International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 07 | July 2022 www.irjet.net p-ISSN: 2395-0072

IMPACTS OF FLASH FLOOD CAUSED BY THE FAILURE OF THENMALA DAM

Jose K George[1], Ajay P Krishnadas[2], Devika Das[2], Elizebeth K Biju[2], Sonu V Sabu[2]

[1]Professor, Department of Civil Engineering, Mar Athanasius College of Engineering, Kothamangalam, Kerala, India
[2] UG Scholars, Department Of Civil Engineering, Mar Athanasius College of Engineering, Kothamangalam, Kerala, India

---

Abstract -*Dam failure leads to the creation of flood waves which is disastrous to the properties and habitats downstream. Predicting the consequences of the disaster is the primary step for calculating the mitigation measures. This project aims to conduct a dam break analysis of the Thenmala dam using HEC-RAS to find inundation maps showing the depth, velocity of discharge and water surface elevations of different locations within the vicinity of the dam breach. The downstream areas being heavily populated emphasizes the need of predicting the consequences of dam break.*

Key Words: flood, dam-break, inundation, breach, discharge

1. INTRODUCTION

Dams provide society with essential benefits such as water supply, flood control and hydroelectric power. The major reasons for dam failure are breaching due to flooding, overtopping failure, seepage failures and structural failures. A recent study conducted by the Indian government has observed that more than 600 dams in the country are located in high-intensity seismic zones. The Thenmala dam was commissioned on the year of 1986 and is a part of the Kallada irrigation and tree crop development scheme and is the largest irrigation project in the state. DEM file which is the primary input data is pre-processed using ArcGIS software. HEC-RAS (Hydrologic Engineering Centre River Analysis software) is used for modelling and analysis of the flash flood. For this study overtopping is considered the primary mode of failure.

1.1 OBJECTIVES

The objectives of the study are

- To prepare a flood plain inundation using HEC-RAS.
- To prepare a flood inundation mapping.
- To obtain maximum water surface elevation, depth, velocity and time of arrival of water at different locations in the downstream area of the dam.

2. METHODOLOGY

The input data are

- DEM file
- River basin map
- Dam structural data
- Inflow data.

The study constitutes two main parts:

- Pre-processing of DEM.
- Dam break analysis and simulation of the flash flood using HEC-RAS.

2.1 DEM PREPROCESSING

DEM needs to be processed in terms of flow accumulation and river identification using ArcMap software before using it in the HEC-RAS software.

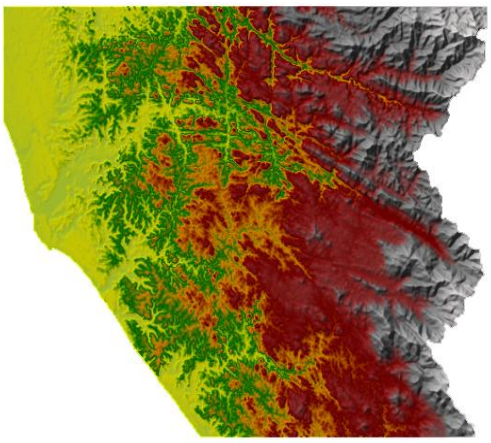

Fig – 1 Digital elevation model of Kollam area

2.2 DAM BREAK ANALYSIS

Processed DEM is added to HEC-RAS as terrain data. The two-dimensional flow area (determined based on the river basin map of the Kallada river), storage area, boundary

conditions and dam are marked manually on the terrain data. Processed DEM is added to HEC-RAS as terrain data. The two-dimensional flow area (determined based on the river basin map of the Kallada river), storage area, boundary conditions and dam are marked manually on the terrain data. Analyzing the DEM, the storage elevation curve will be obtained directly from the software. Data regarding the breach are entered manually considering all factors about the dam including the considered failure type, any foundation problems and historical knowledge of seepage and breach is placed at the most probable location.

After this dam break analysis is done by using St. Venant's equation for unsteady flow. The forces on control volume are limited to the variation of pressure, the friction of channel walls and the effect of gravity. These are the equations used in HEC-RAS for analysis. The flood inundation is simulated and the depth of water, water surface elevation and velocity of discharge at different locations are obtained. The time required by the water to reach different locations more specifically important towns is manually monitored and is recorded as the results.

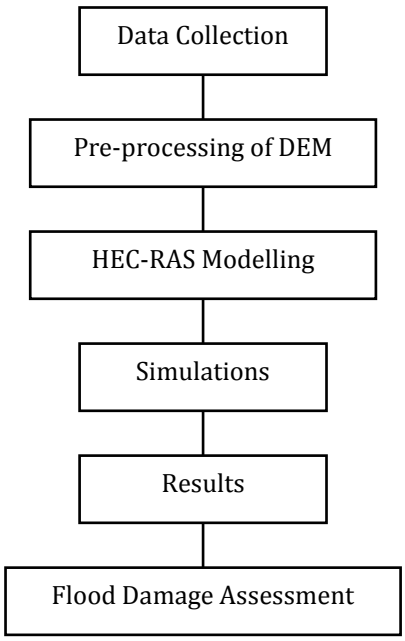

Fig –2 Flowchart of methodology

3. STUDY AREA

The dam selected for this study is the Thenmala dam, situated in the Kollam district. The downstream areas include the Kallada river basin up to Ashtamudi Lake. Being the second-largest irrigation project in Kerala and the longest reservoir in the state increases its relevance to be analyzed. It is a gravity masonry dam with a height of 85.35m, a length of 335m and three ogee-type spillways with radial gates.

4. RESULT AND ANALYSIS

A simulation of the flood is created in RAS mapper showing a flood inundation map of the Kallada river basin. The output data includes depth, velocity, water surface elevation and time of flow. It is observed that the water will take 15 hours to reach the Arabian Sea. The flood water flow mostly follows the Kallada river basin starting from Thenmala, Punalur, Pathanapuram, Pattazhy, Enathu, Puthoor, Sasthamcotta, Ashtamudi Lake and finally reaches the Arabian sea.

Table -1: Result from simulation

Place	Maximum Depth (m)	Time of arrival (hh:mm)	Maximum velocity (m/s)	Maximum water surface elevation (m)
Thenmala	68.58	00:00	26.82	119.58
Thenmala Eco-Resort	50.49	00:01	13.37	98.46
Urukunnu	46.56	00:06	16.69	94.56
Edamon 34 Junction	49.31	00:15	12.42	90.31
Manalil	28.38	00:55	3.18	68.38
Karavalur	40.21	00:42	5.74	75.21
Punalur	40.31	00:33	9.02	64.31
Nedumkayam	43.52	00.40	8.42	65.52
Kunnikode	31.82	01:45	4.2	56.82
Pathanapuram	24.24	01:40	4.25	61.24
Pattazhy	24.46	02:31	4.96	39.46
Enathu	23.73	03:52	4.24	37.73
Puthoor	13.47	05:40	4.16	22.47
Sasthamcotta	12.61	08:46	2.2	15.61
Ashtamudi Lake	9.85	10:00	1.44	11.85

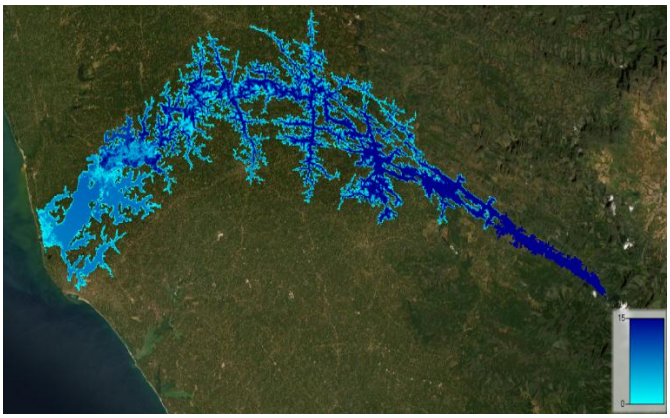

Fig -2: Simulation of Kallada dam break

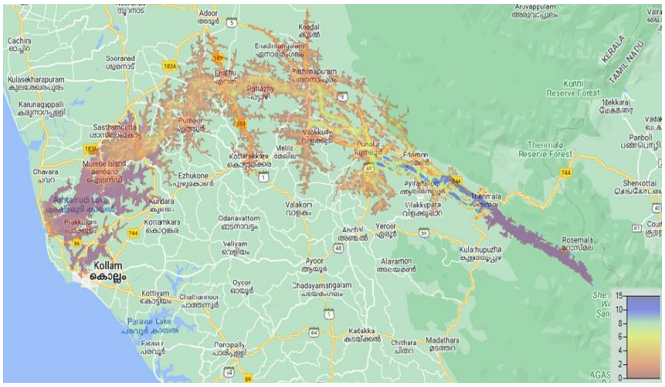

Fig -3: Velocity map layer showing flooded areas

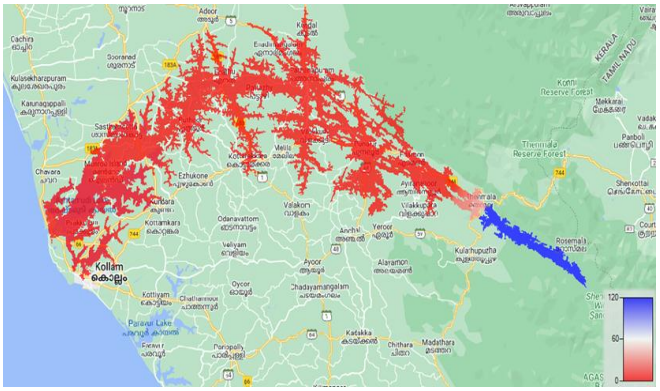

Fig -4: Water Surface Elevation map layer showing flooded areas

5. CONCLUSIONS

From the study conducted it is concluded that

- The maximum velocity of discharge is 26.82 m/s
- The depth of flow varies from 68.58 m to 9.85 m at the end of the breach.
- The time required by the water to reach the Arabian sea is 15 hours

The details about water surface elevation and velocity of discharge give an idea about the extent of flood thereby helping in planning the mitigation measures.

6. REFERENCES

[1] Iroume, J.Y.A., Onguéné, R., Djanna Koffi, F., Colmet-Daage, A., Stieglitz, T., Essoh Sone, W., Bogning, S., Olinga Olinga, J.M., Ntchantcho, R., Ntonga, J.C. and Braun, J.J., 2022. "The 21st August 2020 Flood in Douala (Cameroon): A Major Urban Flood Investigated with 2D HEC-RAS Modeling". Water, 14(11), p.1768.

[2] Lin, X., Huang, G., Wang, G., Yan, D. and Zhou, X., 2021. "Risk Assessment of Dam-Breach Flood Under Extreme Storm Events". Frontiers in Environmental Science, p.453.

[3] Psomiadis, E., Tomanis, L., Kavvadias, A., Soulis, K.X., Charizopoulos, N. and Michas, S., 2021. "Potential dam breach analysis and flood wave risk assessment using HEC-RAS and remote sensing data: A multicriteria approach". Water, 13(3), p.364.

[4] Nharo, T., Makurira, H. and Gumindoga, W., 2019. Mapping floods in the middle Zambezi Basin using earth observation and hydrological modeling techniques. Physics and chemistry of the earth, Parts A/B/C, 114, p.102787.

[5] Quirogaa, V.M., Kurea, S., Udoa, K. and Manoa, A., 2016. "Application of 2D numerical simulation for the analysis of the February 2014 Bolivian Amazonia flood: Application of the new HEC-RAS version 5". Ribagua, 3(1), pp.25-33.

[6] Bahadar, I., Shafique, M., Khan, T., Tabassum, I. and Ali, M.Z., 2015. "Flood hazard assessment using hydro-dynamic model and GIS/RS tools: A case study of Babuzai-Kabal tehsil Swat Basin, Pakistan". Journal of Himalayan Earth Sciences, 48(2), p.129.

[7] Timbadiya, P.V., Patel, P.L. and Porey, P.D., 2011. "HEC-RAS based hydrodynamic model in prediction of stages of lower Tapi River". ISH Journal of Hydraulic Engineering, 17(2), pp.110-117.

[8] Hicks, F.E. and Peacock, T., 2005. "Suitability of HEC-RAS for flood forecasting". Canadian water resources journal, 30(2), pp.159-174.

[9] Operation and Maintenance Manual for Kallada Dam. Kerala Water Resources Department

[10] "HEC-RAS River Analysis System Hydraulic Reference Manual,"2016.

[11] "HEC-RAS River Analysis System HEC-RAS 2D User's Manual."