Solution to the Mountain Reservoir Silting Problem in Georgia

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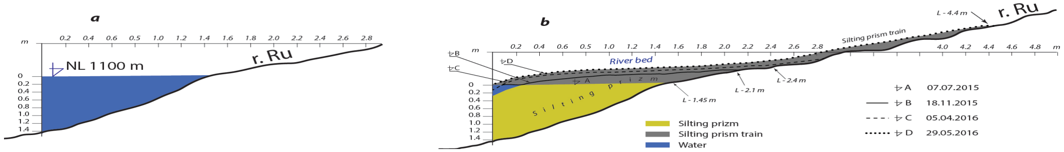
Research Goal

Georgia, as a sea state with mountain rivers, faces three opposing issues: 1. Hydropower development, 2. Coastal protection, and 3. Riparian settlements and infrastructure protection from floods in distributaries mouth. Climate change and global warming intensify beach erosion and further impact these issues as well as silting of mountain reservoirs because of increasing drifts in river deposits. This tendency is supported in the report published by the National Communications of Georgia at the UNFCCC. According to the comparison, the trends in the mean annual air temperature, precipitation and the moistening regime between periods 1955-1970, 1990-2005 and 1986-2010, increment of temperature and precipitation in West Georgia appeared to vary in the range of 0.2-0.4°C and 8-13%, respectively, while in East Georgia the relative values were found to be 0.6°C and 6.0%.

Research Methods

a. Natural experiment on reservoirs constructed on small mountain rivers;
b. Field research silting processes on reservoirs (The reservoirs have been operating for several decades);
c. Methods of Mathematical statistics.

*Mountain reservior siltings filed experiment on the r.Ru in initial **(a)** and finishing phases **(b)***



Natural experiment

Field research: general view of mountain reservoir's silting prism

Findings

1. The rivers deposit in the reservoirs forms silting prisms, consisting of fundamental part and the train (pic. b). The first lies under Normal Backwater Level, the latter, above it and extends in the gorge and distributary's bed. The prism volume (Wp) equals the sum of the reservoir (Wr) and the train (0.33 h_1 F_{ABK}) volumes.
2. The silting prism surface represents an inclined plane that starts from the dam outlet height (H) and extends in distributary's bed till the beginning of Equilibrium Channel (EC).
3. The Equilibrium Channel is the last stage of the river bed, over which river transports all of its deposit to tailrace.
4. At the finished stage silting prism is accumulated terrace that consists of the reservoir and the trains. Therefore it is higher than actual reservoir (pic. a) and is about twice as large and long (pic. c, d).

River deposit distribution over time and **calculation** of silting prism volume

$$R = r_s + r_u$$

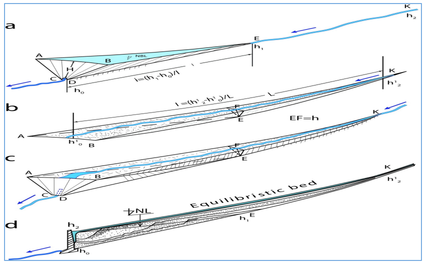
$$\lim_{n \to T} r_s = 0 \qquad \lim_{n \to T} r_s = R$$

$$L = f(h, Q_m, R_m, d, l)$$

$$L \leq 2\,l$$

$$W_t = 0.33\, h_1 F_{ABK}, \quad h_1 = EF$$

$$W_p = W_r + 0.33\, h_1 F_{ABK}$$



a. Reservoir view

b. Train with equilibrium bed

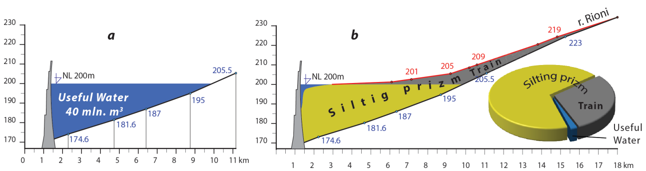
c. Silting prism with equilibrium bed in limited form

d. Longitudinal section of silting prism in limited phase (as terrace)

Solution

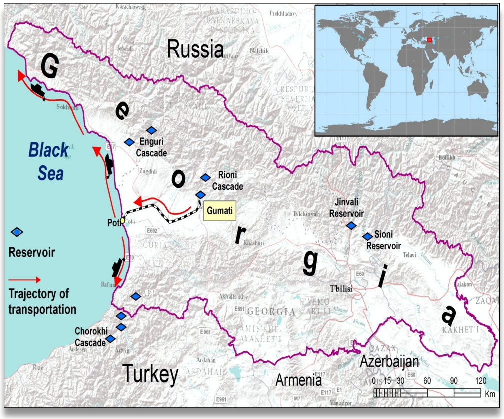
By creating quarries systems in the reservoirs, excavating deposits using them and strengthening beaches with it can simultaneously solve these problems. Removed deposits can be transported using conveyor (car, railway, barge) to the eroded beaches and other consumers. This will permanently increase volume of the useful water in the reservoir, significantly reduce consumption of the inert material from other rivers and save nearby settlements from overflowed tributaries.
Implementation of the proposed method solves several issues at once: it protects the eroded seashores and extends reservoir's lifespan with a minimal environmental impact and a significant economical profit.

Gumati reservior longitudinal sections in initial (a) and finishing phases (b) of operation



Prospective practical implementation

The silting prism and the train of Gumati reservoir contains approximately 60M beach forming material. About 60% of it can be used to recharge eroded coast line. These materials can be transferred from Gumati to seashore via railway and then by barges. This is the most cost efficient way to save both - the beaches and the reservoirs.



Conclusion

Silting prism formation starts from the time reservoir is put into operation and lasts up until it is transformed into a terrace. Annual volume of materials participating in the silting prism and its train wanes off over time.
- Silting prism in volume-limited phase completely covers reservoir and parts of gorge in the distributary's bed. Its volume equals the sum of the reservoir and the train volumes.
- Silting prism surface represents an inclined plane, which starts from the dam outlet and extends in distributaries bed till the beginning of equilibrium channel (EC).
- After forming the EC erosion - accumulation processes is terminated and the processes are managed by other factors.
- The granulometry of sediments in the silting prism is determined by the type of reservoir regulation and intra annual distribution of deposits.