ASSESSMENT OF PRESENT STORAGE POTENTIAL OF RESERVOIRS - A MAHARASHTRA SCENARIO

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Abstract

Reservoirs are the main source of surface water for human beings. In the post-independence era, the number of reservoirs constructed in the country increased in each decade augmenting its total water storage potential. Today in many areas sedimentation is posing threat to reservoirs, causing reduction in their storage potential. The assessment of storage loss on account of sedimentation in reservoirs is important to ascertain the net storage available for realistic planning. The success of planning the water use truly depends on this basic information. It is therefore essential that these reservoirs be monitored in the context of sedimentation. It is practically impossible to undertake sedimentation assessment surveys of all the reservoirs, in a shorter span of time due to some constraints like inadequacy of infrastructure, shortage of manpower and time, paucity of funds with the reservoir authorities etc. However, the conclusions drawn from the sedimentation studies conducted for some representative reservoirs in different river basins / sub basins can help to predict the reduction in useful water storage potential of the reservoirs which are not yet studied. Surveyed reservoirs belonging to same river basin/sub basin with similar catchment characteristics can be grouped and average rate of storage loss (factor) with due consideration of their present age can be arrived at. From this information, the present storage potential of reservoirs can be predicted.

Key words – River basin, sedimentation, multi-spectral image, Bathymetry, LISS III, IRS

Introduction

In Maharashtra, there are three main river basins namely Tapi, Godavari and Krishna and a western region parallel to sea coast known as Konkan region. In each basin there are number of reservoirs from which water is supplied for irrigating the land. These reservoirs are of different age. Some of them are 80 to 100 years old also. The crops and cultivation practices in different parts of the State are heterogeneous and hence water requirement for irrigating the crops is different for different regions. The storage potential of reservoirs constructed for providing irrigation reduces with the time due to sediment deposition. It is experienced that sedimentation in reservoirs is more in the area where agriculture is dominant land use. Considering the importance and necessity of reassessing the present storage capacity of reservoirs for efficient use of available storage, the sedimentation studies of reservoirs are undertaken by M.E.R.I., Nashik. Conventional methods viz. physical ground survey and hydrographic survey would have been a time taking task and exhaustive one. More advanced GPS based bathymetric survey would have been an expensive proposition. Satellite remote sensing technique has provided an economical and faster solution for this purpose. Present storage assessment surveys of some of these reservoirs in each river basin have been done in the state through Maharashtra Engineering Research Institute (M.E.R.I.) Nashik, since last decade and a half. So far, about 80 major and medium reservoirs (with storage capacity > 20 Mm^3) including representative reservoirs from all the sub basins, with different geographical and agro-climatic zones of the state have been studied in the context of sedimentation. Some of them are studied twice and thrice considering their importance. Multi-date IRS P6/RESOURCESAT 2 LISS III images have been used for the studies. However, this number is less than 50% of the total major and medium reservoirs in the state. Considering large number of unstudied reservoirs in the state, another 10 years span will be required to complete their survey. Based on the results of the sub basin wise studies completed so far certain factor for assessing the loss in storage potential of the reservoirs which are not yet surveyed, have been derived giving due weightage to their age. With this sub basin wise factor, prediction of storage

loss in reservoirs has become possible in more rational way. This prediction in capacity reduction provides an important input for water auditing and assessing performance of irrigation project. Moreover, the prediction in loss of storage helps the irrigation manager to utilize the available storage in effective manner and would help the policy makers and the decision makers to allocate water for different uses.

Because of vast scope of the work, at present in the first phase, only major and medium sized reservoirs are being surveyed. At present the surveys are being done using LISS III image having 24 m spatial resolution. In the second phase, Surveys of minor/ small reservoir with storage capacity in the range of 10 to 20 Mm^3 would be taken up using LISS IV multi-spectral images having 6 m resolution.

Table 1 Different river basins and Sub basins in Maharashtra

Sr. No.	Name of Basin	Sub basins covered			
1	Tapi	Purna	Middle Tapi	----	-----
2	Godavari	Upper Godavari	Middle Godavari	Penganga	Wardha and Waiganga
3	Krishna	Bhima	Krishna	----	----

Figure.1 Maharashtra Map showing three main river basins and a Konkan region

Work done and methodology adopted

Storage capacity assessment surveys of reservoirs have been done by two methods viz. by 1) satellite remote sensing technique and 2) Bathymetric survey. Both these methods have some merits as well as demerits also.

Remote Sensing for reservoir capacity assessment survey

This method is more popular because of its cost effectiveness. It is simple, reliable and faster than conventional method. In this method, water-spread areas at the time of satellite over pass are measured. The water-spread area and the elevation information are used to calculate the volume of water stored between different levels. These capacity values are compared with the original capacity values to find out change in capacity between different levels. The entire job is done in-house and therefore can be conducted in any part of the year and requires no field job. Cost of the work is independent of the size of the submergence area i.e. extent of reservoir. The study can be conducted for past period also. Normally satellite images of about 24 m spatial resolution are used for such studies. But the main limitation of this technique is that in general it covers only the live storage part of the reservoir. Capacity of dead storage zone can not be estimated by this technique.

Bathymetric survey

The bathymetric survey is accurate and reliable. The survey gives continuous bed profile along the range lines. The accuracy is better when the range lines are at closer interval. The surveys are expensive. The cost depends on the size and extent of the submergence area to be covered and the cost of transportation of boat to the reservoir area and

requirement of fuel (petrol/diesel) to run the boat for conducting survey. Manpower requirement is also more. For reservoir portion of less than 2.5 meters depth, this survey is to be supplemented with ground survey by total station or any other method as the survey vessel can not freely maneuver in the shallow depth portion where the water depth is less than 2.5 – 3 meters. The hydrographic survey is usually undertaken when the reservoir is at full reservoir level condition so that maximum reservoir zone is covered under the survey.

Scenario in Maharashtra

In Maharashtra, there are about 150 major and medium reservoirs and hundreds of minor reservoirs completed so far, from which the water is supplied for irrigating the land. From many reservoirs, the demand for irrigation and non irrigation use is increasing. For proper assessment of present storage potential of the dams, it is necessary to conduct periodical capacity assessment surveys. But within the limited financial resources and expertise available with the management authorities, it is not possible for them to take up the capacity assessment surveys at their own. Therefore, Maharashtra Engineering Research Institute, MERI, Nashik which is R & D wing of the State's Water Resources Department is undertaking such studies on a regular basis as per the demand from the reservoir authorities. The institute has the necessary infrastructure facilities like remote sensing lab with state of the art computer system and standard image analysis software, and DGPS mounted boat with necessary computer system required to conduct the capacity assessment studies by both the methods either independently or in a blended manner. Since the hydrographic surveys are expensive, most of the surveys have been done by satellite remote sensing technique only. River basin wise surveys conducted and their results in terms of % reduction in useful storage and their age when the survey was done is given in the following tables

(A) Tapi Basin

Table 2 (i) Purna Sub basin

Sr. No.	Name of project	District	% reduction in useful storage	Age Years
1	Katepurna	Akola	16.71	36
2	Morna	Akola	27.21	36
3	Nirguna	Akola	14.41	31
4	Mun	Buldana	5.84	17
5	Mas	Buldana	18.30	28
6	Nalganga	Buldana	16.31	47
7	Dnyanganga	Buldana	11.5	39
	Total		100.28	234

Average Annual percentage loss in storage for Purna Sub basin = 100.28/234 = **0.43**

Table 3 (ii) Tapi Sub basin

Sr. No.	Name of project	District	% reduction in useful storage	Age Years
1	Aner	Dhule	16.77	34
2	Panzara	Dhule	2.53	37
3	Manyad	Dhule	10.26	35
4	Hatnur	Jalgaon	38	25
5	Kelzer	Nashik	0.29	23
6	Girna	Nashik	2.54	41
7	Chankapur	Nashik	18.78	96
8	Bori	Dhule	4	32
	Total		93.17	323

Average Annual percentage loss in storage for Middle Tapi Sub basin = 93.17/323 **=0.29**

(B) Godavari Basin

Table 4 (i) Upper Godavari sub basin

Sr. No.	Name of project	District	% reduction in useful storage	Age Years
1	Gangapur	Nashik	9.52	37
2	Waghad	Nashik	8	31
3	Karanjwan	Nashik	7.64	36
4	Punegaon	Nashik	0.61	16
5	Alandi	Nashik	5.17	31
6	Kadva	Nashik	5.12	14
7	Darna	Nashik	6.82	90
8	Ozarkhed	Nashik	1.93	18
	Total		44.81	273

Average Annual percentage loss in storage for Upper Godavari Sub basin = 44.81/273 =**0.16**

Table 5 (ii) Middle Godavari sub basin

Sr. No.	Name of project	District	% reduction in useful storage	Age Years
1	Mula	Ahmadnagar	5.633	36
2	Jayakwadi	Aurangabad	7	20
3	Yeldari	Parbhani	8.15	43
4	Majalgaon	Beed	6.17	23
5	Manjara	Beed	11.63	20
6	Ter	Osmanabad	29.79	44
7	Bhandardara	Ahmadnagar	4.09	80
	Total		72.46	266

Average Annual percentage loss in storage for Middle Godavari Sub basin = 72.46/266 =**0.27**

Table 6 (iii) Penganga sub basin

Sr. No.	Name of project	District	% reduction in useful storage	AgeYears
1	Upper Penganga	Yavatmal	3.03	20
2	Adan	Washim	17.75	30
3	Sonal	Washim	2.59	25
4	Upper Pus	Yavatmal	8.65	36
5	Lower Pus	Yavatmal	0.575	21
6	Koradi	Buldana	8.64	30
7	Pentakali	Buldana	1.50	9
8	Arunavati	Yavatmal	0.06	12
	Total		42.79	183

Average Annual percentage loss in storage for Penganga Sub basin = 42.79/183=0**.23**

Table 7 (iv) Wardha and Wainganga sub basin

Sr. No.	Name of project	District	% reduction in useful storage	Age Years
1	Upper Wardha	Amravati	4.25	10
2	Jam	Nagpur	5.51	14
3	Kar	Wardha	10.86	10
4	Bor	Wardha	3.3	44
5	Dham	Wardha	4.84	24
6	Vadgaon	Nagpur	0.81	13
7	Nand	Nagpur	17	17
8	Erai	Chandrapur	26.38	24
9	Totla doh	Nagpur	6.80	24
10	Pench	Nagpur	21.71	34

11	Khekra Nala	Nagpur	7.9	26
12	Kolar	Nagpur	2.87	26
13	Ghorazari	Chandrapur	5.32	89
14	Goki	Yavatmal	10.34	26
	Total		127.89	381

Average Annual percentage loss in storage for Wardha +Wainganga Sub basin = 127.89/381 =**0.34**

(C) Krishna Basin

Table 8 (i) Bhima sub basin

Sr. No.	Name of project	District	% reduction in useful storage	Age Years
1	Pimpalgaon Joge	Pune	1.026	6
2	Manikdoh	Pune	9.24	22
3	Wadaj	Pune	8.09	23
4	Yedgaon	Pune	14.4	30
5	Warasgaon	Pune	0.54	21
6	Panshet	Pune	8.32	39
7	Bhatghar	Pune	16.14	80
8	Veer	Pune	11.41	43
9	Ujjani	Solapur	12.31	27
10	Ghod	Pune	10.86	42
	Total		92.34	333

Average Annual percentage loss in storage for Bhima Sub basin = 92.34/333=**0.28**

Table 9 (ii) Krisna sub basin

Sr. No.	Name of project	District	% reduction in useful storage	Age Years
1	Koyna	Satara	5.83	50
2	Dhom	Satara	3.44	30
3	Kanher	Satara	1.12	23
4	Radhanagari	Kolhapur	7.69	103
	Total		18.08	206

Average Annual percentage loss in storage for Krishna Sub basin = 18.08/206=**0.09**

(D) Konkan Region

Table 10

Sr. No.	Name of project	District	% reduction in useful storage	Age Years
1	Tansa	Thane	9.88	116
2	Modaksagar	Thane	9.96	54
3	Tulsi	Mumbai	12.85	131
4	Vihar	Mumbai	6.39	151
5	Bhatsa	Thane	5.79	24
6	Upper Waitarna	Nashik	0.08	30
	Total		44.95	506

Average Annual percentage loss in storage for Konkan region = 44.954/506=**0.09**

Results and discussion

Average reduction factor for estimating the present useful storage of reservoirs in different basins/sub basins is given in the table below. An appropriate sub basin wise factor for the % annual reduction in useful storage capacity reservoir has been worked out as above. Applying this factor, the average % storage loss per year for the reservoirs which are not surveyed, can be predicted which would be helpful to estimate the present useful storage capacity of the reservoir.

Table 11- Basin wise reduction factors at a glance.

Sr. No.	River Basin	River Sub Basin	Reduction Factor*
1	Tapi	Purna	0.43
		Middle Tapi	0.29
2	Godavari	Upper Godavari	0.16
		Middle Godavari	0.27
		Penganga	0.23
		Wardha & Wainganga	0.34
3	Krishna	Bhima	0.28
		Krishna	0.09
4	Konkan Region	Konkan	0.09

*Reduction Factor – Average annual percentage loss in useful storage of reservoir.

References

Reservoir sedimentation survey reports for different projects in Maharashtra. Work done by Maharashtra Engineering Research Institute, Nashik .