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SEDIMENTATION AND WATERSHED MANAGEMENT OF KRISHNAGIRI RESERVOIR, INDIA

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Abstract: *The state of Tamilnadu located on the south east coast of India. The state records an average rainfall of 120 cm out of which 80% is during north east monsoon in November and December. Hence a number of dams were constructed to store the water. Krishnagiri is one such reservoir constructed in 1957 across Ponnaiar River west side of Tamilnadu. It is serving the purpose of both irrigation and drinking water. In order to assess the capacity, surveys of the reservoir were periodically done. As per the calculation, the reservoir's life got reduced. This calls for a detailed monitoring program of the watershed and sedimentation survey. The necessary management activities were planned and executed by incorporating all the user departments of the watershed. Then the sedimentation assessment in the reservoir was carried out during 2006. The results shows that in the initial period of the construction of reservoir, the annual rate of sediment was more when comparing to that of recent studies. This reduction in rate of sediment is due to the improvement activities done in the catchment area and watersheds to manage the erosion of sediments. The details of sediment survey, methodology of capacity estimation, assessment of the life of the reservoir, and improvement measures adopted are explained in the paper*
Keywords: *Sedimentation, reservoir, capacity; survey.*

INTRODUCTION

Sedimentation embodies the process of erosion, entrainment, transportation and deposition in the low lying area. These are the natural process that has been active through out the time. Sedimentation will be activated mostly due to rainfall, runoff, stream flow, and the wind force. The erosion process occurs through the rainfall impact force on the ground. Sedimentation in a reservoir is a serious problem as it reduces the life of the utility of the reservoir which can be termed as its useful life. The life of the reservoir cannot be forecasted precisely as the deposition of the sediment cannot be accurately estimated.. Reservoir acts like a sediment trap by interrupting the fluvial sediments. Without proper measures to balance sediment outflow and inflows, eventually this infill of sediments will completely displace the reservoir storage capacity. The non availability of new dam sites, growing environmental obstacles, high costs are some of the factors that make it increasingly difficult to replace sediment reservoir by developing new sites. Hence it is imperative that proper attention must be focused on the management of

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existing reservoirs to minimize sedimentation and maximize storage volume. As a case study the Krishnagiri Reservoir in Krishnagiri District shown in Fig 1 in Tamilnadu has been taken for assessment of reservoir sedimentation process.

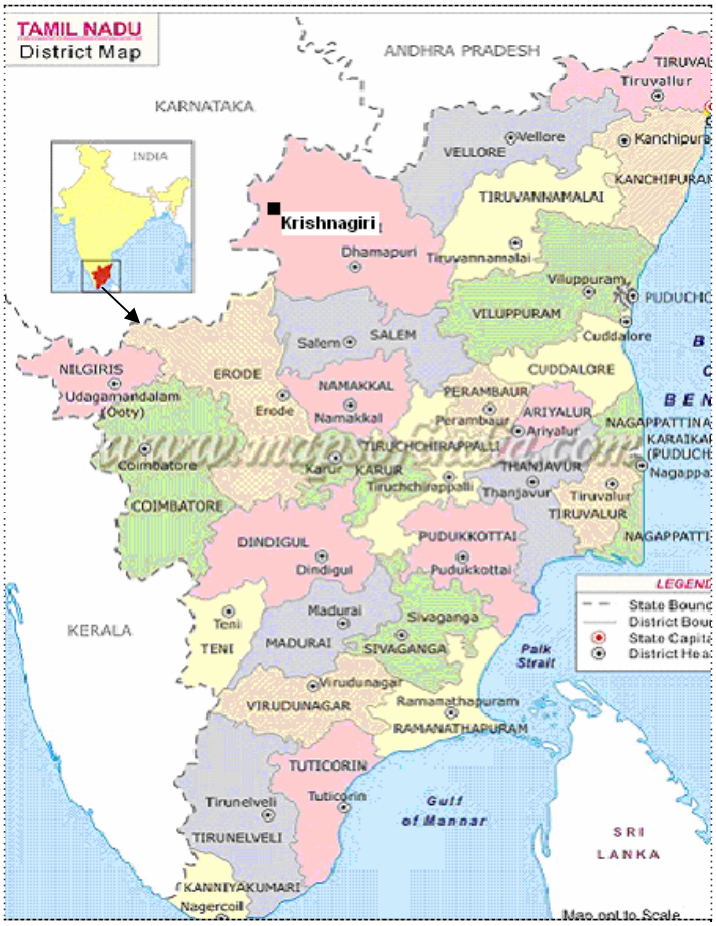

Fig 1 Index map

OBJECTIVE OF THE STUDY

Sedimentation surveys are necessary to get more realistic estimate regarding the rate of silting and to provide reliable criteria for studying the implication of annual loss in storage over a definite period of time with particular reference to reduction in intended benefits in the form of irrigation potential, hydropower, flood absorption capacity and water supply for domestic and industrial use etc., and periodic reallocation of available storage for various pool level. It will also help in proper estimation of loss of storage at planning stage itself besides evaluation of the effectiveness of soil conservation measures carried out in the catchments are of river valley projects. The major cause of the loss in the storage is due to sediment deposition. The monitoring program by systematic capacity survey is useful for estimating the life of the reservoirs. The main objectives of the present study re detailed below

- Storage depletion caused by the sediment deposition
- Annual sediment yield
- Current location of sediment
- Sediment density
- Lateral & longitudinal distribution of sediment deposition
- Reservoir trap efficiency
- Correcting periodically the stage - capacity curve

FEATURES OF KRISHNAGIRI RESERVOIR

Location

Krishnagiri Reservoir finds its location between 78^0 and 79^0 E and 12^0 and 13^0 North across Ponnaiar River in Krishnagiri District of Tamilnadu indicated vide Fig 2 with designed capacity 68.2 million m^3. It was the first reservoir formed across Ponnaiar River, there being only small and big irrigation tanks in the upper reaches of its watershed both in Karnataka & Tamilnadu.

Watershed

Ponnaiar has its origin in south-eastern slope of Chennakesava hills, north-east of Nandhidurg in Karnataka state and runs through Dharmapuri, Vellore and Cuddalore districts of Tamilnadu covering over 416 km in Tamilnadu limit. In broad view up to Krishnagiri in Tamilnadu it runs in mountainous region with deep valleys and gorges and afterwards it plains up to Sathanur dam in flood plains up to Bay of Bengal. The River basin of Ponnaiar River has 12744 Km^2 of catchment area and other details are as follows.

Hydraulic Particulars

River	- Ponnaiar
Construction period	- 1955-1958
Catchment area	- 5428 Km^2
Design flood	- 4234 m^3/sec
F.R.L	- 483.11 m
M.W.L	-484.63 m
Area at F.R.L	-12.46 Km^2
Cap. at F.R.L	- 68.20 million m^3

Fig 2 View of Krishnagiri Reservoir

SEDIMENTATION SURVEY

For conducting sedimentation studies in any reservoir an accurate water spread map is to be prepared. A reconnaissance survey (Fig 3) of the whole water spread should be made so as to mark or to identify the proper location of ranges along which cross sections are to be taken to access the present capacity of reservoir and thereby the volume of the sediment. The ends of ranges should be in the periphery of the water spread well above the F.R.L so that the monuments can be retraceable after a considerable period for conducting subsequent surveys. For locating the position of range pillars or to check already existing range pillars in water spread map triangulation survey connecting all the range pillars should be conducted with reference to base line. The cross sections of the range lines should be found out by conducting hydrographic survey (Fig 4) by echo sounder/ ground survey by leveling depending upon the water level in the reservoir. From the cross section survey, the present bed levels should be plotted in the map and contours should be drawn. Based on the contour map, the present capacity can be calculated by different methods. From this, the reduction in capacity or the total volume of sediment deposited in the reservoir from the date of construction to the present survey can be worked out. Thus the sedimentation survey involves the following.

- Collecting the original water spread map at the time of commissioning of the dam or collecting the water spread map prepared during the previous surveys.
- Reconnaissance for fixing range lines or ascertaining the range lines and erection of range pillars.
- Triangulation survey and fixing the position of range pillars on map.
- Check leveling for finding out the top levels of range pillars.
- Hydrographic survey and ground survey along range lines to find out the present bed level.
- Collection of soil samples along the range lines and their analysis.
- Preparation of contour map and grid map for the present survey.
- Working out the present capacity of the reservoir by different methods.
- Analysis of data and presentation of results

Fig 3 Triangulation survey and fixing the position of range pillars

Fig 4 Hydrographic survey

CAPACITY CALCULATION

The capacity of reservoir is usually calculated by the following methods

- Contour area interval method
- Prismoidal formula method
- Modified prismoidal formula method
- Grid method

Based on the field conditions and experience the Grid method is found to be applicable as given in I H H report (1983) and is shown in Table 1

Table 1 Capacity calculation by Grid method

Sl.no	Contour level (m)	Area in Km^2	Capacity $MillionM^3$
1	471.46	0	0.0000
2	472	154880	0.0010
3	474	748800	0.3899
4	476	1632640	1.9562
5	478	3156480	6.3144
6	480	5785600	14.2119
7	482	10092800	25.5877
8	483.11	10954880	39.7034

RESULTS AND DISCUSSIONS

Totally five reservoir surveys were conducted from 1976 and is detailed in Table 2. The reservoir was constructed in 1957 with a capacity of **68200000 m^3**. But from the subsequent surveys indicate a reduction in capacity and at present it is about **39700000 m^3**. Rate of sedimentation was very high in the initial periods. By adopting suitable watershed management strategies the siltation rates were reduced and is indicated in Table 2

Table 2 Capacity reduction and sedimentation rates.

Year of Survey	Capacity of the Reservoir (Million m^3)	Capacity loss (Million m^3)	Capacity loss in %	Rate of sedimentation between surveys (%)
1976	56.47	17.73	25.99	1.37
1981	47.79	20.41	29.93	0.78
1983	47.18	21.02	30.81	0.44
2006	39.70	28.50	41.79	0.48

CONCLUSIONS

The capacity of the reservoir was reduced by 26% in about 20years. By adopting suitable watershed management strategies through participation of various user department of the watersheds, the siltation rates were reduced. Now attention should be focused on the removal and usage of the trapped silt so that the capacity can be increased.

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