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ABOUT THE PROCESS OF ACCUMULATION OF SEDIMENTS IN THE RESERVOIR

Ashot V. Balayan
Institute of Water Problems and Hydro-Engineering
Named After I.V. Yeghiazarov
125/3, Armenakyan st., 0011, Yerevan
e-mail: ashotbalayan92@gmail.com
ORCID iD: 0000-0001-6084-4377
Republic of Armenia

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Abstract

The accumulation of sediment and the associated loss of useful reservoir capacity is a serious global problem. The problems of quantitative assessment of sediment deposits and forecasting the form of their location in the reservoir are relevant. The first of these problems has been solved quite well, but the second problem remains practically open.

Keywords**:** water, reservoir, bottom sediments, accumulation, sediment expenditure, sediment area

Introduction

Reservoirs play an important role in the development of each country and ensuring its economic security. However, their construction leads to a number of negative consequences, disrupting the river ecosystem that has been formed over centuries.

In many reservoirs, sediment accumulation is observed in varying amounts. Every year, about 0.5-1.0% of reservoir capacity is lost due to sediment accumulation, which affects the physical and economic efficiency of dams. In fact, their accumulation determines the service life of the dam. More active accumulation is observed on small dams and on dams located in the lower reaches of mountain rivers. The analysis shows that in 10% of cases, sediment accumulation led to a loss of 50% of the reservoir's active volume. This means that 25% of fresh water reserves in reservoirs could be lost in the next 25–50 years. Measures to implement releases and trap sediments can increase the service life of reservoirs. Measures to implement releases and trap sediments can increase the service life of reservoirs. Preventing the development of areal and linear erosion in the catchment area can increase the efficiency of reservoirs, but it is necessary to take into account the possibility of some reduction in runoff volume when carrying out anti-erosion measures, primarily in dry seasons [1].

Reductions in sediment loads and nutrient inputs to the tailwaters of reservoirs affect the morphology of the river bed, often causing destruction of fish and other ichthyofauna habitats [1].

Decommissioning dams, especially those with large amounts of sediment stored in reservoirs, can create problems. These can be most significant if the dam is removed and the accumulated sediment begins to wash away and move downstream en masse [1].

There are many known examples where reservoirs built on highly turbid watercourses were filled with silt even before the end of their service life and were effectively decommissioned (Fig.) [2, 3].

Fig. Matilija Dam on the Ventura River (USA),
height 65 m, reservoir capacity 8.6 million m^3
(over 65 years, 95% of the volume has been filled with sediments)

The discharges with sediments of mountain and foothill rivers have a pronounced seasonal character. Very often, spring floods and mudflows bring more sediments than at other times of the year [4]. Their granulometric composition is dominated by clay and fine sand particles (60% and more).

Solid particles move in a suspended state along the current and most of them accumulate in the reservoir. As natural studies show, particles with a diameter of less than 0.05 mm in small and medium reservoirs and less than 0.02 mm in large reservoirs do not accumulate [5].

Sediment management in reservoirs should include [1]:

- monitoring of sediment accumulation in the reservoir, including quantitative and qualitative indicators, as well as data on sediment properties and pollution levels;
- where possible, removal of accumulated sediment by washing and cleaning the bed.

At present, the determination of the amount of sediment deposits and the form of their distribution for a few operating reservoirs has been carried out using the method of geodetic measurements [7].

Conflict Setting

There are quite reliable theoretical proposals for quantitative assessment of sediments. In most cases, the principle of balance of sediments entering and leaving the reservoir is used [8, 9]. However, these solutions do not allow establishing the form of sediment distribution in the reservoir and determining the growth of the accumulation layer in height. These forecasts are very important for finding out how the dead and useful volumes of the reservoir decrease during its operation. Theoretical solutions to these problems are practically absent in the literature. It is necessary to formulate a problem for predicting the form of sediment distribution in a reservoir.

Research Results

The process of sediment accumulation is characterized by a variety of tasks, which is due to the significant difference in physical pictures and mathematical models of the process of deposition of bottom and suspended particles.

Some recent review papers have covered specific aspects of bedload transport [10-13].

The accepted division of sediments into bottom and suspended is not absolute, since when hydraulic conditions in the flow change, they move from one category to another [14]. As bedload transport exhibits considerable spatial and temporal variations, computing the bedload transport rates and morphological changes experienced by streambeds is difficult. A large body of experimental work has revealed scaling laws relating average transport speed to hydraulic conditions. The most common approach used to calculate bedload transport has thus long involved determining the one-to-one function $q_s = f(q_w)$ from experiments or theoretical considerations. However, the predictive power of such relationships is limited: scientists are unable to predict q_s to within better than one order of magnitude, and morphodynamic models based on $q_s = f(q_w)$ fail to explain the development of bedforms without the use of additional assumptions. Progressively, other calculation approaches have appeared, with many relying on the idea that bedload transport is a macroscopic transport process that primarily reflects random particle motion [15].

To develop mathematical models of the mudflows movement is of great importance and drawing up design diagrams of structures requires bringing out distinctive features of the movement of suspended particles by turbulent water. On the basis of experimental investigations carried out to define carrying capacity of the flow has been ascertained that the ratio of coefficients of resistance with saturated suspended particles and clean fluid with high concentrations always greater than a unit, when in many known research works it is believed that this ratio is less than a unit. The obtained experimental results are rigorously substantiated theoretically [6].

Given the initial hydrological, granulometric and geometric characteristics of the flow, sediment and channel, it is necessary to obtain a dependence for calculating the coordinates of sediment deposits along the reservoir.

Conclusion

To develop a theoretical model of the process of sediment deposition and to predict on its basis the coordinates of the location of the accumulation volume in the reservoir, it is necessary to determine a criterion that allows calculating the location of those sections of the reservoir where bottom sediments of different sizes can be deposited.

The hydrodynamic process of sediment accumulation occurs when the channel, sediments and flow interact. The main parameters characterizing these factors are: liquid and sediment flow rate (Q, Q_S); average sediment diameter (d_S); reservoir geometric parameters along the length - depth (h), channel width (B), cross-sectional area (A). These values, which are the initial ones for the task, are established by preliminary studies of the river basin.

To predict changes in the sediment layer, the sediment balance equation should be used.

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ՋՐԱՄԲԱՐՈՒՄ ՋՐԱԲԵՐՈՒԿՆԵՐԻ ԿՈՒՏԱԿՄԱՆ ԳՈՐԾԸՆԹԱՑԻ ՄԱՍԻՆ

Ա.Վ. Բալայան
Ակադեմիկոս Ի.Վ. Եղիազարովի անվան ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտ

Ջրաբերուկների կուտակումը ջրամբարի թասում կարող է հանգեցնել կուտակվող ջրի օգտակար ծավալի զգալի կրճատման: Ջրաբերուկների նստեցման գործընթացի տեսական մոդել մշակելու և դրա հիման վրա ջրամբարում դրանց կուտակման ծավալի տեղակայման կոորդինատները կանխատեսելու համար անհրաժեշտ է ստանալ այնպիսի առնչություն, որը թույլ կտա հաշվարկել ջրամբարում ջրաբերուկների գտնվելու վայրը:

Ջրաբերուկների կուտակման հիդրոդինամիկական պրոցեսը տեղի է ունենում հունի, ջրաբերուկների և ջրի հոսքի փոխազդեցության միջոցով: Այս գործոնները բնութագրող հիմնական պարամետրերն են. ջրի և ջրաբերուկների ելքը (Q, Q_S), ջրաբերուկների միջին տրամագիծը (d_S), ջրամբարի, ըստ երկարության երկրաչափական պարամետրերը՝ խորություն (h), հունի լայնություն (B), կենդանի կտրվածքի մակերեսը (A): Այս պարամետրերը պետք է որոշվեն գետավազանի նախնական ուսումնասիրություններով: Նստվածքային շերտի փոփոխությունները կանխատեսելու համար պետք է օգտագործվի ջրաբերուկների հաշվեկշռի հավասարումը:

Բանալի բառեր. ջուր, ջրամբար, հատակային ջրաբերուկներ, կուտակում, ջրաբերուկների ելք, կուտակման տեղամաս

О ПРОЦЕССЕ АККУМУЛЯЦИИ НАНОСОВ В ВОДОХРАНИЛИЩЕ

А.В. Балаян
Институт водных проблем и гидротехники им. академика И.В.Егиазарова

Накопление наносов и связанные с этим потери полезного объема водохранилищ является серьезной глобальной проблемой. Для разработки теоретической модели процесса отложений донных наносов и прогнозирования на ее основе координат расположения объёма аккумуляции в водохранилище необходимо определять критерий, позволяющий вычислить местоположение тех сечений водохранилища, где могут отлагаться донные наносы разного размера.

Гидродинамический процесс аккумуляции наносов происходит при взаимодействии русла, наносов и потока. Основными параметрами, характеризующими эти факторы, являются: расход жидкости и наносов (Q , Q_S); средний диаметр наносов

(d_S); геометрические параметры водохранилища по длине - глубина (h), ширина русла (B), площадь живого сечения (A). Эти величины, являющиеся исходными для поставленной задачи, устанавливаются предварительными исследованиями речного бассейна. Для прогнозирования изменения слоя отложений, следует использовать уравнение баланса наносов.

Ключевые слова: вода, водохранилище, донные наносы, аккумуляция, расход наносов, участок отложений.

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