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## POSSIBLE ECONOMIC CHANGES ESTIMATION IN USE OF SELENGA AND IRKUT RESOURCES

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### *Abstract*

At present, in connection with a part of an urban population increase, the necessity of providing stable food production in Mongolia is growing. Stabilized production of crops, vegetables in rising volumes in the conditions of a dry climate of Mongolia is possible only basing on irrigated cropping.
This will decrease transboundary rivers flow. First of all, Selenga is the main feeder of Lake Baikal that, in turn, will cause a water volume reduction, flowing into Lake Baikal. The topical task is to search for countervailing measures taken by Russia and Mongolia to reduce the water volume flowing into lake Baikal developing the irrigated cropping in Mongolia, based on the use of available technological, financial, natural and resource opportunities. The goal of this scientific work is to find some efficient proposals of rational exploitation of transboundary water resources of Lake Baikal.

The authors estimate an additional water volume in the basin of the Selenga river, when the capacity of irrigation for producing food and crops is increased instead of imported ones at present. To compensate this volume, it is suggested that the waters of the Irkut river (Russia) should be turned to Baikal.



**Keywords:** Food security of Mongolia, irrigated cropping, the basin of the Selenga river, the basin of Lake Baikal, the Irkut river, water transfer.

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## 1. Introduction

The growing deficit of water resources, including transboundary ones, conditions the necessity of finding solutions, based on honest usage of available technological, financial, natural and resource opportunities of each party.

## 2. Problem Statement

The Baikal-Mongolia region has geographical (Naprasnikov, 2015) and geological (Levi, Gileva, Demberel, Zadorina, Chechelnitsky & Ulzibat, 2016) peculiarities. The cumulative average annual river runoff into Lake Baikal is about 60 km³. The main tributary of Bakal is the Selenga river. Flowing into Baikal, the Selenga river has average long-term consumption of 900 m³/sec. On the average, during the year, the Selenga river brings approximately half of the entire flow into Baikal, which is 30 km³ per annum. On the territory of Mongolia there is 2/3 of the area of the catchment basin of Selenga. The water flow is about 14.0–15.0 km³ per annum. It is 45–50% of a cumulative runoff volume of Selenga coming into Baikal.

The necessity of providing steady food production predetermines the increase of the volumes of irrigated cropping, that, in turn, will cause the decrease of the transboundary rivers flow, first of all, of the Selenga river.

## 3. Research Questions

The key problem of the work is to search for countervailing measures of Russia and Mongolia against decreasing water volume, flowing into Lake Baikal, while developing irrigated cropping of Mongolia.

## 4. Purpose of the Study

Let us consider the opportunities of the countervailing measures of Russia to maintain the level of Lake Baikal.

### 4.1. The tendencies to the changing of the pattern of consumption and food production in Mongolia

The increase of the urban population part in Mongolia inevitably gives rise to the growth of feed grain consumption and output of stock-raising products in stockbreeding complexes producing poultry, eggs, pork (for the manufacturing of sausage goods), milk and dairy products. The stable production of crops, vegetables in ever-increasing amounts in the conditions of the Mongolian dry climate is possible only basing on the irrigated cropping, that, in turn, will result in changes of the water balance of the main transboundary rivers – Selenga and Kerulen.

In 2003, urban population made 56%. In 2015, it became 69%. In the city of Ulan Bator the population share was 45% out of three million inhabitants of the country. The consequences of such changes in Mongolia are the increase of the demand for feed grain and reduction of arable animal produce consuming.

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The food pattern of the youth, making 70 % of the population, is especially quickly changing. The consumption of arable animals' meat is being cut down. The consumption of market bird meat, sausage goods is growing. The portion of vegetables and rice is growing. It is evidence that dietary intake of the Mongolian population is changing. At present the country (2015) imports 27–30 thousand tons of poultry meat (approximately, 10 kg per annum per head), 192.8 mln. pcs.of eggs from Russia. In 2015 the import of pork is 19.9 thousand tones, the import of salted pork fat is 7.6 thousand tones from China.

According to the article by Damdinsuren (2011) the deficiency of food products, unsupported by domestic manufacture in Mongolia, is: grains (obviously, rice) - 42 thousand tones, vegetables – 66 thousand tones, eggs - 16.4 thousand tones (about 270 mln. pcs.). The already mentioned import of pork and salted pork fat should be added to the total amount of about 28 thousand tons (for production of sausage goods).

In 2016, rice consumption in Mongolia is evaluated at the rate of about 1.8 kg per week per person (In the valley of the river Selenge growing rice, 2017) that corresponds to the yearly consumption of 65 thousand tons. Taking into account the tendency of the rice intake growing in Mongolia, let us estimate the long-range need of this product at 100 thousand tons per annum.

Grain consumption per 1 tone of poultry meat and pork is taken at the rate of 5 tones; per 1 tone of eggs - 160 tones. Thereby, at present, general supplemental grain need (without rice) in Mongolia is estimated at 354 tones per year.

Crop production in Mongolia is unstable and greatly depends on weather conditions, first of all, precipitation in summer. The average grain crop yield from 1961 to 2016 made 9 dt/ha, in 2012 the crop yield was 15,6 dt/ha. In 1980s in Mongolia on an average 600 thousand tons of wheat was grown per annum. In 1999 the yield was only 190 thousand tones, i.e. the production of grain reduced by more than 3 times. To satisfy the demands of three million population for grain, according to Molomzhamts Demchigzhavyn, Doctor of Economics (Molomzhamts, 2001), it is necessary, at least, 540–600 thousand tonnes of grain, 160–180 thousand tone of potatoes and 110–120 thousand tons of vegetables per annum. Thus, the total need of potatoes and vegetables is about 300 thousand tonnes.

Undoubtedly, at a fundamental level of the strategy providing stable food production it should be supposed that soil productivity using soil-saving technologies is increasing, including such directions of organic farming as mulching of harvest organic residues, crop rotation with permanent grasses, legumes, that makes it possible not to only minimize chemical fertilizers and pesticides application, but save water in the soil. That is why the estimated water need for irrigation is either simultaneously minimized (trickle irrigation application) or overstated following the principles of organic agriculture.

Obviously, the amount of grain consumption of 600 thousand tones, achieved in the 1980s, should be assessed as a minimum one today, to which it should be complementarily added about 350 thousand tones to supply a want in poultry keeping and pigstry production, taking into consideration the tendencies of urban population growth. Consequently, the total estimated grain need in Mongolia is about 1 mln. tones per year under a new consumption structure. The approximate investment cost for creating trickle irrigation system for grain (without rice) can make 0.,2–0.6 billion dollars.

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The total minimized water volume, necessary for irrigation, is estimated at 645 mln. m³ per annum (Table 01). It is significant that during trickle irrigation water is advantageously used for plants absorption and evaporation, that is why, conditionally, it does not return into underground water.

The indicated amounts of water consumption for irrigation purposes, calculating per head of the Mongolia population, are estimated at 0.2 thous. m³ per annum, whereas at present, for example, in Kyrgyzstan they are 10 times more, - approximately 2 thous. m³.

Another trend of water consumption , providing withdrawal from the basin of the Selenga river, is a subproject of waterworks facility of the Orkhon river within the World Bank investment programme, supporting investments into the development of the infrastructure of metal mining industry of Mongolia (Summary of Terms of Reference for conducting a regional environmental assessment and environmental impact assessment and social impacts of the project "Regulating the flow of the Orkhon River and the construction of a complex of reservoirs",2016) . The project stipulates water transfer to the southeast of the country, into the Gobi Desert, about 2.5 m³/sec (0.08 km³ per annum), for water supply of coal thermal power stations and mining enterprises on the deposits of Oyu Tolgoi and Tavan Tolgoi (Makarov, 2014). The mentioned project is defined by some authors as a very probable one to be realized. Let us take this position in connection with the considered problem of the development of the irrigated cropping in the basin of the Selenga river. The evaporation from the reservoir storage of the Orkhon river is determined at the rate of 0.038 km³ per annum (Grechushnikova & Edelstein, 2016, pp. 217-223).

The alternative of building most hydro powers in Mongolia, taking into account their possible negative impact on the hydrological regime and ecology of the basin of Lake Baikal is, in our opinion, the construction of joint hydroelectric power stations (for example, Mokskaya HPS).

**Table 01**. Volume Estimation of Probable Withdrawal from the Basin of Selenga for the Needs of National Economy of Mongolia

| **Uses** | **Economic capacity, th. t.** | **Water consumption per 1 t, m³** | **Water requirement, mln. m³** |
|---|---|---|---|
| Grain production | 1000 | 500 | 500 |
| Rice production (trickle irrigation) | 100 | 1000 | 100 |
| Vegetables and potatoes production on irrigable lands | 300 | 150 | 45 |
| In total for irrigated cropping | | | 645 |
| The evaporation from the reservoir storage of the Orkhon river and withdrawal for TPS in the South of the Gobi Desert | | | 118 |
| **Sum total:** | | | 763 |

At present, water spending for irrigation in Mongolia is 98.5 mln. m³. The service life of underground waters is estimated at 926.5 thous. m³ per day (Otgonbayar & Tserenkhand, 2012), it corresponds to 0.338 km³ per annum. Taking into consideration the connection between the surface and underground waters, conditionally, let us think them to be the common source of irrigation.

We are of the opinion that irrigation problem solving in Mongolia should not obligatory be supported by river dam blocking; in most cases, it is sufficient to use piped water supply points from the

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rivers, using floodplain lakes and various artificial reservoirs as reservoir storages in the consumption areas.

It should also be noted that alongside with underground waters, there are pressure waters, mainly widespread in the mountain and steppe districts of Mongolia, with the depth of occurrence up to 80–100 meters, possessing, as a rule, high drinking grades. The common resources of underground waters in Mongolia, according to the data of Water Economy Ministry, make 6.9 km³ (Kremenetskiy, 2017).

In the immediate future figuratively non-returnable water volume from the basin of the Selenga river can be evaluated at 0.76 km³ per annum, that conforms to 5.4% of its annual flow to the border of Russia (14 km³ per annum), 2.4% from the flow of Selenga into Baikal and 1.2% from the total flow into this lake.

## 5. Research Methods

### 5.1. Compensating Measures Determination Reducing the Flow of the Selenga River

The indicated reduce (by 1.2%) of water flowing into Lake Baikal from its main tributary - the Selenga river, to our opinion, cannot have some disastrous effects against the background of the observed average many years lasting fluctuations. In his speech at the Baikal Water Forum held in Irkutsk I. Bychkov (director of Matrosov Institute for System Dynamics and Control Theory of Siberian Branch of Russian Academy of Sciences) mentioned that during a low-water season of 1976–1982 the average annual flow into Baikal was 45.6 cu. km., in 1996–2013 – 54,5 km³, and in the period of 2014 – 2016 the average annual inflow into Baikal during that time was 36.2 km³ ( Chinese barrier before Baikal. Independent newspaper. Ecology, 2017). Having taken zero to be the flow volume during the period of 1996–2013, we get the fluctuations in the low-water seasons, concerning average annual flow (60 km³), from minus 34 up to minus 17 percent.

However, it is necessary to identify the directions of compensation of estimated here in 0.76 km³ per annum possible water volume reduce, flowing into lake Baikal on developing irrigated cropping in Mongolia. The projects of directing the river flow of the Irkut river into lake Baikal are advantageous, considered on constructing the Trans-Siberian Railway at the end of the XX century and the development of power engineering in 1920–1940-s of the XX century.

One of the alternatives of constructing HPP at the Irkut river provided for changing the course of the Irkut river, directing its water into lake Baikal. The flow of Irkut, in the vicinity of the village of Bystroye, makes 40 m³/sec (Water and hydropower resources, 1999), that conforms to the annual flow at the level of 1.2 km³. The chemical analysis of the water of the Irkut river in the vicinity of the village of Tibelti (Bystrinskiy municicpal settlement) is sufficiently close to the chemical analysis of the water of Lake Baikal in the district of Slyudyanka. As discussed in Nokhrin, Gracheva & Gribovsk, 2008, the water of the river of Irkut is ultrafresh and soft. According to pH, it approximates to acid precipitated water and has a weak-acid reaction (pH < 6.5). The salinity quantity is a bit higher than in the Baikal sample water because of the greater content of sulphate-ions and calcium ions. The content of nitrogen and phosphorus in the sample water of the Irkut river (village Tibelti) is comparable with the sample water of Lake Baikal, though it has a clearly greater oxidation characteristic (in Nokhrin, Gracheva & Gribovsk, 2008).

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In consideration of the sufficiently close chemical composition of the water of Lake Baikal and the river of Irkut, in the vicinity of the village of Tibelti, it should be said that the direction of the water of the river of Irkut into Lake Baikal to maintain the level will not have fundamental negative ecological implications for the ecosystem of the lake.

The general idea of Irkut water transfer into Lake Baikal from the time of the realization of the project prospecting on the construction of the Trans-Siberian Railway foresees its direction into the river of Kultushnaya by its tributary – the stream of Ilcha. It is evident that such a decision only determines the most general direction and demands a very detailed working out.

As the flow of Irkut in the vicinity of the village of Bystroye many times exceeds the flow of the river of Kultushnaya and, in addition, is able to expand in the period of summer floods. To transfer Irkut, it is necessary to build a canal 18 km long with reinforced walls. Realizing the idea of a damless HPP, a part of such a canal should be covered with slabs for pressure containment in the pipe (canal), feeding water to the turbine.

As an additional argument of admissibility of the directing waters of the Irkut river into Baikal, let us indicate the position of the then director of Limnological Institute of Siberian Branch of Academy of Sciences of the USSR , G. Galaziya, who suggested constructing Kultukskaya HPP with discharge water of the Irkut river into Baikal during a discussion on the project of increasing water pass through Irkutsk HPS to accelerate filling of the Bratsk reservoir storage by blasting a rock at the river head of the Angara river (Shaman-rock) (Nechaev & Prokopyeva, 2014).

### 5.2. New Opportunities of Constructing a bypass railroad around Baikal

The option of constructing a bypass railroad at the riverbed of Irkut (Irkut option), let us remind, was considered as the main alternative of building the Circum-Baikal Railway (the Baikal option).

The problem of high power-producing and operating costs for the transportation of goods on the main existing Trans-Siberian way at the section of Bolshoy Lug – Slyudyanka is a principal one at present, putting obstacles in the way of increasing the carrying capacity of the East-Siberian railroad, since, on account of a steep slope, it is needed to use two electric traction limiting the speed to 60 km/h. Therefore, up to present, some investigations are taking place identifying an alternative option of the avoiding line.

In this way, on the instructions of the East-Siberian railroad, Design Institute «Vostsibtransprojekt» carried out preproject prospectings assessing the options of constructing the third avoiding line at the section of Bolshoy Lug – Slyudyanka. The preproject prospectings specified the motion from the station of Goncharovo to Slyudyanka-2 in the river valley of the Bolshaya Olkha river. To provide such parameters of the line, there will be the construction of six tunnels of the total length of 21.7 km. New route miles will make 105 km. The total cost of the construction is estimated at 114 bn. rub. in the prices of 2013 (Kez, 2014).

The investigations, implemented at present, proceed from the main difficult problem to be solved constructing the railroad bed along the Irkut river: the rise of the river level up to 15 meters in the period of summer floods. However, directing the flow of Irkut into Baikal, this problem will be removed from the agenda, to a large extent. This allows, if necessary, to use a drained stream canal to lay a railroad bed

(building other necessary drain and offtake constructions). Nevertheless, for the suggested option of the avoiding line, there is the constructing of the great number of mining structures, including a tunnel 3.8 km long through the Zyrkuzun range of mountains, complicated in construction and maintenance.

## 6. Findings

Thus, the total minimized water volume needed for irrigation is estimated at 645 mln. $m^3$ per annum.

Moreover, the possible ways of solving the problem of compensation of probable reducing of flowing waters into Lake Baikal consists in the idea of Irkut water transfer into the lake, that will not entail considerable negative ecological consequences for the ecosystem of the lake owing to the sufficiently close chemical composition of waters in Lake Baikal and the Irkut river.

## 7. Conclusion

The rational use of the transboundary water storage of the basin of Lake Baikal is only possible estimating the needs and opportunities of the Mongolian and Russian parties in good faith during their amicable co-operation and reciprocal compromises.. .

## References

Chinese barrier before Baikal. Independent newspaper. Ecology. (2017). Retrieved from https://ng.ru/ecology/2017-10-11/9_7092_china.html.

Damdinsuren, L. (2011). Foreign experience of development of agricultural and food systems. *Resources development of the meat industry of Mongolia*. *The region's economy*, 4, 155.

Damdinsuren, L. (2011). Resources of the meat industry of Mongolia. *The economy of the region*, 4, 254-257.

Grechushnikova, M.G, Edelstein, K.K. (2016). Assessment of possible changes in runoff. Selenga in the implementation of plans for hydraulic engineering in the territory of Mongolia. *Water: Study and Management (limnological school practice). Proceedings of the V International Conference of Young Scientists, 2.* (pp: 217-223) Petrozavodsk. Research Center of RAS.

In the valley of the river Selenge growing rice. (2017). Retrieved from https:// montsame.mn/read/113790.

Kez, S. (2014). Around Mount. *Gudok*, *3*.

Kremenetskiy, I.G. (2017). There is an alternative to the hydroelectric power station Mongolian Selenga. Retrieved from https:// baikal-mir.ru/2017/05/23/est-alternativa-mongolskim-ges-na-selenge.

Levi, K. G., Gileva, N. A. Demberel, S., Zadorina, N. In. Chechelnitsky, V. V., Ulzibat, M. (2016). The seismogeodynamics of the Baikal-Mongolian region. *Modern geodynamics and hazardous natural processes in Central Asia, 6*, 41-57.

Makarov, A.V. (2014). Formation of the strategy and protection of transboundary waters in the basin of Lake Baikal, *Contours of global transformations: politics, economics, law, 1* (33), 74-87.

Molomzhamts, D. (2001). Problems of the development of the agrarian sector of the economy of Mongolia. *International Journal Problems of Management Theory and Practice, 1.*

Naprasnikov, A. T. (2015). Methodological approaches to the analysis of the variability of heat and moisture of the Baikal-Mongolian region. *International journal of applied and fundamental research, 5,* 69-70.

Nechaev, A., Prokopyeva, A. (2014). Identification and management of the enterprises innovative activity risks. *Economic Annals-XXI, 5-6* (1), 72-77.

Nokhrin, D.Yu., Gracheva, I.V., Gribovsk,y Y.G. (2008). Study the chemical composition of the water samples of Lake Baikal and Irkut River in 2007 year. *Herald of the Chelyabinsk State University, 17,* 86-90.

https://dx.doi.org/10.15405/epsbs.2018.12.130
Corresponding Author: N.A. Shamarova
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

Otgonbayar, E., Tserenkhand, E. (2012). Water resources and water use in Mongolia. High-level seminar for the countries of Eastern Europe, Caucasus and Central Asia (EECCA) on "Water resources statistics". Almaty, Kazakhstan.

Water and hydropower resources. (1999). *Distillers m.a., dry lands Ap Economy of Irkutsk region, 1*. Irkutsk: BGUJeP

.