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Assessment of sedimentation in Ajwa reservoir in the Vadodara Gujarat region using remotely sensed data.

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Abstract — *The sedimentation process is the most important problem that affect directly the performance of reservoirs due to the reduction of the storage capacity and possible problems affecting the operation. Thus periodic assessment of the storage capacity and determining sediment deposition patterns is an important issue for operation and management of reservoirs. In this paper efforts are made to explore the Satellite Remote Sensing (SRS) method for assessment of reservoir sedimentation at Ajwa Reservoir. It uses the fact that the water spread area of reservoir at various elevations keeps on decreasing due to sedimentation. Remote Sensing technique gives us directly the water- spread area of the reservoir at a particular elevation on the date of pass of the satellite. This can help to estimate sedimentation over a period of time.*

Keywords- *Reservoir sedimentation rate, storage capacity, Land Cover, Remote sensing, Satellite images.*

I. INTRODUCTION

A reservoir will generally be situated towards the end of a huge watershed and receive inflows from main rivers. On the other hand, reservoirs have a smaller residence time but a much larger watershed which can be more difficult to control. Therefore, capacity surveys are important for proper distribution and management of water in a reservoir. Knowledge about the important of sediment and its deposition form in various zones of a reservoir is very crucial to assess the balance life of reservoir. In view of this, regular capacity surveys of a reservoir should be conducted from time to time. Using the Remote Sensing techniques, it has become very efficient and convenient to quantify the sedimentation in a reservoir and to assess its distribution and deposition pattern. Remote Sensing technology, offering data acquisition over a long period of time and wide-ranging spectral range, can provide synoptic, repetitive and timely information regarding the sedimentation characteristics in a reservoir. Reservoir water spread area for a particular elevation can be obtained very accurately from the satellite data. Reduction if any, in the water spread area for a particular elevation shows deposition of sediment at that level. This when combined over a range of elevations via multi-date satellite data enables in computing volume of storage lost due to sedimentation. In this paper satellite imageries to measure sedimentation in Ajwa Reservoir in Gujarat state of India. The main objective of this paper efforts are made to explore use of assessment of present status of reservoir storage by estimating revised capacity using remote sensing approach, Assessment of soil loss from catchment area and Development of management plan for catchment area with area specific soil conservation measures for minimizing sedimentation in reservoir.

II. LITERATURE REVIEW

"Assessment of reservoir sedimentation using remote sensing satellite imageries", for proper allocation and management of water in a reservoir, knowledge about the sediment deposition pattern in various zones of a reservoir is essential. In view of this, systematic capacity surveys of a reservoir should be conducted periodically. Using the remote sensing techniques, it has become very efficient and convenient to quantify the sedimentation in a reservoir and to assess its distribution and deposition pattern. Remote sensing technology, offering data acquisition over a long period of time and broad spectral range, can provide synoptic, repetitive and timely information regarding the sedimentation characteristics in a reservoir. Reservoir water spread area for a particular elevation can be obtained very accurately from the satellite data. Reduction if any, in the water spread area for a particular elevation indicates deposition of sediment at that level. This when integrated over a range of elevations using multi-date satellite data enables in computing volume of storage lost due to sedimentation.[4]

"Evaluation of reservoir sedimentation as a methodology for sediment yield assessment in the Mediterranean: challenges and limitations", Altogether, it can be concluded that reservoir sedimentation data are a valuable tool for monitoring sediment dynamics at the basin scale and assess problems related the loss of storage capacity and of sediment export to rivers downstream as well as to coastal areas. Furthermore, reservoir sedimentation data also can provide insight in sediment dynamics within the basin, though no information is obtained on the spatial distribution of sediment sources. For insight in the spatial pattern of erosion and sedimentation probably tracer studies in combination with modeling are the most appropriate. Nevertheless, for modeling at the basin scale very few models exist that are capable to incorporate both erosion and sediment delivery accurately, and these models will require data on sediment yield at various scales for calibration and validation.[5]

III. DESCRIPTION OF STUDY AREA

Ajwa reservoir Also Known as Sayaji Sarovar, It is an earthen dam that was built early 20th century by the then ruler of Vadodara, Maharaja Sayajirao Gaekwad III. Its main aim was to provide water to the residents of Vadodara. Although the population of Baroda at that time was 100,000 it was the ruler's vision to build the reservoir 3 times larger. This reservoir has the ability to attend to the water requirements of about 300,000 people residing in the eastern parts of the city. Its construction was started in 1885 & completed in 1890. The dam is about 5 km long. The reservoir has 64 gates. It can store water to the height of 64.5m above the sea level (its overflow level).

A. Geology and soils

The soils of Vadodara district can be broadly classified into three groups. They are black soils, alluvial soils and hilly soils. At Ajwa reservoir, Available Ground Water Recharge 63.84 MCM / Year, Existing Gross Ground Water Draft for all uses 14.69 MCM / Year, Level of Ground Water Development 23.01%, Status of Magnesia 5-10ppm (Medium), Status of pH. 6.5-8.2 (Natural), Status of Sulphur 10-20ppm(Medium).[12]

B. Meteorological conditions

Vadodara district area, in general, being located south of Tropic of Cancer and in transition zone of heavy rainfall areas of South Gujarat and arid areas of North Gujarat plains, have sub-tropical climate with moderate humidity. The various season of the year are (a) monsoon - middle of June to October, (b) winter - November to February, and (c) summer – March to June. From March onward the temperature starts rising till it reaches maximum, as high as 45.2° C (22/05/2010) in some parts of the district. January is the coldest month of the year. There is an Indian Meteorological Department (IMD) station located at Baroda (Vadodara), where observation of climatic data is recorded since 1900. Details of this climatological data is given in table No. 1.1 and same is depicted graphically in figure No. 1.1 [13,14]

Table No. 1.1 - Climatological Data of IMD Station - Vadodara

Month	Max Temp (Deg.C)	Mini Temp (Deg.C)	Humidity (%)	Wind Spd. Kmpd	Sun shine (Hours)	Solar Rad. (MJ/m2/d)	Eto (mm/d)	Rainfall (mm)
January	30.30	12.00	50.00	65.80	9.10	17.23	3.02	1.20
February	33.00	13.80	43.00	67.50	9.70	20.07	3.81	0.60
March	37.10	18.40	36.50	69.10	10.20	23.16	4.88	2.20
April	40.20	22.90	36.50	79.00	10.80	25.75	6.03	0.90
May	40.90	26.50	44.50	143.20	10.90	26.38	7.46	4.40
June	37.10	27.00	63.50	169.50	7.10	20.62	5.97	146.80
July	32.70	25.70	80.00	138.20	4.40	16.51	4.11	297.60
August	31.50	25.00	82.00	116.80	4.50	16.32	3.82	284.70
September	33.20	24.30	74.50	83.90	6.90	18.87	4.28	141.70
October	36.00	21.30	58.00	49.40	9.30	20.24	4.12	22.00
November	34.30	16.70	52.50	49.40	9.40	18.02	3.24	16.20
December	31.20	13.40	55.00	59.20	9.10	16.50	2.83	4.40
Total	-	-	-	-	-	-	-	**922.70**
Average	**34.79**	**20.58**	**56.33**	**90.92**	**8.45**	**19.97**	**4.46**	-

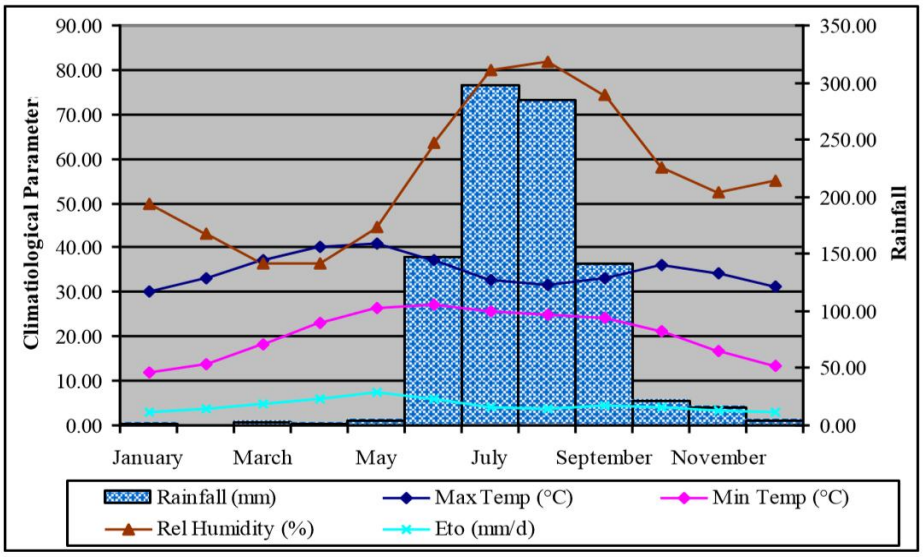

Figure No 1.1 - Plot of Climatological Data - Vadodara IMD Station

IV. METHODOLOGY

In the present research flow chart is shown how the water spread areas of the reservoir at different levels between Full reservoir level FRL and MDDL in different months of the year can be computed from satellite imaginaries. By knowing the reservoir levels (as ground truth) on date of pass of the satellite, new elevation-capacity curve can established and compared with that at the time of impoundment of reservoir. The Shift in the capacity curve will indicate extent of loss of reservoir capacity.

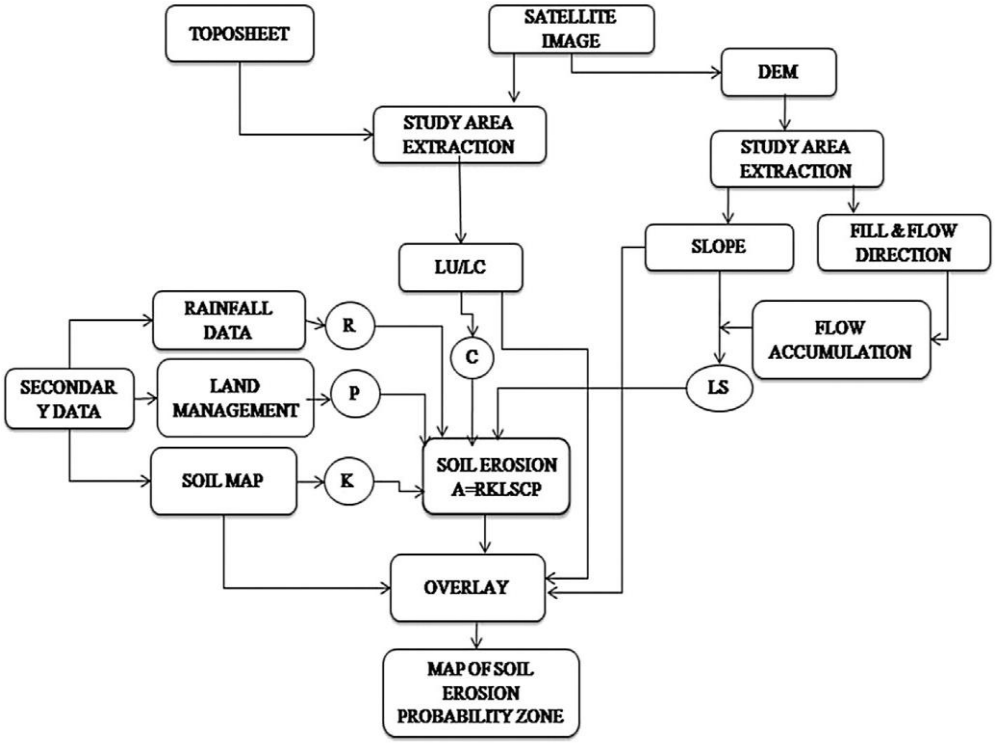

Figure No 1.2 - Flow chart of methodology

Courtesy: B.P. Ganasri, H. Ramesh*Department of Applied Mechanics & Hydraulics, National Institute of Technology Karnataka, Surathkal, Mangalore 575025, India

Table No. 1.1- Represents Data collected for the same

Sr. No.	Data type	Source	Description
1	Digital elevation model	www.bhuvan.nrsc.gov.in	DEM
2	Satellite image	www.bhuvan.nrsc.gov.in	LISS-3 Image
3	Soil data	The National Bureau of Soil Survey and Land Use Planning, India	Soil map based on the type of Soil, Status of Magnesia, Status of pH. in soil, Status of Sulphur
4	Rainfall data	Indian Meteorological Department, India	Rainfall data.

V. RESULT AND DISCUSSION

To Effective estimate soil erosion and to establish soil erosion management plans, many computer models can be part of study. The revised Universal Soil Loss equation (RUSLE) can be used in many countries, and input parameters data for RUSLE can be well established over the years. In this study RUSLE can be used by developing new input Parameters for the web –based sediment decision support system using a GIS interface.

VI. SCOPE OF STUDY

This type of research work will be useful in Water Resources Department, Agriculture Department, Command Area Development Authority, Forest Department and Water Users Association.

CONCLUSION

By this methodology as studied in domain area the various techniques and research, It can be conclude that a remote sensing based framework has been proposed for forecasting quantity of sedimentation load via different water sources by integrating satellite data. This proposed system which is still under development will help to develop the assessment of sedimentation in Ajwa reservoir as well as for other hydraulic structures. This will be immensely useful as the best part of our knowledge and such a classification system (Assessment of Sedimentation in Ajwa reservoir) does not exist uptill now. The success of this proposed method will lead to development of similar model in other commands in Gujarat and elsewhere in the India. By using this method one can find soil sedimentation as well as soil erosion from tributaries of river which will facilitate in finding the difference in storage capacity and also remove the sedimentation which is experienced in this method. As a result of this method the demand of water supply in the respective cities and bypass the flood disaster will be fulfilled.

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