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Sediment Deposition and Its Evaluation in the Earthen Dam (Arzengarzen) In Budgam District of Jammu and Kashmir

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Abstract: The management of sedimentation in a reservoir offers a comprehensive assessment of the sediment transportation and erosion processes. Understanding sedimentation is helpful for managing reservoirs. Dam silting volumes can be evaluated by bathymetric surveys. The Arzengarzen earthen dam in Budgam district of Jammu and Kashmir had two surveys conducted, and the data are available. Initial data regarding the amount and variability of silting as well as the mechanism of sediment deposition are provided by the measurements. The average annual specific sediment output of the Arzengarzen earthen dam watershed is projected to be 2851 t m^3/yr based on measurement results. The average yearly volume of confined sediment varies, ranging from 2300 m3 in 2010 Over time, the sedimentation rate rises from 0.20 to 0.43%. The findings show a relationship between the presence of soils on steep slopes and particular rates of erosion. The only source of income in the area (Agriculture)is at risk due to the strain that the area's population has placed on the land through overgrazing and plowing, which has caused increased erosion and further deterioration.

Keywords: Sediments. Arzengarzen, Earthen dam, Erosion

I. INTRODUCTION

Rainfall, particularly early in the rainy season, increases the movement of silt via watershed runoff. Because of the high flow velocity during rainy season, the stream flow separates more river bed particles, increasing the stream's capacity (the total mass of sediment) and competence (the maximum particle size it can carry). The flow energy and velocity of a stream reduce when it enters a reservoir, causing sediment to deposit. The small particles are often deposited along the reservoir's water flow direction, whereas the coarse silt is typically deposited at the reservoir's mouth.

Erosion poses a hazard to 53% of districts land area (Boussema, 1996). In dammed reservoirs, 2851 m^3/yr of sediment are deposited yearly on average. As was already said, one of the main issues with dam is silt deposition, which raises the risk of flooding by reducing the amount of water that can be stored, which in turn affects the amount of flood water that can be stored. The decreased storage capacity has an impact on the reservoir's safe output to satisfy various water demands. Numerous models have been proposed for the study of siltation in reservoirs. For instance, a three-dimensional model of silt concentration and flow in reservoirs was presented by Campos (2001). He employed two bed load functions, one for each direction of the bed. In order to verify the model, both real field data and laboratory test data from Brazil's Itaipu Reservoir were taken into account. Laboratory test results showed that projections of sediment deposition through the reservoir and flow and sediment routing simulations agreed well. In order to compare the model outputs with the measured data, Pak et al. (2010) assessed a compatible reservoir sedimentation model using HEC-HMS, which was applied to two reservoirs. The outcomes showed that the daily flow rates and sediment loads could be reasonably predicted. Issa et al. (2013) used a bathymetric survey approach to estimate the usable life of Mosul Dam in Iraq. The study conducted by Mohammad et al. (2016) examined the silt deposition that occurred within the reservoir of the Mosul Dam between 1 utilizing the model HEC-RAS 4.1. During the study period, sediment depositional simulation was evaluated at monthly intervals (time step), and the pattern was evaluated at five-year intervals (1980, 1985, 1990, 1995,2000,2005 and 2010).

As a result, the simulation included the years 1975—when the Arzengarzen earthen dam operation started—through 2010. The yearly sediment output of a tiny (235m^3) In this study, a sediment delivery ratio (USLE-SDR) in conjunction with the Universal Soil Loss Equation were used to quantify the suspended sediment intake to a reservoir. Three separate bed load formulas and the flow time curve were used to estimate the annual bed load. Four surveys of reservoir bathymetry were conducted. The amount of sediment deposited in the reservoir and the sediment input calculated using the bed load and USLE-SDR formulas agreed quite well.

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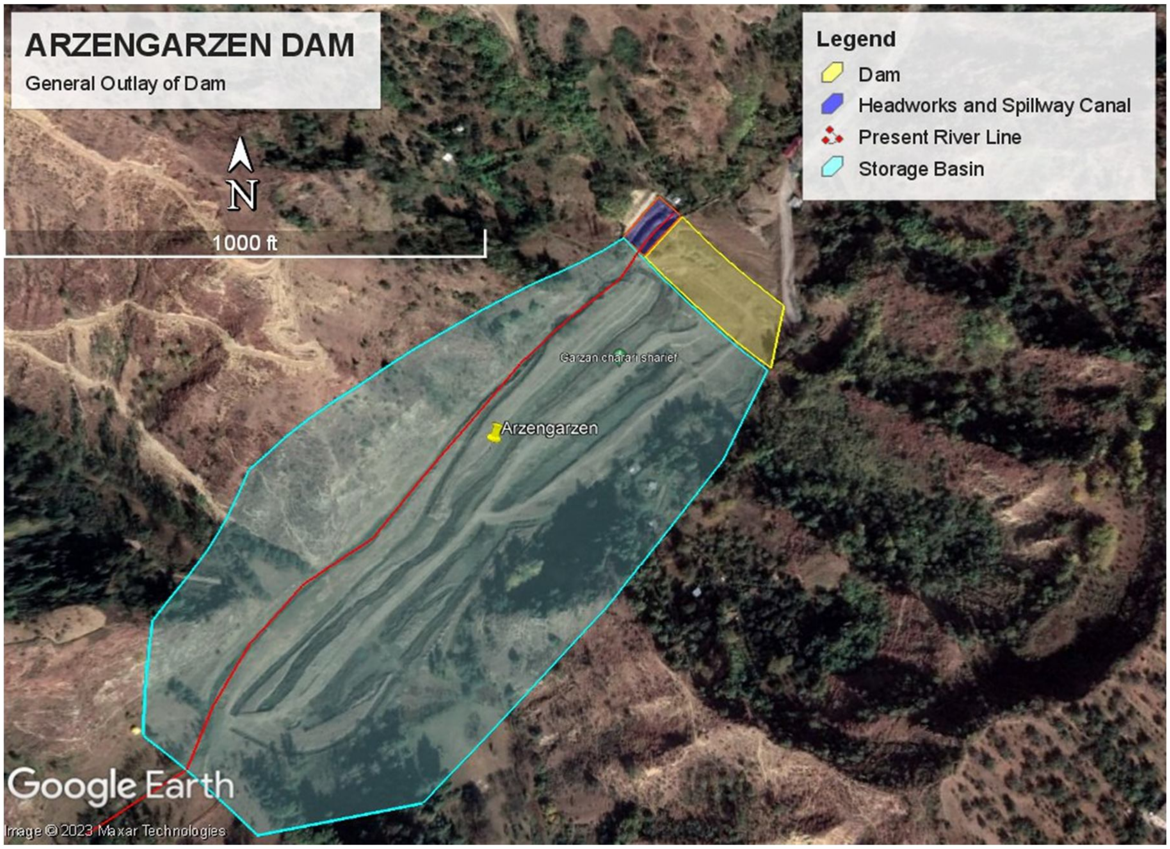
II. STUDY AREA



Location of the sediment profiles surveyed in the Arzengarzen dam

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III. METHODOLOGY

A bathymetric survey of the flooded portion of the reservoir and a direct topographical survey of the non-flooded portion, which is the area between the usual water level and the water level at the time of the measurement, are typically used to measure siltation in reservoirs. The foundation of the bathymetric survey is a straightforward comparison of the reservoir shape at two distinct points in time: the dam's construction and the survey's completion. A bathymetric survey of the reservoir bed was carried out along previously recognized transverse profiles in this study. This technique is straightforward and user-friendly, but it lacks precision and cannot be applied consistently to depths of less than five meters (Claude and Chartier, 1977). The cross section of the reservoir to be surveyed for this study is selected using a topographical plan of the dam reservoir's area at a scale of 1: 5000 and contour spacing of 2 m. Although there isn't a set criterion to follow, we usually look for cross sections that go to the wadi's bed, avoiding narrowing and ideally selecting the largest parts. If there are multiple branches that split from the reservoir,

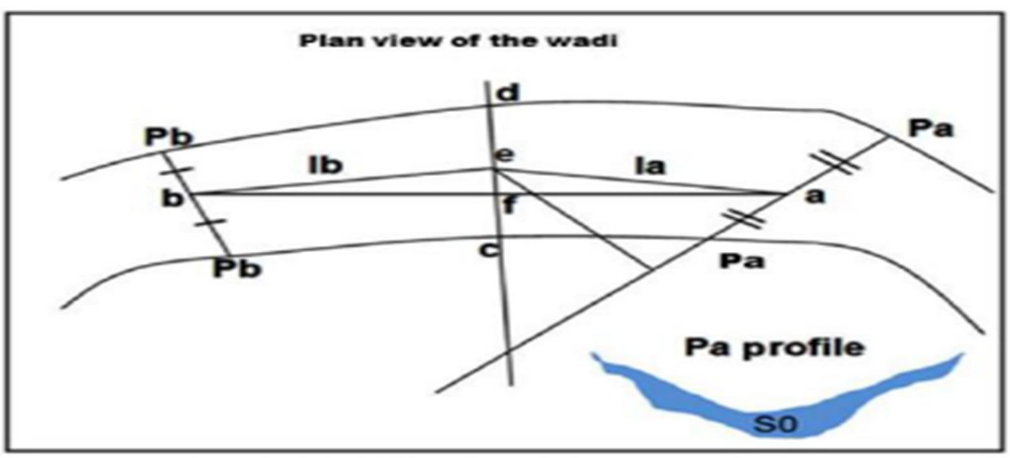
Nine cross sections of the Arzengarzen earthen dam were located (Figure below). The topographical plan was used to determine the original (initial) cross section of the reservoir for each profile at the time of impoundment in 1975. Subsequently, bathymetric studies were carried out in order to determine the present reservoir depths. The original profile and the updated profile are contrasted. The area of siltation (measured in meters squared) of a section at the height of the water site where the measurements were taken is what is quantitatively determined in a GIS using the two profiles thus obtained and the profile's silted surface. The General Method was employed in this study to calculate the siltation volume. The angles between neighbouring sections, represented as Pa and Pb in (Figure below), are also taken into consideration by this method, which is based on silted portions of the surveyed profiles (Claude and Chartier, 1977; Alahiane et al., 2014).

The two retention profiles Pa and Pb's sediment surfaces, Sa and Sb, respectively, are first identified. The separation between these two profiles is then computed

To do this, we draw a line ab between the places where Pa and Pb are centred, and we draw a line cd at the centre of segment ab that is perpendicular to it. The lengths la and lb are determined by measuring the distance between points a and b and the midpoint (e) of segment cd.

The slopes αa and αb, respectively, for Pa and Pb in relation to the straight sections ea and eb are taken into consideration when calculating the total volume. V_{ab} is entire volume (Claude and Chartier, 1977) as follows:

Diagram showing the whole approach to estimation



Legend: S0 = silted section on the survey profile Pa

$Va_b = S_a \sin\ \alpha\ a/a + S_b \sin \alpha\ b/b$

Where αa is the angle z}|{ eaPa and αb is the angle z}|{ ebPb.

volume of sedimentation. Partially seen are a plan view and, in the lower right corner, a cross-section profile view.

Two thousand three hundred m3 year/yr 0.25 percent of the reservoir's live capacity (which is 9.1 × 106 m3). Based on the second measurement, 14.8% of the reservoir capacity has been filled, which translates to an annual siltation rate of 2851 t m^3/yr. This implies that the reservoir will take approximately 12 years to fill completely. From 1975 to 1989, the annual rate of siltation rose twice, resulting in a reduction of the dam's life from about 25 years to 7 years.

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This can be explained by the watershed's maquis vegetation being cleared out as a result of annual crops' exponential growth. The latter activity, which entails plowing in the slope's direction, accelerates and exacerbates erosion inside the Arzengarzen earthen dam. The estimated erosion from the watershed increased from 0.48 to 1.39 mm yr−1 within the same time period.

Since the Arzengarzen earthen dam has been in use since 1975, 12 years have passed since the last measurements were taken. Table 2 provides an overview of the dam's operating outcomes. Assuming the same value as for the Arzengarzen earthen dam calculated over 12 years, we calculated the total sediment input to the dam by assuming that the volume of water released had a mean load of 3 g L−1 (or kgm−3) of sediment (Ben Mammou and Louati, 2007). This presumption is dependent upon rainfall patterns, land use in the watershed, Furthermore, based on spot measurements taken during rainy season, it was assumed that the spilled water contained 1 g L−1 of sediment, taking into account the reservoir's form

Measurement of siltation in the Arzengarzen earthen dam

Measurement Date	Water level (m)	Siltation 10^6 m^3	Annual siltation (m^3)	Reservoir capacity infilled with sediments (%)	Reservoir capacity with sediment per year (%)	Erosion of watershed tm^3/yr
April 1980	17	0.11	1023	1.01	0.03	0.04
May 1989	2	0.47	2851	0.93	0.002	0.12

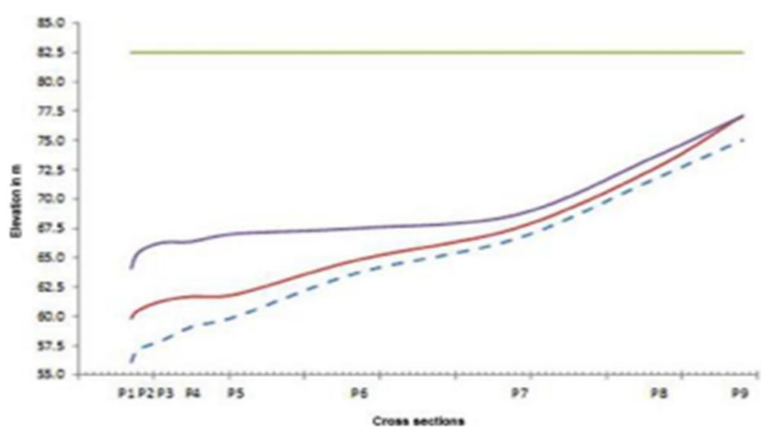
+

The Arzengarzen earthen dams annual average turbidity is estimated to be 6.56 g L−1, which translates to 1.547 × 106 t or 1.289 × 106 m3 solids contributions. This estimate is based on the findings of a comprehensive two-year measurement campaign of the turbidity of the main source in the watershed. When the measured sedimentation in the reservoir is compared to the measured turbidity of the released and spilled water, the difference can be attributed to long-distance transportation. This means that there is thrusting of 0.445 × 106 m3 (1.289 × 106 m3 compared to 1.734 × 106 m3), which is equivalent to 25% of the total sediment transportation (1.734 × 106 m3) and 34% of the suspended transportation (1.289 × 106 m3). Is occurring due to alluvium soils, the reservoirs of Arzengarzen earthen dam lose between 0.5 and 1% of their capacity annually.

The average yearly volume of silt trapped in the reservoirs of Arzengarzen earthen dam ranges from 0.017 x 10^6 m3

Results of sediment transport in Arzengarzen earthen dam during 1980- 1990

	Measured siltation	Sediments in released water	Sediments in spilled water	Total sediment yield
Volume t m^3	1.563	0.113	0.116	1.792



IV. CONCLUSION

One natural process that is thought to be the main contributor to the degradation of agricultural land is water erosion. Corrective action must be taken before soils lose their fertility. The volume of sediment trapped in the Arzengarzen earthen dam can be estimated thanks to the siltation measurements that are shown here. It is claimed that agricultural land could once again receive the sediment that was trapped. Precise mapping of the reservoir bed and the choice of profiles affect the accuracy of the sedimentation estimation approach. It is important to create siltation measures that will track the progress of a dam's life span and enhance operational conditions on a regular basis. The outcomes of these actions have brought attention to the considerable erosion that the Arzengarzen earthen dam's watershed experiences. Utilizing a runoff and erosion model with distributed physical factors throughout the watershed helps enhance comprehension of the variables

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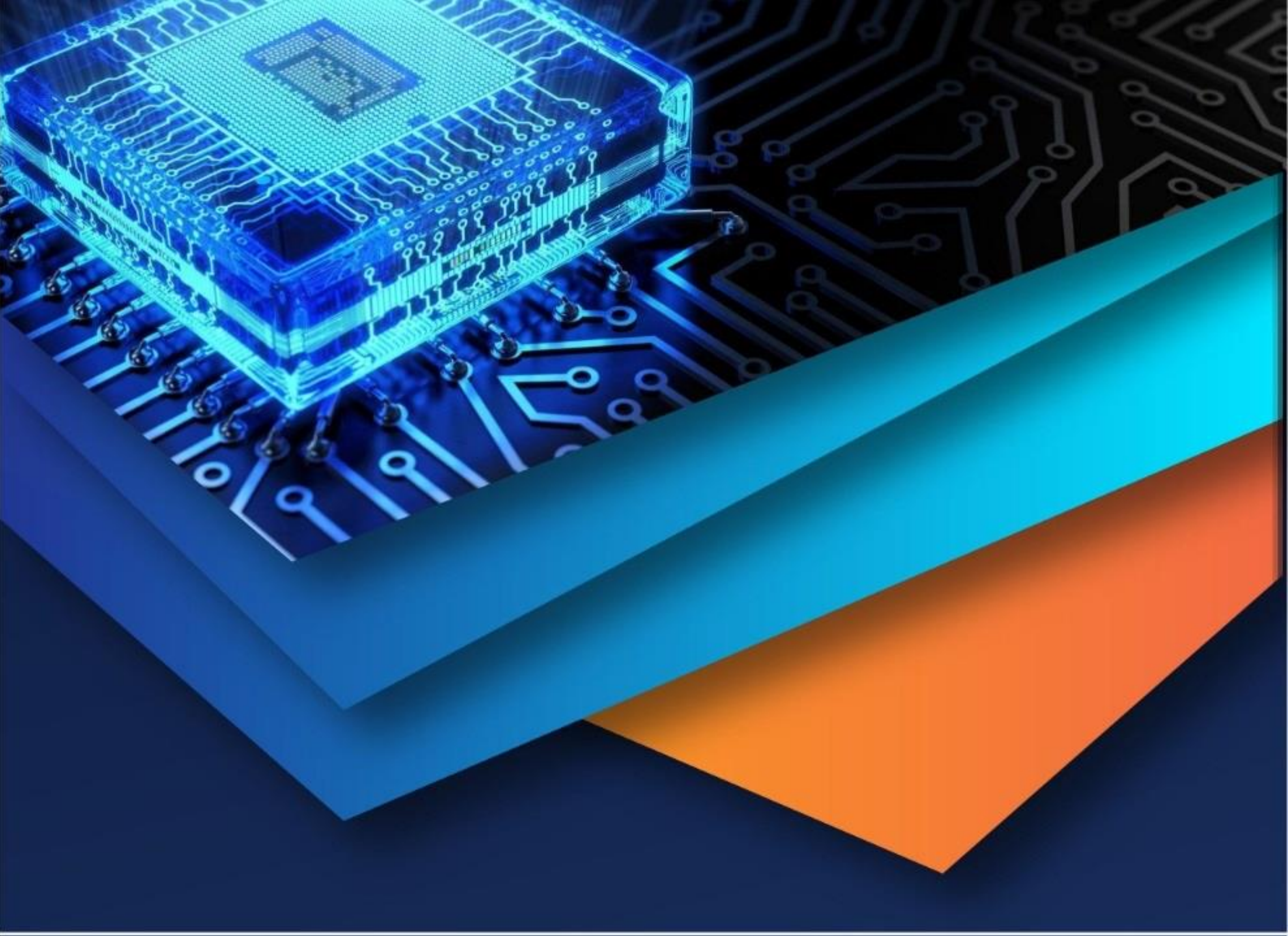

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