Reduction in the Storage Capacity of Dokan Dam Reservoir

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Abstract

Dokan reservoir is located on the Lesser Zab River NE Iraq. Its drainage area is 11,690 km² with a storage capacity of 6.87×10^9 m³. Calculation of the volume of the reservoir before the construction of the dam and from the bathymetric survey conducted in 2014 indicates that an annual average of 7 million cubic meters of sediments are deposited within the reservoir. This reduced the storage capacity of the reservoir by 28%.

Keywords

Dokan reservoir • Lesser Zab river • Siltation of reservoirs • Iraq

1 Introduction

Dokan dam and its reservoir are located on the Lesser Zab River, one of the important tributaries of Tigris River in the northeast of Iraq (Fig. 1). The dam is a multipurpose (flood control, storage, hydropower and irrigation) concrete arch dam. It is the oldest dam in Iraq and it started operating since 1959. The catchment area is 11,690 km². The surface area of the reservoir is 270 km² and its storage capacity at the normal operation level (511 m.a.s.l.) is 6.87×10^9 m³ [1]. The geology of the area is mainly limestone rocks [2].

The actual storage capacity of the reservoir now is not known. Hassan et al. [1] conducted a bathymetric survey in

2014. This survey was compared with the stage-volume curve of the dam. In this research, the designed volume of the reservoir was calculated and compared with that of 2014 bathymetric survey to find out the exact rate of siltation within the reservoir.

A topographical map of the reservoir before the construction of the dam was prepared for the reservoir area. The maps had a scale of 1:20000 and a contour interval of 20 m. These topographic maps were drawn by Hunting Aerosurveys LTD in 1951–1952 [3]. The contours between 420 and 520 m.a.s.l. were digitized, and a Digital Elevation Model (DEM) was prepared using ArcGIS (Fig. 2).

2 Methodology

2.1 Bathymetric Survey

A bathymetric survey for Dokan Dam Reservoir was conducted using a single beam echo sounder in November 2014. Details of the transect lines of the bathymetric survey are shown in Fig. (3a). The bathymetric survey was conducted in a calm environment to avoid water surface fluctuation due to wind waves. The water surface elevations varied between 482.47 and 482.85 m.a.s.l during the surveying days. The error in depth measurement was estimated for the echo sounder, and it has been of a small value of ± 4 cm [1, 4].

2.2 Data Processing

The outputs of the echo sounder were converted to spot the points of water depth of (E, N, D) format in an Excel file. These depth points were transformed to elevation points of the reservoir bed, according to the water surface elevations of the reservoir for that day. A DEM of the reservoir bed was created using the extracted 65,416 elevation points from the bathymetric survey using ArcGIS software (Fig. 3b).

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Fig. 1 Location map of Dokan Dam and its reservoir

Fig. 2 Topographical map of Dokan reservoir in 1952 (prior to dam construction)

2.3 Storage-Elevation Curves

Two sets of storage-elevation curves were prepared depending on the DEMs of the reservoir. The first set is

related to the topography of the reservoir in 1952 (Fig. 4), before constructing the dam. The second set is corresponding to the bathymetric survey in 2014 (Fig. 4).

Fig. 3 a Transect lines of the bathymetric survey in 2014. b Topographical map of Dokan reservoir in 2014

Fig. 4 Storage-elevation curve of Dokan reservoir

Fig. 5 Differences of storage volume in Dokan reservoir with storage reduction percentage for the period 1952–2014

3 Results and Discussion

3.1 Storage Reduction

Comparing these two sets of curves leads to determining the changes in the storage volume at each contour line during the period of 1952–2014. The accumulated sediment in the reservoir at the level of 480 m.a.s.l. was determined at about 407 million m^3 (0.4 km^3) according to the difference in the storage volume at that elevation (Fig. 5). This amount of sediment deposition has reduced the storage capacity of the reservoir by 28% of the design capacity at the level of 480 m.a.s.l. The annually averaged deposition is about 7 million m^3 .

According to Figs. 4 and 5, the storage volume at contour 420 has been fully in aggradation, which is the only

occupied part of the southern reservoir. Contour 440, which extends from the southern reservoir to the south of the northern reservoir, has been occupied by 78% by sediment. While 47% of the contour 460 and 20% of contour 480 have been filled by sediment.

4 Conclusions

The volume of the Dokan Reservoir was calculated at the start of the dam operation in 1959 using topographic maps of scale 1:20000. The result was compared with the volume calculated for the same reservoir using the bathymetric data collected in 2014. Comparison of the results indicates that an annual average of 7 million cubic meters is deposited in Dokan Reservoir. Siltation of the reservoir decreased its storage capacity by 28%.

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