Importance of little depositional island in upper stream of Sharilj river for conservation of Buir lake ecosystem

GOMBO Davaa and KHALZAN Purevdagva,

Institute of Meteorology and Hydrology

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Introduction

The Buir is largest among lakes in Eastern Mongolia and specific in terms of its hydrological regime and abundant aquatic biodiversity. The Khalkh river inflows to the lake and Orshuun river flows out from it. Meanwhile, Sharilj river deviates from Khalkh river and drains to the Orshuun river. Therefore, Sharilj river decreases inflow rate of Khalkh river and causes impacts to the lake. However, there is tiny depositional island or gravelkey, blocking outlet from Khalkh river to Sharilj river, in most upper stream of the Sharilj river.

Field studies in this site carried out by various researchers indicate that blocking ability of the island is decreasing since 1960-th. Therefore, the objective of the study is to reveal importance of tiny depositional island in upper stream of Sharilj river for conservation of Buir lake ecosystem.

Methods and data

Bearing in mind objective of the study, has been applied water balance equation involving water balance elements of the lake and used last 36 years data on discharge of the Khalkh river at Sumber gauging station and meteorological elements observed at the Choibalsan and Sumber meteo-stations. Water balance equation is as follows:

$$E + Y_{Orshuun} = P + (Y_{Khalkh} - Y_{Sharilj}) + dV + dY_{Ground\ water} \quad /1/$$

where: E- evaporation, Y_{khalkh}, $Y_{sharilj}$, and $Y_{orshuun}$ - Khalkh, Sharilj and Orshuun river runoff, dV- change in lake water volume, $dY_{ground\ water}$- the difference of groundwater inflow and outflow

Evaporation from open surface water can be estimated by following empirical formulae (3).

$$E = 0.25\ (1+0.36\ V_{200})(e_o - e_{200}) \quad /2/$$

where: V_{200} - wind speed, m/c, e_o- saturated water vapor at temperature of water surface, gPa. e_{200} - absolute water vapor at 2 m above ground, gPa

Regime of Orshuun river is regulated by lake level fluctuation and regime of Sharilj river also is regulated by the regime of Khalkh river water. Therefore, have been established following dependencies and used for impact assessment.

$$Q_{Orshuun} = 0{,}0005\ H_{Buir}^{2{,}042} \quad /3/$$

$$Q_{sharilj} = 7 \cdot 10^{-5}\ Q_{Khalkh}^{2.2048} \quad /4/$$

There have been established the dependency between total dissolved solids /TDS/ and lake water level /H_{Buir}/ and between TDS and major ions, mg/l, in lake water.

$$TDS = 2 \cdot 10^{8}\ H_{Buir}^{-2{,}5121} \quad /5/$$

$$Na^{+}+K^{+} = 0{,}0003\ TDS^{2{,}0206} \quad /6/$$
$$Mg^{2+} = 0{,}05\ TDS + 15$$
$$Ca^{2+} = 0{,}0443\ TDS + 15{,}246$$
$$HCO_3^{-} = 0{,}6082\ TDS + 7{,}5549$$
$$SO_4^{2-} = 0{,}04\ TDS + 12$$
$$Cl^{-} = -\ 0{,}01\ TDS + 9$$

Change in physical and chemical parameters of the Buir lake will cause change in overall biological activities in Lake Ecosystem. Therefore, estimation of change in primary productivity of the Buir lake is essential and it can be estimated by following equation.

$$A = (T^3/TDS^{0,4})\ B \quad /7/$$

where: A- primary productivity, kcal/ sq. m year, T- average water temperature for the period of May to October, TDS- total dissolved solids, g/kg, B- parameter of primary productivity

The dependency of fish harvesting rate on primary productivity has been established by Bulion and Vinberg, 1981. It expressed as following.

$$Y_i = (1.9 \pm 0.9)10^{-3} A$$

/8/

where: Y_i - possible fish harvesting rate, kcal/sq.m year

Results of the study

Since the start of observation, low flow observed in the period of 1966-1984 and high flow period occurred in 1985-1999. Severe drought sequence is observed in last three years, when dropped intensively water level of the lake /fig. 1/.

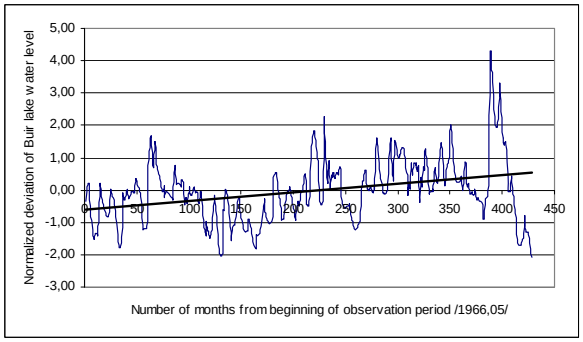

Fig. 1 Normalized difference of monthly average flow series since May1966

In the light of global change, anthropogenic pressures are increasing in the lake basin. This situation ensures identification and protection of key areas having highest significance for ecosystem conservation of lake. To reveal an importance of the island for ecosystem conservation of the lake, it is assumed 2 versions of deviation of island. First version is to remove top of island deposit layer with depth of 0.5 m (layer 1). Second version is to remove top of island deposit layer with depth of 1.0 m (layer 1 and 2). With these versions, has been conducted environmental impact assessment for the lake system.

Cross sectional profiles of the Sharilj river bed, where island or gravelkey is located, has been made in January, 2002 at the point of $48^0$02'01" N and $118^0$08'02"E /fig. 2/.

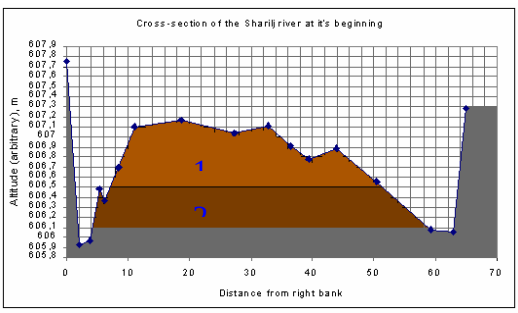

Fig. 2 Cross-section area of Sharilj riverbed with gravelkey and the scheme of removing island deposit layers

Flow of the Sharilj is dramatically increasing with these described above changes. 7 percent of monthly mean flow of the Khalkh river can be lost along the Sharilj river deviated as version 2 /fig. 3/.

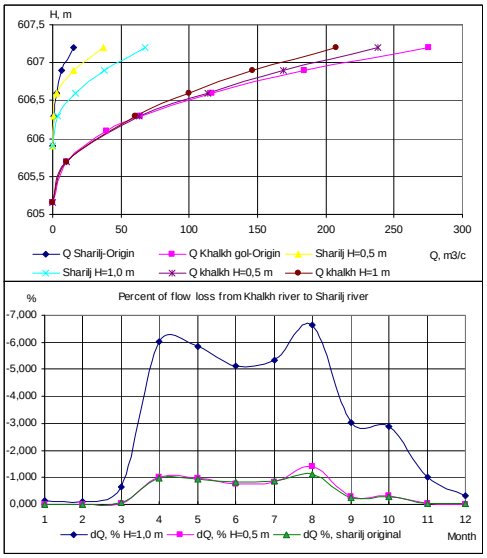

Fig. 3 Rating curves of Khalkh and Sharilj rivers in original, version of deviation 1 and 2 cases and percentage of Khalkh river flow loss due to deviation

The runoff loss of Khalkh river has seasonal character and the daily flow of the Sharilj river will exceed annual mean flow of the Khalkh river in rainfall and snowmelting flood period in accordance with version 2.

With these assumed changes, lake water level will drop by 0.15 m in first case, 1.10 m in second case during 32 years after the deviation made /fig. 4/.

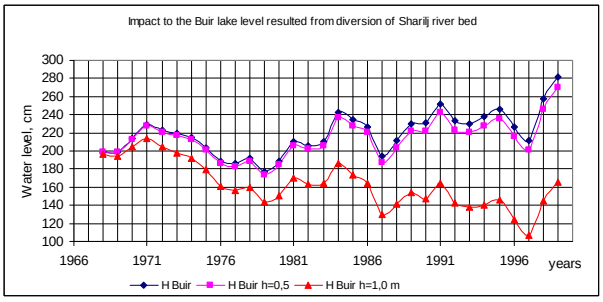

Fig. 4 Water level series and their changes after these deviations

In correlation with change in water level of the lake, total dissolved solid content will increase and exceed even 1 g/kg in dry years /fig. 5/. Ca^{2+} and HCO_3^- ions are dominant in chemical composition of lake water at present. However, after the described above changes, Na^+ and HCO_3^- will be dominant in chemical composition of lake water in low flow period /table 2/.

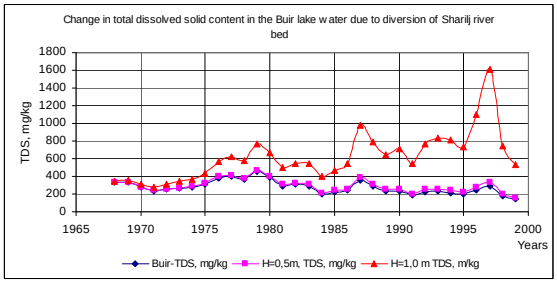

Fig. 5 Change in total dissolved solid content in Buir lake water

Table 2. Chemical composition and its changes after deviation

Version	Water condition	TDS, mg/ kg	$Na+K^+$	Mg^{2+}	Ca^{2+}	HCO_3^-	SO_4^{2-}	Cl^-
Natural regime	Mean	287,4	25,8	28,8	27,5	175,9	23,1	6,2
	Dry	458,1	69,1	37,5	35,2	281,7	30,0	4,5
	Wet	167,8	6,5	22,0	21,4	92,6	17,6	7,6
Version of deviation 1.	Mean	303,1	29,1	29,7	28,3	186,2	23,8	6,1
	Dry	479,1	75,5	38,5	36,1	293,9	30,8	4,3
	Wet	181,7	8,2	22,8	22,2	102,8	18,3	7,4
Version of deviation 2.	Mean	642,4	130,8	45,9	42,6	383,5	36,7	2,8
	Dry	2151,4	904,8	95,5	86,5	986,5	76,4	1,7
	Wet	291,4	26,6	29,1	27,7	178,6	23,2	6,2

These changes in water regime and chemical composition cause alteration of primary productivity and fish habitat. Primary productivity will be decreased by 0.08 % in first version and by 25 % by second version of deviation.

In connection with change in primary productivity, the possible fish-harvesting rate will be decreased by 27 percent in accordance with second version.

As result of the deviation, 0.2-1 sq.km/year and 0.02-0.08 cub km/year will decrease lake surface area and volume of water in first version and 3-15 sq.km and 0.34-0.44 cub.km/year in second version, respectively. Orshuun river flow will be decreased by 5 percent in first version and 45 percent in the second version, relatively to its present flow rate.

Conclusion

1. The tiny island or gravelkey in the upper Sharilj riverbed plays essential role in Buir lake ecosystem functioning. Therefore, it is highly important to protect the island and rehabilitate its condition for overall Buir lake ecosystem conservation.
2. There habitats Leander modestus Heller, 1778 registered in "Red book" of Mongolia. Non proper lake resource management urgently requires to take protection measures against hunting.

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