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ASSESSMENT OF RESERVOIR SEDIMENTATION IN PANSHET RESERVOIR BY HYBRID METHOD

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Abstract: - Water is generally considered as a renewable natural resource, which is true only if it is used wisely. Due to the uneven distribution of rainfall over time and space in India, water storage reservoirs are necessary for ensuring adequate and sustained water supply throughout the year and also to control the irregularities of the stream discharges. Manmade or artificial reservoirs are designed, maintained and operated to serve domestic and industrial water supplies, water based recreation, hydropower, flood control, irrigation and water augmentation for navigation. Probably one of the most important impacts of maintaining a reservoir is the loss of storage capacity caused by sediment deposition behind the dam. Sediment deposition in the reservoir reduces the water storage volume and decrease the utility of the reservoir and the water quality in the reservoir deteriorates. The loss of utility of a reservoir as a result of sedimentation or siltation can be considered an economic, environmental, and even design failure. The present study deals with the finding the capacity loss due to sedimentation using Hybrid technique i.e. combination of DGPS bathymetric survey and satellite remote sensing method of the Panshet dam in Pune district of Maharashtra. The study also reveals that there was loss of the order of 30.24 Mm³ in Panshet dam in gross storage for the year 2007 which is equivalent to 1 month water demand of Pune city. Further, the loss in live storage capacity was calculated for the future year 2051 and suggestions are also given to improve storage capacity and necessary measures to reduce the gap between supply and demand for future years.

Keywords: Reservoir sedimentation, long term sedimentation, loss of storage capacity.



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INTRODUCTION

Panshet Reservoir, popularly known as Tanaji Sagar which is named after great Maratha warrior Tanaji. The Panshet dam on river Ambi, is located at Longitude $73^{\circ} 38' E$ and Latitude

$18^{\circ} 14' N$ at about 40 Km west of Pune city near village Panshet, Taluka Velhe, District Pune of Maharashtra, India Figure 1. The Panshet dam was built to provide irrigation facilities and to cater water supply requirements to Pune city. The dam was completed in the year 1961, but breach was occurred due to heavy and abnormal rainfall in the catchment area. Then the project was revised in 1972 for restoration of Khadakwasla and Panshet dams and further revised in order to extension of Mutha Right Bank Canal (MRBC) from 162 Km to 202 Km to cater irrigation demand of 62,146 Ha command area.



Figure: 1 Location map of Panshet reservoir

The gross storage capacity of Panshet dam at FRL 635.81 m is 303.93 Mm^3 thereby creating live storage of 294.93 Mm^3 between MDDL 597.41 m and the FRL 635.81 m. Considering the 100 year's life of the reservoir, the dead storage capacity of 9.00 Mm^3 was kept at RL 597.41 m to allow silt deposition from the 120.30 km^2 catchment area. The catchment area of Panshet dam is of elongated shape and the average longitudinal slope of the catchment is about 10.0 m/km. At the time of planning, rate of siltation was assumed to be $3.57 \text{ ha-m}/100\text{km}^2/\text{year}$. [1]. River Ambi is a tributary of Mutha River and this river transports a lot of silt to the reservoir. The main reasons of deposition of silt in the reservoir is due to deforestation, indifferent contour terrace farming, over-grazing in the pasture land, unscientific agricultural practices, absence of effective afforestation programs and other development activities undertaken in the catchments area including roads, buildings and commercial complexes. Such developmental activities directly add erosive forces. Moreover ploughing of land and wrong methodology of

cultivation in villages also result in disintegration of soil. The silt thus transported to the river and its tributaries and is deposited in the reservoir, which leads to reduce the life of the reservoir, so the Assessment of sediment deposition becomes very important for the management and operation of reservoir, including periodical assessment of siltation. Different methods of assessing sedimentation in reservoir are in vogue today viz.

1. Conventional Hydrographic survey.
2. Inflow outflow method / stream flow analysis.
3. Remote sensing method.
4. Empirical methods- Area reduction method.
5. Mathematical model etc.

More ever each of these methods has some merits and demerits over each other when applied independently [1].

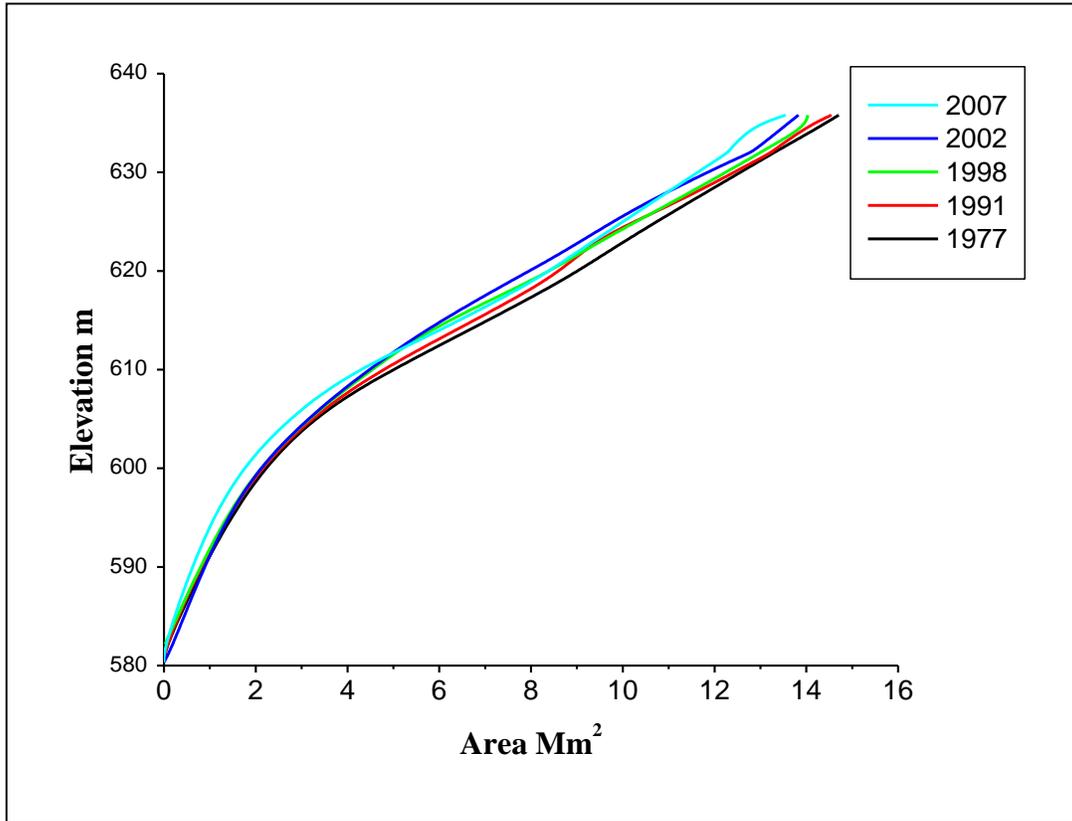
To overcome the demerits of these methods the Remote sensing method and DGPS – Bathymetric survey in combination called Hybrid technique were applied to cover the entire reservoir portion from its bed level to its FRL.

In the present paper loss in capacity due to sedimentation in Panshet, by using hybrid technique is estimated for the future years.

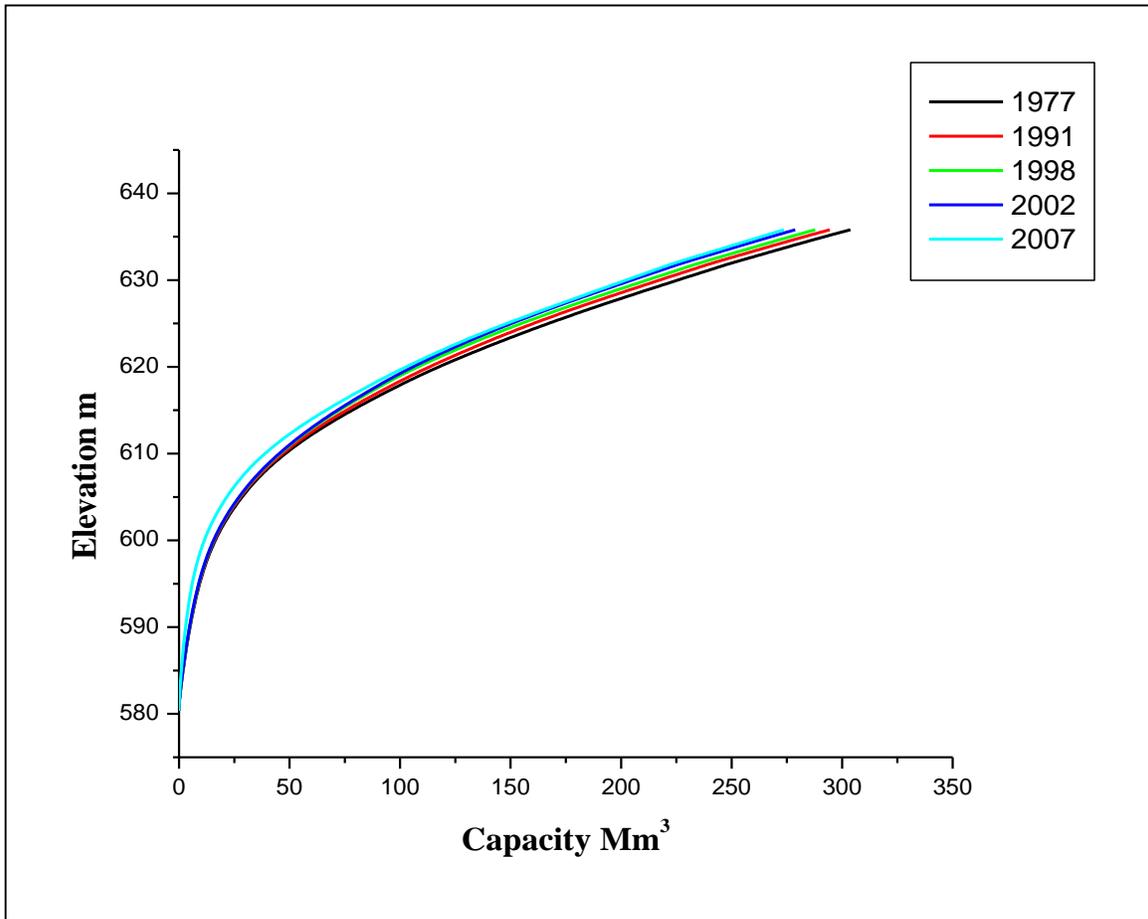
METHODOLOGY:

Hybrid technique is a blending of DGPS Bathymetric survey with satellite remote sensing technique. To estimate total siltation in reservoir from bed level to FRL the area and capacities were found out individually by DGPS & RS survey for different portion of the reservoir, then the result of two different methods for area and capacities are joined together after clubbing both survey, revised area capacity table at 1 m regular interval is prepared, comparing the present gross capacities with the original gross capacities loss in storage capacity of the reservoir was calculated.

Assessment of reservoir sedimentation is done by hydrographic survey in 1977 and by SRS technique for the periods 1991, 1998, 2002 and by hybrid method for the period 2004-2007. The elevation Vs area and capacity curves for different years is shown in Graph 1.and Graph 2



Graph 1: Comparison of the water spread areas of Panshet reservoir



Graph 2: Comparison of cumulative capacities of Panshet reservoir

The difference between the cumulative capacities of original (1977) and SRS survey and by Hybrid technique for the year 2004-2007 gives loss in live storage zones as shown in Table.1

The study shows that there is considerable loss in live storage of Panshet reservoir for the year 2007 was 26.48 Mm³ and annual losses for 30 years was 0.299 [2]. Therefore average annual loss 0.30 % is considered for estimation of loss in storage capacity for future years for Panshet reservoir. The loss in live storage capacity due to sedimentation considerably affects the water supply. The decrease in live storage up to 2051 in these reservoirs is shown in Table I

Table I: Loss of live storage for Panshet reservoir

Year	Reservoir capacity	Loss of capacity Mm ³		Period years		Rate of siltation Mm ³ /year		%Loss of capacity from 1977	% Annual loss
		From 1977	From previous years	From 1977	From previous years	From 1977	Between two survey		
1977	294.93	-	-	-	-	-	-	-	-
1991	285.56	9.37	9.37	14	14	0.66	0.66	3.17	0.226
1998	279.09	15.84	6.47	21	7	0.75	0.92	5.370	0.255
2002	270.21	24.72	8.88	25	4	0.98	2.24	8.38	0.335
2007	268.45	26.48	10.4	30	5	0.88	2.08	8.97	0.299
2011	265.22	29.71	3.23	34	4	0.87	0.80	10.07	0.296
2021	257.22	37.71	8	44	10	0.85	0.80	12.78	0.290
2031	249.22	45.71	8	54	10	0.85	0.80	15.49	0.287
2041	241.22	53.71	8	64	10	0.85	0.80	18.21	0.284
2051	233.22	61.71	8	74	10	0.85	0.80	20.92	0.282

RESULT AND DISCUSSION

1. It is observed that the gross, dead and live storage capacities of Panshet reservoir for the year 1977 were 303.932 Mm³, 9.0 Mm³ and 294.93 Mm³ respectively. As per remote sensing survey for the year 2002 these storage capacities were estimated as 278.85 Mm³, 8.56Mm³ and 270.21 Mm³ respectively. And as per hybrid method for the year 2007 these storage capacities estimated were as 273.688, Mm³, 5.234Mm³, 268.45Mm³ respectively
2. The overall loss in the gross storage capacity of Panshet reservoir since 1977 to recent survey by Hybrid method comes out to 30.24 Mm³ which was 9.94 % of the gross storage. Therefore, the percentage annual rate of siltation for gross storage for the year 2007 was 0.316.
3. It can be seen that for the live storage capacity of 294.93 Mm³, the capacity of the dam has reduced by 26.48 Mm³ 8.97% in 30 years and it will further reduced to 61.71 Mm³ 20.92% in the year 2051 if no measurements are taken.

4. In general, the rate of percent annual loss of gross capacity varying from 0.215% to 0.330% appears to be comparatively on the lower side in comparison to gross percent annual loss of 0.5 to 1.0% in many of the Indian reservoirs. [1].

CONCLUSION:

1. In the Panshet reservoir during 1977-2007, study indicate that net losses in live storage 26.48 Mm³ i.e. 8.97% within 30 years. The rate of siltation was 0.252% for 1998, 0.330% for 2002 and 0.316% for the year 2007. Hence it is seen that as against the design rate of siltation 3.57 Ha-m/100Km²/year, the net rate of siltation works out to be of the order of 73.37 Ha-m/100Km²/year in the live storage respectively.[3]

2. As such, there was the net siltation of the order of 10.07% in the Panshet reservoir upto 2011 could be dredged suitably to recover the storage water of 29.71 Mm³ which contributes for the future need of Pune water supply scheme.

3. It is recommended that the sedimentation survey for the Panshet reservoir may be conducted by such Hybrid technique at a regular interval of 5 years for assessing the net sedimentation in the reservoir as there is considerable sedimentation in Panshet reservoir as compared to other two reservoirs.

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