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Research Article

ASSESSMENT OF SEDIMENT DEPOSITION IN UPPER LAKE BHOPALUSING DIGITAL IMAGE PROCESSING

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ABSTRACT

A reservoir is an essential part of a normal water resource. Regular analysis of the sediment deposition pattern and assessment of available storage capacity of reservoirs is an important aspect of water resources management. The conventional techniques of quantification of sediment deposition in reservoir, such as hydrographic research and the inflow-outflow methods, are cumbersome, costly and time consuming. Further, conjecture of sediment deposition using empirical and statistical methods requires a huge amount of input data and the results are still not encouraging. Due to sedimentation, the water-spread area of a reservoir at various elevations keeps on decreasing. Remote sensing, through its spatial, spectral and temporal attributes, provides synoptic and repetitive information on the water-spread area of a reservoir. By use of remote sensing data in conjunction with a geographic information system, the temporal change in water-spread area can be analysed about the sediment deposition pattern in a reservoir. In this paper A case study, related to the assessment of sediment deposition in Upper Lake Bhopal, Madhya Pradesh State, India, is presented. It was observed that Upper Lake of Bhopal, Madhya Pradesh, India lost its gross storage capacity from 101.6 MCM to 75.72 MCM i.e. 25.88MCM which is 25.47 %.

INTRODUCTION

In Global terms Soil Erosion and Sedimentation are the real cultivating and regular issue for person. When the departure of upper layer of the earth takes place by the action of water, wind and various distinctive strategies like culturing it said to be soil erosion has been taken place. All specialist and examiners are worried about this major issue and they are taking authentic move so that the problem can be sorted out at field level to keep up a key separation from the results of soil disintegration issues. Sheet erosion, rillerosion, Gully erosion, Bank erosion etc are the major types of soil erosion. When the thin sheet of soil is removed from the top of soil sheet erosion occurs and it happens where the grade is uniform. When soil is eroded from m a specific channel which is molded in light of the improvement of overflow, Rill erosion takes place. When Rill erosion is not treated and kept for a long time Gully Erosion takes place, leading to the removal of huge amount of soil every year. Exactly when the rill disintegration isn't controlled authentically and on account of excessive precipitation it takes the shape The basic output from the remote sensing analysis is the water-spread area on the date of satellite pass. Two techniques of remote sensing data interpretation, viz. visual and digital, are used for water-spread delineation. Visual techniques are based purely on the interpretative capability of the analyst. Along the periphery of the water-spread area, the wet land pixels appear very similar to the water pixels and it becomes very difficult to visually judge whether a pixel near the periphery is to be classified as water or land. Using digital techniques, the information of different bands can be utilized to the maximum extent. In this study, digital processing was carried out using the ILWIS image processing software.

Study Area

The Upper Bhopal Lake in the city of Bhopal in the state of Madhya Pradesh is the only source of water for the city of Bhopal. Economic as well as recreational activities of the city of Bhopal is dependent on the water availability in the Upper Bhopal Lake which receives water as surface runoff only during the monsoon period of every year.

Visual techniques

Visual technique are purely based on the interpretive capability of the analyst and with this technique it is not possible to use the information of different band (as in present case LISS-III sensor data have four band) ,after the visual product is generated. Around the periphery of the water spread area the wet land appears very similar to water pixels & it becomes very

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difficult for the eye to decide whether the pixel near the periphery is to be classified as land or water. Moreover, clouds or noise in the scene around the periphery, it is impossible to delineate actual water spread area.

Digital techniques

In digital technique unlike visual technique the information of different band can be utilized for the delineation of water spread area also consistent analysis can be done over the entire range of the reservoir. The information below the clouds can be extracted indirectly using the interpreted imageries of the past and future periods and noise can be removed using different algorithms. Using this technique water spread area can be easily determined. Keeping all these advantage over visual technique this technique has been used for digital analysis for identifying the water pixels and for determining the water spread area.

Import, visualization and Geo-referencing

The data of IRS-1D satellite and LISS-III sensor for different dates are received from the National Remote Sensing Centre (NRSC), India, on CD-ROM media and the same are imported in the ILWIS system. Though the original pixel size of the LISS-III sensor is 23.5 m, the processed pixel size is 24 m. A false colour composite (FCC) of near infrared (NIR), red and green bands combination will prepared. The water-spread area (except at the periphery) of the reservoir was quite distinct and clear in the FCC. The multi-temporal remote sensing images are first geo-referenced to a master map. Using the geo-referenced images, the water-spread areas at different time periods can be compared and revised contours can be overlaid. In order to determine the water spread area of selected area it was essential to arrange the LISS-III sensor data ,for this National remote sensing Centre (NRSC) was contacted for those period which gives adequate information regarding the area chosen & satellite data of selected date must be free from any technical or human error. Following are the date of pass of satellite obtained from NRSC.

Table 1 Satellite data Sensor Information

S.NO	Date of pass satellite	Elevation(ft)	Satellite	Sensors
1.	13-May-15	1657.1	IRS-ID	LISS-III
2.	07-Apr-15	1658.6	IRS-ID	LISS-III
3.	11-Jun-14	1660.35	IRS-ID	LISS-III
4.	26-Nov-14	1662	IRS-ID	LISS-III
5.	26-Jan-17	1664.05	IRS-ID	LISS-III
6.	03-Nov-16	1666.2	IRS-ID	LISS-III

Identification of water pixels

In the visible region of the spectrum (0.4-0.7 urn), the transmittance of water is significant and the absorptance and reflectance are low. The absorptance of water rises rapidly in the NIR band, where both the reflectance and transmittance are low. At NIR wavelengths, water apparently acts as a black body absorber. checks for the normalized difference water index, NDWI, which can be defined as:

$$NDWI = (Green - NIR)/(Green + NIR) \quad OR$$
$$=(BAND2-BAND4)/(BAND2+BAND4)$$

[Eq. 1]

"If the digital number of NIR band of a pixel is less than the digital number of the red band and the green band, and the NDWI is >0.44, then it is classified as water, otherwise not" In other words, if the condition is satisfied, then the pixel is recorded as water, otherwise not.

SLICING

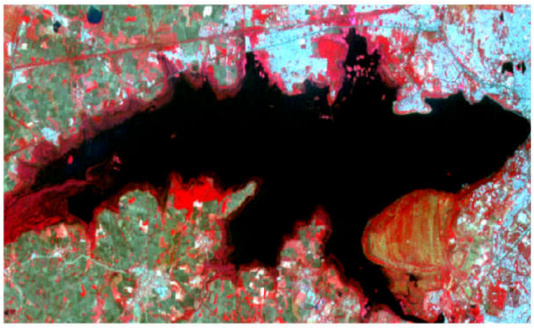
The slicing operation of the NDWI images is carried out to extract the water pixels from the rest. Slicing is a raster operation in an ILWIS image processing software, slicing is done for all the images so that proper histogram can be generated which further gives the value of revised water spread area . The revised areas obtained from this operation may be used to estimate the revised volume between two consecutive elevations with the help of prismoidal formula.

Removal of discontinuous pixels

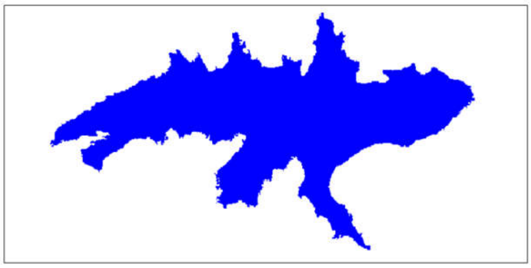
Since the area within a contour is continuous, it is required that the isolated water pixels surrounding the water-spread area and/or located within the islands be removed from the interpreted water image. Similarly, the water pixels downstream of the dam do not form part of reservoir and need to be removed.

Removal of extended tail and channels

The main river at the tail end of the reservoir and numerous small channels joining the reservoir from different directions around its periphery are also classified as water. However, the elevation of water in these channels and the main river remains slightly higher than the water surface of a reservoir receiving inflow through perennial streams. So, the extended tail and channels must be removed from the point of termination of spread. The selection of truncation point is subjective and may be based on the difference between the water levels in the subsequent date imageries.



False color composite (FCC)



Extracted water spread

Figure 1 False color composite and extracted water spread on Nov 03, 2016 (Res. Level: 507.86 m)

Calculation of revised capacity

After finalizing the water-spread areas of all the images, the histograms were constructed and the water pixels in each image were recorded. The reservoir capacity between two consecutive reservoir elevations was computed using the prismoidal formula:

$V = H \times (A1 + A2 + \sqrt{A1 \times A2}) /3$

V= Volume between two consecutive elevation 1 and 2

A1 and A2= water spread area at consecutive elevation

H = Difference in the elevation between elevation 1 and elevation 2

The revised cumulative capacities have been obtained by adding the revised volumes between consecutive intervals. The cumulative capacities between the consecutive levels were added up so as to reach at the cumulative original and the revised capacities at the maximum observed level. The difference between the original and the revised cumulative capacity represents the loss of capacity in the zone under study.

CONCLUSIONS

Sedimentation in a reservoir is always been a tedious problem, and moreover it is very tough to accurately measure the volume of sediments in a reservoir. Traditionally assessment of reservoir sedimentation was done by hydrographic method. But, by the introduction of Remote sensing techniques it becomes quite easy to compute reservoir sedimentation with less error time. The present study of Upper Lake Bhopal demonstrates that the remote sensing technique is time- and cost-effective and convenient approach to estimate the elevation-area-capacity curves for a reservoir. The conventional methods, such as hydrographie surveys, are laborious, costly and time-consuming. For these reasons, the hydrographic surveys of reservoirs are normally conducted at a frequency of 5-15 years, though the recommended frequency is every five years. Remote sensing techniques can be used as a cost- and time-effective tool to estimate capacity loss. The procedure to remove the discontinuous pixels and the derivation of contours has been considerably automated. In a present study work an ILWIS 3.0 GIS software was used for image processing From the analysis it was observed that Upper Lake of Bhopal, Madhya Pradesh, India reservoir lost its gross storage capacity from 101.6 MCM to 75.72 MCM i.e. 25.88MCM which is 25.47 %.

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