특별보고

Current Situation of Water Resources Management in Mongolia

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1. Foreword

In the 21st century which is global era, there is a need to make appropriate decisions concerning population growth, climate change, environmental aggravation and drinking water scarcity. For these decisions science, technology and rapid industrial development must be taken into account as a complex.

In response to the outcome of the 58th Annual Meeting of the United Nations General Assembly, the period 2005-2015 is proclaimed as "Water is the source of life" and it was noted down that "water is the main mover energy of promotion of sustainable poverty alleviation and starvation".

The International Conference on sustainable development declared that by 2015 the number of people who have access to safe drinking water should be increased up to 1.5 billion. In this perspective integrated water resources management has became the attention of all countries in the world.

The United Nations Development Program published "Human development report" as a name of "Authority, poverty and world water crisis are behind the water scarcity" in 2006 and noted in the report that there are 1.1 billion people in the world are lacking access to safe drinking water and appealed world countries to spend at least 1% of their GDP to improve water supply condition.

Carrying out the integrated water resources management should be set in the Government policy as an important strategic objective to use water resources properly, protect it and keep its ecological balance since Mongolia is located in the most desiccated part of Asia and Pacific region; it has lack of precipitation and is rich of evaporation, limited water resource, uneven prevailed water resources within country, its water quality does not meet with the standard of health. Implementing integrated management to keep ecological balance and to protect water resource is basic purpose of government policy.

Because of this, Mongolian government pays attention to strengthen legislation and organization structure of the Water sector. This became a beginning of implementing water resources management to provide sustainable socio economic development of the country.

In accordance with the objectives which are reflected in the Government action plan, such implementation

comprehended increasing investments into the Water sector, strengthening water policy renewal, increasing surface water use, supporting development irrigated agriculture, establishing large reservoirs, encouraging ground water exploratory research.

New provisions are mentioned in the law on Water. They include establishing large river basin council in order to enhance local herders' participation into water management of the area, developing a management plan to provide integrated use of water resources, its protection and restoration of environment. The government will give approval and provide the implementation of the new provisions. In accordance with the law we have started to organize the River basin councils of large rivers including Selenge, Tuul, Kherlen and Khovd and provide them with professional management.

Mongolian government has recently started program "Strengthening integrated water resource management in Mongolia". Important outcome will be a formulated integrated water resources management plan. The government will take the outcome of the project into account, since the aim is that the government water policy will be based on this document.

One of the main factors that influence to country's sustainable development is natural resources specifically water resources. The water resources are strategically significant natural resources that make considerable changes to country's social development and industrial growth.

Evidently, water consumption will increase due to a rise in the urban population and development of society and economy. Impacts of climate change, improper human activities has resulted in increased water scarcity, pollution level of groundwater and surface water, water with depressed quality and changed regime. If this process will continue in the long term of the future, in terms of limited water resources in Mongolia, there might be a possibility Mongolian future generation would be facing with water scarcity and its unequal ecological balance.

Demand to elaborating management for In proper use of water resources and its protection became one of the biggest constrain for the Government in 2000 and it reflected on the Law on Water and other formal legislative acts and their implementation became a vital goal of Mongolian Water sector.

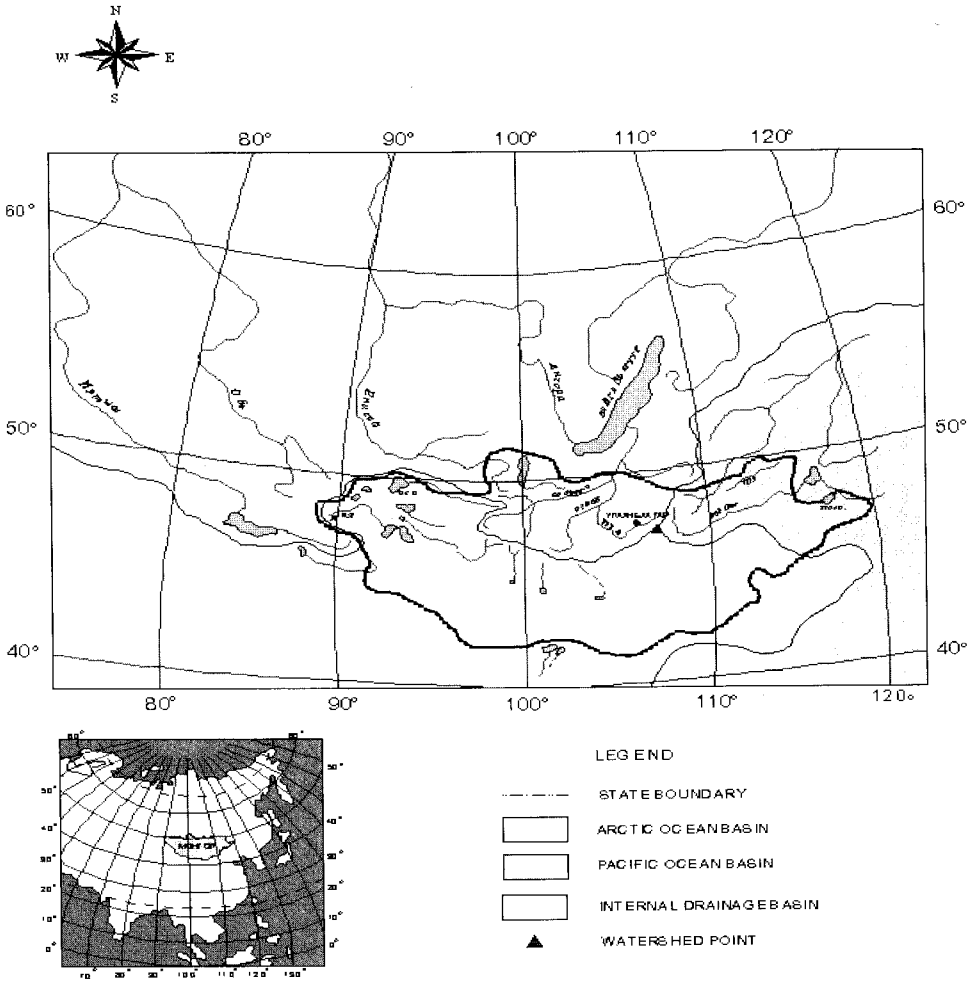
2. Background information

2.1 Geography

Mongolia is located inland in Northwest Central Asia, between China and Russia /Pic 1/. It forms the transition zone between great Siberian taiga and Central Asian desert. Forests cover is limited to the Khangai, Khuvsgul and Khentii mountains in the mountainous region in the north, while bluffs are found in Mongolian Altai and Gobi Altai mountains. High plateaus with gobi desert and steppes cover eastern and southern areas of the country. The total territory of Mongolia is 1.566 thousand km^2 and average height is 1580 m above sea level.

Mongolia is listed the eighteenth largest country in the world by its territory and least densely populated (63 acre land per person).

Due to its inland location and mountainous surroundings the main climate is continental, harsh and dry. Important characteristics of the country climate is long lasting winter, short summer, high fluctuation of daily and seasonal temperature, low precipitation and about 85% of the precipitation falls in summer. The estimated annual water demand in 2006 is very small, just 0.5 km^3-0.7 km^3, in proportion to the water resources volume of 599 km^3. However, geographical distribution of water is unequally distributed in Mongolia since 75% of the fresh water resources is



Pic. 1 Location of Mongolia and 3 water basins

stored in Kvushsugal lake and rivers in the gobi desert are absent.

Traditionally the main type of land use has been (semi-)nomadic livestock husbandry in consequence of the low precipitation. Presently agriculture counts for about 25 % of the country's Gross Domestic Product (GDP) and about 50 % of the workforce is involved in agriculture. However, Mongolia has also extensive mineral deposits: copper, coal, molybdenum, tin, tungsten and gold, and past few years the mining industry became the leading industry in the country: i.e. by 2005, 30% of the GDP was generated by the mining industry as well as 68.5% of the export.

The population is around 2.6 million and the population density is only 1.8 persons per sq. km. Majority of the population, i.e. 956.3 thousand lives in Ulaanbaatar, the capital of Mongolia.

The territory of Mongolia belongs to 3 water basins off which 19,5% belongs to the Arctic basin, 11,5 to the Pacific basin and 69% belongs to the Central Asian basin without external flow. The crossing point of the basins is located at the latitude 47° 39'07"N, 107°31' 28"E, 1854.5M above the sea level in Erdene soum of Tuv aimag "Khunlun uul"

For the state structure, Mongolia is a unitary state and divided administratively into 21 aimags and a capital city. Aimags are subdivided into 340 sums; sums into bags; a capital into districts; districts into khoroos.

For the government, Mongolia is a parliamentary republic. President and State Great Khural (parliament) are elected for four years. In the nineties the country made a transition towards a market economy and changed the social system.

2.2 Climate and climate change

Mongolia has extreme continental climate with short, hot summer and long, cold winter, high temperature fluctuation (both daily and seasonal) and it has relatively more cloudless days. The average annual climate temperature is between -7.8 ℃ and -8.5 ℃.

The precipitation on average is low in Mongolia; it is about 300-350 mm in Khangai, Khentii, Khovsgol mountain ranges, 250-300 mm in Mongol Altai and forested area, 50-150 mm in Gobi desert area.

Mongolia is situated in the region, where climate change is clearly observed compare to the other regions of the world. Main cause of showing such behavior is that the country is located on narrow transition zone between great Siberia taiga and Central Asian desert, apart from the ocean and highly elevated above the sea level.

Past 60 years, annual temperature is increased by 1.9 ℃, winter is 3.6 ℃, spring and fall temperature is 1.3-1.8 ℃ and summer temperature is 0.5 ℃, respectively. During this time, the average precipitation has been decreased by 10% within the country. However, geographical pattern differs around the country.

Based on model projections the future climate change scenarios project that the winter and summer temperature in Mongolia will be increased 0.9-3.9 ℃ and 2.0-6.4 ℃ as respectively. Precipitation will be increased within 24-67% in winter and decreased by 2.5%, then increased 6.4% up to 2080. Summer is getting hot and dry, and winter is getting mild and snowy. Especially, an increase of summer precipitation is low in respect to its mean climate and the temperature increase; this leads to increase of evopatranspiration.

Climate change will have both positive and negative impacts on the main environment and socio-economy sectors (i.e. among others: change in snow cover, permafrost, natural zone, livestock and pasture land), however negative impacts prevail.

2.3 Land use

The table below shows the land classification in the past 20 years. As shown in the table the agricultural land leading role in land resources classification has never changed related to the tradition and features of the country. Pastureland occupies the main area in agricultural land (92.6%). Pastureland is used for natural forage for the nomadic livestock. Crop land occupies only 0.6% of the agricultural land. In Mongolia land has been privatized since 2002, but still most of the country remains state-owned pastureland.

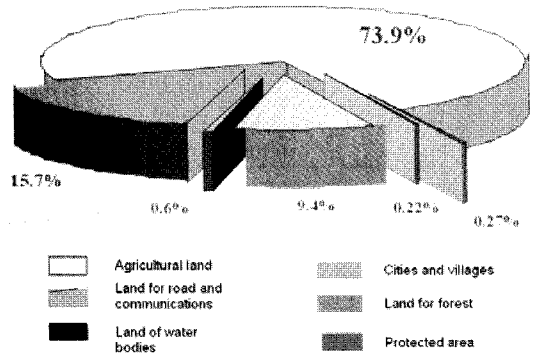
Land cover is divided into two basic types, high Mountain and steppes. In the mountainous region in

Table 1 Coldest and warmest temperature for different regions

Region	Average coldest month (January) (℃)	Region	Average warmest month (July) (℃)
valleys between mountain ranges Altai, Khangai, Khentii and Khuvsgol	-30 to -34	great lake valley, Orkhon and Seleng basin, region between mountain ranges Altai, Khangai, Khentii and Khuvsgol	+15 to +20
high mountains	-25 to -30	Khangai, Khentii and Kvusgol mountains	+15
steppe region	-20 to -25	southern part of Dornod steppe and gobi desert region	+20 to +25
gobi desert	-15 to -20		

Table 2 Land classification types during past 20 years

N	Basic classification of land resources	1986		1998		2004	
		Thous. ha	%	Thous. ha	%	Thous. ha	%
1	Agricultural land	128398.5	82.09	129131.9	82.6	115580.5	73.9
2	Urban, settlements land	473.7	0.30	376.3	0.24	432.9	0.27
3	Protected area	8316.8	5.32	-	-	24427.9	15.7
4	Forest land	14595.2	9.33	17852.0	11.42	14673.8	9.4
5	Water bodies	1634.9	1.05	1665.0	1.06	943.4	0.60
6	Reserve land	2992.2	1.91	7056.2	4.51	-	-
7	Roads and communications land	-	-	330.2	0.21	353.1	0.22
Total area		156411.8	100.0	156411.6	100.0	156411.6	100.0



the north the Altai, Khangai, Khentii Mountains have forests, while the Mongolian Altai and Gobi Altai Mountains are rich of bluffs. High plateaus with gobi, desert and steppes cover the eastern and southern area of the country.

2.4 Soil erosion and degradation of pasture land

Due to climate change the number of dust storming days has increased and repetition of drought and dzud has frequently occurred in the past years. Together with abandoning the traditional use of pasture and pressure on land use for different purpose this is causing plant cover degradation and soil erosion.

It is estimated that 78.8% of pasture territory was eroded. Among the eroded land more percentage 58.6% has erosion caused by wind and water, 14.1 % by water and 5.1 % by wind erosion. Only a few places that have not been affected are left in the Eastern Mongolian steppe.

In addition soil and plant cover of rural land erodes by the constructions of new buildings and industries. Because of dense population in urban settlements area, the land debate can not be solved easily. Also urban settlements land are affected by soil erosion and air pollution more than other classification of land and this area is degrading ecologically.

Another feature that is having a significantly impact on the landscape is mining. Although mining only occupies 0.06% of total land area of Mongolia and plays a main role in the economic development of the country, large mining industries have also caused change in landscape and change in water bodies appearance (e.g. change river bed, polluting soils, etc.). The past years public struggle requires to control natural resource use and to restore used up mining areas.

2.5 Water resources

Water resources in Mongolia are composed of glaciers, lakes, rivers, springs and groundwater. Today surface water resources of Mongolia are estimated at 599 km^3. Majority of the volume, i.e. 500 km^3 is stored in the lakes (including 90 km^3 saline water). A volume of 62.9 km^3 is accounted for in the glaciers and 34.6 km^3 remains in the rivers.

According to flow regime classification, most Mongolian rivers are fed by spring snow melting and rainfall floods in the warm period. 50-70 percent of annual runoff of rivers in Altai mountain area forms from snow and glaciers contribution, while 5-10 per-

Table 4 Results of state inventory for surface water/2003/

Name of province	Rivers, creeks		Spring		Mineral water		Lakes, ponds	
	Total	Dried	Total	Dried	Total	Dried	Total	Dried
Arkhangai	546	124	474	123	31	3	249	32
Bayan-Ulgii	293	17	736	42	13		1180	217
Bayankhongor	299	61	837	55	22		104	38
Bulgan	449	62	668	238	36		254	27
Gobi Altai	219	2	779	35			75	0
Gobi sumber	3	0	19	1	2		1	0
Darkhan Uul	21	4	27	13			4	2
Dornogobi	0	0	345	50	4		1	0
Dornod	156	39	354	121	24		515	233
Dundgobi	1	0	187	15	5		12	0
Zavkhan	217	19	444	18	15		118	2
Orkhon	5	0	28	7			4	1
Uberkhangai	294	51	530	97	37	3	110	20
Omnogobi	2	1	559	20	5		18	0
Sukhbaatar	35	22	368	41	6		55	4
Selenge	596	90	208	70	28	2	46	6
Tov	537	94	413	103	17	1	235	72
Ulaanbaatar	72	22	106	22	20	1	4	1
Uvs	183	0	493	31	16		121	6
Khovd	214	7	468	10	9		201	4
Khuvsugul	1233	70	969	193	78		642	30
Khenteii	246	17	588	179	6		247	65
Country's total	5565	683	9600	1484	374	10	4193	760

cent form from rainfall. In case of rivers originate from Khuvsugul, Khangai and Khentei mountain ranges, 56-76 percent of annual runoff form froms rainfall.

Geographically water resources in Mongolia is unevenly distributed and 380 km^3 of total surface water resources is stored in the Khuvsugul Lake, which totals

Table 3 The result of assessment studies on the water resources in Mongolia

N	Ground water resources, Km^3/year		Surface water resources, km^3				Name of the scientist, year
	total	availability	total	river	lake	freezing, glaicure river	
1	5.58	0.6	-	-	-	-	À.T.Ivanov, 1958
2	12.93	-	-	-	-	-	IWER, 1973
3	-	6.07	-	28.53	-	-	IWER, 1975
4	-	-	-	40.1	-	-	À.Ph.Krashnikov, 1975
5	6.88	6.28	-	-	-	-	N.À.Marinov, 1977
6	12.0	5.6	599.0	34.6	500	62.9	G.Davaa, B.Myagmarjav, 1999
7	-	-	-	-	500	-	J.Tserensodnom, 2000
8	-	10.79	-	-	-	-	N.Jadambaa, G.Tserenjav, 2003

63.4 percent of surface water resources and 74.6 percent of fresh water resources in Mongolia. 70 percent of surface water resources of Mongolia forms in 30 percents of the country's territory, occupying Altai, Khangai, Khentei, Khuvsugul and Great Khyangan high mountain ranges.

In 1958, ground water resources were estimated by Russian scientist A.T.Ivanov for 1,000,000 km^2 of the total area of Mongolia for the first time. According to his research, the total groundwater resources were 5.581 km^3/year in the 1,000,000 km^2 and 0.6 km^3/year water was available for utilization.

Next the Institute of water exploratory research (IWER) estimated the total groundwater resources in Mongolia at 12.93 km^3/year in 1973 and 6.882 km^3/year in 1975. After that, the ground water resources available for use were estimated at 6.2818 km^3/year.

Dr.G.Davaa, B.Myagmarjav estimated groundwater resources in soil and under soil ground of Mongolia at about 12.0 km^3/year. Dr.N.Jadambaa, G.Tserenjav estimated the ground water resources that could be used for pastureland purpose by economic zones. Their estimation was based on the proposed distance between two water points of 5-7 km in the whole territory of the country and it took types of water bearing rock formations and possible rate of discharge into consideration when calculating the groundwater resources. They calculated the groundwater resources at about 10.79 km^3/year.

The following table shows the result of the above scientists' assessment study on water resources in Mongolia.

Study materials and analysis sources determined that mineralization of rivers water mainly 300-500 mg/l and this water resource's condition almost suitable for utilization for whatever economic sectors of the country. In comparison with this the mineralization of main lakes is different. For example water in Uvs lake, Khyargas lake, Khar lake, Boontsgaan lake, Sangiin dalai lake, Khukh lake and Oigon lake has mineralization around 2000-15000 mg/l and Khar Us lake, Khuvsgul lake, Buir lake, Tolbo lake, Terkhiin tsagaan lake and Khoton lake have teh meniralization 50-300 mg/l. Hardness of surface water of Mongolia is not high with gentle component and seasonal changes are relatively permanent.

Although volume of annual water use in Mongolia totals just 0.5-0.7 km^3 and chemical water composition is sufficient for water supply, (new) water resources for supply can become scarce in some areas of the country. Water regime, resources and quality became more and more affected by human influences, climate change and changing soil and vegetation covers.

A state inventory for surface water conducted in 2003 shows that total number of rivers in Mongolia is 5565 and from them 683 dried out in last few years. Also 1484 springs of total 9600 springs and 760 lakes of total 4184 lakes are dried out (Table 4).

It had also shown that although most of the rivers are still mountain fresh water, but at least 23 rivers in 8 aimags riverbeds has changed and/or are polluted due to mining activities. For example, the large Orkhon, Tuul, Kharaa and Eroo rivers in Selenge river basin have been polluted from the impacts of gold mining industries, urbanization and industries activities within the basin.

Water quality in Ulaanbaatar is causing major concern and threatens livelihoods and health. Moreover, research has shown that most industries and enterprises supply 2.5-20 times more than permitted to the centralized sewage system by 2-3 chemical index standard (using old techniques in their processes), and therefore directly affect the functioning of the sewage plant and disrupt equipment.

3. Agricultural water supply management

3.1 Pasture irrigation

Pasture livestock breeding is an important economic sector in terms of employment, export revenues, production of GDP and is a core issue in historic development of the nation. Past, present and future of livestock breeding has been an interesting issue of Mongolian civilization and fortunately, the sector has overcome hardships of transition economy with relatively less losses and has been successfully adapting to market economy relations.

In 1990, livestock breeding made up to 87.6% of agricultural production, while in 2005, it made up to 85%. The figures indicate that Mongolian economy is greatly dependant on the sector development. While in 1990, agricultural production made up to 33.4% of GDP, in 1995 it made up to 38% and in 2000 it was 29.31%, in 2005 it declined down to 21.7%. The decline was due to severe dzud in 2000-2002, which took a considerable number of livestock and negatively affected production growth.

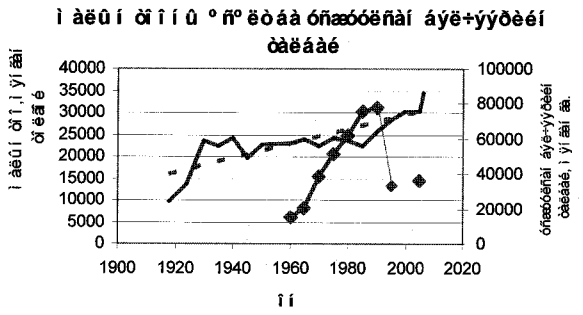
Although having been directly dependant on natural disaster, drought and dzud, inappropriate production and marketing structure, water supply deficiency, and livestock production management being left on it's own have affected the sector, the livestock breeding as traditional way of life with animals adopted to harsh climatic conditions and which provides livelihood to relatively many people has a future. Nationwide datas indicate that the sector employees 365.000 persons, whose are called herders or people's entrepreneurs.

Mongolia ranks world No. 13 in terms of camel number, 7 in horses, 77 in cattles, 22 in sheep and 10 in goat. Assessment of livestock number increase shows that generic number of animals has increasing trend, however, it is seen that structural changes have been taking place. A number of camels reduced by 52.7%, horses 10.3%, cattles 10.3%, sheep 14.6% respectively, while a number of goat herd increased 2.58 times. Increasing number of goat herd is applicable to cashmere market demand.

Waterless pasture is not a pasture at all, it is just grassland, that is why a pasture land should have sufficient water resources. Based on this statement, in a country like Mongolia, which has shortage in water and uneven water source distribution, it is to say that Mongolia has very poor water supply. 67 km long, 3800 rivers, streams, about 1.200 lakes and 6.889 springs provide water for pasture irrigation in Mongolia.

For herders which have been running nomadic livestock breeding a fight for water has been always a struggle for existence. For centuries herders used to move from one pasture to another one following water sources, like rivers, lakes, ponds to feed their animals with nutritious grass. Surface and underground water sources have been provided with water nomadic livestock breeding water demand. As herders water supply has not been resolved as separate issue some herders use appropriate drinking water, while others use inappropriate water with high degree of mineralization, some carry drinking water from far away to meet drinking water demand.

Pasture irrigation facilities are divided into simple and engineered ones. The simple facility includes traditional herder made well, man made pond around spring



Pic 2 Livestock number growth and irrigated pasture

water. Engineered well include wells adopted to harsh climatic conditions and made according to specially developed drawings. Those wells do not freeze in cold season and are further divided into deep, short casing wells, reservoirs, pools and animal watering pump station.

Nomadic livestock breeding pasture irrigation basic facilities are following:

Simple well, -they have many names for example herder made well and herders Khoboo (bucket) well etc. Average depth is 3-5 m.

Pit well, well built by special drilling equipment named Pit. Maximum depth for this construction is 30 m and water lifting from well by pump NV-3, is Horse powering pump with discharge about 1 l/c

Short tube well- cased well with steel pipe. The well is very specific and pumped well, because diameter of the case is 6-8 inch

Borehole- and pump station/engineering well/

Photo 1 Water lifting by "Khoboo" from simple well

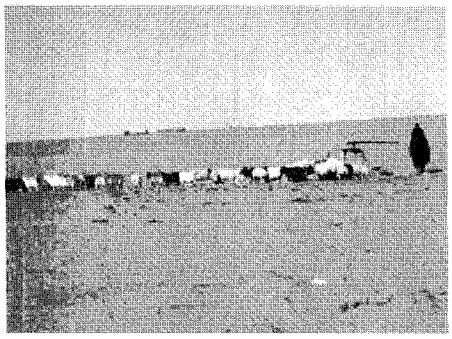


Photo 2 Pit well in operation

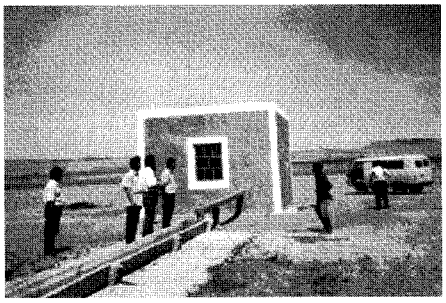
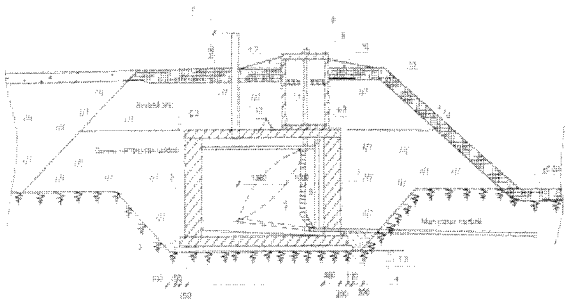


Photo 3 Engineering well

Reservoir for watering animal husbandry. Average volume is 8-16 m^3



Pic 3 Cross section of thew reservoir

Pont for watering

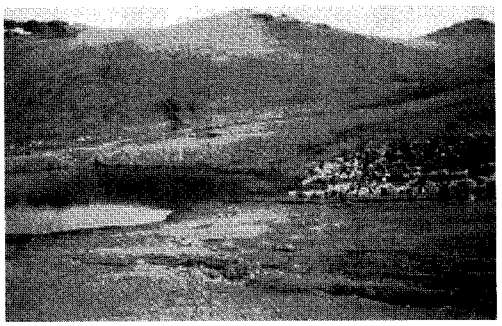
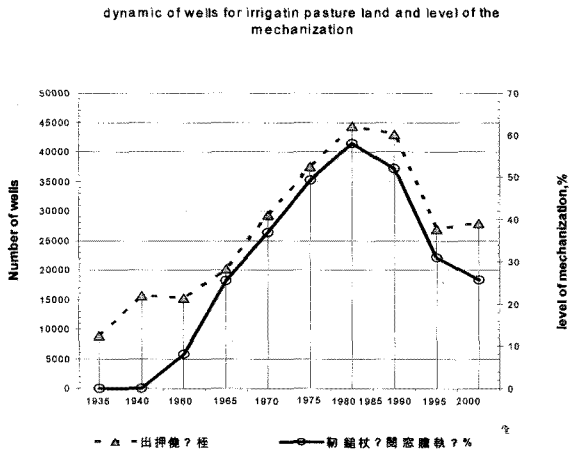


Photo 4 Animal watering in man made rain and snow collecting Pond



Since 1991, due to inadequate state policy many infrastructure facilities, such as shelters, wells were destroyed and pilfered and become useless. This is due to no cost livestock privatization, while pasture and wells have been left in public possession which leads to pilfering of well equipment and deficiency in pasture water supply. Deep and short casing engineered wells equipment was destroyed and narrow diameter shaft wells become unoperational and left neglected.

Estimation show that 39.754 ha pasture is waterless and useless due to inoperable 17.629 wells. Pasture irrigation rate drop down to 32.8% and 30 years efforts to irrigate pasture land just vanished.

The only way to get out of this situation is improvement of pasture irrigation and even pasture distribution, prevention from nature degradation and provision of sustainable development in livestock breeding which is the main sector of economy.

Pasture irrigation through establishment of individual wells should be supplemented with setting up base wells to carry drinking water to herders. It should be noted that in rural areas provision with vehicles has been improving and water might be carried in tank car to supply herder groups at least with drinking water.

According to statistical data from 2006, there were developed 237 wells newly and 2109 wells rehabilitated by international organization's aid and 280 wells were repaired by Government budget.

If based on herder families in Mongolian livestock production, it is necessary to develop 170 thousand wells and at least half of this number or 80 thousand must be constructed in case seasonal management on water supply.

Policy issues to focus on Pasture irrigation:

- Resolve on legislation for privatization of Agricultural water facilities.
- Decrease Water shortage in livestock breeding and pasture degradation.
- Resolve on herders drinking water supply, which has been abandoned until now
- Support ecosystem protection management
- Gradually provide each herder family and herder group (khotail) with water and well. Households with over 1.000 animals should enter into well possession, increase herders participation (local participation) in new well drilling and well rehabilitation, support herder groups in selection of water supply method, establish water supply development fund to overcome water supply shortage.

3.2 Crop Irrigation

Irrigation in Mongolia probably dates from the first century AD and is likely to have been developed during the rule of the Hunnu's.

However, Mongolia was a country of the nomadic and grassland, livestock husbandry, But Mongolians used to engage in the irrigated farming in all its stages of the historical development. It is the country with interesting history and a tradition of the irrigated farming. Development of irrigated farming may be classified into 3 periods such as

- Ancient or People's farming till 1911,
- Farming during centralized planned economy period from 1960 till 1990,

• Free market economy period from 1990

The main crop types are cereal, potatoes and vegetables. Most tons are produced in the central region.

Table 5 Agricultural crop production

agricultural crops	2002	2003	2004	2005
cereals, in thous. tons	125.9	165.0	138.5	75.5
vegetables, in thous. tons	39.7	59.6	49.2	64.2
potatoes, in thous. tons	51.9	78.7	80.2	82.8
fodder crops, in thous. tons	3.5	9.6	9.6	8.3
technical crops, in thous. tons	0.2	0.8	5.9	1.2

Source: National statistical office of Mongolia (2005)

Mongolian agriculture is constrained by short growing seasons and low precipitation. Unseasonable frosts, especially in the late spring or early autumn, can dramatically reduce the length of the growing season, which generally ranges from 70 to 130 days, depending on location. Frosts can occur on any day of the year. Cropping is therefore limited to cool season crops grown during the Mongolian summer. Surface water freezes up, most of them for 140 to 180 days, with ice cover reaching 80 to 120 cm. The rivers become ice-free in April in the plains and from mid May in the mountain regions. With snow melting which generally starts in the second half of April to continue till mid-May, rivers experience a small spring flood during this period.

Supplementary water requirements range from about 300 mm for vegetables and 650 mm for fruit plantation in the north to about 550 mm and 1,000 mm for these crops respectively in the south. Thus, water availability is a constraint to all crops beyond a relatively restricted area in the north of the country, and even here variability in precipitation levels necessitates the use of irrigation in a supplementary capacity for vegetables.

About 418,000 ha of potentially irrigable land were identified in Mongolia.

Nationally, water resources are not a major constraint to irrigation development but uneven regional distribution of water resources limits the development potential, largely to the northern and western regions where both surface and groundwater can be readily exploited. In the southern region, groundwater is found at considerable depths and its exploitation is generally expensive.

Modern irrigation development started in 1958. By the 1980s, irrigation schemes were characterized by highly mechanized sprinkler systems, generally serving 400-500 ha or more, primarily for fodder and cereal production and, to a lesser extent, for vegetables and potato production. According to government figures, the total developed area for irrigation amounted in 1990 to 57,300 ha, of which 45,160 ha (76%) were under highly mechanized sprinkler systems on 156 "registered" schemes, and about 13,900 ha concerned "unregistered" systems using low cost surface irrigation methods./photo 1,2/

Table 6 Potentially irrigable land in Mongolia

Name of aimag	Potentially irrigable land, hectare	Which of	
		Studied for irrigation systems	For surface irrigation
Arkhangai	37200	921	2402
Bayan Ulgii	19982	2230	5890
Bayankhongor	20993	1181	1071
Bulgan	43488	811	1413
GobiAltai	25832	5547	5311
DornoGobi	2380	319	100
Dornod	23563	1771	374
Dundgovi	6140	-	140
Zavkhan	42068	1651	649
Uvurkhangai	21000	3735	771
UmnoGobi	530	388	46
Sulhbaatar	2786	90	61
Selenge	34351	6067	1358
Tov	27000	3674	421
Uvs	33190	7063	3376
Khovd	22176	5684	6703
khovsgul	8984	307	595
Khentii	46592	1530	310
total	418255	45160	30491

Source: Institute of Geoecology

Geographically, existing irrigation is mainly concentrated in the north, central and western parts of Mongolia, but is scarce in the south and the eastern regions.

About 27 earth dams are currently storing water for irrigation use on registered schemes. About 46% of the total irrigated area is served by gravity canals and the remaining 54% by buried steel pipes. On-farm irrigation equipment comprises exclusively sprinkler devices such as tractors with water guns or sprinkling wings, centre pivots, side rolls, and movable laterals. Most of the equipment has been affected by the severe fuel and spare parts shortage and is in poor condition. On many farms, equipment has simply disappeared.

After collapse socialist planning economy and privatization of irrigation systems number of irrigation schemes falling down.

In Mongolia irrigated lands account for nearly 1.7% of the cultivated land area and at present they cover about 26000 ha/2006/. A network of irrigation schemes has been created in the each aimag, the small schemes sometimes covering in the arid zone. Agricultural production on irrigated lands is aimed at supplying vegetables and small portion for cereals.

There are several options the irrigation schemes divided into two categories: surface irrigation, and sprinkler irrigation. Simple surface irrigation, which is being used by most individual farmers who have taken over small plots on the schemes, consists of small level basins of just a few square meters or furrows, which are watered by gravity from a tertiary canal.

Simple sprinkler irrigation would use existing tertiary canals for small engine-driven pumps located on the canal banks to pressurize either a single sprinkler on a stand or a small hand-move aluminum lateral. Large-scale sprinkler irrigation is the type favored by the former state farms, using crawler tractors with water guns or booms, centre pivots, side-rolls, or movable laterals.

Photo 5 Narrow irrigation

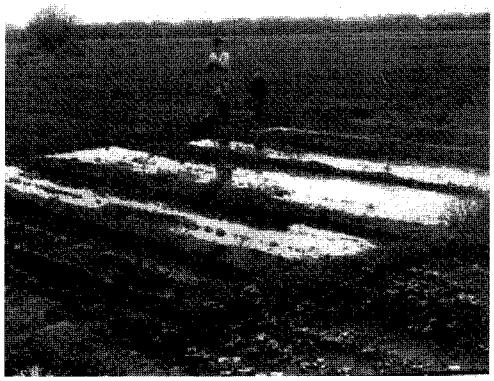


Photo 6 Small plots for vegetables

The main advantages of surface irrigation are the cheapness and simplicity of operation. However, it also demands a high labor input to reform plots every year and to maintain canals, a task which also requires a high level of cooperation amongst farmers. Water losses are also high, with over-watering a common problem, leading to water logging.

The advantages of sprinkler systems are that they are better suited to vegetable production, allowing better regulation of water delivery to match the needs of the plant at different stages; they have far higher water use efficiency, thus avoiding water logging problems; they are suited to sites with undulating topography, avoiding the need for expensive land leveling; existing water conveyance systems can be utilized with the minimum of remodeling; and, the simple systems allow

Photo 7 Sprinkler irrigation

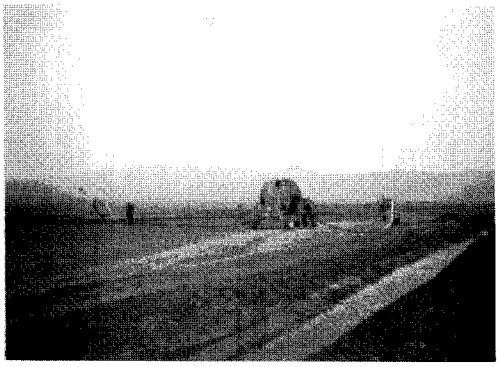


Photo 8 Small tube sprinkler

farmers to irrigate largely independently of their neighbors. The main disadvantage of sprinklers, of course, is the cost of operation and, for the large scale systems, the difficulty of maintenance.

Of the sprinkler irrigated area, side roll systems accounted for 43%, tractor mounted water guns or sprinkling booms 28%, centre pivots 25%, and movable laterals 4%.

If consider the result of the highest harvest taken from the registered irrigation systems with in 1986-1999 as an example:

Harvested 228 kg/ha grain in 1987, 4820 kg/ha cultivated fodder, 15.4 ton/ha potato in 1990, 18740 kg/ha vegetables, 2380 kg/ha fruit in 1998. This result confirms that it is possible to take the products we need from the irrigated field if we could acquire technology.

The main aim of the Mongolian government are:

- to restore registered irrigation schemes to full productive capacity around 45160 ha, of old irrigation schemes;
- to enable small individual irrigators, cooperatives and irrigation companies to optimize their utilization of the rehabilitated irrigation infrastructure and to identify and formulate a long term national irrigation policy (investment strategy, capacity building etc…)

Irrigation development strategy

The Ministry of Food and Agriculture (MOFA) has overall responsibility for formulating irrigation development policy, through the Pasture and Crop Irrigation Department, with responsibilities extending into rural water supplies and as well as irrigated crop production.

With Mongolian agricultural traditions being based on livestock, the possibility existed that the paralysis of state farming companies and the decline of formal irrigation infrastructure in recent years might lead to the dissipation of enthusiasm for irrigation. This ap-

Table 7 Number of Rehabilitation systems

N	Number of Rehabilitation Irrigation systems	Kind of investment, mln.tug.				New buildings
		Government budget	International Project	Some self investment	total	
2003	18	0	262.8	0	262.8	4
2004	15	800.0	80.9	1352.9	2233.8	0
2005	17	653.6	0	619.2	1272.8	0
2006	12	769.9	0	575.4	1345.3	0
Total:	50	2223.5	343.7	2547.5	7662.2	4

pears not to be the case, however, with Aimag and Soum governors reporting strong interest from individuals desiring a plot of land in irrigation schemes.

The strategy draws on the irrigation department of MOFA, of the various specialists, to draw up the guiding principles for irrigation development.

Irrigation has potentially a small but crucial role to play in meeting Mongolia's food needs, at least in the short to medium term. Irrigation is both essential and economically viable for vegetable production and also economically viable for early potatoes and certain berry crops. No other irrigated crops have been identified as viable within the current market economy.

The expenditure of Government or borrowed funds on irrigation should therefore be limited to horticultural crops in the short term. As the demands of the free market are increasingly felt, irrigation of most other crops is anticipated to decline. Cabbages, turnips and carrots dominate horticultural production. Cultivation of such vegetables is well suited to intensive, small scale production and complements other Government programs such as poverty alleviation, employment generation, and food security.

Vegetables and berry fruits are in high demand in urban areas and are an important dietary component. The national diet is dominated by livestock products and cereals to which the nomadic herders may be well adapted. However, there is concern that this diet may not be as well suited to the more sedentary urban dwellers who make up about 60% of the total population.

Nationally, the per capita consumption of vegetables dropped to less than 10 kg per year in the early 1990s according to MOFA Nutritional requirements are estimated to be 66 kg per year. Even if consumption were to increase only to levels of the late 1980s (about 23 kg per capita per year), there is considerable scope for expanded production. Supplying the current population at 1980s consumption levels is estimated to require about 3,500 ha of irrigated horticulture. Estimates based on population growth and increasing consumption levels to the nutritional requirements suggest that over 13,000 ha of irrigated horticulture would be required over the next 10 years. The required area would be less if yields were to improve beyond the assumed 15 t per ha average.

Developing or rehabilitating schemes having this total area is likely to be about the extent of work capable of being undertaken in the current economic situation. In the longer term, however, other crops should be sought which meet national needs or have export potential and which are economically viable under irrigation. High protein fodder for dairy herds, such as Lucerne or barley, is in short supply and could possibly be economically irrigated in the peri-urban areas or the western region

Irrigation has a high priority within MOFA but has to take its place amongst other priorities at the national level. At the Aimag and Soum level, however, irrigation is on of the highest priorities, as it is at this level that poverty and unemployment are most keenly felt.

The Soums feel considerable pressure to allocate irrigation land, particularly to those who formerly farmed the land as employees of a state owned, now defunct, company. While there may also be a temptation to develop irrigation schemes for resettlement of unemployed urban dwellers, this should be resisted unless the schemes meet the basic criteria of economic viability. Any scheme which is not capable of sustaining itself is doomed to failure, as the Government is not in a position to subsidies its operations, resulting in disappointment and subsequently greater hardship.

4. Water demand - present use

According to scientists analysis, in terms of the volume of water resources per person and the volume of water that is used for agriculture and industrial pur-

poses, Mongolia ranks very low (2.5-5 times less) compare to the other countries in the world.

Even though, by the year of 2000, water consumption in Mongolian is about 500 million m^3 and water consumption is decreased by 1.5 times compare with situation in 1990, there are no monitoring system on the volume of water consumption, estimation on total volume of used water by the water sources and water users, lack of databases of water users and researches and studies. As a result of that, the above estimation on the total water consumption of the country has been elaborated based on the data that were published in the "Monthly Bulletin of Statistic of Mongolia" and other research works.

Drinking and domestic water supply

The water use of city dwellers in ger district and of agriculture and industry in Mongolia is ranking lower than world average. By the year of 2004, 30.8 % of Mongolian population was provided from the central water supply system, remaining 69.2% of them were provided from the un-centralized water supply system including 24.8 % of them from water transportation service, 35.7 % of them from water distribution units and wells, 9.1 % of them from natural springs, creeks and rivers. But this estimation is changing in past 3 years due to urbanization and over 10,000 settlement apartments had been established.

As an outcome of the actual water consumption surveys conducted through the country, it has been revealed that the daily water consumption of the settlements in comfortable apartments in the cities and bigger settlements reaches up to 230-350 liters, while the ger area residents of the capital city and most of province and sum centers as well as the rural herders daily use is 5-10 liters water in average. For the country, the capital Ulaanbaatar and Darkhan, Erdenet and Choibalsan, the bigger cities or settlements, are considered duly with maximal water consumptions.

The water consumption in the settlements in the central area has been estimated based on the appointment N153 by the Minister of Nature and Environment in 1995.

The source for the estimation of the daily water consumption in the settlements which is provided from the water delivery unit, rivers, springs, ice- snow water and transportation water services is the "Access to water and sanitation services in Mongolia" (2004) joint study by the Government of Mongolia, UNDP, WHO and UNICEF.

Livestock water use

Pasture livestock breeding is an important economic sector in terms of employment, export revenues, pro-

Table 8 Total drinking water consumption in Mongolia (2005)

N	The water sources for the drinking water supply	The number of settlements (thousand. people)	Average amount of drinking water consumption (l/day)	Total water consumption (thousand m^3/year)	Involved areas
1	Central system	781.5	230	65.61	Apartments in central area
2	Water delivery unit	630.4	10	2.30	Ger districts in UB city, central of provinces and sub provinces
3	Water transportation service /track, pack animal/	917.3	9	3.01	Ger districts herders and local people
4	Rivers, creeks, springs and ice, snow water	233.2	5	0.43	Local people and herders
5	Total	2562.4		71.35	

Table 9 Total water consumption of livestock in Mongolia

1	year	Total number of live-stock (million)	Small livestock			Large livestock									Total water con-sumption (million m^3/year)
			Number of sheep and goat (million) goat (ñàÿ)	Water con-sump-tion norm (l/day)	Water con-sump-tion (million m^3/year)	Number of cow (million)	Water con-sump-tion norm, l/day	Water con-sumption (million m^3/year)	Number of horse (million)	Water con-sumption norm, l/day	Water con-sump-tion (million m^3/year)	Number of camel (million)	Water con-sumption norm, l/day	Water con-sump-tion (million m^3/year)	
1	2000	30.2	24.0	3.6	31.5	3.0	21.6	23.6	2.7	24.6	24.2	0.3	35.2	3.9	83.2
2	2001	26.0	21.5	3.6	28.2	2.0	21.6	15.7	2.2	24.6	19.7	0.3	35.2	3.9	67.5
3	2002	23.9	19.7	3.6	25.9	1.9	21.6	15.0	2.0	24.6	18.0	0.2	35.2	2.6	61.5
4	2003	25.4	21.4	3.6	28.1	1.8	21.6	14.2	2.0	24.6	18.0	0.2	35.2	2.6	63.0
5	2004	28.0	24.0	3.6	31.5	1.8	21.6	14.2	2.0	24.6	18.0	0.2	35.2	2.6	66.3
6	2005	30.4	26.2	3.6	34.4	2.0	21.6	15.8	2.0	24.6	18.0	0.2	35.2	2.6	71.0
7	2006	34.9	30.3	3.6	39.8	2.2	21.6	17.3	2.1	24.6	18.9	0.3	35.2	3.9	80.0
Average :					31.4			16.5			19.2			3.2	70.3

duction of GDP. By 2005, livestock breeding made up to 84.9% of agricultural production. In Mongolia, ground water surface water, snow and glacier water are used for livestock water supply By 2005, there were 30.4 million head of livestock. But by 2006, the head of livestock had been increased up to 34.9 million and total water consumption of livestock became 80.0 million.

The estimation of the number of livestock is based on the norm which is in the appendix # 4 of the appointment #153 by the Ministry of Nature and Environment in 1995.

Irrigated crop water supply

Mongolia has been a country of the nomadic and pastureland. Nevertheless, crop irrigation has been present in all its stages of the historical development.

The Mongolian climate condition (lack of precipitation, harsh climate) is not beneficial for crop production. There is a lack of good conditions for plants to grow. Especially the lack of precipitation makes Mongolia to develop irrigated crop.

By 1990, the crop irrigation was developed well. There were 45.0 thousand ha engineer designed irrigated areas, 16.0 thousand ha surface irrigated area. 100% of the produced volume of fruits and vegetables were cultivated in the irrigated crop area, 20% of the potatoes, 15-18% of the fodder, 2.5% seeds.

During 1986-1999, the maximum volume (22.8 tsentner = @@@ tonnes) of seeds, (48.2 tsentner) fodder were cultivated from the engineer designed crop area in 1987, in 1990, there were 154 tsentner potatoes, 187.4 tsentner vegetable cultivated and in 1998, there were 23.8 tsentner fruits cultivated respectively.

In the table below the estimated volume of water is shown that was used for the irrigated crop area from 1989 to 2006, based on the appendix # 5 of the appointment # 153 by the Ministry of Nature and Environment in 1995.

According to the estimate, the irrigated area has increased by 13-15.9% in the past years; about 50.664-52.282 million m3 water was used for the total irrigated area in 2005-2006.

Industrial water supply

In 1991-1993, industrial water use is 99.5-115.7 million m^3 annually: 53.2% was used for the mining sector, 32.6% for the manufacture industrial sector, 14.2% for the construction industrial sector. In 1995 108.4 million m^3 water was used for industry and office sup-

Table 10 Irrigated area and total water use for it

ı	years	Type of crop						Cultivated are, ha	Total water use (million m^3/year)
		seed	wheat	Green fodder	potato	vegetable	fruits		
		Average irrigating norm, m^3/ha							
		2500	2400	2900	3000	3200	6000		
		Cultivated area, ha							
1	1989	10030,4	7060,8	842,5	1398,3	2131,2	715,0	22178,2	59.76
2	1990	10849,4	8300,8	17092,6	1248,2	1762,7	88,1	39341,8	106.524
3	1991	7869,0	6912,0	10287,2	712,3	959,8	606,9	27347,2	74.940
4	1992	6167,1	5229,5	4125,9	522,3	1054,5	335,5	17434,8	46.885
5	1996	4129,6	4129,6	1326,0	393,9	858,3	555,8	11393,2	31.341
6	1998	2018,0	2018,0	185,0	254,6	820,4	35,1	5331,1	14.022
7	1999	3070,0	3070,0	300,0	190,0	369,0	40,0	7039,0	17.903
8	2000	3631,5		746,7	330,0	708,25	153,0	5569,45	15.417
9	2001	3828,4		896,0	461,2	1066,1	158,52	6410,22	17.914
10	2002	3870,1		1199,8	930,7	1057,4	161,5	7219,5	20.298
11	2003	3875,4		1357,0	748,7	925,8	161,3	7068,2	19.798
12	2004	4463,7		1148,4	5111,8	4247,1	250,7	15221,7	44.918
13	2005	4080,0		1641,0	6497,0	5243,0	176,0	17637,0	52.282
14	2006	4980,1		1357,2	5501,3	5140,2	221,4	17200,2	50.664
Average:									40.9

ply, of which 55% was used for mining industries, 33% is for industries and 12% is for construction industries. From the total volume of water used for industries, about 9.4% of it, which equals to 10.2 million m^3, was recycled and reused.

By 2006, the annual power plants water use in Ulaanbaatar, Darkhan and Erdenet cities was 27.6 million m^3 and the annual mining industries water use was 93.8 million m^3. To determine the volume of water that used for food production industries' (vodka, beer, wine, beverage) in 2005, we calculated by the average norm that is indicated on the appendix # 1 of the appointment # 153 by the Ministry of Nature and Environment in 1995. As a result of the estimation, the total volume of water used for food production industry were 0.6 million m^3.

Other manufacturing industry like cashmere washing, carpet, spin tread, felt, felt boots, peltry, buff exploitation, bread production, construction industry, meat-dairy production, flour production industry's water use were about 18.0 million m^3 and within the country, annual water use were approximately 140.0/157.2 million m^3. The national annual water use in increased by 29% compare with water volume that used 1995.

Hydro power

In 1994, the Institute of Water Policy of Mongolia estimated gross theoretical potential energy is 56,200 MW or 6400 MW capacity for river run-off that is more than 1 m^3/s. The technical possibility to use is 20 to 60% of this estimation.

Six hydro power plants were established with 3428

Table 11 Total industrial water use (in year2006)

Sectors that use water	Power plant	Mining industry	Exploitation industry	Total annual water use (million m^3/year)
Total water use (million m^3/year)	27.6	93.8	18.6/35.8	140.0/157.2

Table 12 Total water use of Mongolia (by 2005)

'	Sectors that use water		Total water use/million,m^3/
1	Drinking water use		71.35
2	Agricultural	Livestock	71.00
		Crop irrigation	52.28
3	Industrial	Exploitation industry	35.8
		Extracting mining industry	93.8
		Energy production, Power plants	27.6
		Hydro Power Plant	80.0
4	Green area		0.27
Total:			432.1

kW capacity, but they can only be used for warm season and thus their utilization status is very low.

By the year 2005, above HPPs produced about 3.9 million kW energy and it covers about 0.1% of the total energy. About 80 million m^3 water is used for producing the total energy amount.

Green area structure water use

A certain volume of water is used for city's green area, but it is difficult to estimate the volume of water that is used for it. Six district service companies are irrigating the green area in Ulaanbaatar. Green area irrigation is done from April 1 to August 1, while one last irrigation activity is done before winter ('charge irrigation'), usually in October. According to the intangible information, annually 0.15 million m^3 water is used for the green area irrigation of Ulaanbatar, Darkhan, Erdenet and other central towns. There is no irrigation and watering around the main road and the district's green area.

Under the "Green wall" national program / by 2005-2006/, 500,000 trees were planted in about 1000 ha area and about 0.12 million m^3 water was used to water them.

Overall water use

The table below shows the total water use for all sectors (above mentioned) in national wide. But this estimation is based on a survey and the amounts are calculated averagely. During the project main phase, we will estimate the volume of water use by each sector by doing a specific study on national water use.