VOL- VIII ISSUE- X OCTOBER 2021 PEER REVIEW e-JOURNAL IMPACT FACTOR 7.149 ISSN 2349-638x

Application of Geospatial Technique to Estimate Elevation Area Capacity Curve for Kanhar Dam

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Abstract

Water management has become one of the major concerns in many countries. Estimation of Elevation Area Capacity at a proposed location of a reservoir is a very important criterion at the planning stage itself of any reservoir. GIS has widely used in hydrological studies. GIS is simply the processing, analysis, and presentation of spatial data. In this study, the application of GIS has been utilized as a decision support tool to calculate the amount of water volume and surface area of water volume for an appropriate dam crest height of Kanhar Dam. We have identified three major methodologies for the selection of suitable dam site location-GIS and Remote Sensing, Hydrological Modelling. The most common criteria used for the selection of suitable dam sites were DEM, rainfall. Data from ASTER DEM (30m. resolution) was utilized for the study.

Keywords: *Site Suitability, Arc Map 10.3, Arc Scene10.3.*

1. Introduction:

Geographic Information Systems (GIS) has widely used in hydrological studies. The advantages of using Digital Elevation Models (DEM) within GIS are to generate flow direction, flow accumulation, flow path, slope, and aspect, elevation, and drainage network maps faster and accurately in comparison to the common classical cartographic methods. In this study, the application of GIS has been utilized as a decision support tool to calculate the amount of water volume and surface area of water volume for an appropriate dam crest height of Kanhar Dam. The use of RS & GIS has been explored to estimate the capacity and water spread area for different elevations to a reasonable accuracy.

2. Aim and Objective:

The aim of the study is to Estimate Stage – Area - Capacity Curve for Kanhar Dam using Remote Sensing and GIS Techniques.

- Water Spread Area of Kanhar Dam at different levels
- Extract the water capacity at different levels

3. Study area:-

3.1 Location of Study Area:-

Kanhar irrigation project is located at 240 7' 48"N Latitude and 830 17'14"E Longitude & 240 7' 8"N Latitude and 830 18'26''E Longitude at the downstream of the confluence of river Pagun with river Kanhar (a tributary of River Sone) near village Sugawan in Tehsil Dudhi of District Sonebhadra, Uttar Pradesh.

The Project proposes a 3.003 km earthen dam having a maximum height of 39.90m from the deepest bed level. The project envisages the submergence of 4131.5 ha land (Including 980 ha forests) which includes parts of Uttar Pradesh, Chhattisgarh, and Jharkhand. The Project was approved in 1976 and completely abandoned since 1989 and construction work is started on 5th December 2014. When the modified project with increased spillway was approved on 16 September 2010 by Central Water Commission it has been considered under the category 'NEW MAJOR' project.

Location Map of Study Area:

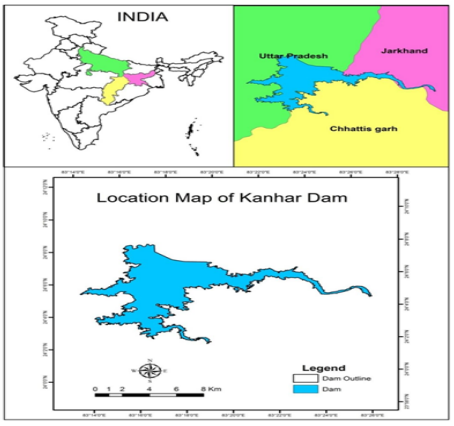

Fig.No.1. Location Map of Kanhar Dam

4. Data and Methodology:-

4.1 Data used:-

Toposheet No.63 M/5(1:50000) SOI
Satellite Data:-Landsat-7, sensor Id-"OLI_TIRS" Path=142, Row=43.
The satellite data-ASTER DEM 30M Resolution.

4.2 Methodology:-

Software used:-Arc Map 10.3 version Arc Scene 10.3 version

DEM (Digital Elevation Model) is used to find out the water-spread area and the elevation information is used to calculate the volume of water stored between different levels. The methodology to estimate the capacity of the reservoir using DEM broadly consists as follows:-

1 Launch the Arc Seen
2 Add the DEM Layer in Arc seen
3 set projection same as DEM is WGS_1984_UTM_Zone_43
4 open DEM layer property set base height 'custom'
5 open seen layer property set base height 'geographic'
6 open surface volume tool –Add Raster file–set output location for text file – Set reference plane Above/below –set to add the value of plane height -click ok
7 open Table and see the volume field Volume shows in cubic meters.

5. Cartographic Presentation

DEM of Kanhar Dam

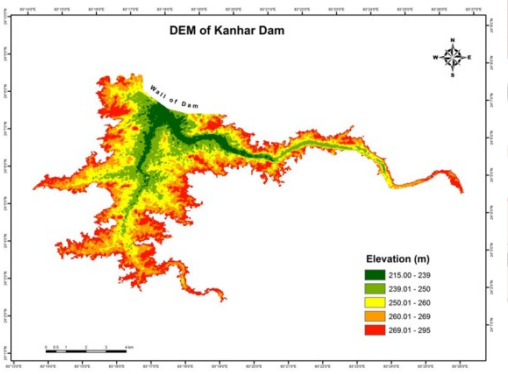

Fig. No.2. DEM of Kanhar Dam

3D Model of Kanhar Dam

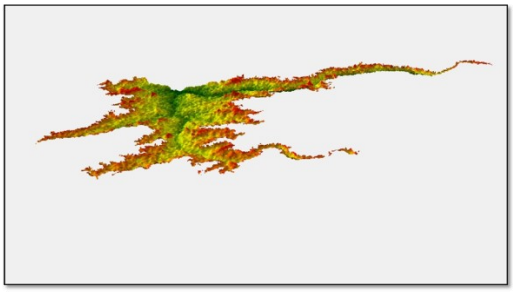

Fig. No.3. 3D Map of Kanhar Dam

ASTER DEM by using Arc Scene.3D view of the depth of the terrain

3D view in Arc Scene

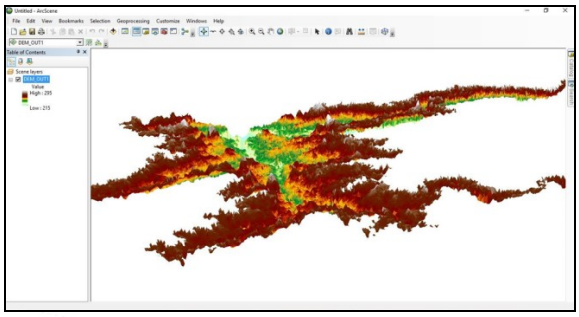

Fig. No.4. 3D view of Arc Scene

Cross Section of Dam Wall

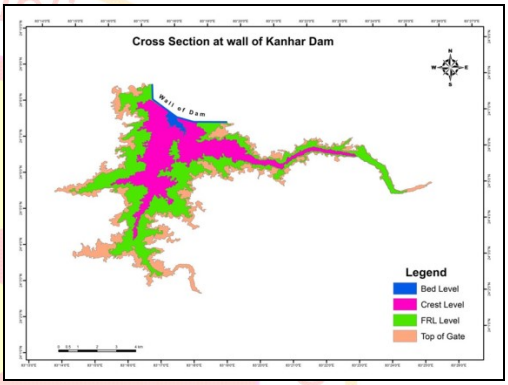

Fig. No.5. Cross Section of Wall

The cross-section at the Wall of the Kanhar Dam.

Water Spread Area at Different Levels Capacity Curve Map

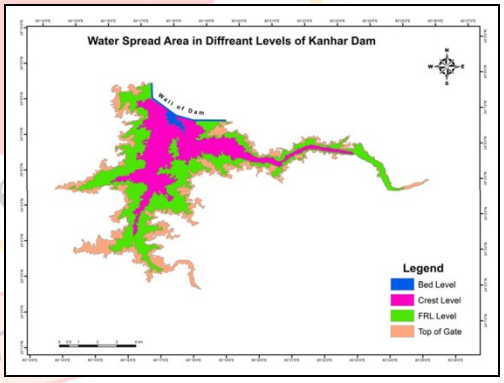

Fig. No. 6. Water Capacity Curve (Levels)

Water Elevation Area Capacity Levels Curve Calculate by Prismodel Formula

$$\text{Volume} = h/3 * (A1 + A2 + \sqrt{A1 * A2})$$

V is Reservoir capacity between two successive elevation h1 and h2 his elevation difference (h2-h1); A1 and A2 are an area of reservoir water spread at elevation h1 and h2.

When the Volume is calculated by using DEM and TIN is approximately the same. But when the volume is calculated using the Prismodal

formula there is a slight change in the curve, the curve comes down towards FRL and Top of the Gate. This is because the resolution of DEM and TIN is 30 m which makes us difficult to understand the exact elevation of that Area.

Conclusion:

In this study, DEM was used to determine the storage volume of reservoirs and the surface area of the storage volume of Kanhar Dam at different elevations. These calculations can be done easily and quickly using GIS. This application seemed to provide useful information for water managers and planners. Water storage capacity and water surface area can be analyzed for different dam locations easier than reservoir surveys Method to find the most suitable location for the dam construction.

Elevation (m)	Water Capacity Levels	Volume		
		DEM (mcm)	TIN (m^3)	Prismodal (m^3)
228	Bed Level	1130180.461	1371906.725	1323528.477
251	Crest Level	1209526628.5	121344268.3	120731289.4
265	FRL	450769586.6	450068589.8	459716858.2
272	Top of the Gate	727465807	725714698.8	644035367.1

When the Volume is calculated by using DEM and TIN is approximately the same. But when the volume is calculated using the Prismodal formula there is a slight change in the curve, the curve comes down towards FRL and Top of the Gate. This is because the resolution of DEM and TIN is 30 m which makes us difficult to understand the exact elevation of that Area.

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Acknowledgment:

We would like to thank our research guide Dr.H.N.Singh, Dr.H.N.Rede, and Dr. M.V.Suryavanshi. We would also like to thank our family for being supporting us.