The current state of the water erosion system of the Selenga river basin

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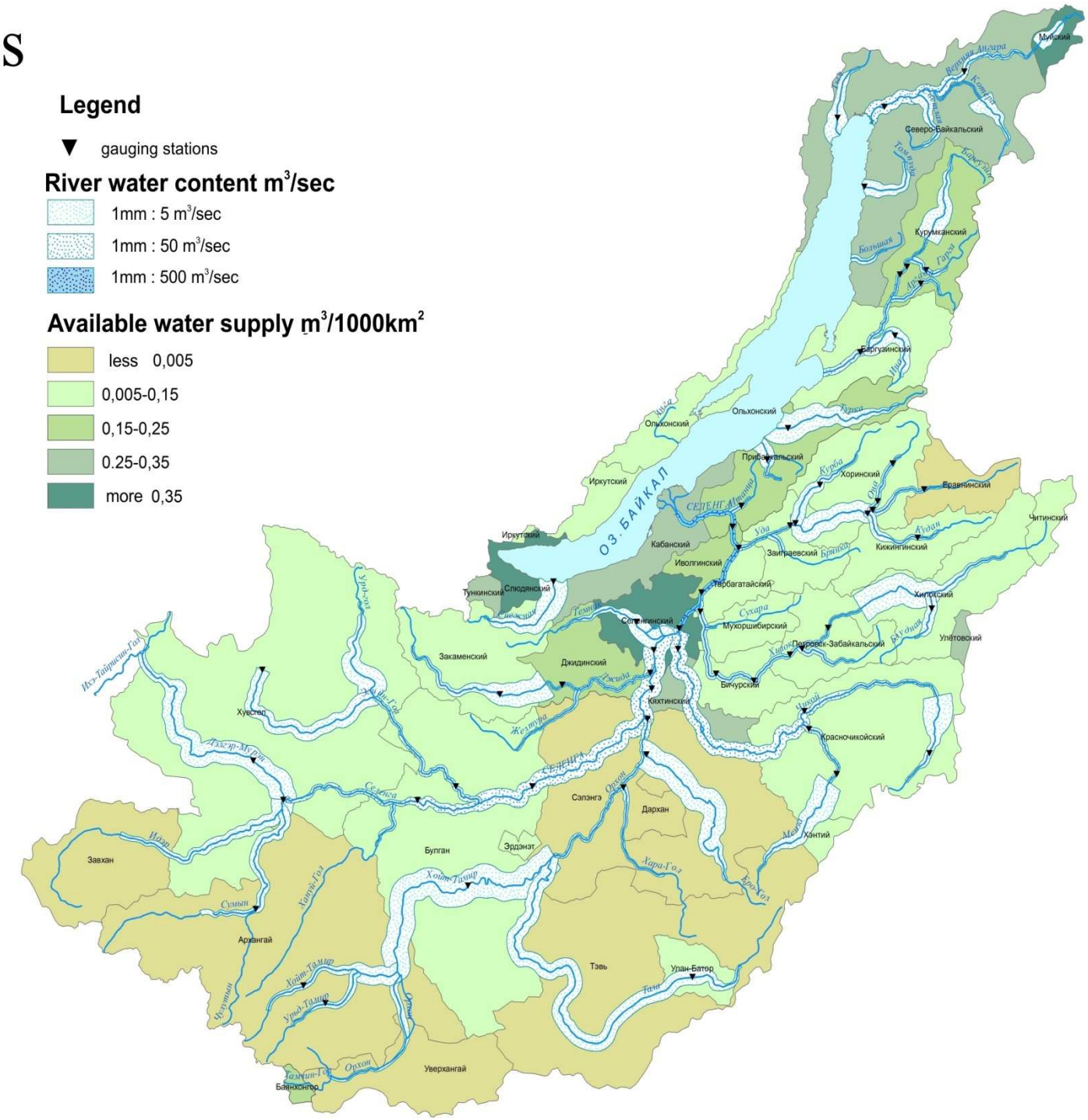
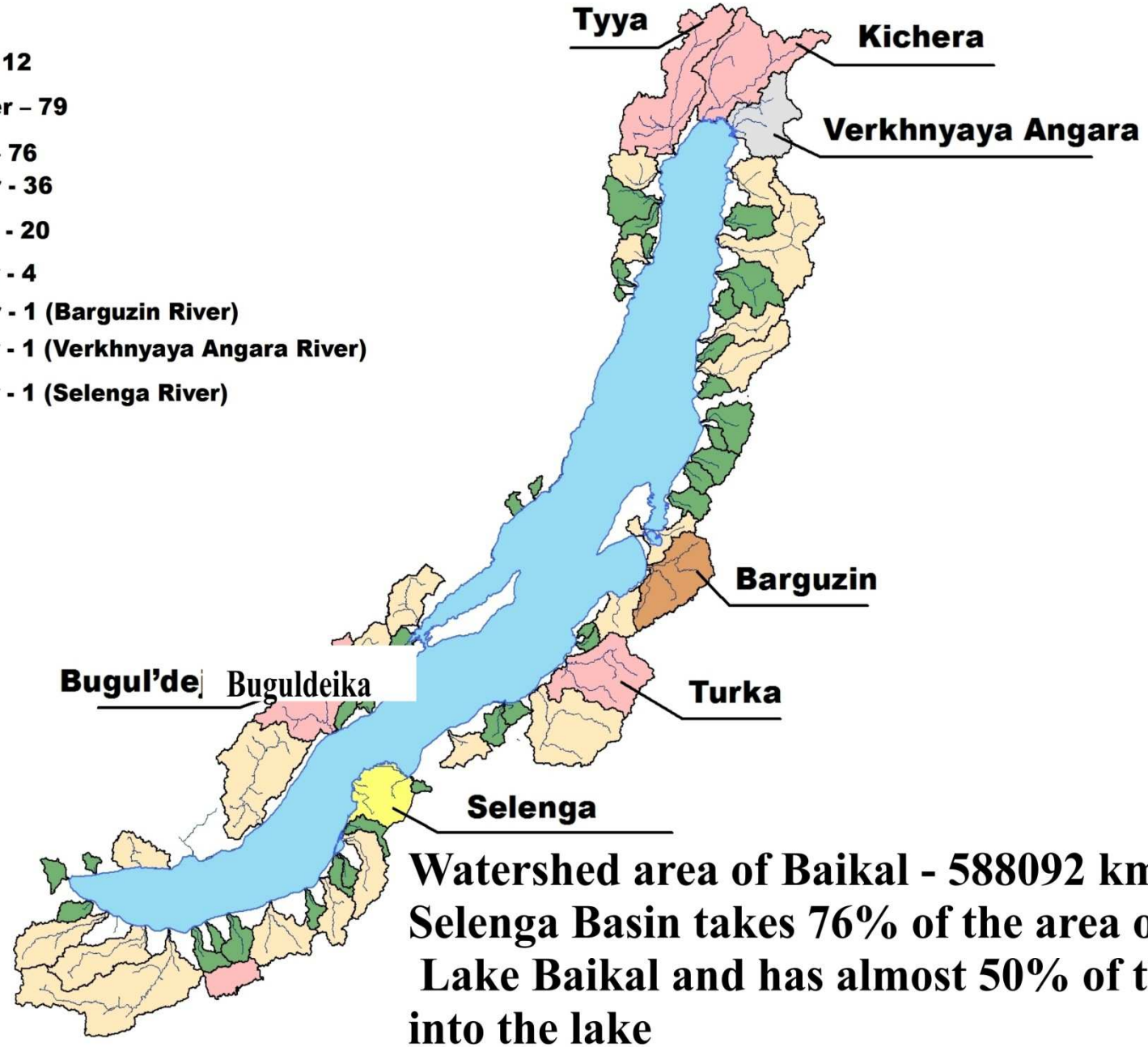
water resources



There are 230 Rivers flow into Baikal

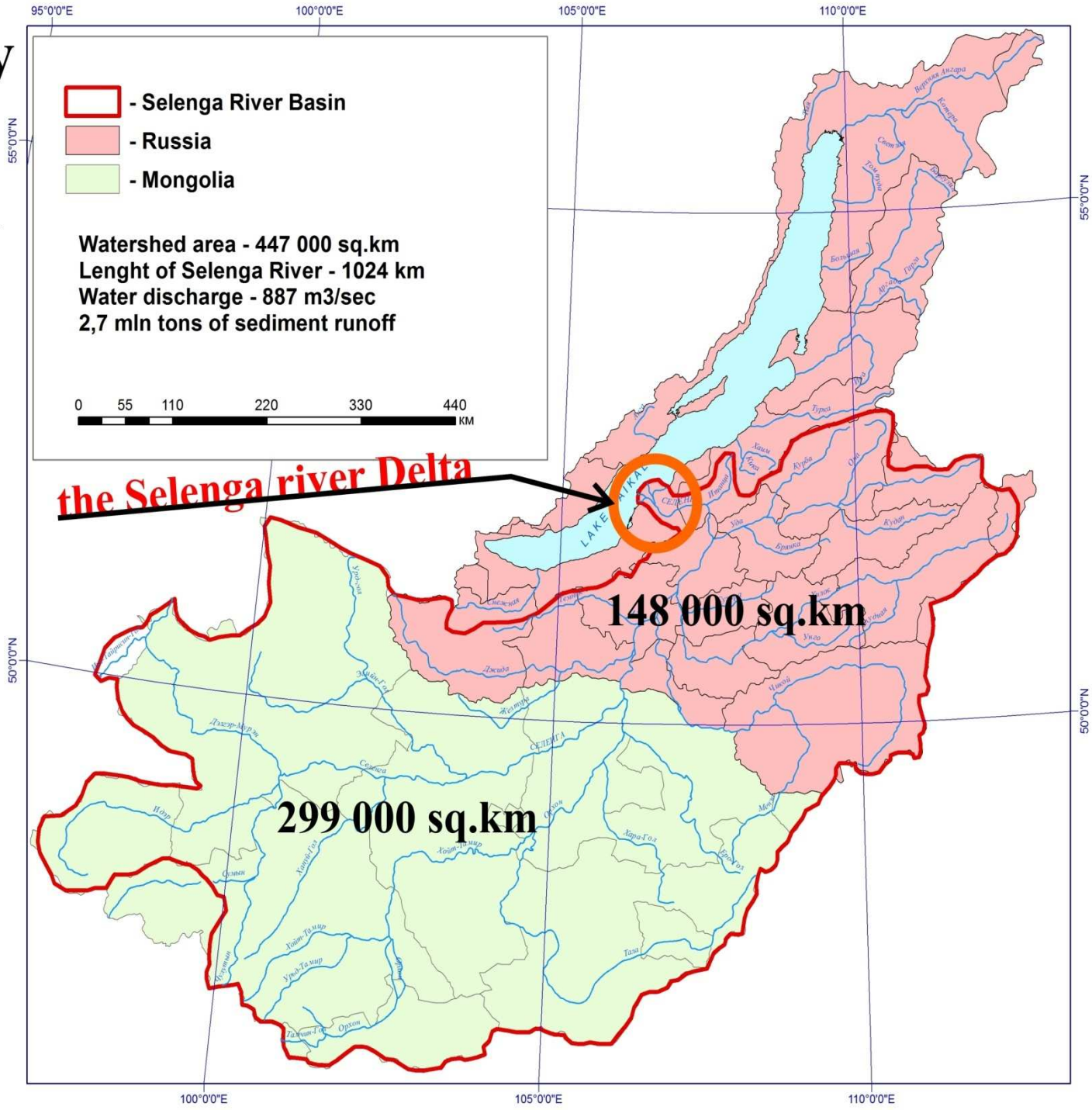
River systems of Baikal Lake

River systems:
The first order – 12
The second order – 79
The third order – 76
- 4-th order - 36
- 5-th order - 20
- 6-th order - 4
- 7-th order - 1 (Barguzin River)
- 8-th order - 1 (Verkhnyaya Angara River)
- 9-th order - 1 (Selenga River)



Watershed area of Baikal - 588092 km^2
Selenga Basin takes 76% of the area of Lake Baikal and has almost 50% of the flow into the lake

transboundary basin of the Selenga river



the structure of the river systems

Analysis of the river network structure showed that the most branched fluvial network is formed on the right side of the basin.

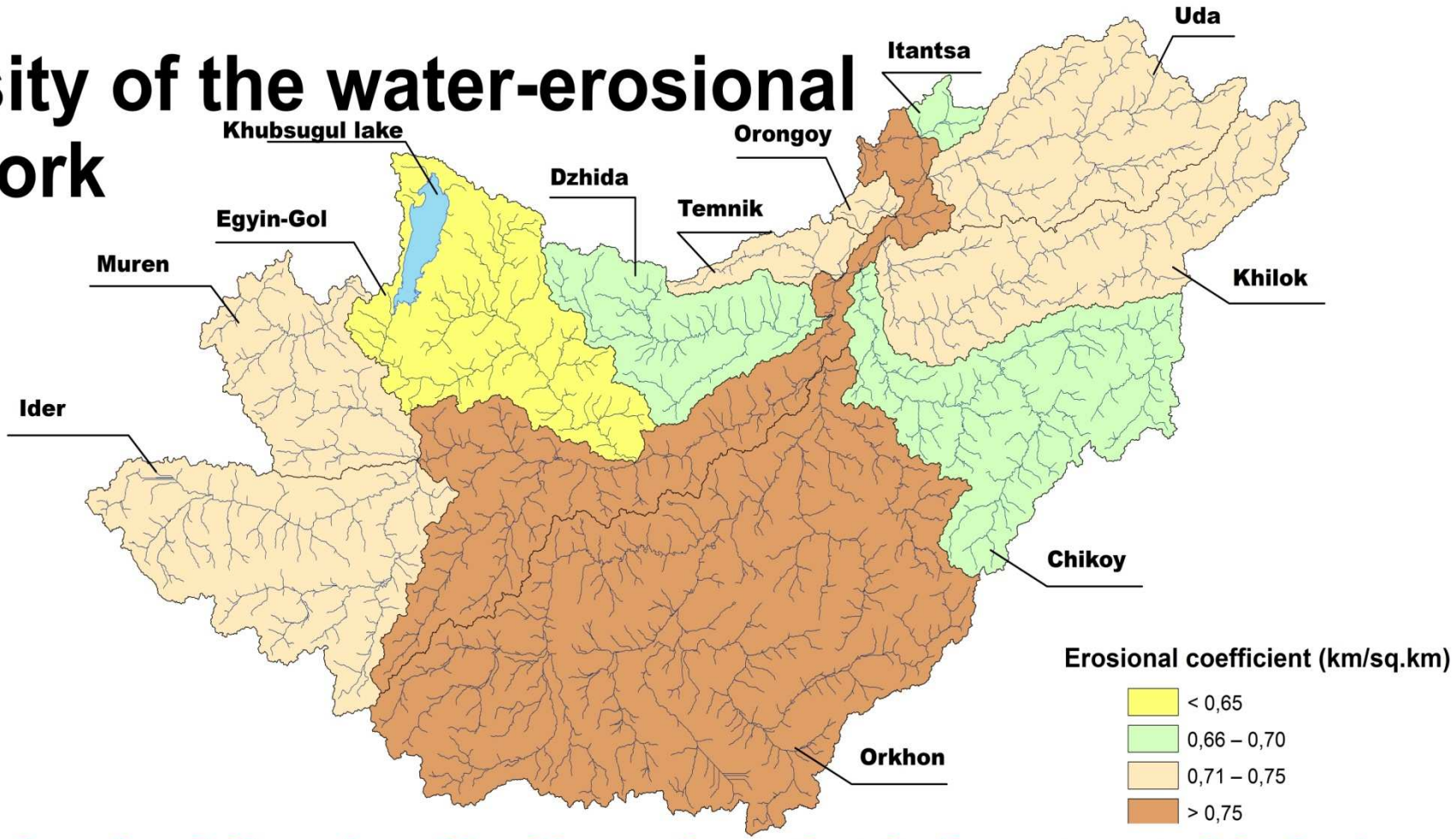
Selenga basin has three systems with VII order (Chikoy, Khilok and Uda), and the Orkhon River system (IX order). Inflows Chikoy, Khilok Uda have VII order and contain 11480, 9708 and 9026 elements respectively.Selenga River becomes the IX order at the merger with Orkhon. The large left inflows – Egyin-Gol River and Dzhida River have VII order.These rivers contain 10281 and 5717 elements of the I order

Hydrographic and morphometric characteristics of the main inflows Of the Selenga River basin

River system	F, km^2	H, m	Q, m^3/sec	Total length, m	Erosion coefficient, km/km^2
Selenga, including:	**458649**	**1199**	**935**	**351418**	**0.77**
Ider	**47062**	**1866**	**36.6**	**33110**	**0.70**
Muren	**25356**	**1829**	**36.4**	**17670**	**0.70**
Egvin-Gol	**42328**	**1476**	**88.6**	**27094**	**0.64**
Orkhon	**140030**	**1230**	**116**	**108160**	**0.77**
Dzhida	**23703**	**1135**	**63.8**	**15741**	**0.66**
Chikov	**44973**	**1060**	**261**	**30281**	**0.67**
Khilok	**38433**	**890**	**101**	**26919**	**0.70**
Uda	**34873**	**823**	**69.8**	**24593**	**0.71**

F – watershed area, km2; H – the average height of a watershed, m; Q - mean annual discharge in the mouth area, m3/sec

Density of the water-erosional network



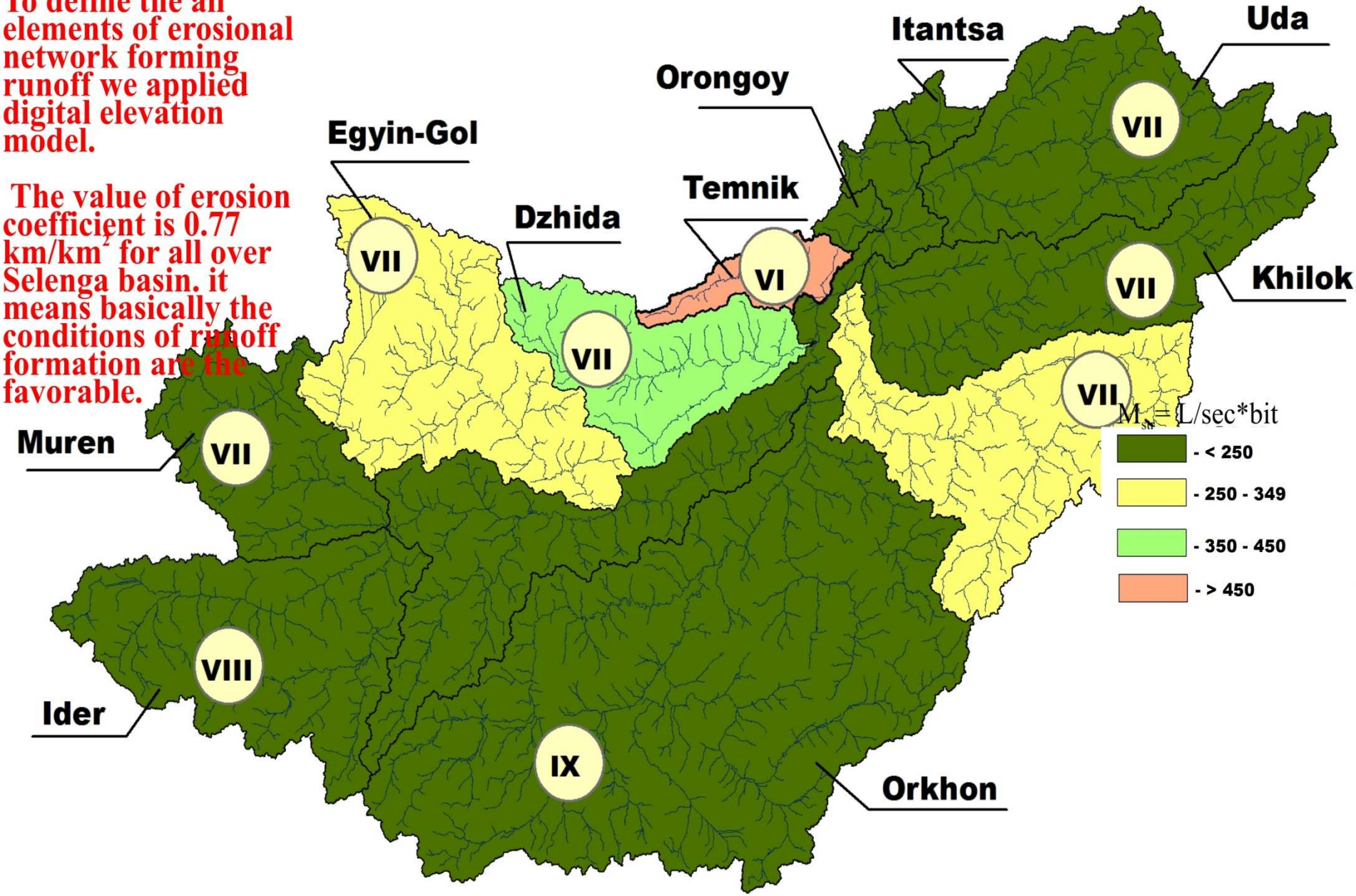
Analysis of erosional dissection of landforms shows that the largest part of the basin (41%) is characterized as a highest erosional dissection of landforms, and small part of the territory (9%) has a low erosional dissection and 16 % of the territory has a medium erosional dissection, 34 % - a high coefficient.

The erosion coefficient depends on the altitude of surface:
1- there is the low erosional dissection at an altitude from 1000 to 1200 m,
2- the average - from 800 to 900 and from 1200 m to 1900 m,
3- High - 1400-1500 m.

the conditions of runoff formation (by structural modulus, M_{str}) and orders of river systems (Horton-Straler classification)

To define the all elements of erosional network forming runoff we applied digital elevation model.

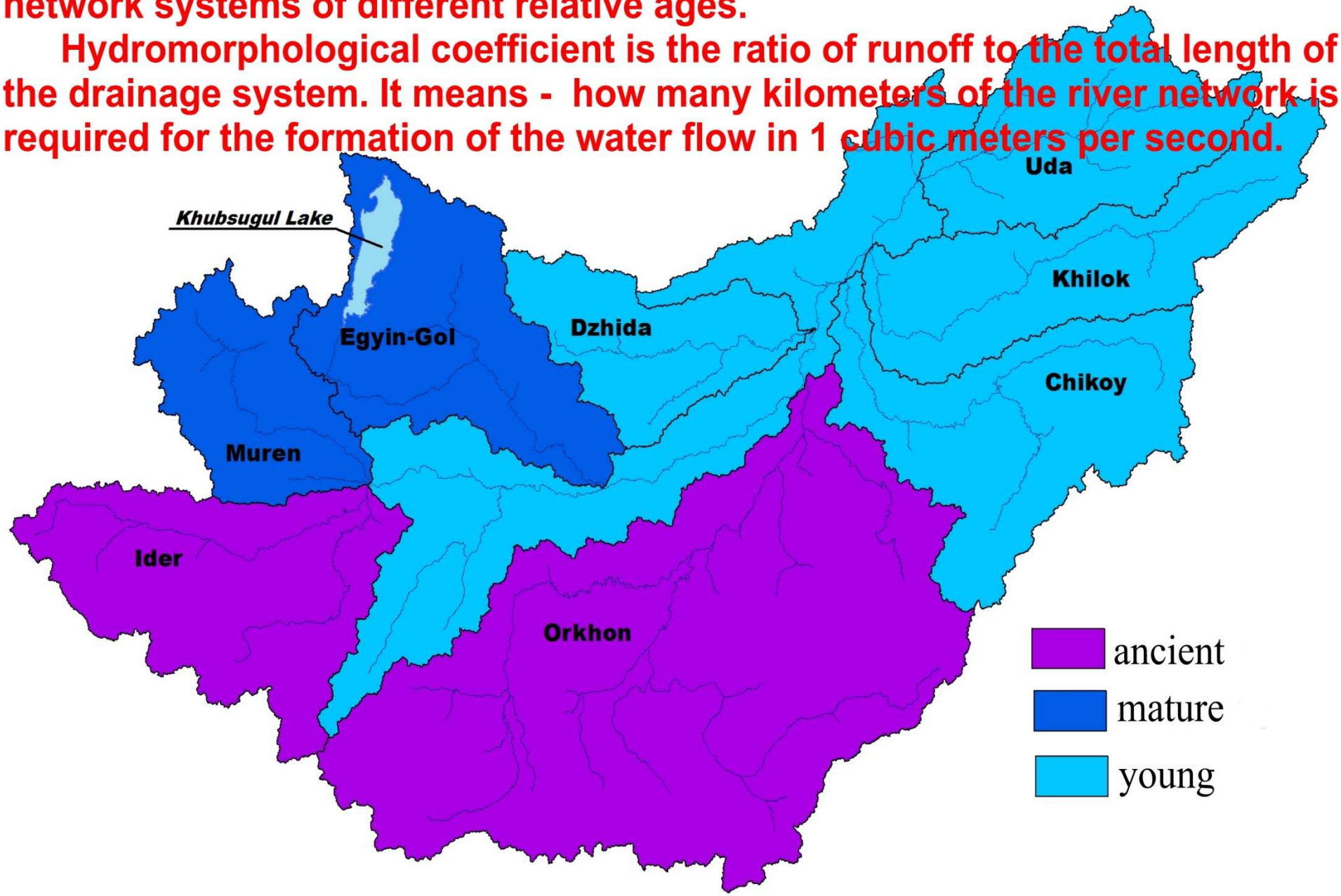
The value of erosion coefficient is 0.77 km/km^2 for all over Selenga basin. it means basically the conditions of runoff formation are the favorable.



relative age (stage of development) of river systems

The hydromorphological coefficient shows that the Selenga basin has river network systems of different relative ages.

Hydromorphological coefficient is the ratio of runoff to the total length of the drainage system. It means - how many kilometers of the river network is required for the formation of the water flow in 1 cubic meters per second.



The Factors of the Selenga delta landforming:

1. level of Lake Baikal
2. climate
3. runoff
4. sediment load
5. Tectonics (?)

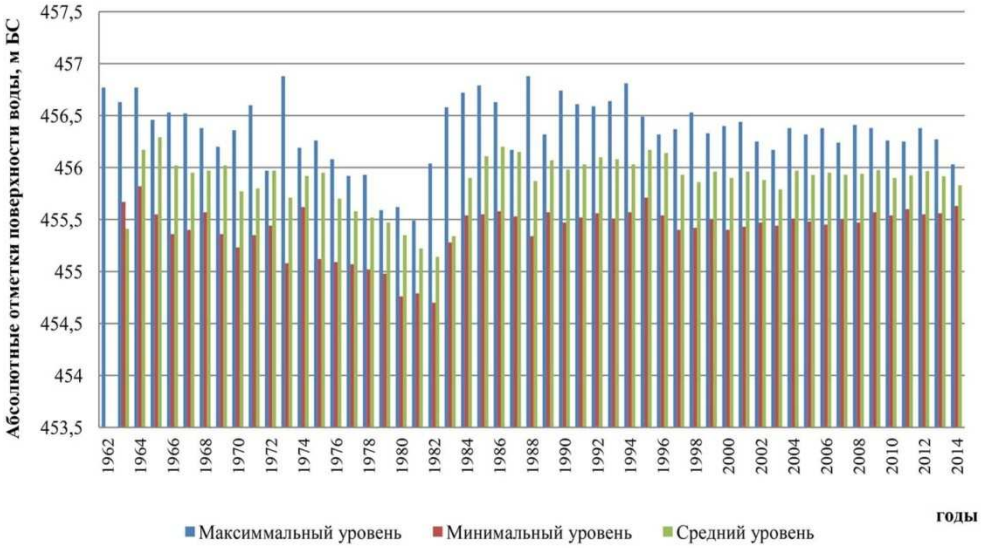
The level of Lake Baikal as the receiving reservoir is one of the most important factors influencing on the formation of the Selenga River Delta, along with the climate, manifested in the river basin.

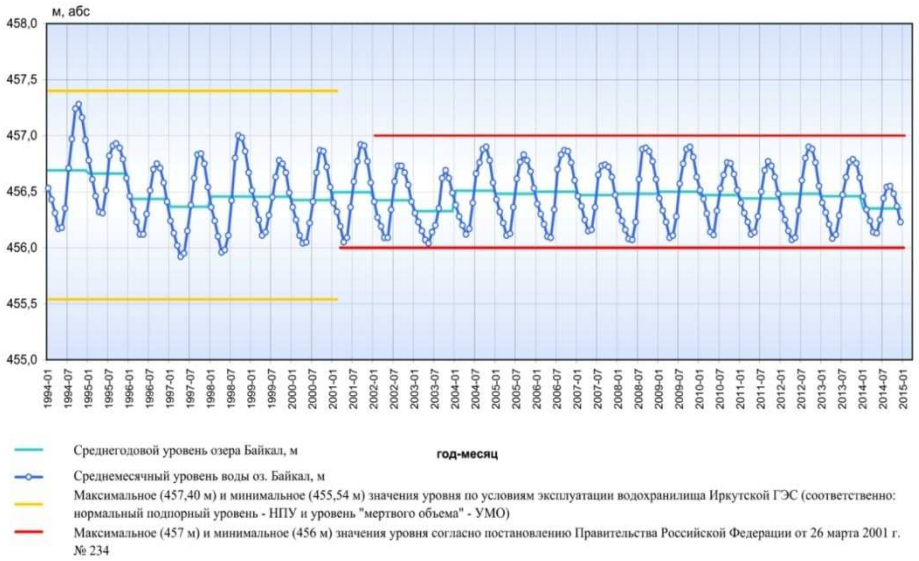
In turn, the lake level depends on the ratio precipitation in watershed and inflow of surface and groundwater, evaporation and Angara River runoff, but also on the regime of the Angara HPP.

One of the most important events at the present stage of the delta body formation - is total lake level increase after the construction of the Irkutsk hydropower station and the filling up of the Irkutsk reservoir in 1956-1958. The end of Construction of the HPP in 1959 coincided with the high-water period and led to a rapid increase of lake level, when daily the level raising reached up to 70 cm. Up to 1964, the average annual level exceeded 1.3 m (456.8 m - PS; 456.28 m - BS), and maximum level was observed in 1972. Average long-term over-regulated lake level is maintained at 1 m above the mean level of the lake that existed before the construction of the HPP. Annual variations in the level of overpressure conditions generally remained close to the natural regime.

The regulation is manifested in increasing an amplitude from 80 to 113 cm.

Baikal levels





The minimal level was noted in 1982 and was 455,22 (PS)

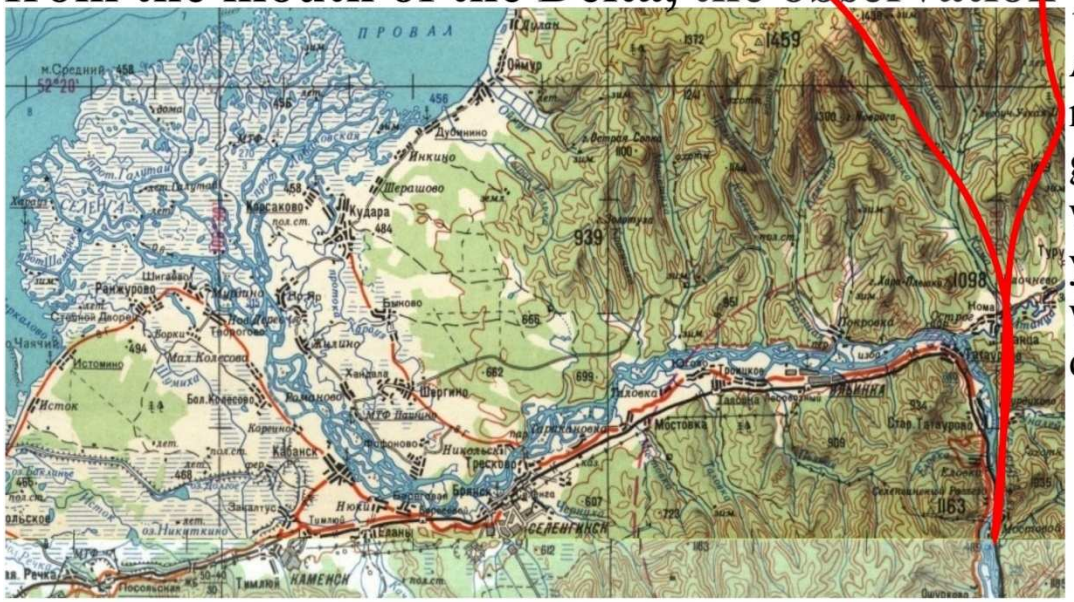
maximal - in 1973 and 1988 - 457,3 (PS)

minimal level in 2015 - 455,87 m.a.s.l (PS)

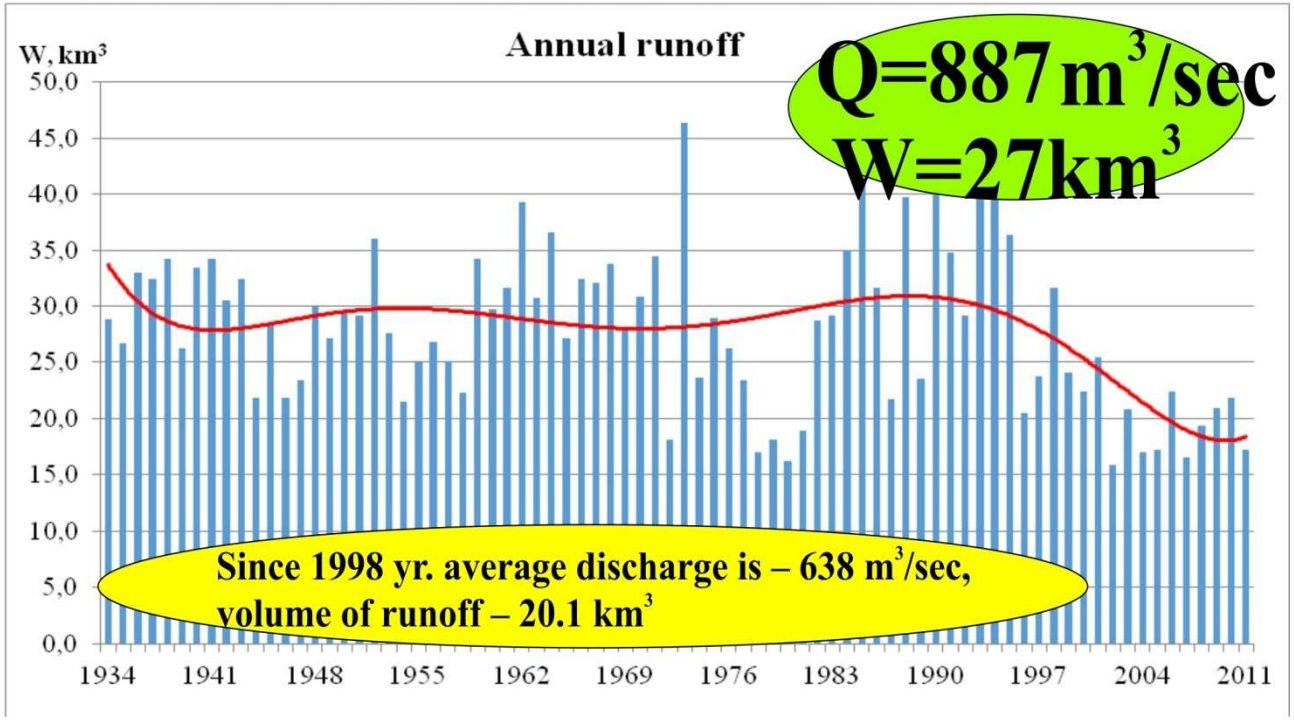
Since 2001, the amplitude of fluctuations of Lake Baikal level is maintained within the 456.0 - 457.0 m (Pacific System), established by the RF Government.

Currently, the water level of the lake varies as a result of the useful inflow into the lake and regulate the work of the Angara HPP in accordance with the Rules of use of water resources and the Government Decision.

annual distribution of runoff ”Mostovoy” gauging station, 127 km upstream from the mouth of the Delta, the observation period – since 1934 to present)

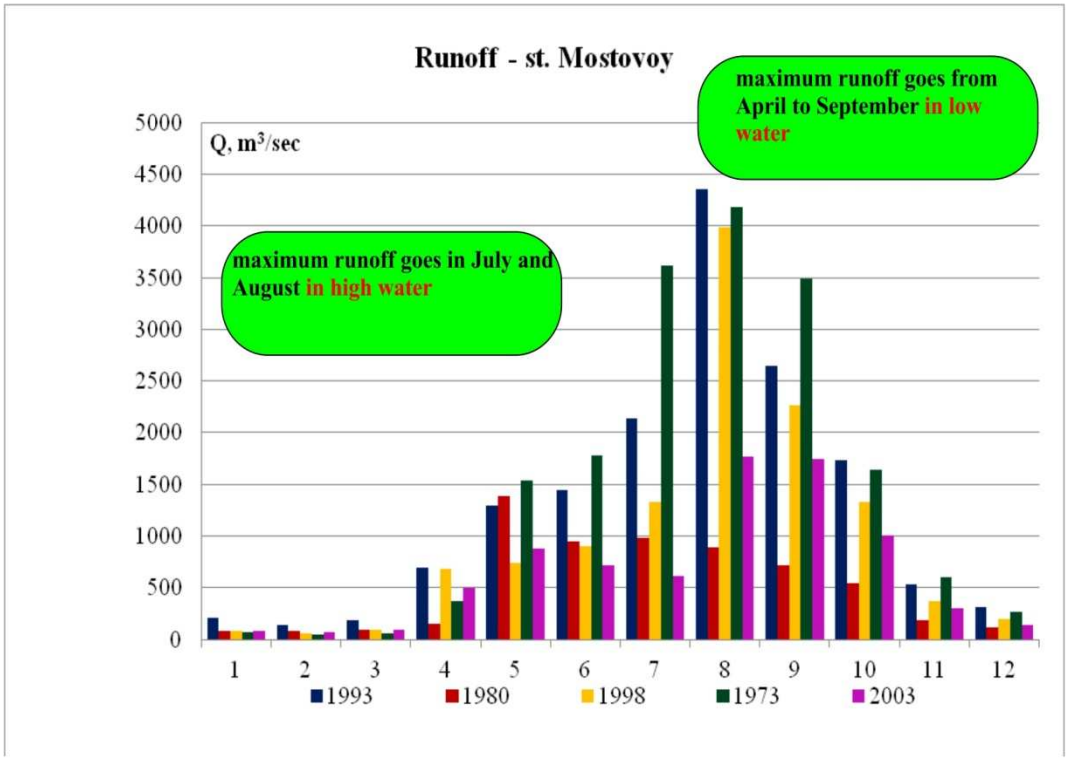


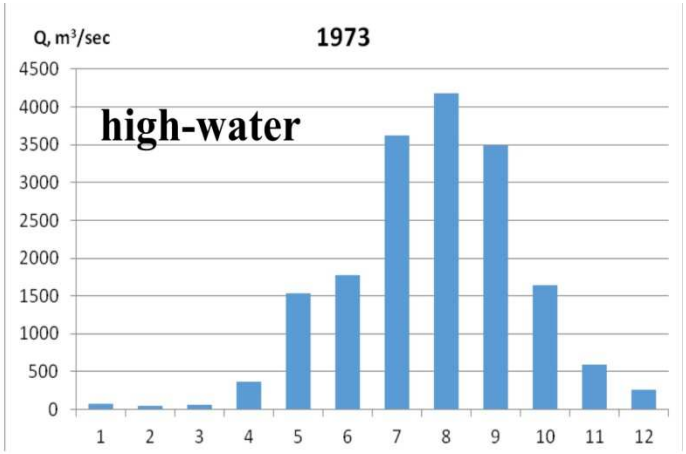
Annual and seasonal variations of the Selenga river runoff is estimated at traditionally used gauging station in Raz'ezd Mostovoy. the average water flow was about 930 m3/sec, or 29.3 km3 per year. Since 1996 to 2017 it is marked the low water period with an average annual water discharge - 505-809 m3/sec.

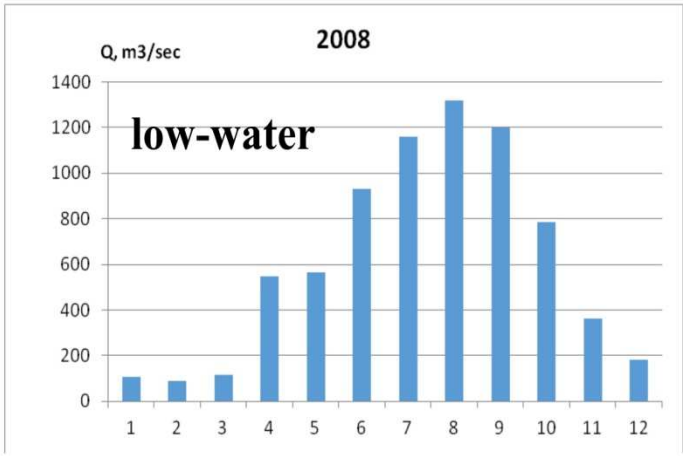


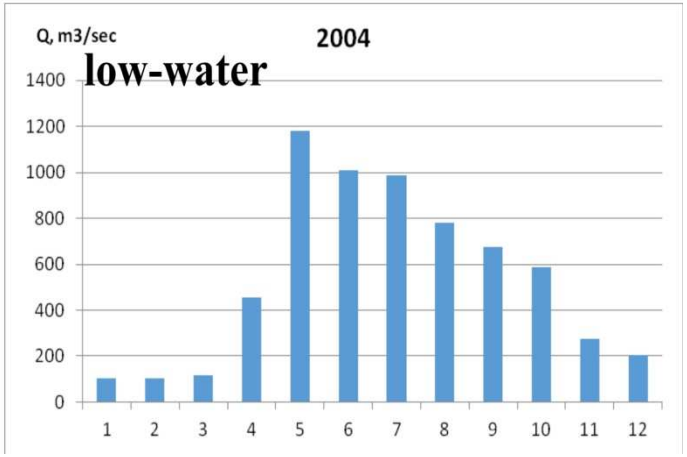
the water content decreases in Selenga Basin. The average annual runoff is 612 m3/sec (2003-2016). Nevertheless, during the regulation period in the receiving reservoir, it was observed several peaks since 1972 to the middle of 1990-s , which led to a significant restructuring of the river network.

intra-annual distribution of the Selenga river runoff

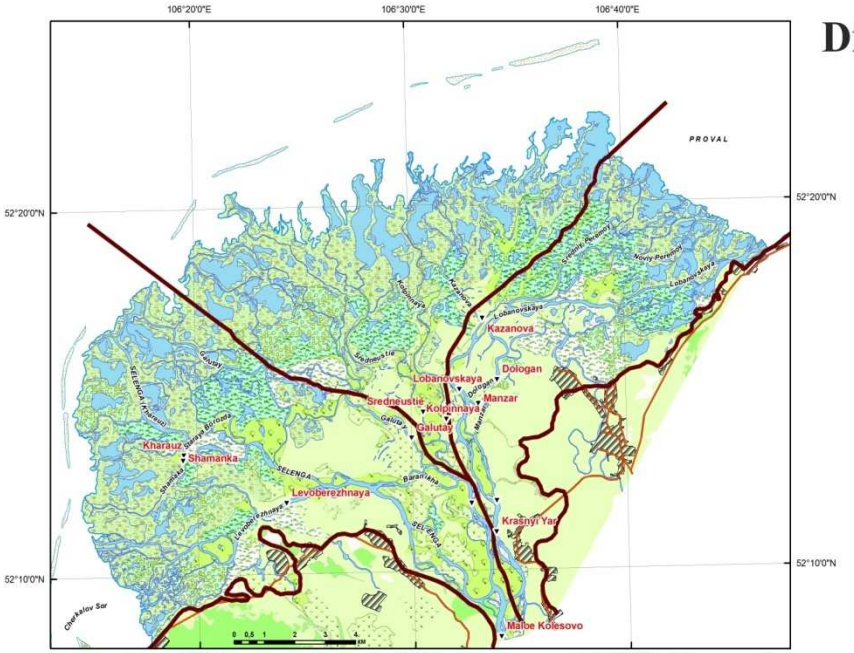








The runoff in the mouth of the Selenga, and for all tributaries of Lake Baikal is characterized by extremely uneven of intra-annual distribution. River runoff in summer reaches 5-7 thousand m3/sec, decreasing in January-March down to 70-80 m3/sec.



Distribution of water flow throughout the sectors (%) under different discharge in the top of the delta

DISCHARGE IN TD, M³/SEC	SELENGINSKIY	LOBANOVSKIY	SREDNEUSTEVSKIY
1100	40	40	~ 20
1700	>20	>20	~ 20
500-1000	↑35 - 40	↓50 - 40	< 20
1000-1500	↑35 - 45	↓ 40 - 35	~15
1500-2000	↑45 - 50	↓ 35 - 20	↓ 12 - 5
2000-3000	35	35	15
>3000	50	35	12

The analysis of the distribution runoff between the sectors of the delta showed:
1- from 5 to 20% of runoff passes through Sredneustevsky sector almost always
2 - equal parts of runoff (40, 20, 35%) pass through the marginal sectors of the delta when discharge in the top of delta is 1100, 1700 and 2000-3000 m3/sec respectively.

The distribution of flow in various water content years depends on the water surface slope between bifurcation node and base level of erosion.

Average slope of water surface is about 0.11 ‰. Minimum values (0.07 ‰) were observed in 2011 and 2014, maximum (0.13 ‰) - in 2006, 2012.

Maximum slope has Levoberezhnaya channel (0.14-0,18‰)in the same period. Levoberezhaya in recent years is the most active in the Selenga River Delta, due to the highest slope and straightening of the riverbed.

I hope,
U are not tired a lot.....

Thank you for the attention