MAIN HYDROLOGICAL AND GEOMORPHOLOGICAL PROBLEMS CONCERNING WITH SIBERIAN RESERVOIRS' FUNCTIONING

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Abstract:

In the Siberian area (Russia) are one with the largest on the Earth artificial water reservoirs. The study present development of geomorphological processes as a result of the water reservoirs creation and functioning on the Angara River. The cascade has been built since 1956. It include the following water reservoirs: Irkutsk, Bratsk, Ust-Ilimsk and Boguchansk (under construction). The Angara River cascade extends north to south on the length of 1,000 km in the forest-steppe and taiga area. The cascade width oscillates from 12 up to 25 km and the total length of the shore line exceeds 8,700 km. As a result of the Irkutsk Reservoir formation in 1962 the deepest lake in the world - Baikal has been dammed up at 1.2 m as well. The reservoirs are characterized by a few-meters (up to 10 m) seasonal and long-term water level fluctuations.

The water reservoirs creation has provoked intensification of existing exogenic processes and appear of new ones. Among them the most visible are increasing activity of shore zone, karst and aeolian processes. The shore zone of the reservoirs is still subjected to an intensive abrasion embracing nearly 30 up to 50% of the shore zone. The pace of the shore recession reaches max. 5 m a year. In loess-like formation areas occurs the intensification of existing gullies. Active dunes are observed in approximately one-kilometer zone of the reservoirs. Of all exogenic processes, karst processes are most frequent here. The active karst holes are observed in distance up to 2 km from the reservoir.

Key words: **Siberian reservoirs, human impact, exogenic processes**.

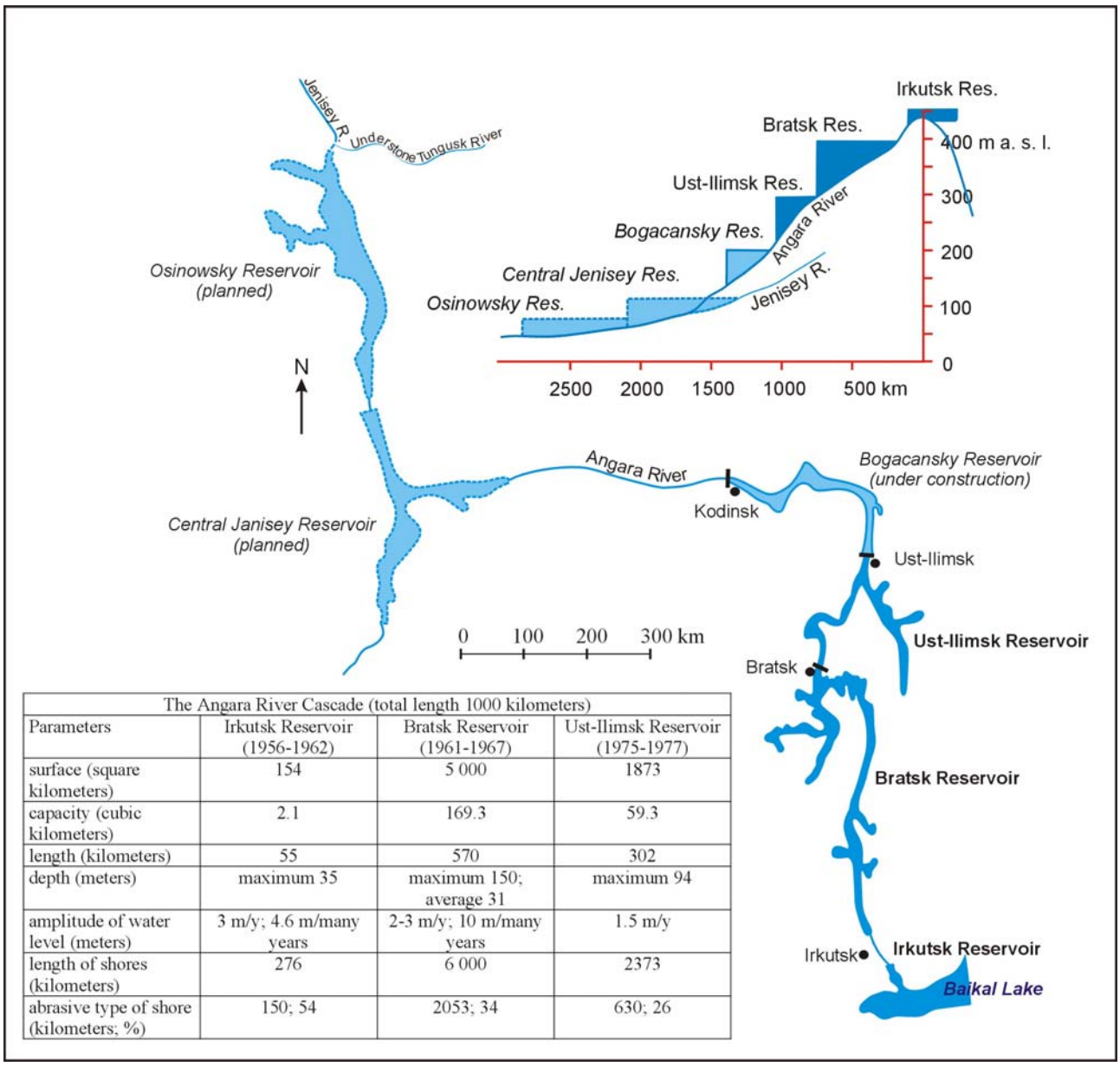
1. Introductions

The creation of the artificial water reservoirs on the Angara River provoked the intensification of existing exogenic processes and appear of new ones. Among them the most visible ones include the activation of shore zone, karst and aeolian processes. In these article we especially focused and presents forms and processes connected with Brack Reservoir – creations and functioning it.

2. Study area

The Angara River Cascade lie in a zone of typically continental type of climate with annual air temperatures below zero, from -1.1 to -3.2 C degrees. The temperature regime conditioning present of seasonal ground freezing up to 3 m depth. Water reservoirs are ice-cover from 5 to 6 months. Mean annual precipitation is about 300-450 mm, which are irregular distributes during the year with the maximum in July-August, and minimum in March. On these area dominates wind of W- and NW-directions. The Angara River Cascade lie on south part of the Central Siberian Plateau which builds very thick layer of Mesosoic and Paleozoic deposits (Bratsk Reservoir…, 1968). Quaternary sediments in shore zone of water reservoir are very common and their thick is about few meters. Only locally alluvial and delluvial sediments are 5-15 meters, sporadically 70 m (Ovchinnikov et al. 1999). More than 65% length of shore zone reservoirs Angara Cascade develop in rock and semi-rock sediments (Ovchinnikov 2003).

The Angara River Cascade creates three reservoirs: Irkutsk, Bratsk, Ust-Ilimsk. Under construction is Boguchansk Reservoir and in future will be create two next reservoirs (Fig. 1.). Now the Angara River cascade extends north to south on the length of 1.000 km in the forest-steppe and taiga area. The cascade width oscillates from 12 up to 25 km and the total length of the shore line exceeds 8.700 km. As a side effect of the Irkutsk Reservoir (Fig. 1.) formation in 1962 the deepest lake in the world - Baikal has been dammed up at 1.2 m as well!



The Angara River Cascade (total length 1000 kilometers)			
Parameters	Irkutsk Reservoir (1956-1962)	Bratsk Reservoir (1961-1967)	Ust-Ilimsk Reservoir (1975-1977)
surface (square kilometers)	154	5 000	1873
capacity (cubic kilometers)	2.1	169.3	59.3
length (kilometers)	55	570	302
depth (meters)	maximum 35	maximum 150; average 31	maximum 94
amplitude of water level (meters)	3 m/y; 4.6 m/many years	2-3 m/y; 10 m/many years	1.5 m/y
length of shores (kilometers)	276	6 000	2373
abrasive type of shore (kilometers; %)	150; 54	2053; 34	630; 26

Figure 1. The Angara River Cascade – distributions and parameters (base on Ovchinnikov 2003, Ovchinnikov et al. 1999)

The creation of the water reservoirs provoked the intensification of existing exogenic processes and the appear of new ones. Among them the most visible ones include the activation of shore zone, karst and aeolian processes. The shore zone of the reservoirs is still subjected to an intensive abrasion embrace nearly 30 up to 50% of the shore zone. The pace of the shore recession reaches max. 5 m a year. In loess-like formation areas occurs the intensification of existing gullies. Active dunes are observed in approximately one-kilometer zone from the reservoirs. Of all exogenic processes, karst processes are most frequent here. Active karst holes are observe in distance 2 km from the reservoir.

3. Results

The biggest reservoir included in the Angara River Cascade is Bratsk Reservoir. It is our main study object. This reservoir was created in 1961-1967 in the valley of Angara River and her tributaries Oka and Iya. This is a one with the largest reservoir on the Earth. The surface of the reservoir is 5,5 square kilometers and capacity 170 cubic kilometers (Fig. 1.). The shore zone is 6000 kilometers length.

The Bratsk Reservoir is marked by permanent regulation of water level, the value of the level draw-down reaching 10 meters. In year maximum water level have occurred in autumn and minimum in spring time. The

interaction between water and shore slopes occurs at different level and duration. These processes do not fade since the time of reservoir creation till nowadays (Mazaeva et al., 2004; Trzhtsinsky at al. 2007).

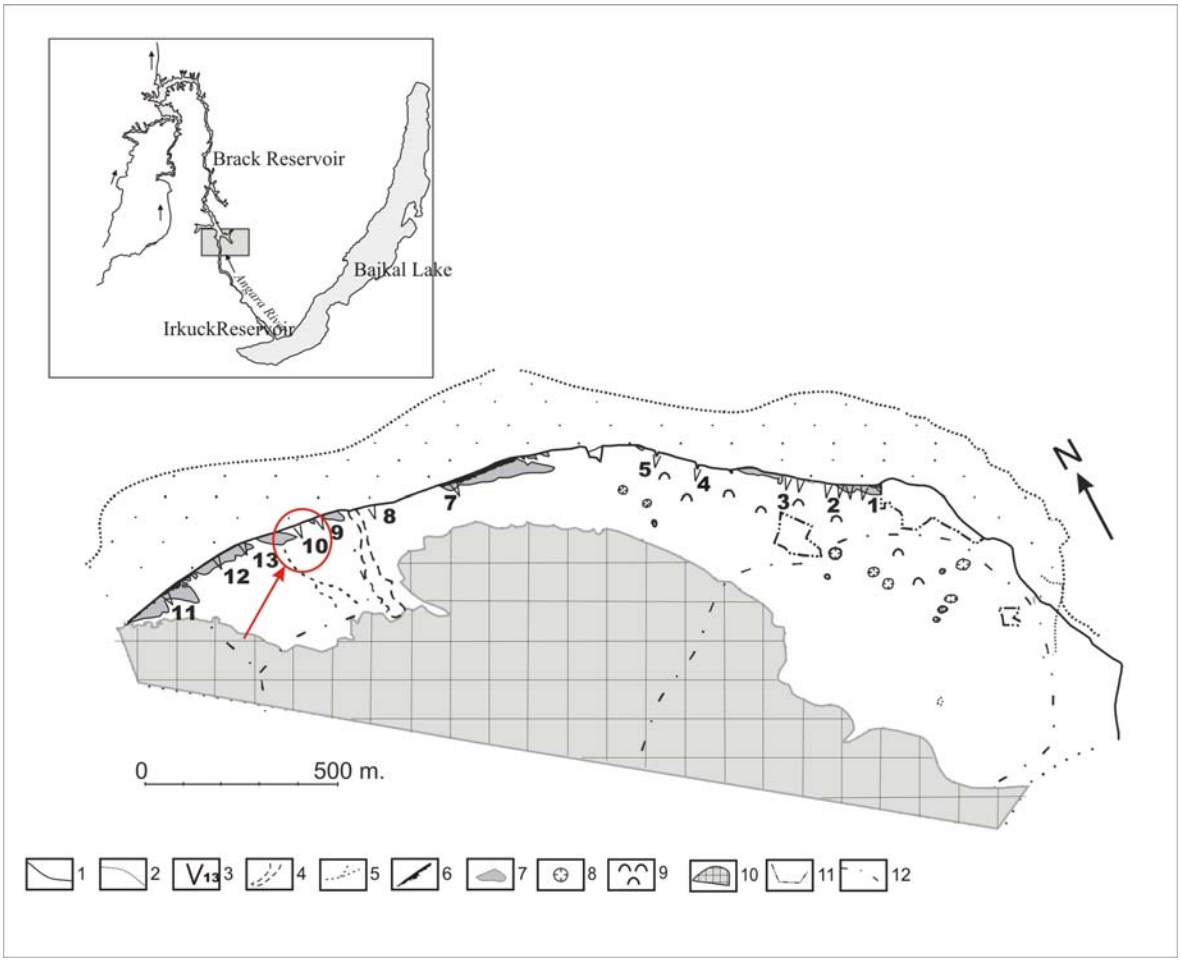


Figure 2. Location of the study area – Rassviet, Brack Reservoir.
1- cliff edge, 2 – water level border, 3 – active gully, 4 – arroyo, 5 – slope border, 6 – area covered by aeolian sands in 1969, 7 – area covered by aeolian sands in 1980, 8 – karst kettle hole, 9 – collapse area, 10 – forest, 11 – outcrop border, 12 - ground road. The arrow sign the gully nr 10, presents on the picture nr 1.

The geologic-geomorphologic situation in the shore zone of Bratsk Reservoir determines the conditions for development of different geodynamical processes. The loose rocks deposits presented by sandy loams, and in some places by loess-like loams, are intensively scoured in the process of shore abrasion. The combination of clay-rocks susceptible to plastic deformations, and high steep slopes, preconditions the landslide development. The intensive development of karst in deposits contain carbonate rocks. The loess-like grounds of 18-22 meters thickness are associated with erosion-suffosional and subsidence processes. The bedrock are susceptible to intensive weathering.

Despite the fact Bratsk Reservoir has been functioning from 40 years its shore zone is still active. Actually more than 2000 kilometres of them are abrasive. In depend on of rock type width of abraded shore zone is from 80 meters in sandstones to maximum 140-200 metres in loess-like grounds (Ovchinnikov 1999). Now, in our study area located in middle part of reservoir (Fig. 2.) in 2006-2007 year, the average annually rate of abrasion of shore zone is from 0 to 8 m (Khak *in press*; the work has been done under financial support of RFBR- Project No. 06-05-64392).

The shore zone has developed here in loess-like grounds, very susceptible erosion processes (Fig. 2., Fig. 3.). In shore zone have developed gullies. These are small forms, mean 2-30 meters length, maximum 12 meters width and 4.5 meters depth (Grobelska 2007). These are active forms. Its activity is closely connected with changes of ground moisture conditions which are result climate conditions and few meters fluctuations of water level in reservoir. The most of gullies has grooved with spread equal abrasion of shore zone, but sometimes it is higher or lower. Developing of gullies is a extreme process (Fig. 3.).

Along abrasive parts of shore zone have developed coastal platform maximum wide 200 meters. In spring and summer time, where water level on reservoir is low, coastal platform is periodically drying out. There are going aeolian processes. The sands covers these area have been moved by wind on the zone lie above cliff edge. The area of sands dunes have 2 kilometers width. Aeolian sands are active and have about 0.5-1.0 meters thickness (Wika et al. 2000, Khak 2006).

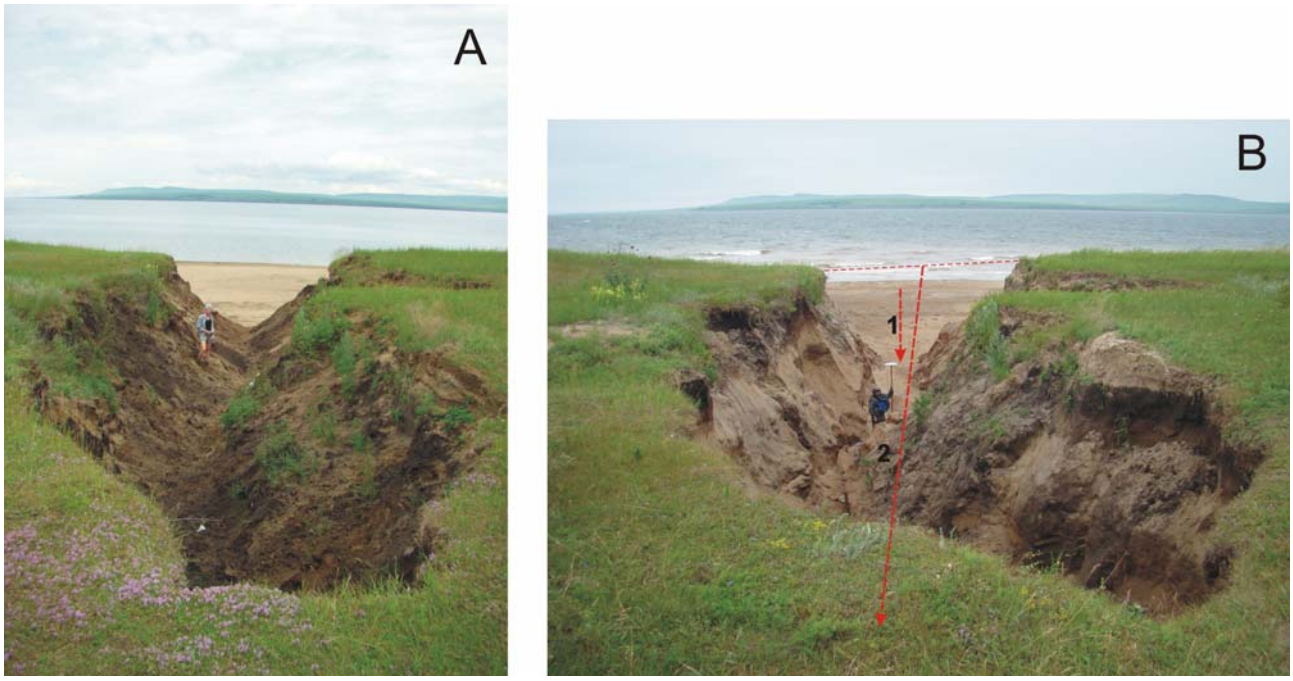


Figure 3. The gully form on the Brack Reservoir shore. Form nr 10 after four days: A- before (3 July 2007) and B- after rainfall (11 July 2007); 1- depth increase from 3.6 to 4.2 meters; 2- length increase from 26.7 to 28.3 meters.

The result of construction water reservoirs on Angara River are activation karsts processes too. It has gone in carbonate and gypsum rocks in zone 0.5-6.0 kilometers width from reservoir (Kozyreva 2002, Trzhinski et al. 2007). On these surface still we have observed new karsts forms. The most popular are holes. Maximum, in one year we have observed up to 6 holes on 1 square kilometers (Figure 4.). Locally, in gypsum cliffs we observed small seasonally caves. Their length is up to 6 meters and weight up to 1,2 meters.

Figure 4. The karst holes, Bratsk Reservoir 2007 y.

4. Conclusions

The creation of the water reservoirs provoked intensification of existing exogenic processes and appear of new ones. Among them, on Angara River cascade, the most visible is activation of shore zone, karst and aeolian processes. After 40 years functioning Bratsk Reservoir its shore zone and exogenic processes are still active.

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