

Analysis and preparation of DEM by using GIS software and designing of physical model- case study: Temghar dam

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Abstract

The water in our bodies is essential for our life. Without water, we can't survive. Water is limited vital natural resources, which is indispensable for the expanse of all living matters, plant, animal and man. But excessive water leads to flood which further cause to damage and destruction in Natural resources, Human resources, infrastructures, agricultural land and disturbance to ecosystem as well as backing to age of the region. Floods are one of the most widely distributed hazards around the world and their management is an important issue of concern. As there are severe floods throughout India in the monsoon season, it's very difficult to divert the water or reduce its intensity as of now. The aim of the project is to mitigate the floods and reduce its intensity thus reducing the further damage. It also protects the dam from overflowing where only spillway can't help much under high speed of the water. Emergency stepped spillway can be used in every dam so that the discharge in case of any emergency does not affect the downstream areas. It's a modern and simple solution for flood control. It should be considered as a permanent and essential component of dam and its design. The Digital Elevation Model(DEM) of Temghar dam (which is located about 40km from Pune district) is developed with help of GIS. And the data required to construct the DEM got using remote sensing. With the help of GIS analysis of Temghar dam is done to fulfil the desired goals.

Keywords— DEM, GIS, Flood, Flood control

I. INTRODUCTION

1.1 General Introduction

Flood is a term used to denote an enormous amount of water. The situation caused when water

becomes uncontrollable is said to be flooded. Pune experienced flood situations due to bursting of Panshet dam wall on 12 July 1961 – This fateful day will remain etched forever in the history of Pune. Recently flood situations occur in Pune region due to heavy rainfall. The city witnessed its most intense rain spell of this monsoon recorded 46.2 mm rainfall in an hour on 24 September 2019. The average annual rainfall is 60.133mm. The site (located about 40km from Pune district) Temghar dam is selected. It is an earthfill gravity dam on mutha river near mulshi, Pune district in the state of Maharashtra in India. This dam is surrounded by hilly and had slope region. Area nearer to the dam has large population and huge vegetation as well as resources.

II. LITERATURE REVIEW

Flood management of various case studies have been analyzed by many researchers through advanced methods like GIS and HEC-HMS. D. K. Mathur and P.K. Udan have studied application of remote sensing and GIS for flood vulnerability and mitigation, where discussion of flood planning for 3 villages situated at bank of Mahi river in Gujarat by using QGIS have led to finding that the study is helpful during disaster management using QGIS software. A viable approach for flood management strategy in a river basin based on the European Floods Directive presents by Nektarios N. Kourgialas & George P. Karatzas. By drawing map of flood hazard area, the settlement and high risk flood areas can be identified. This proposed methodology can be applied to any river basin and here was applied to the koiliaris river basin in Greece. Annunziato Siviglia; Alessandro Stocchino; and Marco Colombini have studied the analysis and response on two detention reservoirs. This analysis has been carried out with the aid of a physical model and one-dimensional numerical simulations. T.Reshma, P.Sundara Kumar, Dr.M.J.Ratana Kanth Babu, K Sundara Kumar have provided an integrated procedure for river flow forecasting and simulation advanced by integration of different models for improving predictions of the river flood risk outputs. A case study on river flow modeling and simulation for river flood risk analysis is given.

III. METHODOLOGY

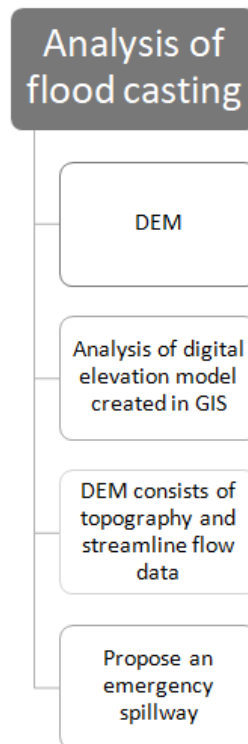


Fig.1.Methodology

3.1. Data Required for process:

- ▶ Precipitation (Rainfall Data)
- ▶ History of flood occurrence
- ▶ Flood intensity
- ▶ Population
- ▶ Topography

3.2. Selection of Area

The selection criteria based on amount of rainfall, flood intensity, runoff and topography of the region. At first, Bhide Bridge at Deccan Gymkhana in Pune was to be surveyed, but it is located on a plateau topography whereas steep slope is required for our project which was available at Temghar Dam. Thus, after consulting the same with our guide, We finalised Temghar Dam as it has got the requirements. The Temghar dam located about 80 km from here has received over 4100 mm rainfall since June 1, which is the highest among the four dams that supply water to Pune city. Temghar Dam is an earth fill and gravity dam on Muthariver near Mulshi, Pune district in the state of Maharashtra in India. It is 1,075m (3,527 ft) long and 42.5m (139 ft) high. The total capacity of dam is 101,010,000 m³ (3.567×10⁹ cu ft). It has surface area 55,512 km² (21,433 sq mi) and dam volume is 1,188,000 m³ (42,000,000 cu ft).



Fig.2. Temghar dam

3.3. Role of GIS

A geographic information system (GIS) is a system designed to capture, store, manipulates, analyse, manage, and present spatial data or geographical data. GIS applications are tools that allow users to create interactive queries (user created searches), analyse spatial information, edit data in maps, and present the results of all this operations. GIS can refer to a number of different technologies, processes, and methods. It is attached to many operations and has many applications related to engineering, planning, management, transport/logisticst, insurance, telecommunications and business. For that reason, GIS and location applications can be the foundation for many locations-enabled services that rely on analysis and visualization. Digital elevation model will be prepared with the help of GIS tools. Streamline and direction of flow will be identified with the help of DEM.

3.4. Steps involved in GIS Analysis:

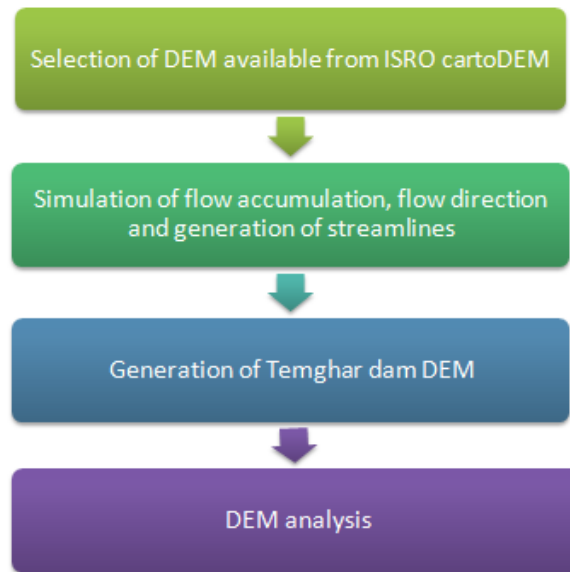


Fig.3.Steps Involved in GIS

3.5. DEM Data:

DEM data is easily available for whole India at open achieves from www.bharat.nrsc.gov.in website at free of cost. DEM required for Temghar dam is selected and downloaded in various format like .tif and .shp formats. Selected area is clipped from DEM downloaded for simulation.

3.6. Flow Accumulation and Flow Direction:

Using hydrology tool in GIS software, Flow accumulation and Flow direction is simulated based on topography of the DEM. Flow accumulation is used for generation of streamlines in the basin area. The density of flow accumulation can be controlled using raster calculator tool of GIS software. All the unnecessary data is eliminated from the DEM and useful data is highlighted.

3.7. Generation of streamlines:

Based on flow accumulation and flow direction features of DEM, streamlines are generated and shape file is created in the GIS software based on these streamlines. The Basin is simulated based on streamlines in that area. Also boundaries of basin can be found out. Use of GIS software comes in handy for various hydrological and geographical analysis of DEM.

IV. SOFTWARE AND MODEL DESIGN

4.1. GIS

A geographic information system (GIS) is a computer-based tool for mapping and analyzing feature events on earth. GIS technology has played critical roles in all aspects of watershed management, from assessing watershed conditions through modelling impacts of human activities on water quality. An advanced information system like GIS plays a vital role and Information System (GIS) is computer based system that handles the attribute data as well as spatial data where geographical information is an important characteristic. A GIS consists of:

- Digital Data – the geographical information that you will view and analyze using computer
- Computer Hardware & Software – Processes digital data.

GIS can be helpful in following fields of civil engineering:

- **Planning:** In planning its major contribution is to give us with an organized set of data.

- **Data Collection:** Precise and accurate data is the core driving factor of any successful project.
- **Analysis:** Analysis is one of the major and most influential phases of infrastructure life cycle. Analysis guides us about the validity or correctness of design or we can say that analysis is a method which supports our design.
- **Construction:** To keep the construction within budget and schedule GIS guides us about how to utilize our resources on site efficiently.

4.2. Introduction to DEM

- A digital elevation model (DEM) is a 3D CG representation of a terrain's surface – commonly of a planet (e.g. Earth), moon, or asteroid – created from a terrain's elevation data.
- DEMs are used to determine terrain attributes such as elevation at any point, slope and aspect.
- It includes not only heights and elevations but other geographical elements and natural features such as rivers, ridge lines, etc.

DEM is very useful in following areas:

- 1) Extracting terrain parameters for geomorphology.
- 2) Modelling water flow for hydrology or mass movement.
- 3) Modelling soils wetness with Cartographic Depth to Water Indexes.
- 4) Creation of relief maps
- 5) Rendering of 3D visualizations.
- 6) 3D flight planning.
- 7) Creation of physical models.
- 8) Geographic information systems (GIS).
- 9) Engineering and infrastructure design.
- 10) Satellite navigation.

The quality of a DEM is a measure of how accurate elevation is at each pixel (absolute accuracy) and how accurately is the morphology presented (relative accuracy).

V. OBSERVATIONS AND CALCULATIONS OF RESULTS:

5.1. Onsite observations:

1. The Temghar dam is earthfill and gravity dam on mutha river near Mulshi, located 40 km away from Pune district in the state of Maharashtra in India
2. It is 42.5 m high and 1,075 m long.
3. Lavharde, Kolawade, Kharwade, Andgaon, Watunde are the nearby villages located at downstream side of Temghar dam.

5.2. GIS analysis:

1. Temghar dam digital elevation model (DEM) is constructed using data available from remote sensing. Topography of area is found out in GIS software.
2. A shapefile of Temghar dam, spillway is obtained from GIS.
3. In DEM yellow line indicates the dam and the red spot indicates the spillway in dam.

Result:

The digital elevation model (DEM) of Temghar dam is constructed and analysed by using GIS software.

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