WORKSHOP

ON

RESERVOIR SEDIMENTATION ASSESSMENT USING REMOTE SENSING DATA

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Module 7

Sedimentation Analysis of Mahi Bajaj Sagar Reservoir Through Satellite Remote Sensing

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SEMENTATION ANALYSIS OF MAHI BAJAJ SAGAR RESERVOIR THROUGH SATELLITE REMOTE SENSING.

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The present paper describes the work carried out on Bajaj Sagar Reservoir using 5 dates of satellite data. The stage - area - capcacity curves were modified and the reservoir storage loss was estimated.

The natural hydrologic processes like erosion in the catchment area, movement of sediment and its deposition in various parts of reservoir require careful consideration in planning of major reservoir projects. The silt which gets deposited at different levels, reduce the storage capacity of reservoir. Periodical capacity surveys of reservoir help in assessing the rate of sedimentation and reduction in storage capacity. This is not only necessary for efficient management of reservoir, but also helps in taking a decision about treatment of catchment area, if the rate of sedimentation is excessive.

Satellite Remote Sensing by virtue of its synoptic coverage and repeativity is found to be very useful in capacity surveys of the reservoirs. Its multi date data directly provides the elevation contours in the form of water spread area. Any change in relation between elevation and aerial extent of reservoir is indicative of sedimentation in the reservoir. The loss of storage capacity of the reservoir can thus be determined by evaluating the change in the aerial spread of reservoir at different elevations. The new values can be used for modification of stage area capacity curve.

The present paper describes the silt status of Mahi Bajaj Sagar reservoir.

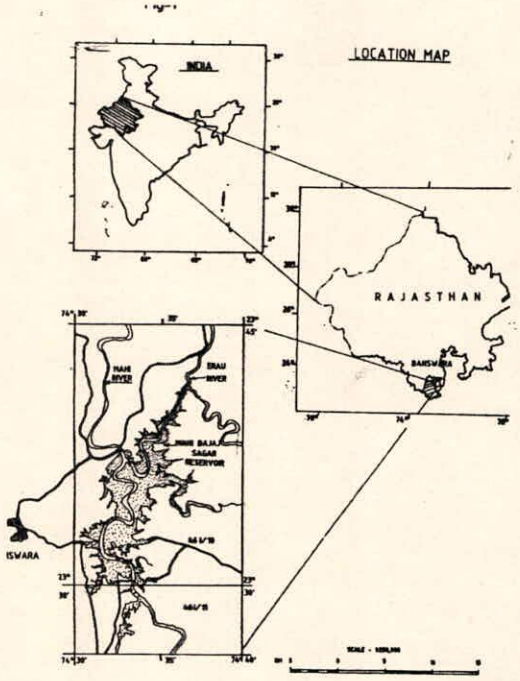
OBJECTIVES

Objectives of the present study were :

- Updating the stage - area - capacity curve.
- Estimation of storage loss due to sedimentation.

STUDY AREA

Mahi Bajaj Sagar reservoir located near village Borekhera, about 16 km North-Est of Banswara town has its spread between 23o20' to 23o45' East longitude (Figure 1). The dam was built across river Mahi which has its source in Amarkantak area of Dhar district in Madhya Pradesh. After flowing 120 km in Madhya Pradesh towards North-West, it enters Rajasthan and turns North wards. In Rajasthan Mahi receives water from four of its major tributaries viz. Erau, Som, Chap, and Anas.



DATA USED

IRS 1B LISS II data with 36 m resolution was used for the analysis. The date of pass for the study are given in table 1.

Table 1: Date of pass for data

Quadrant	Date of pass
30 / 51 A2	21 October 94
	28 April 94
	30 January 94
	17 December 93
	06 March 93

The other data which were used include :

- SOI toposheets at 1:50,000 scale.
- Reservoir level, area and capacity on date of pass of satellites data.
- Original stage - area - capacity curve

METHODOLOGY

The methodology consisted of following steps

1. Data base creation
2. Water spread area estimation
3. Estimation of reservoir capacity
4. Estimation of capacity loss due to sedimentation

Data base creation : The satellite data was georeferenced with respect to SOI toposheets using neighbourhood technique and 0.5 pixel r.m.s. error. Other images were registered with georeferenced image.

Water spread area estimation : Water spread area estimation was done using near infrared and red bands of satellite data. NIR band was density sliced to obtain water spread. NDVI output was also used for the analysis. FCC, NIR band and NDVI output, all were used to correctly demarcate water pixels on the image. Tail portion of the reservoir were it merges with river were removed. FCC of different dates are shown in plate 1. Water spread area was calculated by multiplying number of pixels with area of each pixel. Table 2 shows the area for different dates and corresponding elevation values obtained from Bajaj Sagar dam authorities.

Table 2: Areal extent of reservoir from R.S. data.

Date of pass	Areal extent $M^2 \times 10^6$	Elevation in meter
21 October 94	111.73	279.25
28 April 94	49.01	264.35
30 January 94	80.52	272.75
17 December 93	99.43	276.75
06 March 93	59.32	267.8

The elevation 279.25 m for October 1994 is near to full reservoir level (FRL), whereas elevation 264.35 m for April 94 is near minimum draw down level(MDDL).

Estimation of reservoir capacity : To calculate the elevation values corresponding to satellite date of pass and at closer intervals required for treapezoidal formula, a graph was plotted between area and elevation. The table 3 shows the aerial extent of reservoir at regular interval from graph.

Table 3 : Areal extent

Elevation in m	Area in meter^2
233.78	0.0
234.69	1.20
237.74	2.30
240.792	3.50

Elevation in m	Area in meter^2
243.84	5.20
246.888	9.15
249.936	13.17
280.750	120.39

Reservoir water capacity was estimated using three formulae

Trapezoidal formula $V = (h/2)(A_1 + A_2)$

Modified trapezoidal formula $V = (h/3)(A_1 + A_2 + SQRT(A_1 * A_2))$

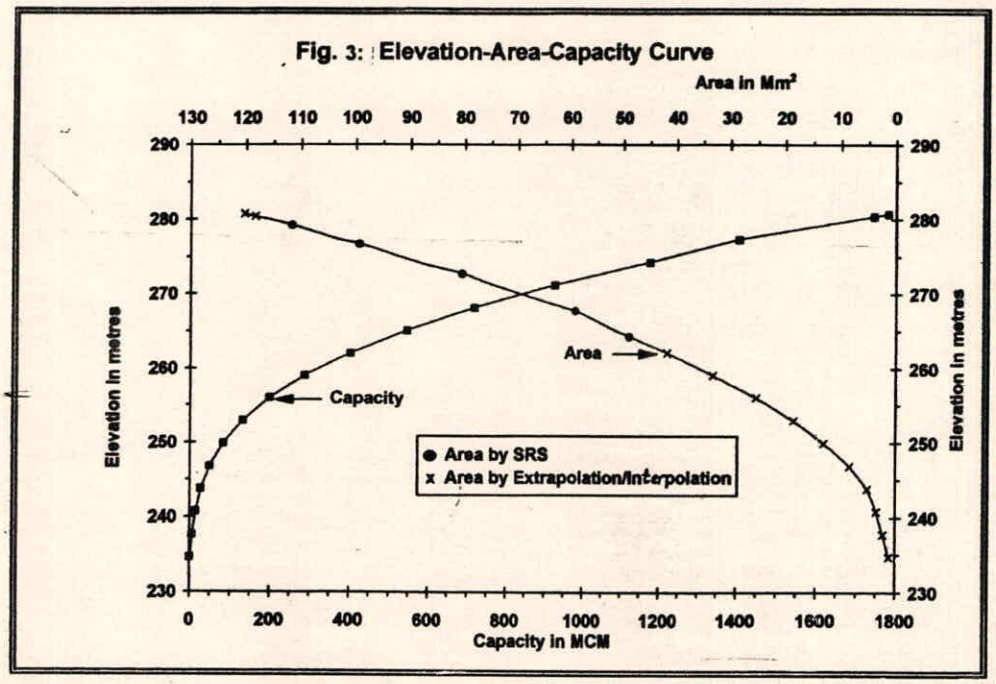
Prismoidal formula $V = (h/3)(A_1 + 4A_2 + 2A_3 + 4A_4 + ...)$

Where A1 and A2 are the area of successive contours and h is the interval between successive contours. The capacity between successive contours and the cumulative capacity is given in table 4.

Elevation in m	Capacity in Mm3	Cumulative capacity
233.38		0
	0.546	
234.69		.546
	5.334	
237.74		5.88
	8.840	
240.792		14.72
	13.260	
243.84		27.98
	21.870	
246.88		49.85
	34.020	
249.94		82.87
	48.340	
252.98		132.21
	66.900	
256.03		199.11
	89.270	
259.08		288.38
	114.570	
262.128		402.95
	142.650	
265.176		545.60
	172.440	

Elevation in m	Capacity in Mm3	Cumulative capacity
268.224		718.04
	208.030	
271.272		926.07
	249.780	
274.32		1175.85
	229.990	
277.368		1405.84
	337.870	
280.416		1743.71
	36.38	
280.75		1780.09

Figure shows the modified elevation - area - capacity curve.



Capacity loss estimation due to sedimentation - Table 5 shows the comparison between original capacity and present capacity at different elevations.

Table 5: Capacity loss

Elevation in m	Cumulative capacity in M cum	
	Original	Modified
233.78		0.0
234.69	34.3	.546
237.74	40.1	5.88
240.792	50.25	14.72
243.84	65.4	27.98
246.888	89.07	49.85
249.936	128.13	83.87
252.984	185.27	132.21
256.032	253.14	199.11
259.080	346.88	288.38
262.128	467.23	402.95
265.176	627.22	545.6
268.224	809.86	718.04
271.272	1059.96	926.04
274.320	1329.46	1175.85
277.368	1640.94	1405.84
280.416	2031.71	1743.71
280.750	2058.69	1780.09

New zero elevation of the reservoir has been fixed at 233.78 m against the original of 228 m. Present dead storage is 288.38 cum indicating that the reservoir is filled by 58.62 cuM (2.07 TMC) with sedimentation deposition in dead storage.

Present live capacity works out to be 1491.71 Mm^3 or 52.69 TMC against designed capacity of 1712 Mm^3 or 60.45 TMC. It means that there is 12.85 % reduction in live storage over a period of 11 years. (1983 - 1994).

CONCLUSIONS

The following conclusions emerge from the study -

- The present dead, live storage estimated capacities are 288.38 Mcum (10.18 TMC), 1491.7 Mcum (52.68 TMC) and 1780.09 Mcum (62.86 TMC).

- Capacity loss of 16.86 % is observed in dead storage and 12.85 % in live storage, in a period of 11 years.
- The gross capacity loss of 278.6 Mcum i.e. 9.84 TMC (13.53 %) is observed over a period of 11 years. The annual capacity loss works out to be 1.23 %.
- Capacity estimation by RSR technique enables a quick and dependable estimation of capacity loss due to sedimentation in a major reservoir.