NGO.

As for our country, RBA operates under central state administration organization in charge of environmental issues. Aimag and capital city environmental departments and soums' inspectors will be included in the water related integrated administration. RBA rights and duties are included in new amendments of the law on water as follows:

- Develop river basin management plan;
- Provide local area and inter-sectoral management for implementation of river basin management plan, monitoring on implementation;
- Provide all stage local area governors and citizen's representative meetings with professional recommendations;
- Water inventory will be organized in the basin, river basin water database will be conducted and public will be provided with data and information;
- Receive residents' and entities' request on drilling boreholes and conducting pipelines for the use of water, making recommendations of water use based on water resources management plan, including and registering them in database;
- Granting permission to use water;
- Define basis to impose a fee on water resources use and pollution according to the law and regulations;
- Determine water supply source and waste water discharging points/spots in the basin;
- Recommendations to void water use and waste water discharging rights of citizens, entities and organizations that violated the requirements to use water and discharge waste water; counterclaim of compensation for environmental damage;
- Constant monitoring on possible resources of water use and water use conditions in the basin;
- Having river basin council;
- Developing basis to include followings in state and rural special protection: rivers, lakes, other water sources as well as groundwater aquifers;
- Grant of special permission for natural resources surveys and extraction in the basin, will be based on RBA opinions;

- Waste water discharging permission will be given to water polluters that discharge waste water more than 50 cubic meters a day and waste water that contains hazardous polluting substances, based on decisions of central state administration organization in charge of water issues;
- Recommendations on the use of 50-100 cubic meter water a day;
- Making decision to terminate water use agreement with citizens, entities and organizations before the deadline;
- Agreement with water users that are supplied from non central water supply source;
- Data from users about spa, lake with minerals, composition of healing mud and quality assessment;
- Recommendations on decision to construct hydro constructions;
- Other

Except the duties and rights of the law, RBA can make agreements to cooperate with relevant sectors' professional organizations and experts; give professional advices; demand them; take recommendations from them; make decisions with them if necessary and monitor on implementation. Also it will monitor the implementation of river basin water management plan, give professional advices, introduce it to the relevant local area administration and have a decision made by them, and inform according to the rules of state administration organization in charge of water issues. It receives any opinions and complaints related to river basin water resources and responds urgently after surveying conditions at professional level. The controversial issues related to river basin water resources will be introduced to local area governing body and all-stage governors and their work offices. The decision will be made after discussing with them. RBA will be a water sector professional organization and it will have a RBC. RBC has following duties: to develop river basin water management plan, give recommendations and advices on implementation activities, provide multilateral participation in the implementation. It is an adjunct organization.

Figure 85. Water organization structure in the river basin

7.3.3. The policy to relate river basin water organization activities to other sectors and implement water resources management plan

RBA lacks legal basis to relate its activities to socio-economic sectors. So it is required to determine duties of participants in water resources management issues by each sector. According to the article 9.1.5 of water law, the following full rights were given to the Government: "Conduct inter-sectoral management on water issues, provide with integrated administration, to operate national committee responsible for providing national program implementation". According to article 7.5, "Water users, consumers, citizens, entities and organizations provide data on forming water database to central state administration organization in charge of environmental issues and to RBA according to article 17". Based on these clauses, water users and consumers will work together for implementation of the river basin water resources management plan and its needs to be complied. There will be requirements to make amendments in some activity directions of ministry, agencies, institutes, laboratories, cities, aimags, soums and districts. On the other hand, there are changes in the future activity trends of the participants in water resources management during the implementation of Mongolian Government resolutions number 316 and 335 of the year 2011. There will not be big changes in the water use and water demand activities and current water resources amount. There are some things about general coherence of the activities.

1. RBA should provide local area and inter-sectoral management when implementing river basin water resources management plan within the reach of its full rights. RBA is the 4th stage organization of the Ministry of Environment and Green Development administration. So in order to provide above mentioned management, decision will be reached after passing several stages.

   - In order to provide local area management, issues will be introduced at stages of bag, district, soum, district, aimag and Ulaanbaatar city. At last, it will be sent to the ministry. There are internal units in each stage. For example: bag and district public meeting; Governors' Offices; soum and district environmental experts; state inspectors; district professional inspection agency; Ulaanbaatar and aimags' Citizens' Representatives' Meeting; governors; leaders; environmental agency; professional inspection agency. The cooperation issues with many officers and organizations need to be considered. And the results will be monitored and requested in this order. The river basin integrated water resources management plan contents will be understood in this way.
   - According to the article 17.1.2. of law on water, RBA will conduct inter-sectoral management when implementing river basin management plan. Inter-sectoral management means managing of water use and demand of country's even, river basin socio-economic sectors. National Water Committee has rights to conduct this responsibility as well. It seems that the RBA operates under National Water Committee guidance. But RBA transfers the issues through Administration Division of the River Basin, Department of Policy Implementation and the Ministry of Environment and Green Development and then it negotiates with National Water committee at administration level and it needs to address to the ministries. So river basin administration rules are discussed with division, department, ministry and committee. It is important to have an integrated rule on inter-sectoral management.

The following is included in the responsibility of the Division of River Basin Administration and the Department of Policy Implementation of the MEGD: development and implementation of river basins' IWRM plan will be conducted with the participation of local areas, residents, socio-economic sectors, their branch organizations and units.

2. In order to organize annual river basin water inventory with the participation of local area administration organization, there needs to be consolidated decisions of aimag, capital city and the ministry. It will be useful if it is organized in relation to water resources and quality. The following measures need to be executed: conduct brief chemical, bacteriological and biological surveys at each selected water source and define yields of that time. This will be a big and tough activity. For example: there are some 300 rivers, 4000 boreholes and 50 lakes in the Tuul river basin. 45-60 days activities are required for conducting their inventory with the force of 3 working groups.

1. When conducting amendments in the river basin water resources management plan, activity to develop basis on 16 sub basins' water resources use, protection and rehabilitation, will be conducted under the own organization administration and this issue will be discussed with sub basin and relevant sectors. It will be organized in several stages.

7.3.4. River basin administration financial issues

According to the law on water, Tuul river basin council was established in 2011 and it is operating now. Currently, the council is financed from the project. According to newly-amended 2012 water law, river basin administration is planned to be established and employees will be between 15 and 20. The expense for RBA is presented in Table 98. If Tuul river basin administration operates with 22 employees, 371 million tugrugs are required per year on average.

Table 98. Administrative expenses of the river basin administration

Type of expenses	Annual average, *thous.MNT*
Number of staff, *persons*	22
Total Expenses	370 958.9
Salaries with Social insurance premium	141 147.1
Salaries	127 159.6
Social insurance premium from employer	13 987.6
Chancery, telecommunication, postage and freight	9 000.0
Transport (fuel)	12 000.0
Domestic travel	14 000.0
Utilities	12 000.0
Labor safety facilities	2 500.0
Low value and fact depreciable items	500.0
Research and training	7 500.0
Payment for the others organizations work and service, fee and levies	10 000.0
Information and advertising	3 500.0
Other costs	17 664.7

Also the financial sources of RBAs can be stakeholders' donations and aid. In the future it is necessary to study possibilities to use some parts of water related taxes and fees for RBCs and RBAs. The legal environment should be created.

The above mentioned sources will be spent only for administrative expenses of RBAs. Also it is necessary to determine financial sources for the main activities of the RBAs. They are:

- Monitoring water resources
- Developing water related infrastructures, supplying 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. RIVER BASIN INTEGRATED WATER RESOURCES MANAGEMENT PLAN MEASURES

8.1. Measures of the plan

In relation to the MDG-based Comprehensive National Development Strategy, "Water" National Program, regional and sectors' development policies, within the framework of the above mentioned issues, challenges, objectives and strategic objectives, the measures are defined and their implementing period, investment, activity expenses, organizations and results are presented in Table 99.

8.2. Basic measures to be implemented

The following basic measures are required to be implemented:

Basic measures to be implemented within the framework of strategic objective 1:

- Defining protection border of water supply sources;
- Conducting surveys to define resources of 4 main sources that are used for the Ulaanbaatar city water supply; approving resources;
- Conducting feasibility studies of Tuul water complex and making design study;
- The sources whose resources are defined, will be put into use;
- Expanding CWWTP's capacity and increasing treatment efficiency;

Basic measures to be implemented within the framework of strategic objective 2:

- Conducting pasture capacity study, making layout of pastures and making plan of constructing water points in the basin;
- Improving ownership, use and maintenance of the boreholes that were constructed by state budget;
- Improving intensified entities' water supply;
- Conducting water resources surveys of areas where irrigation is possible to be conducted; developing design and lay-outs;

Basic measures to be implemented within the framework of strategic objective 3:

- Studying possibilities to use surface water for light industry, building material industry and thermal power plants and separating from population centralized drinking water sources;
- Conducting water resources surveys for water supply of industries to be constructed in new settlement areas and satellite towns of Ulaanbaatar city;
- Moving industries out of city center that pollute water a lot and have negative impacts on environment;
- Conducting industries' water use research and putting into water database;

Basic measures to be implemented within the framework of strategic objective 4:

- Establishing protection zones for Tuul and its affluent rivers' flow-generating sources and water body areas, regime will be complied;
- Conducting survey for defining ecological flow of Tuul and its affluent rivers;
- Stopping activities including drilling boreholes without permission, mining gold and building material in flood plain and constructing buildings and facilities in the protection zones;
- In order to decrease natural scarcity of water resources, water regulations will be conducted at possible sections of Tuul river and its affluent rivers;
- Expanding the research of groundwater and surface water regime, regulating water use and demand in terms of seasonal regime;
- Stopping activities including throwing litter into flood channels, washing cars and items in rivers;
- Estimating amount of ecological losses that were inflicted due to mining of gold and popular natural resources in the flood plain of Tuul and its affluent rivers; rehabilitation work will be conducted;
- Expanding and renovating flood protection facilities, constructing new facilities;
- Expanding urban area green areas;

Basic measures to be implemented within the framework of strategic objective 5:

- Strengthening RBA and RBC activities, solving their financial issues wisely;
- Defining activities for conducting inter-sectoral management on management plan implementation;
- When providing management plan implementation, RBA will establish structure of cooperating directly with relevant ministries, agencies and local area organizations;
- Improving work coherence of water sector's state organizations and entities;
- Granting state inspector rights/title to employees responsible for RBA water use;
- Financial budget and expenses of the measures included in the river basin management plan, will be concentrated in the central state administration organization responsible for water resources issues;
- Using Public and Private Sector Partnerships for the wise use of water resources;
- Water sector and water management experts will study at professional education centers of universities by the finance of budget;
- Expanding the network of water resources, quality monitoring and water studies and improving data processing;
- Constructing water quality inspection laboratories and strengthening sector's research, project and scientific organizations;
- Establishing water database of the basin and using networks for the establishment of the database;

Table 99. Integrated water resources management plan of Tuul river basin

Challenges, measures, activities	Implementation period; investments, million tugrugs		Total investments (million tugrugs)	By percentage				Responsible organizations	Results
	2012-2015	2016-2021		State budget	Local area budget	Foreign aid	Private and others		
1	2	3	4	5	6	7	8	9	10
WATER SUB-SECTOR 1: WATER FOR PEOPLE Strategy: Supplying population with safe drinking water, increasing accessibility of improved sanitation									
Challenge 1: Increasing urban population safe drinking water supply and availability of improved sanitation									
Measure 1.1. Establish and enforce sanitation and protection zones around water supply sources									
1.1.1. To newly set hygienic and protection zones of the following sources of Ulaanbaatar city water supply: Upper and central sources, Nisekh, Yarmag, Biokombinat, Uildver, Makhkombinat, Gachuurt and protection regime will be complied.	995.0	1245.0	2 240.0	30	70			MCUD, MEGD, MH, Ulaanbaatar city local representatives' hural, USUG	To fully solve the issue to protect Ulaanbaatar and Zuunmod city water supply source from pollution
1.1.2. To newly set hygienic and protection zones of Zuunmod city water supply source and protection regime will be complied.	10.0	19.0	29.0		100			MCUD, MEGD, MH, Aimags' local representatives' hural, AGO	
1.1.3. Conducting inspections at Ulaanbaatar and Zuunmod city ger district kiosks' hygienic and protection zones and to newly set if necessary and protection zone regime will be complied.	573.5	855.0	1 428.5		100			MCUD, MEGD, MH, GOUC, City and Aimag's local representatives' hural	
1.1.4. To control the implementation of water supply source zone regime				From relevant organizations' operation cost				MEGD, GASI, CSID, RBA	
1.1.5. Assessing implementation and conditions of water source and springs which will be taken into protection in 2015 and make conclusion on whether to continue or not and making decisions.	20.0		20.0		100			MEGD, GASI, CSID, AGO, GOUC, RBA	
Total	**1 598.5**	**2 119.0**	**3 717.5**	**18.1**	**81.9**	**0.0**	**0.0**		

1	2	3	4	5	6	7	8	9	10
Measure 1.2. Local surveys and exploration studies to identify new or verify existing water resources.									
1.2.1. To set recharge area of Ulaanbaatar city water supply's upper and central source; to conduct modifying research of water resources and validating resources.	4 443.0		4 443.0		10	90		MEGD, GOUC, RBA	Validation of water resources of Ulaanbaatar and Zuunmod cities' water supply
1.2.2. Conducting water supply source's water resource research in Yarmag, Nisekh, Biokombinat of Ulaanbaatar city. The resources will be validated.	350.0		350.0		100			MCUD, MEGD, GOUC, RBA	
1.2.3. Conducting groundwater resource research of water supply source in Ulaanbaatar city satellite towns (Terelj, Khonkhor, Uliastai, Nairamdal, Emeelt-Argalant, Bio-Songino, Ulziit) and new residential areas (Gavjiin Shand).	970.0	1800.0	2770.0	100				MCUD, MEGD, GOUC, RBA	
1.2.4. Conducting research to define regime and water resources of Khushugiin Khundii source of Aerocity (new international airport) water supply and validating resources.	350.0		350.0	100				MEGD, GOUC	
1.2.5. Conducting survey on water resources research materials of urban area water supply source in the basin; making overall results; putting into database				From relevant organizations' operation cost				MEGD, RBA	
1.2.6. Conducting detailed inspection and inventory at boreholes that were drilled in private areas by the owners in Ulaanbaatar and Zuunmod cities (currently there are some 1600 drilled boreholes); defining measure directions on water use.	20.0		20.0	50	50			MEGD, GOUC GOUC, AGO, RBA	
Total	**6 133.0**	**1800.0**	**7933.0**	**39.5**	**10.1**	**50.4**	**0.0**		
Measure 1.3. Construction and renovation of water supply sources									
1.3.1. In order to increase Ulaanbaatar city water supply availability, groundwater research was conducted and resources were estimated at Tuul-Terelj confluence, Uvur gorkhi. Its water supply source facility will be newly constructed in coherence with Tuul water complex.	-	8 755.0	8 775.0	50.0		50.0		Government, MEGD, GOUC, RBA	At the level of 2021, not less than 90 percent of Ulaanbaatar and Zuunmod city population will be supplied by safe drinking water.
1.3.2. Choosing dam site where water complex, for energy manufacturing and population and industrial water supply at the Tuul river upstream, is constructed; surveys will be conducted; technical and economic basis and lay-out will be developed.	6500.0		6500.0	100				Government, MEGD, GOUC, RBA	
1.3.3. Construction of Tuul water complex (dam), hydropower plant, water drainage facility		325 000.0	325 000.0				100	Government, MEGD, GOUC, RBA	

1	2	3	4	5	6	7	8	9	10
1.3.4. Construction of water treatment facility which treats water from Tuul water complex to Ulaanbaatar city water supply		65 000.0	65 000.0	50.0			50.0	Government, MEGD, GOUC, RBA	
1.3.5. Construction of water transmitting pipes from Tuul water complex		218 400.0	218 400.0	10.0	10.0	40.0	40.0	Government, MEGD, GOUC, RBA,	
1.3.6. Construction of water transmitting pipelines and water supply source facility of Yarmag and Nisekh new mini-districts of Ulaanbaatar city by KOICA project of the Republic of Korea	49 400.0		49 400.0			100		MCUD, GOUC, USUG, RBA	
1.3.7. Expansion of upper source of Ulaanbaatar city water supply		20 800.0	20 800.0		10.0	90.0		MCUD, MEGD, GOUC, RBA	
1.3.8. Construction of Khui Doloon Khudag water source facility and pipelines as water supply source of Argalant-Emeelt, a satellite town of Ulaanbaatar; it will be solved based on use possibility of water resources	14 430.0		14 430.0				100	MCUD, MEGD, GOUC	
1.3.9. Constructing water supply source of Aerocity (including construction of water transmitting pipes).		58 000.0	58 000.0				100	MCUD, MEGD, GOUC	
1.3.10. Expanding and maintaining Zuunmod city water supply source	352.0	129.0	481.0	100				MCUD, AGO, RBA	
1.3.11. Installing water purifying and chlorination equipment at Zuunmod city water supply source	275.0		275.0		100			MCUD, AGO, RBA	
Total	**70 957.0**	**696 104.0**	**767 061.0**	**8.6**	**3.2**	**20.8**	**67.4**		
Measure 1.4. Renovation and expansion of water supply network and increase of number of connected water supply kiosks									
1.4.1. Renewing and maintaining Ulaanbaatar city fresh water transmitting pipelines - Main part of the city, Industrial zone, Makh kombinat etc - Classifying pipelines by inrush, - Introducing GIS to water transmitting pipelines	19500.0	45500.0	65000.0	100				MCUD, GOUC, USUG	At the level of 2021, not less than 90 percent of Ulaanbaatar and Zuunmod city population will be supplied by safe drinking water
1.4.2. Expanding Ulaanbaatar city fresh water transmitting pipelines - Gachuurt, Uliastai, Hujirbulan - Main part: Fresh water transmitting pipelines, ger district pipelines, new districts in the south part of the city, Selbe, Tolgoit, Bayngol district, - Construction of reservoir and pumping station	36400.0	54600.0	91000.0	100				MCUD, GOUC, USUG	
1.4.3. Installing water transmitting pipelines in Yarmag and Nisekh new districts	46 800.0		46 800.0			100		MCUD, GOUC, USUG	
1.4.4. Construction of fresh water transmitting pipelines of Tsaiz, Gandan, Naran and Unur districts of Ulaanbaatar city	4 875.0	3 120.0	7 995.0	100				MCUD, GOUC	

1	2	3	4	5	6	7	8	9	10
1.4.5. Conducting expansion and renovation of fresh water transmitting pipelines and reservoirs of Nalaikh district of Ulaanbaatar city	2 340.0	9 360.0	11 700.0	100				MCUD, GOUC	
1.4.6. Water and heat transmitting pipelines will be included in the underground tunnel facilities along with other engineering pipelines at 27 km area of Ulaanbaatar city center	11 000.0	30 000.0	41 000.0		50.0	50.0		MCUD, GOUC	
1.4.7. Connecting middle area ger district houses of Ulaanbaatar city to fresh water pipelines	11 000.0	60 000.0	71 000.0		10.0	20.0	70.0	MCUD, GOUC	
1.4.8. Equipment renovation at 42 water and heat transmitting centers /Korean Government grant/	44 200.0		44 200.0			100		MCUD, GOUC	
1.4.9. 470 kiosks will be constructed in Ulaanbaatar city ger districts and they will be connected to the centralized water supply networks	10 140.0	21 060.0	31 200.0	100				MCUD, GOUC, USUG	
1.4.10. 20 kiosks will be constructed at distant ger districts of Ulaanbaatar city that are not connected to the centralized water supply networks; 180 tanker truck supplied kiosks will be constructed (water trucks and equipment will be newly bought)	1 820.0	1 800.0	3 620.0		100			MCUD, GOUC, USUG	
1.4.11. To expand and maintain Zuunmod city water transmitting and distributing pipelines; water lifting facility and equipment will be renovated.	4 687.0	2 395.0	7 082.0	100				MCUD, AGO, RBA	
1.4.12. To maintain and rebuild Zuunmod city ger district kiosks and they will be connected to the centralized water supply networks	30.0	150.0	180.0		100			MCUD, AGO, RBA	
1.4.13. Connecting Zuunmod city ger district houses to the fresh water networks (50-100 houses on average per year)	3 000.0	4 000.0	7 000.0				100	MCUD, AGO, RBA	
1.4.14. Construction of not less than 30 baths with complex service in distant ger districts and middle part of Ulaanbaatar city	5 386.0	2 250.0	7 636.0		100			MCUD, GOUC, RBA	Improving ger district population hygienic condition
1.4.15. 3 baths will be constructed at Zuunmod city ger districts	225.0	450.0	675.0		100			MCUD, AGO, RBA	
1.4.16. To renovate defense units' water supply and sanitation facilities in the basin; it will be coherent to sector planning and orders.	100	100	200.0	100				MD	Supplying defense units with safe drinking water
Total	**201 503.0**	**234 785.0**	**436 288.0**	**49.1**	**9.1**	**28.8**	**13.0**		

1	2	3	4	5	6	7	8	9	10
Measure 1.5. Construction, expansion and renewal of waste water treatment plants									
1.5.1. Developing layout and technical and economic basis to reach Ulaanbaatar city central waste water treatment plant capacity 450 000 m3 a day; conducting expansion with high technology	13 900.0	441 100.0	455 000.0	50		50		MCUD, MEGD, GOUC, RBA, USUG	To improve Ulaanbaatar and Zuunmod city WWTP activities and waste water treatment level will meet the standard
1.5.2. Increasing purifying level of Ulaanbaatar city central waste water treatment plant /by high technology/	156 000.0		156 000.0		50	50		MCUD, MEGD, GOUC, RBA, USUG	
1.5.3. Constructing industries to process sludge from Ulaanbaatar city central waste water treatment plant and other WWTPs in order to supply industrial demand /producing biomass/ and rehabilitating environment (3000-5000 m^3/day)		70200.0	70200.0	50			50	MCUD, MEGD, GOUC, RBA, USUG	
1.5.4. Implementing Nisekh-Yarmag WWTP project	65 000.0	117 000.0	182 000.0				100	MCUD, MEGD	
1.5.5. Expanding Zuunmod city WWTP		5 606.0	5 606.0	100				MCUD, AGO, RBA	
1.5.6. Introducing a system to monitor WWTP treatment level from distance in Bayangol, Nisekh and Nalaikh WWTPs	65.0		65.0		100			MCUD, GOUC, USUG	
1.5.7. Accelerating the work to supply treated waste water from Nalaikh WWTP to southern waste water pipes of Ulaanbaatar city	100.0		100.0		100			MCUD, GOUC, USUG	
Total	**235 065.0**	**633 906.0**	**868 971.0**	**30.9**	**9.0**	**35.2**	**25.0**		
Measure 1.6. Construct and renovate sewerage network									
1.6.1. Expanding and renewing Ulaanbaatar city sewerage systems (including ger districts and new residential areas)	69 810.0	162 890.0	232 700.0	50	50			MCUD, GOUC, RBA, USUG	The number of population connected to the sewerage pipelines will be doubled than that of 2008
1.6.2. Constructing new waste water pipelines in Nisekh, Yarmag, Biokombinat, satellite town and new residential areas of Ulaanbaatar city		45 500.0	45 500.0	100				MCUD, GOUC, RBA, USUG	
1.6.3. To implement the project to discharge waste water of new center of Ulaanbaatar city (to move some administration offices)		71 500.0	71 500.0				100	MEGD, GOUC, RBA, USUG	
1.6.4. The ger district houses in the middle part of Ulaanbaatar city will be connected to the sewerage pipelines (500 houses on average per year)	5 500.0	5 000.0	10 500.0				100	MCUD, GOUC, RBA, USUG	
1.6.5. Expanding Zuunmod city sewerage pipelines	1 295.0		1 295.0	100				MCUD, AGO, RBA	
1.6.6. Connecting some houses of Zuunmod city ger districts to sewerage pipelines (30 houses on average per year)	800.0	2 000.0	2 800.0				100	MCUD, AGO, RBA	
1.6.7. Introducing improved sanitation and eco-toilets to camp and ger district households of Ulaanbaatar and Zuunmod	12 000.0	15 000.0	27 000.0			20.0	80.0	MCUD, GOUC, AGO, RBA	
Total	**89 405.0**	**301 890.0**	**391 295.0**	**41.7**	**29.7**	**1.4**	**27.2**		

1	2	3	4	5	6	7	8	9	10
Measure 1.7. Use of soil water and treated domestic waste water									
1.7.1. To survey and implement the possibility to use some part of treated waste water from Ulaanbaatar city central WWTP for thermal power plant demand	6 500.0	6 500.0	13 000.0				100	MCUD, ME, GOUC, RBA	To introduce the technology to use gray water; purify and reuse not less than 10 percent of domestic waste water
1.7.2. Studying the possibility to reuse water from other WWTPs in the basin		162.0	162.0			100		MCUD, MEGD, RBA	
1.7.3. To develop and implement a project to lower soil water in the territory of Sukhbaatar, Chingeltei and Bayanzurkh districts, using water for green areas and greenhouses	3 000.0	4 500.0	7 500.0		100			MCUD, MEGD, GOUC, RBA	
1.7.4. Reflecting the facility to purify and use gray water in the layout of apartment buildings, public and services facilities to be put in use and implementing it.	3 000.0	4 500.0	7 500.0				100	MCUD, MEGD, GOUC, RBA	
Total	**12 500.0**	**15 662.0**	**28 162.0**	**0.0**	**26.6**	**0.6**	**72.8**		
Total of Challenge 1	**620 671.5**	**1 882 756.0**	**2 503 427.5**	**28.6**	**10.8**	**24.0**	**36.7**		
Challenge 2: Improving rural population water supply and sanitation									
Measure 2.1. Establishing sanitation and protection zone for drinking water supply source of soum center and rural population (herders and farmers)									
2.1.1. Establishing hygienic and protection zone at soum centers' water supply source / rivers, wells, handwells, springs and pond/ and regime will be complied (Khashaat of Arkhangai aimag; Bayannuur, Buregkhangai, Gurvanbulag, Dashinchilen and Rashaant of Bulgan aimag; Burd of Uvurkhangai aimag; Orkhontuul of Selenge aimag; Altanbulag, Argalant, Bayan-Unjuul, Bayankhangai, Bayantsogt, Zaamar, Lun, Undurshireet, Sergelen, Ugtaaltsaidam and Erdenesant of Tuv aimag)	150.0	40.0	190.0		100			MEGD, MH, RBA, Soum governor's office	Soum center drinking water source will be fully protected
2.1.2. Monitoring the regime implementation of soum centers' water supply source zones				From the operational cost of local area administration				RBA, Soum governor's office	
2.1.3. Establishing hygienic zone at rural population kiosks, springs, ponds and rivers used for drinking water; regime will be complied	135.0	315.0	450.0		100			MEGD, RBA, Soum governor's office	
Total	**285.0**	**355.0**	**640.0**		**100**				

1	2	3	4	5	6	7	8	9	10
Measure 2.2. Conducting research on soum center water resources									
2.2.1. Conducting hydrological research of soum center water source and calculating water resources (First stage, Buregkhangai and Gurvanbulag of Bulgan aimag; Burd of Uvurkhangai aimag; Altanbulag, Argalant, Bayan-Unjuul, Bayankhangai, Bayantsogt, Zaamar, Ugtaaltsaidam and Erdenesant of Tuv aimag; Second stage, Bayannuur of Bulgan aimag; Lun of Tuv aimag)	1500.0	250.0	1750.0	100				MEGD, MCUD, RBA, Soum governor's office	To determine and guarantee water supply source groundwater resources of all soum centers in the basin
2.2.2. Conducting groundwater hydrological research in Sharhai valley of Tuv aimag's Altanbulag soum and assessing resources, regime and quality	170.0		170.0	100				MEGD, MCUD, RBA	
Total	**1 670.0**	**250.0**	**1 920.0**	**100**					
Measure 2.3. Constructing, expanding and renewing soum center and rural population water supply source									
2.3.1. Conducting technical inspection and renovate soum center kiosks for drinking water	570.0	0.0	570.0		100			MCUD, MEGD, Soum governor's office	By 2021, not less than 70 percent of soum center and rural population will be supplied by safe drinking water.
2.3.2. Constructing new kiosks for drinking water in soum center (First stage: Gurvanbulag of Bulgan aimag; Altanbulag, Argalant, Bayan-Unjuul, Khailaast, Lun, Ugtaaltsaidam and Undurshireet of Tuv aimag; Orkhontuul of Selenge aimag; second stage: Bayannuur of Bulgan aimag; Ugtaaltsaidam of Tuv aimag	300.0	60.0	360.0		100			MCUD, RBA, Soum governor's office	
2.3.3. Constructing and expanding water supply pipelines in soum centers and connecting followings to the fresh water pipelines: hospitals, schools, kindergartens, offices, services and public apartment blocks (First stage: constructing new pipelines in the following areas: Khashaat of Arkhangai aimag; Gurvanbulag and Dashinchilen of Bulgan aimag; Zaamar and Lun of Tuv aimag; pipelines will be maintained and expanded in the following areas: Rashaant of Bulgan aimag; Khailaast village of Zaamar soum and Erdenesant of Tuv aimag; Orkhontuul of Selenge aimag; second stage: Buregkhangai of Bulgan aimag; Altanbulag, Argalant, Bayankhangai, Bayantsogt and Sergelen of Tuv aimag)	2 560.0	1 536.0	4 096.0	100				MCUD, RBA, Soum governor's office	
2.3.4. Soums' entities and private houses, which have centralized water supply networks, will be connected to the networks (40 entities and private houses on average per year)	800.0	2 000.0	2 800.0			50.0	50.0	MCUD, RBA, Soum governor's office	

1	2	3	4	5	6	7	8	9	10
2.3.5. Installing equipment to purify, soften and treat water in soum centers and Ulaanbaatar city districts where there is water with much mineralization and hardness; old equipment will be maintained (Dashinchilen of Bulgan aimag; Bayan-Unjuul and Zaamar of Tuv aimag)	78.0	78.0	156.0		100			MCUD, RBA, Soum governor's office	
2.3.6. Rural population drinking water boreholes will be changed in coherence to livestock watering activities	Cost is included in Challenge 4							MIA, RBA, Local area governor's office	
2.3.7. Conducting survey in warm season water supply conditions of farmers; developing and implementing measures to be taken	100.0	100.0	200.0		100			MIA, RBA, Local area governor's office	
Total	**4 408.0**	**3 774.0**	**8 182.0**	**50.1**	**15.7**	**17.1**	**17.1**		
Measure 2.4. Constructing and renewing low-capacity WWTPs in soum centers									
2.4.1. Implementing the work to construct and improve low capacity WWTPs in soum center (First stage; Constructing new ones in following areas: Gurvanbulag and Dashinchilen of Bulgan aimag; Zaamar and Lun of Tuv aimag; Conducting expansion and maintenance work in the following areas: Rashaant of Bulgan aimag; Erdenesant and Khailaast villages of Tuv aimag; Orkhontuul of Selenge aimag; Second stage, Khashaat of Arkhangai aimag; Buregkhangai of Bulgan aimag; Altanbulag, Argalant, Bayankhangai, Bayantsogt and Sergelen of Tuv aimag, will be conducted in these soums from the year of 2021)	13 640.0	10 850.0	24 490.0	50		50		MCUD RBA, soum's governor's office	The number of population who do not have connection to improved sanitation will be decreased twice
2.4.2. Expanding and renewing soum center waste water pipelines and connecting hospitals, schools, organizations and public apartments to pipelines (First stage, Gurvanbulag and Dashinchilen of Bulgan aimag; constructing new one in Zaamar and Lun soums of Tuv aimag; conducting expansion and maintenance for the followings: Rashaant of Bulgan aimag; Erdenesant and Khailaast village of Tuv aimag; Orkhontuul of Selenge aimag; Second stage, Khashaat of Arkhangai aimag; Buregkhangai of Bulgan aimag; Altanbulag, Argalant, Bayankhangai, Bayantsogt and Sergelen soums of Tuv aimag; will be conducted in these soums from the year of 2021)	4 550.0	5 687.5	10 237.5	50		50		MCUD RBA, soum's governor's office	

1	2	3	4	5	6	7	8	9	10
2.4.3. Conducting connection at some households of the soums with centralized sewerage systems (40 houses on average per year)	800.0	1000.0	1800.0			50	50	MCUD RBA, soum's governor's office	
2.4.4. Introducing improved sanitation and eco-toilet at soum center ger district households (10 households in one soum on average per year)	997.5	2 850.0	3 847.5				100		
2.4.5. Complying "Rule to define spot where waste water is discharged" if not possible to supply domestic waste water to sewerage systems				From operational cost of local area administration				MEGD, MCUD, RBA, soum's governor's office	
Total	**19 987.5**	**20 387.5**	**40 375.0**	**43.0**	**0.0**	**45.2**	**11.8**		
Total of Challenge 2	**26 350.5**	**24 766.5**	**51 117.0**	**45.7**	**3.8**	**38.5**	**12.0**	**49 397.0**	
Challenge 3. Improving water supply and sanitation of tourism and sanatorium									
Measure 3.1. Expanding and improving water supply facilities of tourism and sanatorium									
3.1.1. Conducting inspection and assessment at water supply and waste water treatment conditions of tourist camps and sanatoriums	49.0	21.0	70.0		100			MCST, MEGD, GASI, RBA	Water supply condition of some 50 percent of tourist camps and sanatoriums will meet international standard
3.1.2. Establishing hygienic and protection zone at spa source and water supply source of tourist camps and sanatoriums; regime will be complied	150.0	100.0	250.0				100	MCST, MEGD, RBA, Soums' governor's office	
3.1.3. Improving drinking water quality and water supply condition of tourist camps and sanatoriums	3 560.0	4 450.0	8 010.0				100	MEGD, MCST, RBA	
Total	**3 759.0**	**4 571.0**	**8 330.0**	**0.0**	**0.8**	**0.0**	**99.2**		
Measure 3.2. Introducing new advanced waste water treatment technology in tourism and sanatorium places									
3.2.1. Introducing new advanced waste water treatment technology at tourist camps (Tuul-Terelj national park etc)	4 116.0	5 515.0	9 631.0				100	MEGD, MCST, RBA	Hygienic conditions of 30 percent of tourist camps and sanatoriums will meet international standard
3.2.2. Improving sanitations of tourist camps and nursing homes (Ar Janchivlan, Songino etc)	161.4	53.8	215.2				100	MEGD, MCST, RBA	
Total	**4 277.4**	**5 568.8**	**9 846.2**				**100**		

1	2	3	4	5	6	7	8	9	10
Measure 3.3. Developing sanatorium services on the basis of spa									
3.3.1. Professional organization will conduct research on mineral components in the whole basin and defining their healing importance; regulating ownership and usage within the framework of law and it will be under local area protection.	140.0	205.0	345.0		100			MH, MEGD, GASI, RBA, soum's governor's office	Improving the level of spa use in sanatorium
3.3.2. Conducting inspection at minerals/spas used for healing and nursing; usage will be improved.	25.0	25.0	50.0		100			MH, MEGD, GASI, RBA,	
Total	**165.0**	**230.0**	**395.0**		**100**				
Total of Challenge 3	**8 201.4**	**10 369.8**	**18 571.2**	**0.0**	**2.5**	**0.0**	**97.5**		
Water sub-sector 1 total	**651 713.4**	**1 921 402.3**	**2 573 115.7**	**28.7**	**10.6**	**24.1**	**36.6**		
WATER SUB-SECTOR 2: WATER FOR FOOD Strategy: Improving agricultural water supply									
Challenge 4: Improving livestock water supply conditions									
Measure 4.1. Conducting research on defining water points in the pasture									
4.1.1. Developing layouts to establish pond; conducting inspection to establish pond for the purpose of making eco environment, watering trees and pastures (10-15 areas)	1 928.0	1 416.0	3 344.0	100				MIA, MEGD, RBA	
4.1.2. Conducting integrated geophysics-hydro-geological survey and researches at 20 pastures areas with good capacity by aimag and soum orders (areas not less than 6-9 thousand ha which is not used due to lack of water points)	300.0	300.0	600.0	100				MIA, MEGD, RBA	
Total	**2 228.0**	**1 716.0**	**3 944.0**	**100**					
Measure 4.2. Constructing and rehabilitating water points in accordance with pasture capacity and use									
4.2.1. The activity to use wild pastures and construct ponds will be conducted with the participation of herders, herders' group and it will be based on the order of herders and herders' group (at possible areas)	360.0	720.0	1 080.0	100				MIA, MEGD, RBA	
4.2.2. Constructing new engineering designed boreholes in relation to pasture capacity (Total of 200-240 boreholes)	1 000.0	1 680.0	2 680.0		60.0	20.0	20.0	MIA, RBA	
4.2.3. Renovating engineering designed boreholes (Total of 420 boreholes)	825.0	2 325.0	3 150.0	70		20	10	MIA, RBA	
Total	**2 185.0**	**4 725.0**	**6 910.0**	**47.5**	**23.3**	**16.9**	**12.3**		

1	2	3	4	5	6	7	8	9	10
Measure 4.3. Improving water point use and maintenance									
4.3.1. Supporting the initiative to establish pasture management group in the field of improving use and ownership of engineering designed boreholes and ponds (170 groups of 30 soums)	1 725.0	230.0	1 955.0			50	50	MIA, MEGD, RBA	
4.3.2. Implementing contract duty and rules to improve the usage and ownership of water points in all levels				From operational cost of local area administration				MIA, MEGD, Local area governor's office, RBA	
4.3.3. Supporting herders' idea to start irrigation field near boreholes which have good yield (20 areas)	120.0	120.0	240.0		50.0		50.0	MIA, MEGD, Local area governor's office, RBA	
Total	**1 845.0**	**350.0**	**2 195.0**	**0.0**	**5.5**	**44.5**	**50.0**		
Measure 4.4. Supporting the improvement of intensified farming water supply									
4.4.1. Improving farm water supply near urban areas (55 entities)	875.0	1 050.0	1 925.0		50		50	MIA, MEGD, RBA	
Total	**875.0**	**1 050.0**	**1 925.0**		**50**		**50**		
Total of Challenge 4	**7 133.0**	**7 841.0**	**14 974.0**	**48.3**	**18.0**	**14.3**	**19.4**		
Challenge 5: Supporting stable development of irrigation field									
Measure 5.1. Conducting research on irrigation field, harvesting area water source									
5.1.1. Establishing reservoir after building ponds in middle and down parts of Tuul River; conducting research on areas where head building is constructed; technical and economic basis will be developed.	150.0	300.0	450.0	100				MIA, MEGD, RBA	
5.1.2. Inspecting possibilities to increase water resources near Ulaanbaatar city and use it for the farming (Science and technological fund project)	300.0		300.0			100		MEGD, AS (Academy of Science), GEI (Geo-Ecology Institute)	
Total	**450.0**	**300.0**	**750.0**	**60.0**	**0.0**	**40.0**	**0.0**		
Measure 5.2. Constructing reservoirs and ponds for irrigation field									
5.2.1. Ponds and reservoirs are constructed on areas where it is possible to do construction		1 000.0	1 000.0	70.0			30.0	MIA, MEGD, RBA	
Total		**1 000.0**	**1 000.0**	**70.0**			**30.0**		

1	2	3	4	5	6	7	8	9	10
Measure 5.3. Constructing or renovating irrigation system head buildings, channels and irrigation system									
5.3.1. Developing layouts to maintain old irrigation systems at 10 areas if necessary and conduct research on water resource accessibility of old irrigation systems	300.0	375.0	675.0	100				MIA, MEGD, RBA	
5.3.2. Constructing head buildings and canals for the purpose of irrigating agriculture based on research		600.0	600.0	100				MIA, RBA, Local area governor's office	
5.3.3. Constructing and maintaining irrigation systems in the following areas (They include: Bukhug of Khan-Uul district of Ulaanbaatar city; Uliastain Am of Bayanzurkh district; Daliin Bulag of Bayannuur soum of Bulgan aimag; old irrigation systems will be maintained in the following areas: Bayannuur, Buregkhangai, Gurvanbulag, Dashinchilen, Mogod and Khishig-Undur soums of Bulgan aimag)	1 750.0	2 000.0	3 750.0	30.0			70.0	MIA, RBA, GOUC, Local area governor's office	
5.3.4. Supporting people's idea to use surface water for agricultural irrigation	1 050.0	1 500.0	2 550.0		50.0	20.0	30.0	MIA, RBA, GOUC, Local area governor's office	
Total	**3 100.0**	**4 475.0**	**7 575.0**	**31.7**	**16.8**	**6.7**	**44.8**		
Measure 5.4. Improving irrigation system use management									
5.4.1. Conducting water auditing at water use situation of entities and citizens that conduct irrigation field in the basin; activity to register them and provide them with passport, will be organized	17.0		17.0		100			MIA, MEGD, RBA	
5.4.2. Making clear of irrigation system ownership and use; improving use management				From relevant organization operational cost				MIA, MEGD, RBA	
5.4.3. Supporting the establishment of water users' union at big irrigation systems with capacity of irrigating more than 100 ha area	340.0	100.0	440.0		50.0	50.0		MIA, MEGD, RBA	
Total	**357.0**	**100.0**	**457.0**	**0.0**	**51.9**	**48.1**	**0.0**		
Measure 5.5. Improving irrigation field agro-technology and introducing activities that save water									
5.5.1. Introducing modern watering equipment in irrigation system which saves water	325.0	650.0	975.0				100	MIA, MEGD, RBA	
5.5.2. Introducing irrigation technology which use methods of drops and soil infiltration for the irrigation	12.0	36.0	48.0				100	MIA, MEGD, RBA	
5.5.3. Taking measures to prevent from negative ecological influence caused by human activities; taking measures to decrease it and fight against it	24.0	72.0	96.0		100			MIA, MEGD, RBA	

1	2	3	4	5	6	7	8	9	10
5.5.4. The activity to install water meter at crop water use will be conducted in the basin								MIA, MEGD, RBA	
5.5.5. Monitoring irrigation crop water use; organize activity to be complied irrigation norm	18.5	22.0	40.5		100			MIA, MEGD, RBA	
Total	**389.5**	**780.0**	**1 169.5**	**0.0**	**11.7**	**0.0**	**88.3**		
Total of Challenge 5	**4 296.5**	**6 655.0**	**10 951.5**	**32.4**	**15.1**	**9.4**	**43.1**		
Water sub-sector 2 total	**11 429.5**	**14 496.0**	**25 925.5**	**41.6**	**16.7**	**12.2**	**29.4**		
WATER SUB-SECTOR 3: WATER FOR INDUSTRY, MINING AND ENERGY Strategy: Solving water supply of industries, mining and energy									
Challenge 6: Solving industrial water supply									
Measure 6.1.Conducting research on big industry water source									
6.1.1. Conducting water auditing in industries and having assessment on water use conditions (1200 industries and entities)	260.0		260.0	100				MEGD, RBA	
6.1.2. Big industries' water source is separated from population water supply	150.0	450.0	600.0	20.0			80.0	MEGD, MIA, RBA	
6.1.3. Industries that cause water pollution and negative impacts on environment will be moved from city center and their water source will be solved (tanneries and wool washing etc)	25.0	25.0	50	100				MEGD, MCUD, MIA, RBA	
6.1.4. Conducting water supply source survey of big industries that are constructed in new settlement zones and satellite towns of Ulaanbaatar city	1 800.0	750.0	2 550.0	100				MEGD, RBA	
6.1.5. Conducting inspection on water use condition of construction, building material and auto road industries; solving water supply issues by conducting water source research and survey	1 720.0	2 220.0	3 940.0	10.0			90.0	MEGD, MCUD, RBA	
Total	**3955.0**	**3 445.0**	**7 450.0**	**45.6**	**0.0**	**0.0**	**54.4**		
Measure 6.2. Solving water supply issues of new soon-to-be built industrial parks									
6.2.1. Construction of water supply facilities and pipelines of Ulaanbaatar city satellite towns and new settlement zones' industrial parks; establishing maximum and minimum limits of water demand and water use	3 000.0	1 750.0	4 750.0	20.0			80.0	MEGD, MIA, RBA	
6.2.2. If big industries' water source is not sufficient, activity to bring/pipe water from distant area, will be organized	3 000.0	2 500.0	5 500.0				100	MEGD, MCUD, MM, MIA, , RBA	
Total	**6 000.0**	**4 250.0**	**10 250.0**	**9.3**	**0.0**	**0.0**	**90.7**		

1	2	3	4	5	6	7	8	9	10
Measure 6.3. Separating industrial water supply from population drinking water supply									
6.3.1. Industrial water supply is separated from population water supply if possible and surface water is used mostly	715.0	650.0	1 365.0				100	MEGD, MIA, RBA	
6.3.2. Industrial water use is fully water metered and monitoring will be conducted	33.6		33.6	From operational cost				MEGD, RBA	
Total	**748.6**	**650.0**	**1 398.6**	**0.0**	**0.0**	**0.0**	**100**		
Measure 6.4. Industrial WWTPs will be located separately									
6.4.1. WWTPs will be reflected on big processing industries' technical and economic basis and layouts				From ministries' and agencies' operational costs				MEGD, MCUD	
6.4.2. Implementing project to construct industrial waste water treatment plants in Ulaanbaatar city	39 000.0.	65 000.0	104 000.0			90	10	MEGD, MCUD, RBA, GOUC	
6.4.3. WWTP of newly-build industrial parks is constructed separately from the domestic WWTP	3 120.0	3 120.0	6 240.0				100	MEGD, MCUD, RBA, GOUC	
6.4.4. Conducting monitoring on how waste water treatment level of some independent 50 WWTPs of entities and organizations meets standard requirements (not less than once each year)	15.0	30.0	45.0	100				MCUD, GOUC, USUG,GASI,	
6.4.5. If it is impossible to supply industrial waste water to sewerage networks, it will be solved according to "Rule to define spot where waste water is discharged"				From local area administration operational costs				MEGD, MCUD, GOUC, RBA	
6.4.6. Installing measurer at industrial waste water discharge pipes and fee rules will be complied	260.0	650.0	910.0				100	MCUD, GOUC, USUG	
Total	**42 395.0**	**68 800.0**	**111 195.0**	**0**	**0**	**94.2**	**15.8**		
Measure 6.5. Reuse of treated industrial waste water									
6.5.1. Introducing technology to reuse waste water from Ulaanbaatar city food industries in tanneries and wool-washing industries.	1 456.0	1 937.0	3 393.0	20.0			80.0	MEGD, MIA, RBA	
Total	**1 456.0**	**1 937.0**	**3 393.0**	**20.0**			**80.0**		
Total of Challenge 6	**54 554.6**	**79 082.0**	**133 636.6**	**3.8**	**0.0**	**70.0**	**26.2**		
Challenge 7. Solving mining water supply on the basis of water resources									
Measure 7.1. Conducting research on mining water supply source									
7.1.1. Conducting inspection and assessment on water source and water use of some 30 mining deposits in the basin	50.0		50.0	100				MEGD, MM, RBA	
7.1.2. Conducting survey on water supply source of mining deposits soon be to in use in the basin	100.0	200.0	300.0				100	MEGD, MM, RBA	

1	2	3	4	5	6	7	8	9	10
7.1.3. Surface water will be used in mining industries with water regulation; develop laws related to limitation of groundwater use and laws/rules will be complied				From ministries' and agencies' operational costs				GASI, MEGD, MM, RBA	
7.1.4. Legalizing the issue to define the size of mining processing industries in accordance with water resources; use will be changed to the regime which limits by water resources				From ministries' and agencies' operational costs				GASI, MEGD, MM, RBA	
Total	**150.0**	**200.0**	**350.0**	**14.3**	**0.0**	**0.0**	**85.7**		
Measure 7.2. Solving mining water supply issues which will be put in use newly									
7.2.1. Rules will be developed and complied which require to survey water supply possibilities before solving issues related to running soon-to-be-in –use mines in the basin	100.0	200.0	300.0				100	MEGD, MM, RBA	
7.2.2. Developing water supply technical conditions and standard of washing sands with gold in the gold mine; it will be introduced in the production	25.0		25.0	100				MEGD, MM, RBA	
Total	**125.0**	**200.0**	**325.0**	**7.7**	**0.0**	**0.0**	**92.3**		
Measure 7.3. Reuse of mining water									
7.3.1. Taking measures to have a facility to reuse water which used for washing sand and gravel by sand gravel carriers	650.0	1 300.0	1 950.0				100	MEGD, MM, RBA	
7.3.2. Developing and complying rules to define industry location where widespread natural resources of the basin are used				From ministries and agencies's operational costs				MEGD, RBA	
Total	**650.0**	**1 300.0**	**1 950.0**				**100**		
Measure 7.4. Purifying and discharging industrial waste water into nature									
7.4.1. Waste water from gold and other mines, sand and gravel carriers will be treated and discharged to environment	10 680.0	17 800.0	28 480.0				100	MEGD, MM, RBA	
7.4.2. Complying rules to purify waste water from mines, carriers and washing during the natural resources survey and extraction and purified water will be supplied to water source and soil				From ministries' and agencies' operational costs				GASI, MEGD, RBA, Local area governor's office, MM	
Total	**10 680.0**	**17 800.0**	**28 480.0**				**100**		
Total of Challenge 7	**11 605.0**	**19 500.0**	**31 105.0**	**0.2**	**0.0**	**0.0**	**99.8**		
Challenge 8. Solving energy water supply in accordance with water resource regime									
Measure 8.1. Conducting research on areas where hydropower stations are constructed; technical and economic basis as well as layouts will be developed									
8.1.1. Making layout and technical and economic basis for to-be-build water complex on Tuul river upstream with hydropower plant	(Total amount is included in the activity to construct Tuul water complex)							MEGD, MCUD, ME, RBA	

1	2	3	4	5	6	7	8	9	10
8.1.2. Water complex with hydropower plant will be constructed on Tuul river upstream	(Total amount is included in the activity to construct Tuul water complex)							MEGD, MCUD, ME, RBA	
Measure 8.2. Solving water supply of already-constructed and soon-to-be-constructed thermal power plants and steamboilers									
8.2.1. Solving water supply of thermal power plants	100.0		100.0	100				MEGD, ME, RBA	
8.2.2. Conducting survey and assessment on water use of thermal power plants 2, 3 and 4. Implementing measure to introduce wise water use technology	15.0		15.0	100				MEGD, ME, RBA	
8.2.3. Tuul-Songino water resources complex's treated water is used for energy		176000.0					100	MEGD, MCUD, ME, RBA	
8.2.4. Solving water supply of soon-to-be-build thermal power plant 5	250.0		250.0	100				MEGD, ME, RBA	
8.2.5. Solving heating system water use of Zuunmod city and other 19 soum centers in the basin. Taking measures to decrease water loss	320.0	480.0	800.0	100				MEGD, MCUD, ME, RBA, Local area governor's office	
Total	**685.0**	**480.0**	**1 165.0**	**100**	**0.0**	**0.0**	**0.0**		
Measure 8.3. Surveying possibilities to use geothermal water									
8.3.1. Conducting geothermal survey in urban areas	200.0		200.0	100				MEGD, ME, RBA	
8.3.2. Surveying work experience of national center for renewal energy that geothermal water is used for heating of Zuunmod city kindergartens, schools and hospital facilities; making recommendations on possibilities to introduce to other urban areas of the basin and it will be implemented in possible areas	10.0	500.0	510.0	100				RBA, Local area governor's office, National Center for Renewal Energy (NCRE), MEGD	
Total	**210.0**	**500.0**	**710.0**	**100**	**0.0**	**0.0**	**0.0**		
Total of Challenge 8	**895.0**	**980.0**	**1 875.0**	**100**	**0.0**	**0.0**	**0.0**		
Water sub-sector 3 total	**67 054.6**	**99 562.0**	**166 616.6**	**4.2**	**0.0**	**56.2**	**39.6**		

1	2	3	4	5	6	7	8	9	10
WATER SUB-SECTOR 4: WATER FOR ENVIRONMENT Strategy: Keeping ecosystem balance									
Challenge 9. Implementing measures to increase water resources and prevent from water resource scarcity									
Measure 9.1. Establishing protection zone regime of river flow generating source									
9.1.1. Establishing protection zone for flow-generating part of Tuul affluent rivers and it will be under local area protection	45.0		45.0	100				MEGD, RBA, Local area governor's, DET	
9.1.2. Integrating Galttain river basin (affluent river on the eastern part of Tuul river) into Gorkhi-Terelj national park and it will be under protection	49.5	15.0	64.5	100				MEGD, RBA, Local area governor's, DET	
Total	**94.5**	**15.0**	**109.5**	**100**	**0.0**	**0.0**	**0.0**		
Measure 9.2. Protection zone of water bodies will be established and complied									
9.2.1. Putting signs on water boundary which was established along the Tuul river according to law	1 000.0	600.0	1 600.0	100				MEGD, RBA, Local area governor's office, DET	
9.2.2. Establishing protection zones of reservoir areas /lakes, ponds, springs/ in the basin and regime will be complied	50.0		50.0		100			MEGD, RBA, Local area governor's office	
9.2.3. Conducting specific research on recharge zone and areas of Khagiin Khar nuur, Khokh nuur, Kherkheluur nuur and other very small rivers; taking measures to supply their normal condition	45.0	90.0	135.0	100				MEGD, RBA, Local area governor's office	
9.2.4. To estimate ecological damage amount caused by mining of popular natural resources in Tuul and its affluent rivers' flood plain; in order to have rehabilitation fee, professional organization will conduct environmental impact assessment,	300	150	450.0		50		50	GASI, RBA, Local area GO	
9.2.5. Creating professional working group to identify the reasons why Tuul river flow interrupts in the spring of recent years and to make conclusions.	50	-	50	100				MEGD, RBA, GOUC	
9.2.6. To implement the project against infiltration of river water in the area where Tuul river is interrupted	1 500	-	1 500		100			MEGD, RBA, GOUC	
9.2.7. Halting the mining of widely-distributed mineral resources / sand, gravel, stone and mud etc/ in the flood channel of Tuul river and its affluent rivers / distance less than 500 meters from river bank/				From ministries' and agencies' operational costs				GASI, MEGD, RBA, GOUC	
Total	**2 945.0**	**840.0**	**3 785.0**	**47.2**	**46.9**	**0.0**	**5.9**		

1	2	3	4	5	6	7	8	9	10
Measure 9.3. Water metering water use and water demand									
9.3.1. Water metering water use and water demand periodically	1 509.0	762.0	2 271.0				100	MEGD, RBA, Local area governor's office, USUG, PUSO	
9.3.2. Introducing computer monitoring and integrated administration networks to the Ulaanbaatar city water supply source constructions	100.0		100.0		100			MEGD, RBA, GOUC, USUG	
9.3.3. Introducing computer monitoring and integrated administration networks to Zuunmod city water supply source constructions		20.0	20.0		100			MEGD, RBA, Local area governor's office	
Total	**1 609.0**	**782.0**	**2 391.0**	**0.0**	**5.0**	**0.0**	**95.0**		
Measure 9.4. Rehabilitating river banks which belong to urban possession and protection zones will be constructed									
9.4.1. Developing layout on straightening 25 km watercourse between Bayanzurkh bridge of Tuul river and Sonsgolongiin bridge; building water regulation facility/overfall; rehabilitating the river bank and constructing leisure parks; construction work will be conducted	4 125.0	8 375.0	12 500.0	50.0			50.0	MEGD, MCUD, RBA, GOUC	
9.4.2. Conducting specific research on natural possibility to rehabilitate recharge zones of Selbe, Uliastai, Tolgoit, Khul and Khurkhree rivers, research on recharge zone limit, features and current condition; stabilizing flow	500.0	4 500.0	5 000.0	50.0			50.0	MEGD, MCUD, RBA, GOUC	
Total	**4 625.0**	**12 875.0**	**17 500.0**	**50.0**	**0.0**	**0.0**	**50.0**		
Measure 9.5. Constructing water accumulating and water regulating reservoirs									
9.5.1. Constructing posts to study physical, chemical and bacterlogical features of water; precipitation and snow flooding conditions on affluent rivers of Tuul.	84.0	120.0	204.0	100				MEGD, RBA, GOUC	
9.5.2. "Tuul Water Complex" will be constructed based on the detailed survey of technical and economic basis; the water complex is for protecting ecosystem of the upper part of the basin, supplying Ulaanbaatar city water supply safety, producing energy, developing tourism and making flood regulation		543 400.0	543 400.0				100	MEGD, MCUD, RBA, GOUC	
9.5.3. Conducting research and exploration to construct flood protection pond, to collect sediments and water in the upper part of the rivers which have permanent and temporary flow in the Tuul river basin; layout will be developed at possible areas	75.0	300.0	375.0	100				MEGD, RBA, GOUC	

1	2	3	4	5	6	7	8	9	10
9.5.4. Conducting activity to prevent multi-year permafrost from melting in the upper part of Selbe river; recommendation will be made	0.0	58 500.0	58 500.0	100				MEGD, AS, RBA, GOUC	
Total	**159.0**	**602 320.0**	**602 479.0**	**9.8**	**0.0**	**0.0**	**90.2**		
Total of Challenge 9	**9 432.5**	**616 832.0**	**626 264.5**	**11.1**	**0.3**	**0.0**	**88.6**		
Challenge 10. Implementing measures to prevent from water resource pollution and decrease pollution									
Measure 10.1. Preventing from water resource pollution									
10.1.1. Protection zone regime of the water reservoir-areas will be strictly complied				From ministries' and agencies' operational cost				MEGD, GASI, RBA	
10.1.2. Inspection and inventory of polluting source in the basin will be conducted in each district, aimag and soum	7 500.0		7 500.0	100				MEGD, GASI, RBA	
10.1.3. Studying influence of Ulaanbaatar city soil degradation, air and soil pollution to water source in the basin	100		100.0	100				MEGD, RBA, AS	
10.1.4. Taking measures to move and close polluting source that pollutes soil and water	Cost is included in 6.1.3.							MEGD, GASI, RBA	
10.1.5. Implementing measures not to use water that its quality and components exceeded the amount reflected in the surface water freshness degree norm; purifying and elimenating water pollution and preventing from further pollution	150.0	150.0	300.0	100				MEGD, GASI, RBA	
10.1.6. Renewing surface water freshness degree classification and it will be complied in the basin				From ministries' and agencies' operational cost				MEGD, GASI, RBA, Geo-ecological Institute	
10.1.7. Conducting survey on domestic and industrial waste water of Ulaanbaatar, Zuunmod and other soum centers; defining technical indicators of equipment which is suitable for treating pollution	150.0	100.0	250.0	20.0			80.0	MEGD, GASI, RBA	
10.1.8. Conducting monthly chemical, bacterlogical and hydrobiological research of water and research for bottom aquifer of Tuul river watercourse in the area from Ulaanbaatar city central WWTP to Altanbulag bridge of Tuv aimag; recommendations will be made	40.5	81.0	121.5	100				MEGD, RBA, NAMHEM	

1	2	3	4	5	6	7	8	9	10
10.1.9. Chrome volume in the waste water which was treated in some 40 WWTPs of Ulaanbaatar city central WWTP, tanneries and wool washing industries will be defined each week; recommendations will be made	351.0	702.0	1 053.0	20.0			80.0	MEGD, GASI, RBA, Chamber of Commerce and Industry (CCI)	
10.1.10. Halting the use of 6 valence chrome in tanneries, wool washing industries and all productions				From operation cost of GASI				MEGD, GASI, RBA	
10.1.11. Developing methods to use zeolite in activity of tanneries and wool washing and introducing it in the production	50.0		50.0	100				MEGD, MIA, RBA, MUST	
10.1.12. Halting river water use temporarily until it reaches maximum pollution level in the area from the joint part where Nalaikh WWTP waste water joins Tuul river to Altanbulag soum bridge of Tuv aimag				From operation cost of GASI				MEGD, GASI, RBA	
10.1.13. Taking measures to halt the activities if the waste water from industries, service units and households that did not have connection to centralized sewerage pipelines, does not meet the standard requirement				From operation cost of GASI				MEGD, GASI, RBA	
10.1.14. Conducting deep treatment in waste water of central WWTP; Tuul-Songino water complex will be established	**64000.0**						**100**	MEGD, ME, MCUD, RBA	
10.1.15. Conducting survey on whether there are pesticides with low decomposition (6-chlorous benzol, fungicide etc) in the soil of crop field along Tuul river; recommendations on water resources pollution will be made and public will be informed.	10.0		10.0	100				MEGD, GASI, RBA	
10.1.16. In order to protect Tuul river from pollution, providing safety of tourists and residents, temporary watch spots will be constructed along the river in summer time and providing tourists and visitors with data/information,	110.0	230.0	340.0		100			RBA, GOUC	
Total	**8 461.5**	**53 263.0**	**61 724.5**	**97.8**	**0.5**	**0.0**	**1.7**		
Measure 10.2. Implementing "polluter pay principle"									
10.2.1. Monitoring the implementation of regulations on water polluting fees				From ministries' and agencies' operational costs				MEGD, CIA, RBA, GOUC, Local area governor's office	
10.2.2. Spending surface water and groundwater polluting fee income of Tuul river valley on activities to clean sludge and wastes in the bottom of midstream part				It will be discussed by budget amendment				MEGD, RBA, GOUC	

1	2	3	4	5	6	7	8	9	10
Measure 10.3. Improving ger district sanitation facilities									
10.3.1. Introducing bio and eco latrines in ger district households which do not have connection to sewerage pipelines (Ulaanbaatar and Zuunmod)	23 250.0	75 000.0	98 250.0	20.0			80.0	MEGD, MCUD, RBA, GOUC	
10.3.2. Improving pit latrines of ger district households which do not have connection to sewerage pipelines (10000 households on average per year in Ulaanbaatar and Zuunmod)	15 000.0	30 000.0	45 000.0			20.0	80.0	MEGD, MCUD, RBA, GOUC	
Total	**38 250.0**	**105 000.0**	**143 250.0**	**13.7**	**0.0**	**6.3**	**80.0**		
Total of Challenge 10	**46 737.5**	**158 302.0**	**205 039.5**	**39.0**	**0.2**	**4.4**	**56.4**		
Challenge 11. Determining ecological flow and regime; protecting biological species									
Measure 11.1. Conducting research to determine ecological flow of the rivers									
11.1.1. Developing and validating ecological flow-determining methods of running and dead water; using some methods and they will be complied in the activities	120.0		120.0	100				MEGD, RBA, GOUC, Local area governor's office	
11.1.2. Conducting research to determine Tuul river ecological flow	150.0		150.0	100				MEGD, RBA	
11.1.3. Conducting research to determine affluent rivers' ecological flow of Tuul river	300.0		300.0	100				MEGD, RBA	
11.1.4. Calculating water amount from upstream, midstream and downstream parts of Tuul and its affluent rivers which can be used for water use in comparison with water demand; it will be normalized and complied				From river basin council operation costs				MEGD, RBA	
Total	**570.0**	**0.0**	**570.0**	**100**	**0.0**	**0.0**	**0.0**		
Measure 11.2. Conducting research to determine groundwater ecological regime									
11.2.1. Clarifying distribution of groundwater types and aquifers of Tuul river valley and flood channels; conducting research on determining exploitable resources and estimating possibilities to use for population and industrial water supply (Upstream, midstream, downstream)	192.0		192.0	100				MEGD, RBA	
Total	**192.0**	**0.0**	**192.0**	**100**					
Measure 11.3. Keeping water in nature which is enough for biological species									
11.3.1. Rehabilitating Tuul riverbank and constructing artificial ponds where migratory birds gather		130.0	130.0	100				MEGD, RBA, GOUC, Local area governor's office	

1	2	3	4	5	6	7	8	9	10
11.3.2. Breeding endangered fish of Tuul river /taiman, Siberian sturgeon, grayling/; halting fishing temporarily during its breeding season	520.0	650.0	1 170	50.0	50.0			MEGD, RBA, GOUC, Local area governor's office	
11.3.3. Conducting research on living condition of animals which live in mountain taiga and forest steppe of the basin /moose, deer, hog, river otter, forest sable, lynx, antelope, fox, marmot, wildcat, steppe fox/; making environment for animals to drink safely	150.0	300.0	450.0	100				MEGD, RBA, GOUC, Local area governor's office	
11.3.4. Practicing activity to breed beavers in order to increase river flow in Tuul river upstream; if it is fruitful, activity to breed beavers in big affluent rivers, will be organized	3 500.0	1 500.0	5 000.0	50.0				MEGD, RBA, GOUC, Local area governor's office	
11.3.5. Developing standard and technical condition which include measures to provide migration and let fish pass through in each engineering designed water constructions that are based on surface water				From ministries' and agencies' operation cost				MEGD, MCUD, RBA	
11.3.6. Taking measures to decrease Tuul river pollution; preventing from extinction and decreasing of fish and other aquatic animals' population and species	It is included in Challenge 10							MEGD, RBA	
Total	**4 170.0**	**2 580.0**	**6 750.0**	**47.6**	**8.7**	**0.0**	**37.0**		
Measure 11.4. Preventing groundwater level decrease caused by human activities									
11.4.1. Estimating water amount possible to use from the headworks of areas whose groundwork resources are estimated and unestimated on the basis of renewal water resources; it will be normalized and complied				From ministries' and agencies' operation cost				MEGD, RBA	
11.4.2. Usage will be halted if Ulaanbaatar city water supply source kiosk water is overused /exceeding redline by exceeding ecological limit and norm/				From ministries' and agencies' operation cost				MEGD, GASI, RBA	
11.4.3. Making geological-hydrogeological map at scale of 1:50 000 in Ulaanbaatar territories	200.0		200.0	100				MEGD, RBA	
11.4.4. Installing monitoring equipment in some kiosks and conducting water quality survey based on studies and registration of Ulaanbaatar city ger districts and industries' own kiosks	37.5	75.0	112.5				100	MEGD, GASI, RBA, GOUC	
Total	**237.5**	**75.0**	**312.5**	**64.0**	**0.0**	**0.0**	**36.0**		
Total of Challenge 11	**5 169.5**	**2 655.0**	**7 824.5**	**53.3**	**7.5**	**0.0**	**33.4**		

1	2	3	4	5	6	7	8	9	10
Challenge 12. Implementing measures to rehabilitate damaged water sources									
Measure 12.1. Conducting inspection at broken and polluted river flows; making them natural and clean them									
12.1.1. Conducting survey and inspection at Tuul river basin rivers' channels which were affected by human activities; reports and conclusions will be made	45.0		45.0	100				MEGD, RBA	
12.1.2. Rehabilitating damage caused by mining sand and gravel in the river channel from users' compensation	4 500.0	3 000.0	7 500.0				100	MEGD, GASI, RBA	
12.1.3. Halting gold mining of Zaamar soum of Tuv aimag legally and rehabilitating Tuul river channel	2 000.0	7 000.0	9 000.0				100	MEGD, GASI, RBA	
12.1.4. Rehabilitation work will be conducted by entities and civilians who are mining gold or once mined there according to standards MNS 1915:2000, MNS 1916:2000, MNS 1918:2000 in the west affluent of Tuul river in Zaamar soum of Tuv aimag including Tsagaan bulag, Tosongiin bulag, Khailaastiin bulag and Bayangoliin bulag	750.0	2 250.0	3 000.0				100	MEGD, GASI, RBA	
Total	**7 295.0**	**12 250.0**	**19 545.0**	**0.2**	**0.0**	**0.0**	**99.8**		
Measure 12.2. Rehabilitate forest areas of reservoirs in the basin									
12.2.1. Conducting research and exploration of basin forest, developing drawings, taking measures to rehabilitate forest	500.0	1 000.0	1 500.0	100				MEGD, RBA	
12.2.2. Conducting research of forest areas in Tuul upstream; developing drawings and implementing measures to rehabilitate forest	250.0	1 000.0	1 250.0	50.0	50.0			MEGD, RBA	
Total	**750.0**	**2 000.0**	**2 750.0**	**77.3**	**22.7**	**0.0**	**0.0**		
Total of Challenge 12	**8 045.0**	**14 250.0**	**22 295.0**	**9.7**	**2.8**	**0.0**	**87.5**		
Challenge 13. Constituting environment to neutralized natural disasters including flood, drought and famine									
Measure 13.1. Maintaining and constructing flood protection facilities									
13.1.1. Maintaining and improving Ulaanbaatar city flood protection facilities	36 254.3	43 505.2	79 759.5	100				MEGD, MCUD, RBA, GOUC	
13.1.2. Constructing flood water regulating ponds in upstream parts of Uliastai, Selbe and Tolgoit rivers /Tuul affluent rivers/		29 003.4	29 003.4	100				MEGD, MCUD, RBA, GOUC	
13.1.3. Renewing and improving Zuunmod city flood protection facilities	700.0		700.0	100				MEGD, MCUD, RBA, AGO	

1	2	3	4	5	6	7	8	9	10
13.1.4. Constructing flood protection facilities in soum centers that might be affected by flood. • Orkhontuul soum of Selenge aimag • Undurshireet soum of Tuv aimag	1 000.0	2 000.0	3 000.0	100				MEGD, MCUD, RBA, Local area governor's office	
13.1.5. Taking measures to prohibit hard waste in flood protection channels				From ministries' and agencies' operation cost				MEGD, RBA, Local area governor's office	
13.1.6. Constructing facilities to keep hard waste in the downpart of flood protection channels like Khailaast, Chingeltei, Bayankhoshuu, Bayangol and Tolgoit of Ulaanbaatar city	150.0	225.0	375.0		100			MEGD, MCUD, RBA, GOUC	
13.1.7. Examining and calculating whether urban flood protection facilities are suitable for the maximum flow of the rain flood.	30.0		30.0	100				MEGD, RBA, GOUC, Local area governor's office	
Total	**38 134.3**	**74 733.6**	**112 867.9**	**99.7**	**0.3**	**0.0**	**0.0**		
Measure 13.2. Installing rain generators for the purpose of artificial rain from clouds									
13.2.1. Installing rain generator at suitable areas for the purpose of preventing from forest fires and decreasing drought danger.	300.0	300.0	600.0	100				MEGD, NAMHEM, RBA	
13.2.2. To continue activity to have rain from clouds on purpose and there will be legal regulation that organizations and residents who ordered this service, will pay for the activity fee				From relevant organization's operational cost				MEGD, NAMHEM, RBA, Local area GO	
Total	**300.0**	**300.0**	**600.0**	**100**					
Measure 13.3. Constructing waste water and flood water discharging facilities of urban area roads									
13.3.1. Expanding and rehabilitating Ulaanbaatar city road rain water accumulating and discharging facilities	1 000.0	2 000.0	3 000.0	100				MEGD, MCUD, RBA	
13.3.2. Studying possibilities to use flood accumulated water for green areas	48.0		48.0	100				MEGD, MCUD, RBA	
Total	**1 048.0**	**2 000.0**	**3 048.0**	**100**	**0.0**	**0.0**	**0.0**		
Total of Challenge 13	**39 482.3**	**77 033.6**	**116 515.9**	**99.7**	**0.3**	**0.0**	**0.0**		
Water sub-sector 4 total	**107 316.8**	**869 072.6**	**976 389.4**	**27.9**	**0.2**	**0.9**	**70.9**		

1	2	3	4	5	6	7	8	9	10
WATER SUB-SECTOR 5: Water management environment Strategy: Constituting comfortable environment for water management									
Challenge 14. Developing legislation environment to operate in the basin									
Measure 14.1. Improving legislation environment to operate in the basin									
14.1.1. Environment to stabilize river basin administrative activities will be established				From ministries' and agencies' operation cost				MEGD, GOUC, Local area governor's office	
14.1.2. The rule will be developed and approved in order to improve the work coherence of MEGD, basin authority and council.				From ministries' and agencies' operation cost				MEGD, RBA	
14.1.3. Developing legislation structures which enable private gold miners and NGOs to participate in the activities to rehabilitate river environment				From ministries' and agencies' operation cost				MEGD, RBA	
Challenge 15. Constituting definite structures of basin organizations									
Measure 15.1. Developing basin authority and structures									
15.1.1. Supporting to form the organizations of the basin authority and implementing integrated water resources management plan; conducting inter-sectorial management, conducting monitoring and reports				From ministries' and agencies' operation cost				MEGD, RBA	
15.1.2. Expanding public service range of basin authority	Total is integrated							MEGD, RBA	
15.1.3. Implementing basin management plans and increasing public participation in the monitoring	Total is integrated							MEGD, RBA, GOUC, Local area governor's office	
Challenge 16. Developing water management financial structures of the basin									
Measure 16.1. Solving financial source required to implement water sector activities									
16.1.1. Some percentages of the water use and water polluting fees will be spent in activities of basin authority and council.	Total is integrated							MEGD, RBA, GOUC, Local area governor's office	
16.1.2. Investment to implement each sector's activities included in this plan, will be included in annual budget of relevant sectors' ministries and local areas; implementation will be organized	Total is integrated							MEGD, other relevant ministries, Aimag and Ulaanbaatar city governor, RBA	

1	2	3	4	5	6	7	8	9	10
16.1.3. Special purpose fund will be established at the basin level, the objective is to collect required money for stabilizing water sector activities	Total is integrated							MEGD, MCUD, GOUC, Local area governor's office	
16.1.4. Promoting activities including: protect and increase water, reuse of waste water	Total is integrated							MEGD, GOUC, Local area governor's office	
16.1.5. Establishing a fund which supports activities to improve water supply and sanitation of ger district people and soum center population; develop structures to grant a soft loan.	Total is integrated							MEGD, MCUD, GOUC, Local area governor's office	
Challenge 17. Building capacity to implement water management in the basin									
Measure 17.1. Improving human resource capacity of basin authority and council									
17.1.1. Building capacity of basin authority human resources	Total is integrated							MEGD, RBA	
17.1.2. Regularly organizing training and seminars to build capacity of Ulaanbaatar city and local area environmental experts	Total is integrated							MEGD, RBA	
Challenge 18. Increasing water resources, quality monitoring, researches and study levels									
Measure 18.1. Establishing, expanding and renewing water resource and quality monitoring-exploration networks									
18.1.1. Establishing surface water and groundwater resources and quality monitoring-exploration sub networks in the basin (areas not less than 25)	240.0	510.0	750.0	100				MEGD, RBA, GOUC, Local area governor's office	
18.1.2. Increasing number of monitoring stations to make surface water observation and measures in the basin (areas not less than 20)	96.0	204.0	300.0	100				MEGD, NAMHEM, RBA, GOUC, Local area governor's office	
18.1.3. Increasing monitoring boreholes number which conduct observation of groundwater regime change of basin urban area water supply source (19 soum centers)	150.0	325.0	475.0	100				MEGD, RBA, GOUC, Local area governor's office	
18.1.4. Establishing permafrost monitoring-exploration networks in the area where there is continuous permafrost distribution (areas not less than 20)	240.0	560.0	800.0	100				MEGD, AS, RBA, GOUC, Local area governor's office	
Total	**726.0**	**1 599.0**	**2 325.0**	**100**	**0.0**	**0.0**	**0.0**		

1	2	3	4	5	6	7	8	9	10
Measure 18.2. Expanding and renewing monitoring and exploration laboratory base									
18.2.1. Establishing complete water quality inspection laboratory in Zuunmod city	150.0		150.0	100				MEGD, GASI, AGO	
18.2.2. Establishing water quality inspection laboratory in Ulaanbaatar city	250.0		250.0	100				MEGD, GASI, RBA	
18.2.3. Establishing integrated laboratory for the drinking water supply sources and WWTPs of soums (10 soums)	180.0	420.0	600.0	100				MEGD, GASI, Soum governor's office	
18.2.4. Domestic and industrial WWTPs will be equipped with water quality inspection laboratory (40 WWTPs)	400.0	1 200.0	1 600.0				100	MEGD, GASI, Local area governor's office	
Total	**980.0**	**1 620.0**	**2 600.0**	**38.5**	**0.0**	**0.0**	**61.5**		
Measure 18.3. Conducting constant and repeatedly research of water resources and quality									
18.3.1. Each water supply surface water and groundwater sources will be involved in general chemical inspection each year and total conclusion will be made	36.0	108.0	144.0	100				MEGD, GASI, , Local area governor's office	
18.3.2. Conducting quality inspection at each population drinking water source each month (300 boreholes)	324.0	648.0	972.0	50.0			50.0	MEGD, GASI, Local area governor's office	
Total	**360.0**	**756.0**	**1 116.0**						
Total of Challenge 18	**2 066.0**	**3 975.0**	**6 041.0**	**65.5**	**0.0**	**0.0**	**34.5**		
Challenge 19. Developing data and data management; expanding advertisements									
Measure 19.1. Establishing database and improving data exchange									
19.1.1. Training basin water resources and quality data expert	Total is integrated							MEGD, RBA	
19.1.2. Supplying MEGD, basin, aimag and Ulaanbaatar environmental offices, and soum preservationists with data equipment and safe operation will be supplied	Total is integrated							MEGD, RBA	
19.1.3. Improving data processing level, establishing database on basin water resource and its quality, pollution, protection, usage and rehabilitation	Total is integrated							MEGD, RBA	
19.1.4. Improving data exchange in all levels	Total is integrated							MEGD, RBA	
19.1.5. Constituting public-informing structures	Total is integrated							MEGD, RBA	
Measure 19.2. Conducting public advertisements on water protection, wise use of water and rehabilitation									
19.2.1. Advertising traditional exercise to protect water resources, preparing and providing lectures, speaking topics and handouts	Total is integrated							MEGD, RBA	

1	2	3	4	5	6	7	8	9	10
19.2.2. Information on water resources and its use will open to public and information will be put on the internet	Total is integrated							MEGD, RBA	
19.2.3. Organizing study and advertising activities to prevent from water pollution	Total is integrated							MEGD, RBA	
Challenge 14-17, 19 total	**25 351.9**	**87 496.0**	**112 847.9**	**40.0**	**40.0**	**10.0**	**10.0**		
Water sub-sector 5 total	**27 417.9**	**91 471.0**	**118 888.9**	**41.3**	**37.9**	**9.5**	**11.3**		
Grand total	**866 482.2**	**2 996 003.9**	**3 862 486.1**	**27.9**	**8.4**	**19.1**	**44.6**		

Remarks: *USD 1=MNT 1300.00*
JPY 1= MNT 16.30

9. THE ORGANIZATION AND CONTROL OF THE ACTIVITIES TO IMPLEMENT THE TUUL 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 86.

Figure 86. 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 Tuul 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 Tuul 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 101. 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 River Basin IWM plan and means of finance

Some 3862.5 billion tugrugs investment is required for the implementation of the Tuul river basin IWM plan (Table 100).

Table 100. Expenses of River Basin IWM plan

Issues	Required budget amount, *mln tugrugs*
Main issue 1. Water for people	2 573 116
Main issue 2. Water for industry	25 926
Main issue 3. Water for agriculture	166 617
Main issue 4. Water for environment	977 939
Main issue 5. Water legal environment and administration	118 389
Total required investment	3 862 486

Most of the required investment will be used for addressing the population drinking water supply issues.

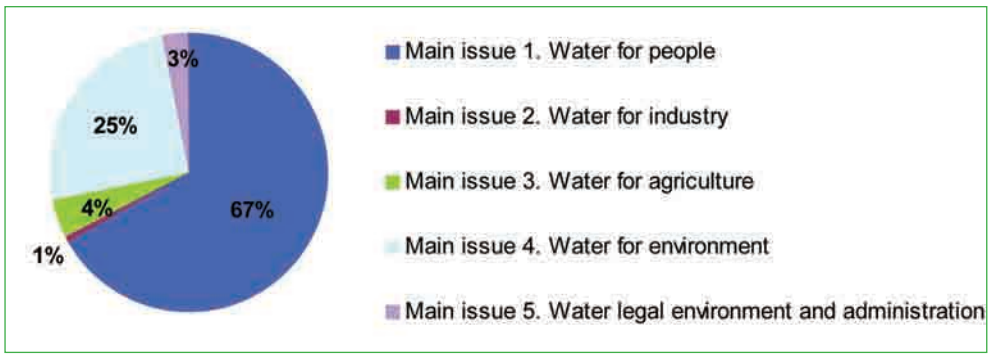

Figure 87. Investment structure of River Basin IWM plan

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 101. Stakeholders' roles in the implementation of the River Basin IWM

Sub-sector	Challenges and measures	MEGD	MCUD	MIA	MT	MM	ME	MSCT	MH	MED	GASI	NEMA	MF	Ulaanbaatar, aimag and soum CRM, GO	RBA	NGO	Required investment, *million tugrugs*	Starting year	Finishing year
1: Water for people	1: Supplying population with safe drinking water; increasing sanitation availability.																2 573 116	2013	2021
	Challenge 1. Supplying urban population with safe drinking water; increasing improved sanitation availability.																2 503 428	2013	2021
	Establishing hygienic and protection zone at drinking water supply source	+	○○										○	○○	○○		3 718	2013	2021
	Conducting research on water supply source' water resources; approving resources	+	○○										○	○	○○		7 933	2013	2021
	Expanding water supply source facilities	○○	+										○	+	○○		767 061	2013	2021
	Expanding and renewing water supply networks; increasing number of kiosks		+										○	+	○	○	436 288	2013	2021
	Establishing new WWTP; its expansion and renewal	○○	+										○	+	○○	○	868 971	2013	2021
	Renewing and expanding waste water pipelines		+										○	+	○○	○	391 295	2013	2021
	Using soil water and treated domestic waste water	+	○○				○○		○○				○	○○	○○	○	28 162	2013	2021
	Challenge 2. Improving rural population water supply and sanitation.																51 117	2013	2021
	Establishing hygienic and protection zone at drinking water supply source of soum center and rural population	+							○○				○	+	+		640	2013	2021
	Conducting soum center water resources survey	+											○	○○	+		1 920	2013	2021
	Establishing new water supply source of soum center and rural population; its expansion and renovation	○○	+										○	○○	○○	○	8 182	2013	2021
	Renewing and constructing low capacity WWTPs in soum centers	○○	+										○	○○	+	○○	40 375	2013	2021
	Challenge 3. Improving water supply and sanitation of tourism and sanatorium.																18 571	2013	2021
	Improving tourism and sanatorium water supply facilities							+			○○			○	○○	○○	8 330	2013	2021
	Introducing advanced waste water treatment technology at tourist camps and sanatoriums	○						+			○○			○	○○	○○	9 846	2013	2021
	Developing sanatorium services based on spa	○						+	○○		○○			○	○○	○○	395	2013	2021

Sub-sector	Challenges and measures	MEGD	MCUD	MIA	MT	MM	ME	MSCT	MH	MED	GASI	NEMA	MF	Ulaanbaatar, aimag and soum CRM, GO	RBA	NGO	Required investment, *million tugrugs*	Starting year	Finishing year
2: Water for agriculture	2: Improving rural water supply condition.																25 926	2013	2021
	Challenge 4. Improving animal husbandry water supply condition.																14 974	2013	2021
	Conducting water point surveys in pasture	+		○○									○	○○	○○		3 944	2013	2021
	Constructing and rehabilitating water points in relation to pasture capacity and use	○○		+									○	+	○○	○○	6 910	2013	2021
	Improving water point use and maintenance			○○										+	○○	○○	2 195	2013	2021
	Supporting activity to improve farming water supply	○		+										○○	○○	○○	1 925	2013	2021
	Challenge 5. Supporting sustainable development of irrigation field.																10 952	2013	2021
	Conducting survey at water source of irrigation field and harvest	+		○○									○	○○	○○		750	2013	2021
	Building dam for harvest irrigation; constructing reservoirs and maintenance	○○		+									○	○○	○○		1 000	2016	2021
	Constructing and renewing irrigation system head construction, main channels and irrigation systems	○○		+									○	○○	○○		7 575	2013	2021
	Improving irrigation system use management	○		+										+	○○	○○	457	2013	2021
	Improving irrigation field agrotechnology; introducing activity that use water in an economical way	○		+										+	○○		1 170	2013	2021
3: Water for industry, mining and energy	3: Solving water supply of industry, mining and energy.																166 617	2013	2021
	Challenge 6. Solving water supply of industries.																133 637	2013	2021
	Conducting water source surveys of big industries	+			○○								○	○○	+	○	7 450	2013	2021
	Solving water supply issues of newly constructed industrial parks	○○		+									○	○○	○○	○	10 250	2013	2021
	Separating industrial water supply from that of population drinking water supply	○○	○	+					○○				○	○○	○○	○	1 399	2013	2021
	Establishing separate industrial WWTP	○○	○	+									○	○○	○○	○○	111 195	2013	2021
	Reusing industrial treated waste water	○○	○	+	○								○	○○	○○	○○	3 393	2013	2021
	Challenge 7. Solving mining water supply based on water resources.																31 105	2013	2021
	Conducting survey on mining deposit areas' water supply source	+				+								○○	○○		350	2013	2021
	Solving water supply issues of new natural resource deposits	○○				+								○○	○○	○	325	2013	2021
	Reuse of water in mining	○○				+					○			○	○○	○	1 950	2013	2021
	Discharging treated mining waste water into nature	○○				+					○○			○	○○	○	28 480	2013	2021
	Challenge 8. Solving energy water supply in coherence with water resource regime.																1 875	2013	2021
	Conducting research at areas where hydro power plants are constructed; developing feasibility studies and layouts; commencing construction	+		+			+						○	○	○○			2013	2021
	Solving water supply issues of new and existing thermo power plants	○○					+						○	○	○○		1 165	2013	2021
	Studying possibility to use underground hot water	○					+						○	○○	○○	○	710	2013	2021
																		2013	2021

Sub-sector	Challenges and measures	MEGD	MCUD	MIA	MT	MM	ME	MSCT	MH	MED	GASI	NEMA	MF	Ulaanbaatar, aimag and soum CRM, GO	RBA	NGO	Required investment, *million tugrugs*	Starting year	Finishing year
4: Water for environment	4: Providing ecosystem balance in a sustainable way.																976,389	2013	2021
	Challenge 9. Implementing measures to prevent water resources from scarcity; its protection and growth.																624,715	2013	2021
	Measure 9.1. defining protection zone of river runoff forming sources and regime will be complied	+									○○		○	+	○○	○	110	2013	2021
	Measure 9.2. Defining protection zones of water bodies and regime will be complied	+									○○		○	+	○○	○	2 235	2013	2021
	Measure 9.3. Water metering water users and consumers	○○	○		○	○	○							+	+	○	2 391	2013	2021
	Measure 9.4. straightening river channel that are in the ownership of urban areas; rehabilitating protection zones	+	○○					○○					○	+	+	○	17 500	2013	2021
	Measure 9.5. Regulating runoff and constructing reservoir	+	+										○	+	○○	○	602 479	2013	2021
	Challenge 10. Implementing measures to protect water resources from pollution; decreasing pollution.																205 040	2013	2021
	Protecting water resources from pollution	+	○○	○○	○	○○	○○	○○	○○		+		○	+	○○	○○	61 725	2013	2021
	Implementing polluter-pay principle	+									○○		○	+	○○		65	2013	2021
	Improving ger district sanitation	○○	+										○	+	○○	○	143 250	2013	2021
	Challenge 11. Defining ecological flow and regime; protecting biological species.																7 825	2013	2021
	Conducting research on defining rivers' ecological flow	+											○	○	+	○	570	2013	2015
	Conducting research on defining groundwater ecological regime	+											○	○	+	○	192	2013	2015
	Storing water in nature for biological species	+											○	○	+	○	6 750	2013	2021
	Preventing from decrease of groundwater level due to human activities	+	○○	○○		○○	○○				○○		○	○	+	○	313	2013	2021
	Challenge 12. Implementing measures to rehabilitate damaged water sources.																22 295	2013	2021
	Conducting inspection at damaged and polluted rivers' channel; conducting treatment	+									○○		○	○○	+	○○	19 545	2013	2021
	Rehabilitating river basin water body areas' forest fund	+	○○	○○	○○	○○			○○				○	○○	+	○	2 750	2013	2021
	Challenge 13. Forming condition to neutralize damage of floods, drought, famine and other disasters.																116 516	2013	2021
	Constructing and maintaining flood protection facility		+		○							○○	○	○○	○○		112 868	2013	2021
	Installing rain generator	+											○	○○	○		600	2013	2021
	Constructing urban area roads' waste water drainage facilities	○			+								+	○○	○		3 048	2013	2021

Sub-sector	Challenges and measures	MEGD	MCUD	MIA	MT	MM	ME	MSCT	MH	MED	GASI	NEMA	MF	Ulaanbaatar, aimag and soum CRM, GO	RBA	NGO	Required investment, *million tugrugs*	Starting year	Finishing year
5: Establishing enabling environment for water management	Strategy: Establishing water management comfortable environment.																118 889	2013	2021
	Challenge 14. Developing legal environment to conduct activities in the basin.																	2013	2021
	Improving legal environment to conduct activities in the basin	+												○○	○○	○		2013	2021
	Challenge 15. Establishing appropriate structure of river basin organizations.																	2013	2021
	Developing river basin authority and structure	+												○○	○○	○		2013	2021
	Challenge 16. Developing river basin water management financial structure.																	2013	2021
	Defining finance sources that are required for implementing water sector activities	+												○○	○○	○		2013	2021
	Challenge 17.Building capacity to implement water management in the basin.																	2013	2021
	Building capacity of river basin authority and council human resources	+												○○	○○	○		2013	2021
	Challenge 18. Improving level of water resources and quality monitoring, researches and surveys.																3 975	2013	2021
	Establishing water resources and quality monitoring networks; its expansion and renewal	+	○○										○	○○	○○		2 325	2013	2021
	Expanding monitoring laboratory base	+									○○		○	○○	○○		1 620	2013	2021
	Conducting regular survey of water resources and quality	+									○○		○	○○	○○		1 116	2013	2021
	Challenge 19. Developing data management and expanding advertisements.																	2013	2021
	Forming database and improving data exchange	+									○○		○	○○	○○	○		2013	2021
	Advertising the followings to the public: issues on water protection, wise use of water and rehabilitation.	+									○○		○	○○	○○	○		2013	2021
	Total of Challenges 14-17, 19.																112 848	2013	2021
Grand total																	3 862 486	2013	2021

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 28 percent of total investment is from the state budget, 8 percent is from the local area budget, 19 percent is from the project and program budget and the remaining 45 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 "Tuul Water Complex" project will be implemented in the basin. Many big projects will be implemented and they will be financed by loans, PPP and private investment. The costs of sector measures and activities will be included in the general sector's budget.

The measures will be financed based on the Mongolian Law on Water article 7.3 (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.

9.3. 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 Tuul river basin IWM plan are included in this sub-chapter.

9.3.1. Activity risks which might occur during the implementation of the project

When implementing the Tuul river basin IWM plan successfully, several types of risks may occur: environmental condition, economy and finance, level of infrastructure development, administration structure, working 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 administration 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 2010, the Tuul river basin council was established. The Tuul RBA was established in 2012. It was vital for implementing this plan. But this organization is new and young, it will take some time to be noticed by public and finance also is needed. RBC and RBA will play 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, Ulaanbaatar city USUG had a loss of 1.5 billion tugrugs in 2011. Inflation is high in 2012 and cost of materials and petrol is increasing. Salary is increasing as well. But water service fee has not been changed. There is a chance that losses will be inflicted in this year.

The Mongolian economy is growing strongly 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 88. River pollution near Ulaanbaatar city

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.

The pollution has a negative impact on people's health. As for Tuul river basin, when Tuul River is polluted, residents who live downstream of Ulaanbaatar city, do have psychological and economical pressures and their chance to live in a healthy environment is decreased. So the people who live in Ulaanbaatar city do not have knowledge on compensation fees. But it is possible to provide the public with this kind of knowledge by using training, studies and media.

Their understanding on river basin IWM 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.

9.3.2. 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 changes is 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. When the changes increase, natural disasters increase as well. In other words, drought or flood frequency will increase.

Earthquake. Earthquake can cause some risks for the implementation of the management plan. The territory of Mongolia is located in the active earthquake zone of Central Asia. According to the data of Earthquake Studies Sector of the Astronomy and Geophysics Research Center of the Academy of Sciences, the number of earthquakes in and around Ulaanbaatar city has increased since 2005. The 1967 Mogod earthquake was felt in Ulaanbaatar city at 6-7 magnitude. If there are strong earthquakes in the basin, there will be much damage on population, industries, services and constructions of Ulaanbaatar city and other urban areas. 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. There were big floods in the Tuul river basin in the years of 1934, 1959, 1966, 1967 and 1995. There was strong, continuous rain near Ulaanbaatar city on 10 and 11 of July, 1966. The precipitation was 103.5 mm or 43 percent of the annual precipitation amount. The Tuul River flooded and the flow speed was 4-5 m/sec. The discharge rate was 1700 m^3/sec and the water level increased by 151 cm per day. Recently, there are sudden strong rainstorms which trigger floods. There was much damage to population living near urban areas. There were two big floods in the last 5 years. Ulaanbaatar city land management was not that good and people started to move their gers into areas where floods may occur. There is a high risk due to flood damage. For example: according to data of May, 2012, there are 3000 households in the regions which are vulnerable to floods.

Figure 89. Some parts of Ulaanbaatar are affected with flood due to weak flood protection

In 2011, with the help of Landsat and SRTM satellite images, areas near Ulaanbaatar city which are vulnerable to flood damage, were defined. If a flood protection dam is not constructed on the Selbe River, areas where people live, will be flooded as follows (Figure 88).

Source: *Ch.Narantsetseg, G.Enkhbayar, 2011.*

Figure 90. Potential areas which can be flooded if flood protection dam is not constructed on Selbe river

The following was included in the plan: conduct extra researches in areas where flood protection facilities are required to be constructed; construct and rehabilitate new ones. In our country, hydro construction calculation is conducted with 1 percent probability. The rainwater floods and maximum flow of flood will be increased in the future and risk which can occur during intense precipitation, will be calculated. Between 2012 and 2014, the "Improvement of Flood Damage Risk Management" project will run within the framework of a World Bank grant. Its purpose is to decrease potential flood damage near Ulaanbaatar city.

Forest and steppe fires. These are uncertain risks occurring in our country causing much damage to forest resources and impacting surface flow. There is 33.6 thousand ha forested area in the territories of Khan Khentii, Batkhaan and Khustai in the Tuul river basin. The experts consider that the Tuul river basin forest resources are decreased and

natural impact on river flow by forest cover is worsened. Also the Tuul river water regime is changed and annual flow is decreased. It is required to implement regular measures to prevent forest fires caused by careless action; and to prevent forest damage caused by legal and illegal logging.

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. Waste water discharged from tanneries (which use much chemical substance), pollutes Tuul River a lot. Inspection on the use, storage and protection of the chemical and hazardous substances, needs to be conducted. The measures need to be defined and implemented.

Drought, famine. There are periods with low precipitation in our country. The scarcity of water resources has a negative impact on pastoral animal husbandry and agriculture. Between 1999 and 2002, some 50-70 percent of 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 from a downfall. 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 famine, 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. Famine occurs especially after summer drought causes much damage. The drought and famine do not have a direct risk for the implementation of IWM plan. The risk is felt 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".

9.4. 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:

- River basin urban areas' drinking water supply sources will be fully protected and water supply facilities will be extended and renovated. By doing so, 97 percent of population will be supplied with safe drinking water.
- If the Tuul water complex is constructed, surface water use will increase by 30 percent and it will protect Ulaanbaatar city from water scarcity occurring after 2015.

- By introducing technologies that improve population drinking water supply and wise water use, the daily water demand of one person in a household with connection to the central network, will decrease to 160 l/day and ger district and rural area daily water demand will increase to 20-25 l per person.
- Population sanitation availability will increase and 50 percent of river basin population will have a connection to sewerage networks.
- Livestock water supply will increase based on integrated geophysical and hydrogeological research; water point ownership and use will be improved and herders' ideas will be supported.
- Irrigation area will reach 3.3 thousand ha and the harvest from 1 ha will increase; irrigation system ownership and use will be improved.
- There will be possibilities to solve issues of water supply, sewerage and WWTPs of new settlement areas, new industrial complexes and mines to be newly put in use; industrial water reuse and recycling will be increased.
- River basin water users will be included in the water auditing and water use will be totally water metered.
- To define protection zone of Tuul river and its affluent rivers' runoff-forming sources; protect sources of rivers, ponds and springs and construct protection fences; they will be under local area protection.
- To estimate ecological damage due to mining of natural resources in Tuul River and its affluent rivers' flood plain; professional organizations will conduct environmental impact assessments and rehabilitation cost will be paid; mining of natural resources will be prohibited and stopped.
- Research to construct water and sediment accumulating facilities and flood protection dams in the upper sections of river basin rivers with permanent and temporary runoff; facilities will be constructed at required areas.
- Protection zone regime of water bodies will be complied.
- 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.
- River basin monitoring networks will be expanded and the number of monitoring and inspection laboratories will be increased; database will be enriched and operation level will be improved.

The Tuul 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;
- Improvement of waste water quality and content;
- Urban area and public entities' water supply service and growth of water availability;
- Number of purified water sources that belong to natural water areas;

- 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;
- 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;

Table 102. The indicators of the Tuul river basin IWM plan results

Indicators		Measuring unit	Level 2010	Projected level	
				2015	2021
1. Main challenge: Water for people					
1.1	Population percentage supplied by safe drinking water source	%	89	93	97
	Urban	%	91	94	98
	Rural		46	55	65
1.2	Population percentage who connected to the centralized networks of water supply and sewerage of urban areas	%	38	45	52
1.3	Kiosks connected to the centralized networks	Kiosk number	234	390	705
1.4	Number of mobile kiosks to be newly constructed in Ulaanbaatar and Zuunmod cities	Kiosk number	313	413	515
1.5	Kiosk registrations that were constructed for the purpose of private drinking water and production in Ulaanbaatar and Zuunmod cities	%	Registration will be 100 percent by 2021		
1.6	Household water metering of Ulaanbaatar	%	42	60	90
1.7	CWWTP capacity	m^3/day	170000	450000	
1.8	Sludge processing industry capacity	m^3/day	-	3000-5000	
1.9	Number of basin soum center low capacity WWTPs (normal operation)	Number of WWTP	2	10	17
1.10	Houses to be connected to the sewerage	connection/ year	530-1000		
1.11	Grey water use level	%	Reaching 10 percent		
1.12	Number of tourist areas where water supply and sanitation condition needs to be improved	piece/year	On average 5-10 per year		
2. Main challenge: Water for agriculture					
2.1	Research of areas where ponds are constructed	Number of areas	10-15 areas		
2.2	Areas where integrated water point geophysics-hydrogeological research is conducted	Number of areas/ ha area	20/ 6-9 thousand		
2.3	Number of boreholes that need to be newly constructed and rehabilitated in the pasture	pieces	-	220	400-440
2.4	Herders' groups that are supported for their support for improving water point ownerships and usage	Number of groups	170 in 30 soums		
2.5	Farming-its water supply condition needs to be improved	pieces	-	20	35
2.6	Irrigation system percentage where water audit, passporting and water metering are conducted	%	Reaching 100		
2.7	Irrigated area size	Ha	1350	2150	3300
3. Main challenge: Water for industry					
3.1	Number of industries where water audit was conducted	pieces	-	400	1200
3.2	Water metering of industrial water use	%	Reaching 100 percent		

Indicators		Measuring unit	Level 2010	Projected level	
				2015	2021
3.3	Mining organization percentage where inspection is conducted on water source and water use	%	100 percent involvement		
3.4	Water reuse level at mining	%	70	75	90
3.5	Water reuse level at energy	%	Reaching 100 percent		
4. Main challenge: Water for environment					
4.1	Surface water use	%	8	Reaching 30 percent	
4.2	Area of protected runoff forming source	thous. ha			
4.3	Water demand per person who live in apartment that connected to centralized networks	l/day	230	220	160
4.4	Water demand per person who live in ger districts and rural areas	l/day	7-9.	10	20
4.5	Length of Tuul river whose channel needs to be straightened and rehabilitated	km	-		25
4.6	Number of rivers whose recharge regime needs to be studied in a detailed way and runoff needs to be stabilized	pieces	-	1	4
4.7	New water observation spots are to be constructed for the purpose of conducting survey on flow; water physical, chemical and bacteriological features; precipitation and flood conditions	pieces	-	2	7
4.8	Conducting inspection and inventory at river basin water resources polluting sources	%	-	30	70
4.9	Chrome content measurement in waste water of WWTP	Number	Regular measurement every week		
4.10	Use level of water /which was deep treated in "Tuul-Songino" water complex/ for thermo power plants, agriculture and other industries	%	-	-	100
4.11	Temporary observation spots to be constructed in summer	Pieces	-	10	25
4.12	Ger district households whose sanitation facilities are to be improved	thous. household	-	On average 10-15 per year	
4.13	Number of river whose ecological flow is defined	pieces	-	6	-
4.14	Establishing ponds where migratory birds stay	pieces	-	-	1
4.15	Fish breeding areas to be newly constructed/formed	pieces	-	1	1
4.16	Rehabilitation is conducted in Tuul river flood plain and valley where there is damage caused by mining	km^2	-	50	100
4.17	Forest areas that will be rehabilitated in upper section of Tuul river	km^2	-	40	80
4.18	New flood flow regulation dams to be constructed	pieces	-	-	2
Main challenge 5: Comfortable environment for river basin water management					
5.1	Groundwater monitoring spots to be newly constructed	pieces	-	7	18
5.2	Surface water observation spots to be newly constructed	pieces	-	5	15
5.3	Number of new regime change monitoring boreholes of groundwater	pieces	-	5	14
5.4	Permafrost monitoring-inspection spots/points to be newly constructed	pieces	-	7	13
5.5	Laboratories to be newly constructed	pieces	-	3	9

9.4. 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.

- Tuul 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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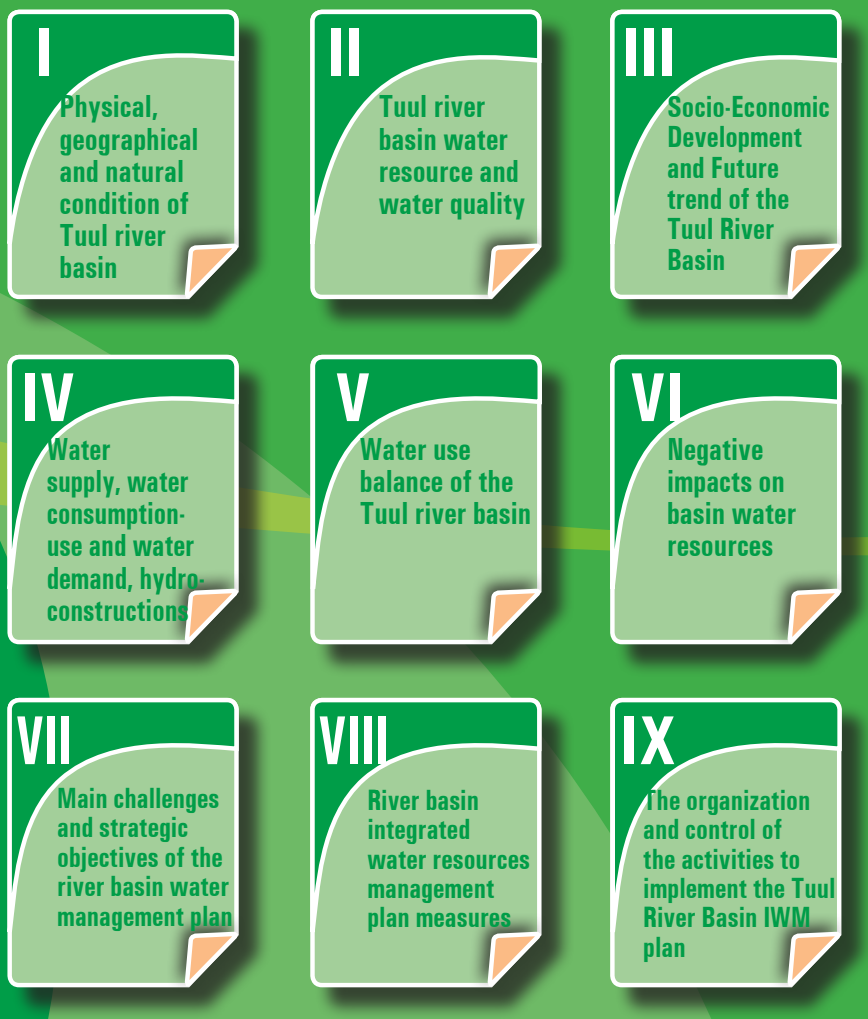

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