Flood Simulation of Mazum River at Modasa City

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Abstract - Excessive rain, dam failure or dam overflow can be a reason of River flooding. It causes several human and financial casualties, and hence, it is necessary to perform research studies and implement subsequent actions consistent with the nature of the river.

The present study develops a flood model for the Modasa city through which Mazum River is passing. To study the effects of flood in Modasa city, the flood is modelled for Mazum River using the Digital Elevation Model (DEM) considering the peak flood scenarios i.e. either due to heavy rainfall or due to failure of the Mazum dam. The river reach is divided into different cross sections, and a one-dimensional steady flow analysis is performed on Hydrologic Engineering Centre's River Analysis System (HEC-RAS).

This study can help governing bodies to plan the city and attenuate the losses caused by floods in the Modasa town.

IndexTerms - Mazum River, Digital Elevation Model, HEC-RAS, Modasa.

I. Introduction

"Floods are 'acts of God,' but flood losses are largely acts of man."

Flood is one of the serious natural hazards in the world. On the global scale, storms and floods are the most destructive of natural disasters and cause the greatest number of deaths. Intense rainfall, drainage congestion, imperviousness of ground surface, and bank erosion are primarily responsible for causing flooding.

HEC-RAS is a computer program that models the hydraulics of water flow through natural rivers and other channels. HEC-RAS models are very useful and have the capability for generating flood simulation and estimating hydraulic parameters.

Modasa is a town and a municipality of Aravalli district in Gujarat. Modasa became headquarters of new Aravalli district, carved out from Sabarkantha. The new district was declared on 26 January 2013 and formed on 15 August 2013. Due to becoming municipality of district town is developing very rapidly in last couple years.

Mazum River is tributary river of Sabarmati river. It is situated in upper sub basin of Sabarmati basin.

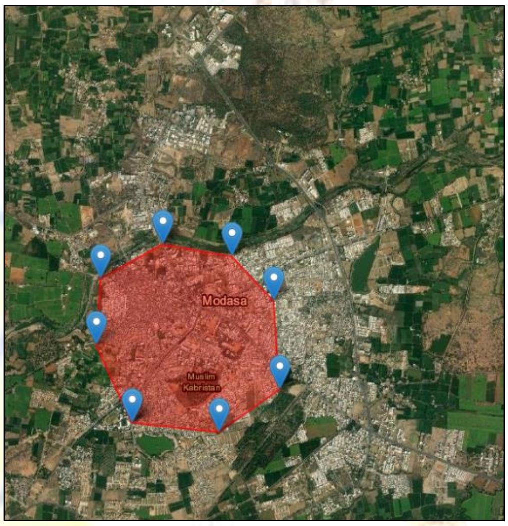


Figure I Development difference of Modasa

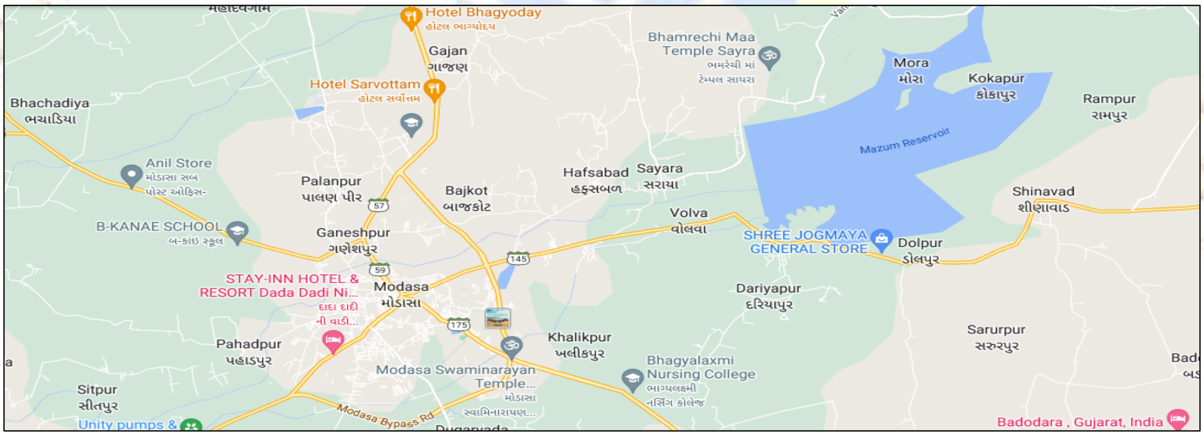


Figure 1 Mazum dam and Modasa city Satellite image

II. Motivation

An informative workshop of five days long was held in institute LDRP-ITR, on subject of remote sensing and GIS. In which knowledge of recent application of RS-GIS was given briefly. Different experts also provided practical knowledge of different softwares to use with remote sensing.

In one of the session of this workshop idea of flood simulation came out. I had observed in past about situation of topography in Modasa city besides river, and well-known to risk of flood in excessive rainfall. Hence to simulate the flood over mazum river in Modasa city was decided to work in dissertation.

III. Aim of Study

Aim of study is to simulate the river flood in Modasa city and get to know about the areas are at flood risk and also suggest precautions to overcome losses in future flood scenarios.

IV. Objective of Study

- To carryout steady flow analysis on the Mazum River and to calculate the water head.
- To simulate the previous floods in Modasa using hydrodynamic models.
- To simulate the critical situation of future flood and its impact in Modasa city.
- To determine areas at risk of flooding by simulating impact of flood on the population and land cover in different flood type.

V. Need of Study

- Overflow of Mazum dam can result in surplus water in stream than river capacity.
- Construction of residence area in both Side Rivers which is likely gets flooded in excess rainfall.
- Due to becoming municipality of district town is developing very rapidly in last couple years.
- Proper regulations or precautionary work is necessary to encounter future possibilities of human and financial looses.
- Proper preplanning of town with reference to flood risks can reduce different looses in future.

Figure 1 Flood prone area

Figure 2 Mazum River

VI. Methodology

HEC-RAS uses a number of input parameters for hydraulic analysis of the stream channel geometry and water flow. These parameters are used to establish a series of cross-sections along the stream. In each cross-section, the locations of the stream banks are identified and used to divide into segments of left floodway, main channel, and right floodway.

At each cross-section, HEC-RAS uses several input parameters to describe shape, elevation, and relative location along the stream such as:

- River station (cross-section) number.
- Lateral and elevation coordinates for each (dry, unflooded) terrain point.
- Left and right bank station locations.
- Reach lengths between the left floodway, stream centreline, and right floodway of adjacent cross-sections.
- Manning's roughness coefficients.
- Channel contraction and expansion coefficients.
- Geometric description of any hydraulic structures, such as bridges, culverts, and weirs.

Given the flow and water surface elevation at one cross-section, the goal of the standard step method is to compute the water surface elevation at the adjacent cross-section.

VII. DATA REQUIREMENTS FOR HEC RAS:

HEC RAS Version 6.2 was used to carry out flow analysis and simulation of flood at river reach. This software allows the user to perform one-dimensional steady flow, one and two-dimensional unsteady flow calculations, sediment computations, and water quality modelling.

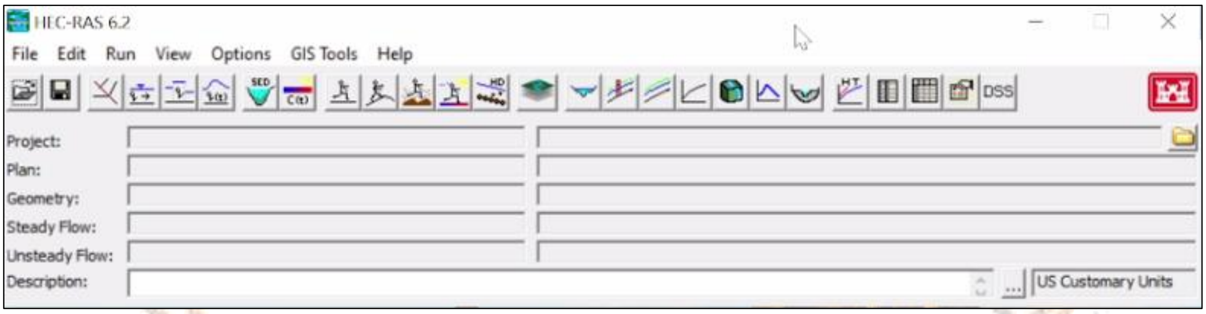


Figure VII HEC RAS Main screen

Required data:

1. **Geometric data**
   - ➢ River system schematic
   - ➢ Cross section geometry
   - ➢ Reach length
   - ➢ Obstructions

2. **Flow data**
   - ➢ Flow rate
   - ➢ Profiles
   - ➢ Boundary conditions

Geometry data in HEC RAS can be entered in different ways 1) survey data 2) using Digital Elevation model.

VIII. ONE DIMENSIONAL FLOW ANALYSIS:

- ➢ In RAS mapper at first DEM was imported which was SRTM DEM. This Dem consist whole Sabarmati region.

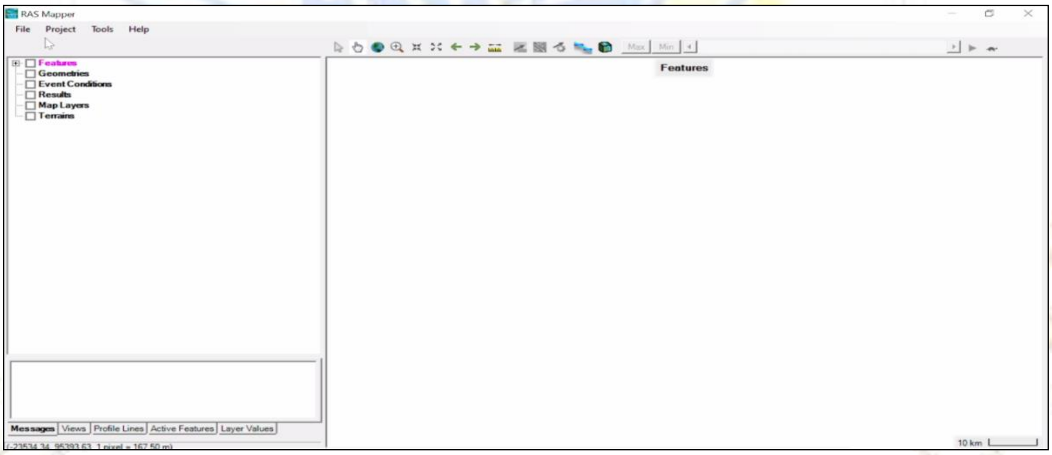


Figure 6 RAS Mapper

- ➢ For study area shape file was inserted in RAS Mapper and DEM was accordingly zoomed in for entering further data.
- ➢ Shape file was downloaded from Government website and separated using ARC GIS software.

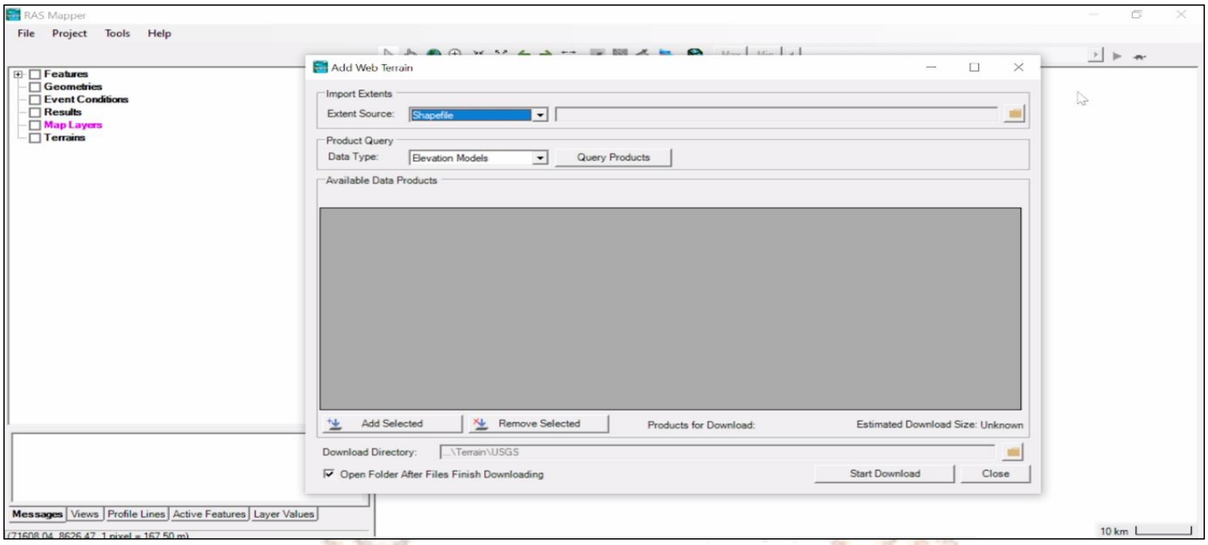


Figure 7 Inserting shape file

- Now DEM of study area is visible on screen we can adjust DEM layer as per our requirement for better visualization of details.
- This DEM consist the terrain data of river and surrounding with elevation at each point which is mainly needed for flood simulation.

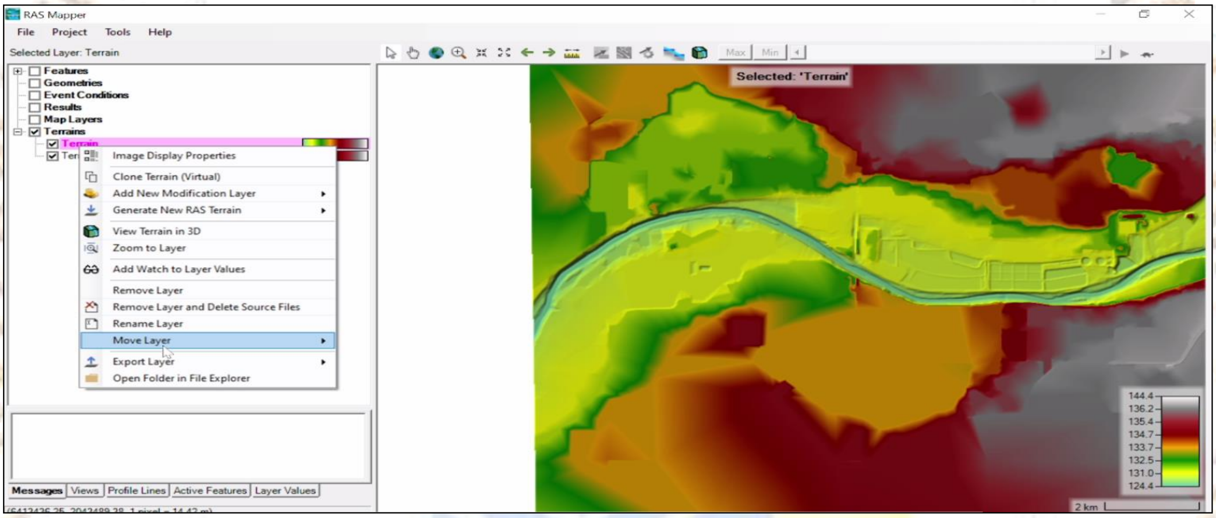


Figure 8 AddedcDEM in RAS Mapper

- RAS mapper shows a terrain profile of every length of river because of DEM entered on it. It shows a elevation at every location in river in which water is subjected to flow in analysis.

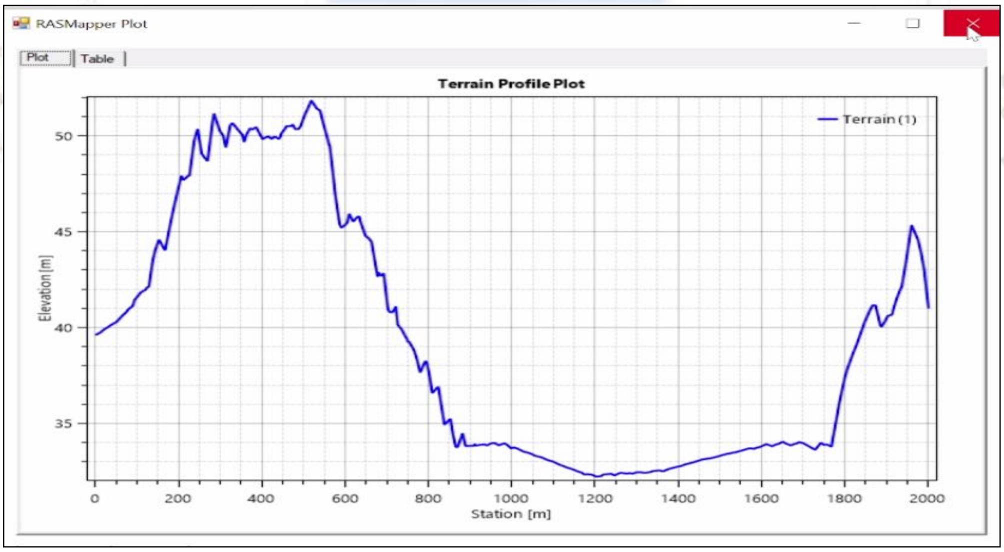


Figure 9 Terrain Profile Plot

- Further River was assigned to RAS layer manually with help of joints and lines.

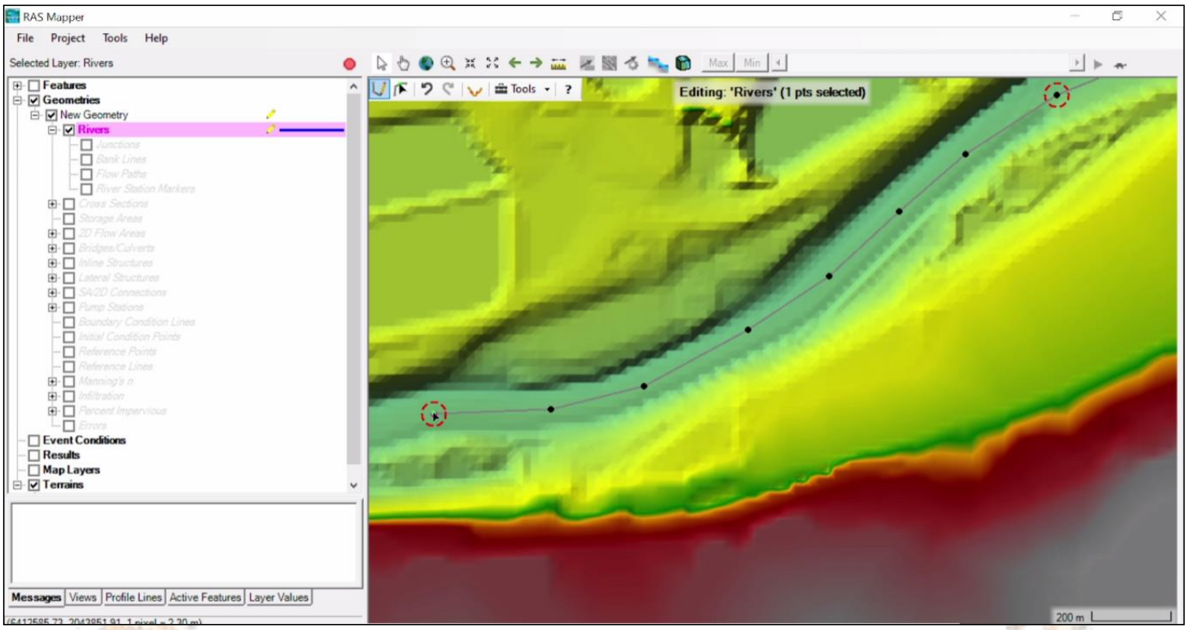


Figure 10 Assigning River

- Similarly like river was assigned Bank line and flow path was also assigned to the RAS layes using lines mannually. Red line is shown for bank line and green line is for flow path. Accuracy of this lines is necesarry for more accurate results.
- Now cross section was created with proper spacing and assigned width. Lesser the spacing more the cross section we will get.
- Cross section is automatically generated by the software from the created DEM .

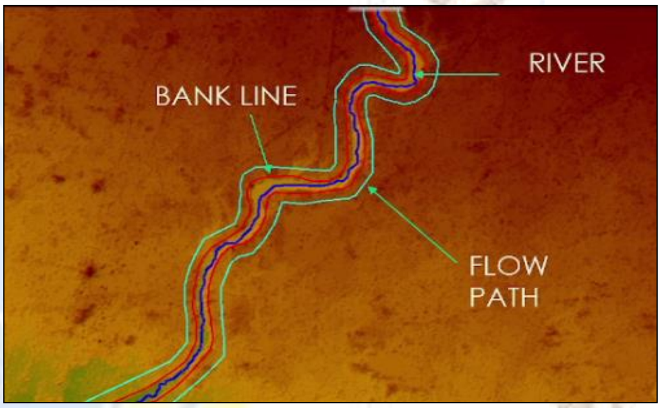


Figure 11 Bank line and Flow path

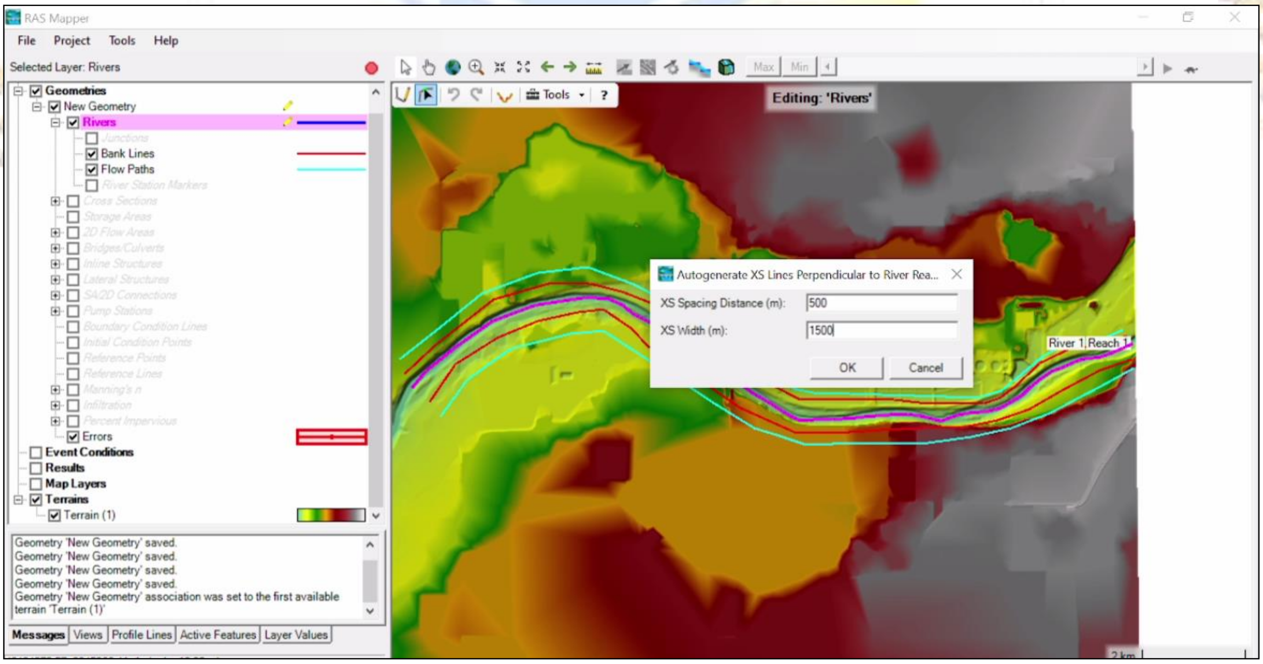


Figure 12 Cross sections

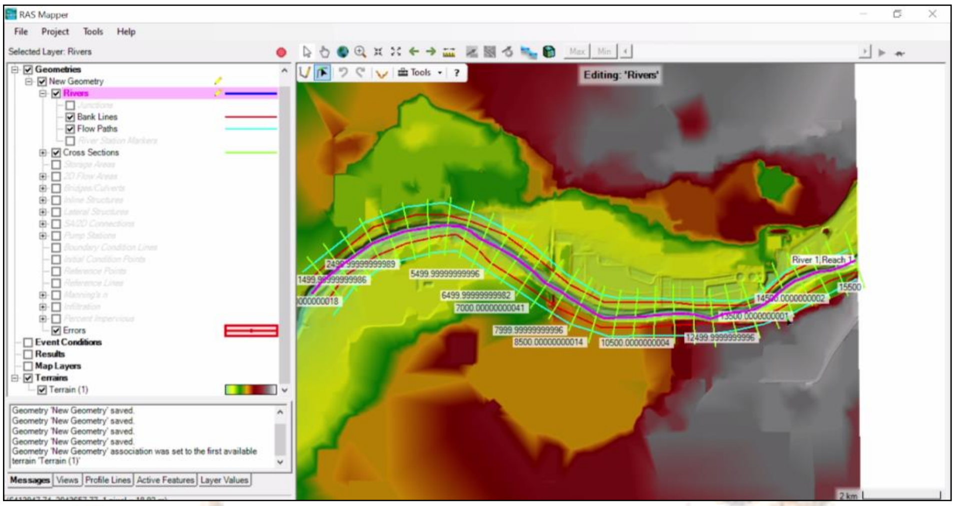


Figure 13 Cross sections

➢ At every cross section we get different elevation data, cross section details of left bank/right bank of river.

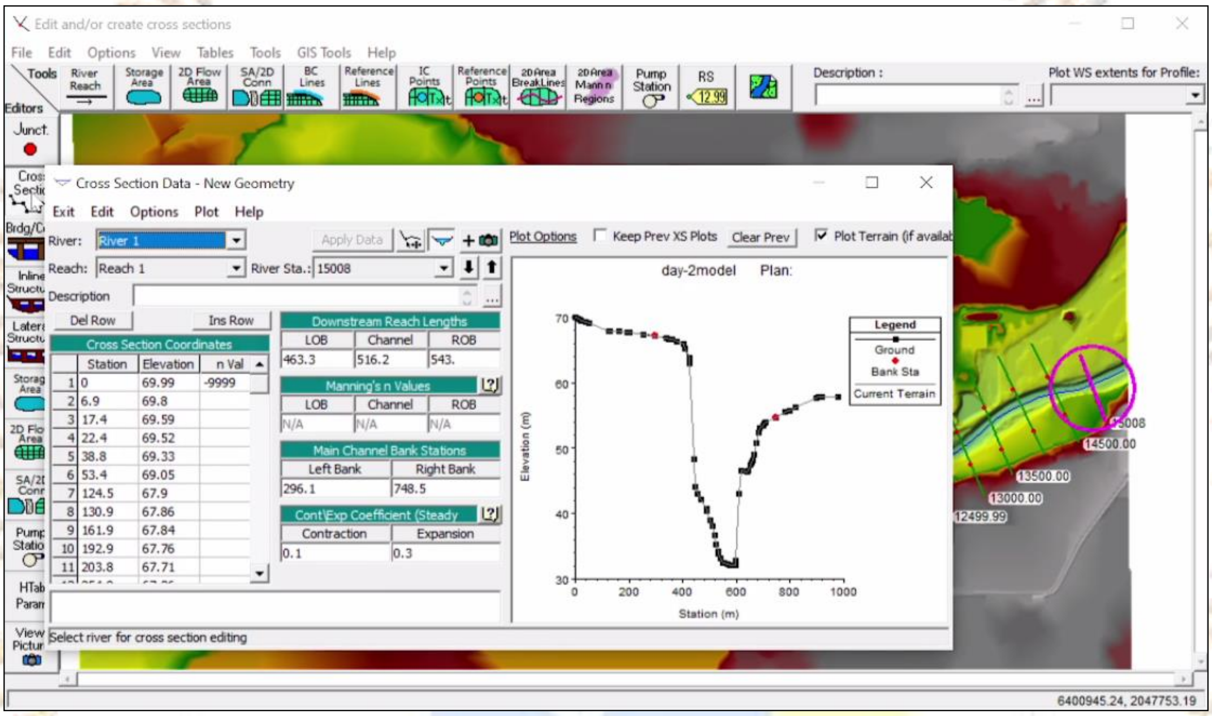


Figure 14 Cross section data

➢ After entering flow data we get different water levels at all cross section. This shows how much water will flow at river at particular water inflow.

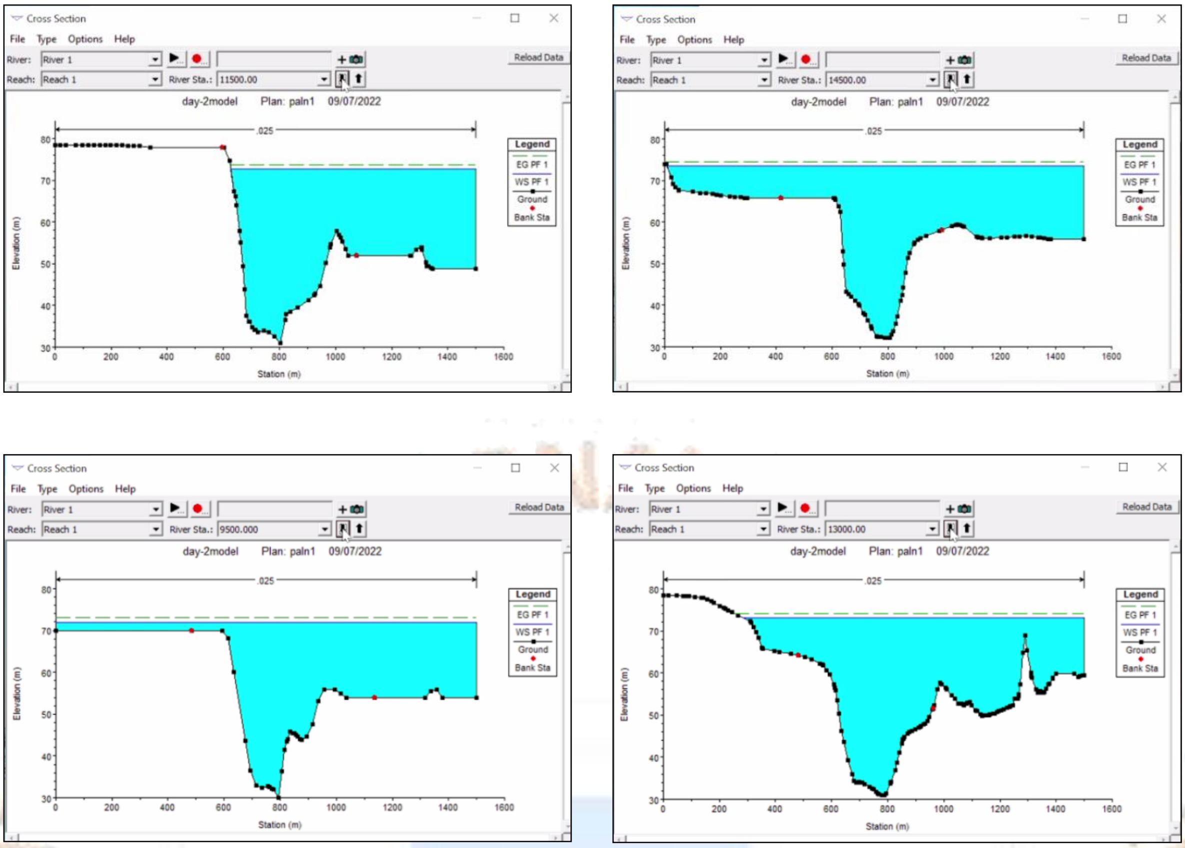
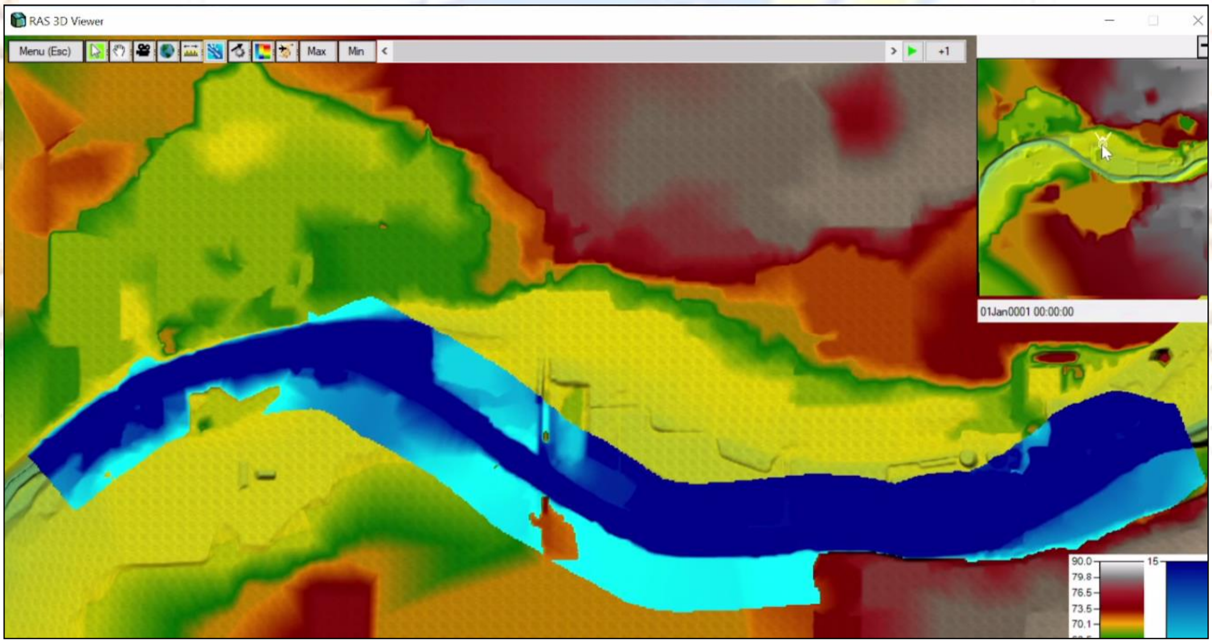


Figure 15 Water levels in cross sections

- After water level in cross section water spread can be visible in 3D top view of DEM.
- It also shows flow direction in video format and can be paste on any layer below as well as Google maps also.



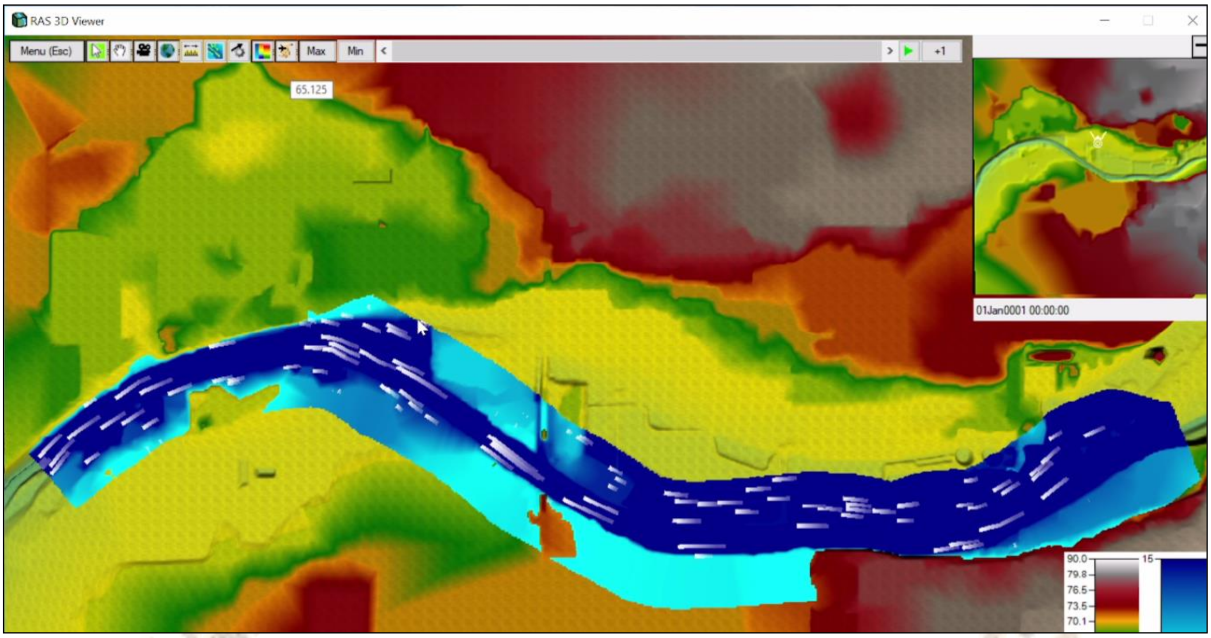


Figure 16 3D water flow

IX. Conclusion

After running flow analysis in software HECRAS of Mazum River in Modasa city, simulation shows that the both side of river is getting flooded by water flow. It can cause a huge damage to living hood as well as Properties. For prevention of this damage governing authority of Modasa city should introduce some constructional criteria in this area to minimize residential construction and provide area for recreational facilities. Contraction of bank wall also can reduce the amount of water entering city and reduce flood risk in particular area. Contraction extra waterways from downside of dam also can be helpful to divert water quantity and less water intake in city area river.

X. Refrences

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