

# Sediment Transport Analysis On Mandavya River Using Hec-Ras Software

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## ABSTARCT:

Sediment transport is an essential aspect of river engineering that affects channel stability, flood risks, and hydraulic structures. This study focuses on analyzing sediment behavior in the Mandavya River using HEC-RAS modelling software. The objective is to evaluate sediment movement, erosion, and deposition under different flow conditions by incorporating river geometry, flow data, and sediment characteristics into the model. Both steady and unsteady flow simulations were carried out, and various sediment transport functions were tested to determine their suitability. The analysis highlights sediment load distribution, bed level changes, and areas prone to aggradation and degradation. Results indicate that sediment transport is highly influenced by discharge variations and channel slope. The model successfully identifies critical zones of erosion and deposition, supporting effective river management and flood mitigation planning. Overall, the study demonstrates that HEC-RAS is a reliable tool and provides a strong scientific basis for sustainable river basin management and infrastructure development.

**Keywords:** Sediment Transport, River Engineering, Channel Stability, Erosion and Deposition, Hydraulic Modeling

## INTRODUCTION:

Sediment transport refers to the way in which silt or even gravel or even larger particles are detached off the bed or side of the channel which are transported downstream by the flowing water. Typically, two methods of converting the sediment in channel exist. The former one is the movement of the suspended particle where they are suspended on the water

flow through turbulence and second is the movement of the bed load particles where the sediment particle flows along the bottom of the channel with intermittent splashes.

The river streams transportation of the sediment is determined by its size and nature, basin size and its slope, vegetation and land cover around the basin areas, inundation events,

temperatures, climatic variations et cetera. An archetypal procedure of comparing the sediment discharge to stream flow by rating curve is an affirmative approach to the calculation of the sediment. Individual hydrologically high discharge may transport a significant quantity of sediment in a shorter time and therefore transport a significant quantity of sediment. Besides these, channel geometry and channel width are also affecting the sediment transport processes.

## II. METHODOLOGY

HEC-RAS is a combined system of hydraulic analysis software, where the user is dealing with the system through a Graphical User Interface (GUI). System is capable of doing Steady Flow water surface profile, One and Two dimensional unsteady flow, Sediment Transport/movable boundary, water quality analysis and a number of hydraulic design computations. A Project in HEC-RAS terms is a collection of data files related to a given river system. As part of the project, the modeler can undertake any or all of the different types of analyses, which is part of HEC-RAS package. These classifications of data on a project are plan data, geometric data, steady flow data, unsteady flow data, quasi-steady flow data, sediment data, water quality data and hydraulic design data.

It was based on the HEC-RAS Geometry editor to produce geometric data. Nonetheless, in order to introduce terrain data, extract model

elevation data of the terrain, and inundate map the model results, it is necessary to create a geospatial coordinate system and a terrain model through HEC-RAS Mapper. The user manual of HEC-RAS Mapper is quite independent and presents the following details: the creation of geospatial coordinate system of the project on the basis of which a terrain model will be created and, based on the constructed model, the results will be represented as maps, graphics, and tables.

## III. STUDY AREA

The Mandavya River is a large tributary to the Penna River system located in Southern Andhra Pradesh in India and plays a crucial role in supporting the region's hydrological, agricultural and socio-economic systems. The Mandavya river which rises from the Nallamala hills is formed by the joining of the two main streams Cheyyuru river and Gadikotta river near Veeraballi village of Annamayya district. It winds through rough lands, fertile valleys and plains and takes a mostly north-eastern route before joining its major stream, the Penna River near Toorpu Kanupur in the Kadapa district. It is one of the significant sub-basins of the broader Penna basin in which the Mandavya river has a total length of about 47 Kilometers, while its catchment area is spread over an areal coverage of 7,326 square Kilometers of land. Its basin is covering geographical coordinates falling, somewhere between 13°30' to 14°30' N range

and 78°30' to 79°30' E longitude, encompassing a broad range of physiographic, ecological zones. The Mandavya river basin terrain consists of rolling hills, plateaus, and flat plains, and the Nallamala ranges varied formation is the prominent geomorphological options in the upstream catchment area.

Similarly, precipitation in the basin is managed at 700-800 mm a year, with the majority of rain falling during the South-West Monsoon (June to September) which accounts to nearly 80 percent of the overall rain. The region also receives a fair amount of rainfall from the North-East Monsoon (October to December).

There are red loamy soils, black cotton soils, and sandy loam around the basin and such soil distribution is generally consistent with surface runoff properties and sediment delivery. In the basin, land use and land cover is majorly dominated by agricultural activities, with vegetation such as paddy, groundnut, sunflower and millets hugely cultivated, supported by both rain-fed and canal irrigation systems. Mainly, forest cover exists in the upper elevated portions of the basin, soil conservation and runoff regulation being some of the contributory effects of such cover during peak rainfall periods. Fig.4.1 shows the study area.

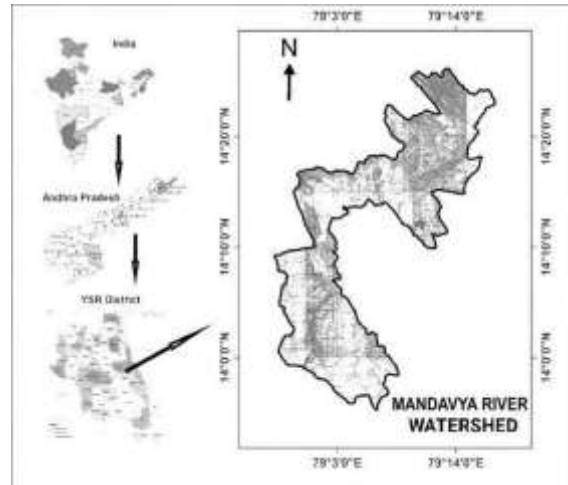


Fig 4.1 Study area – Mandavya river

Besides, water reservoirs occur under unconfined conditions because of increased groundwater storage in summer but deteriorated when the summer season ends. Water resource management in the basin needs an integrated strategy which combine surface water management with groundwater management together with sediment dynamic and land-use practice planning.

Researchers simulate Mandavya River floods using hydraulic modelling HEC-RAS and sediment movement and channel stability to provide better drainage plans for flood control and sediment management and agricultural irrigation.

These models help the researchers jointly with the planners to identify erosion-prone areas and sedimentation vulnerable areas and the

flooding-prone areas to devise appropriate flood control measures including levees, revetments and sediment traps (1994).

#### IV. RESULTS AND DISCUSSIONS

Calculate the satisfied sediment transport value that took place in Mandavya river between 01 Jan 2025 and 01 Feb 2026.

The flow data are simply entered at the beginning of the river as the first point of cross-section where the natural slope exists. We gather sediment data of starting point and end points of the river stream. Fig 6.1 shows sediment analysis.

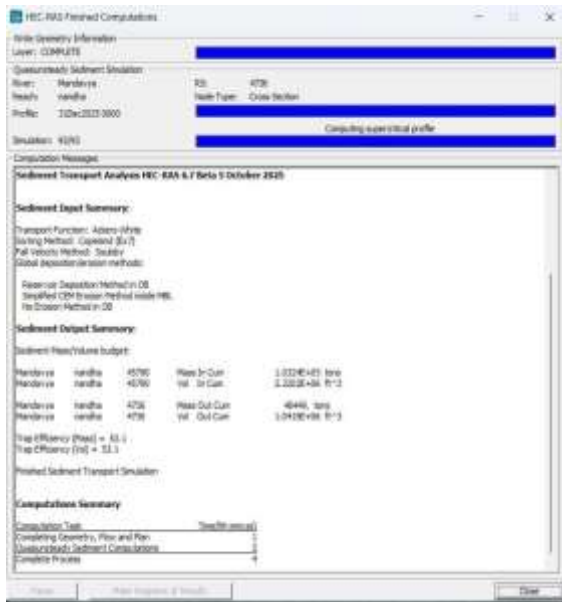


Fig 6.1 Sediment transport analysis of Mandavya river

In this production we have spoken majorly of the concentration of sediment (mg/lit). The concentration of sediment is the mass of

sediment in unit volume of water. It is typically measured in parts per million (ppm) or mg/lit.

#### Types of Sediment Concentration

The laboratory determines the point sediment concentration from a specific time in the river cross-section. Fig 6.2 shows sedimentation concentration.

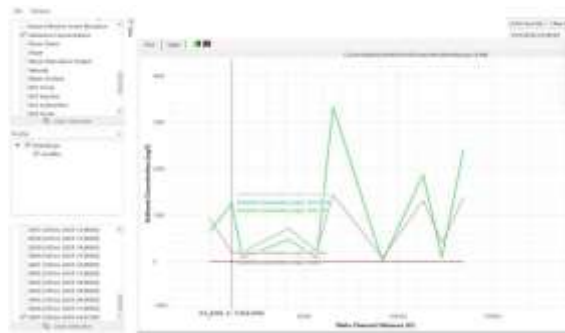


Fig 6.2 Sediment concentration output at cross-section 45.7 KM along time

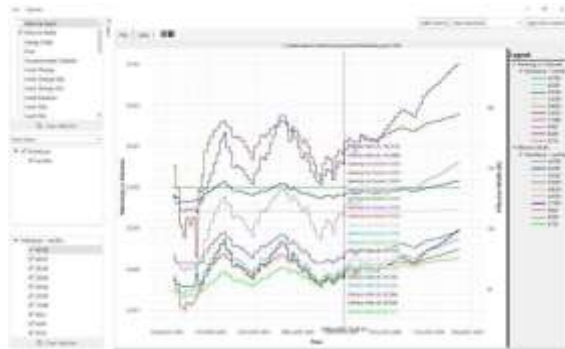


Fig 6.3 Sediment concentration output at cross-section 45.7 KM

Cross-Sectional Averaged Sediment Concentration. The cross-sectional average content of the whole river. Fig 6.3 illustrates Time series cross-section sedimentation concentration Sediment output.

### Flood mapping

The flood mapping analysis presented by the RAS mapper provides a visual depiction of the effects of water on the area under analysis. The flood mapping consists of three basic properties that comprise of water velocity and depth measure as well as water surface elevation.

### Velocity

The unit of measurement of velocity is either m/s or ft/s as the standard unit. Velocity is an important hydrodynamic parameter that is essential in HECRAS (Hydrologic Engineering Centre River Analysis System used in flood mapping and flood model). Velocity is used to determine the rate of movement of water within a channel as river floods take place. The HECRAS velocity field shows the velocity of flows of the water at all points of a river channel and the floodplain adjacent to the river channel assisting technicians to identify equipotent flood risks areas. The constrained river channels yield high speeds that are attained closer to their origins. Fig 6.4 shows depicts Velocities visualization view in Mandavya river.

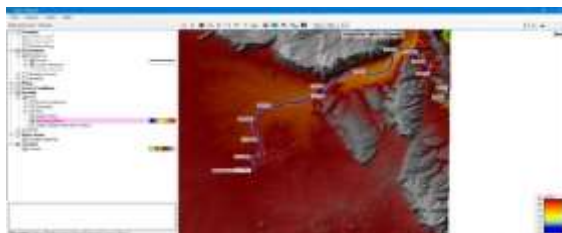


Fig 6.4 Velocities visualization view along Mandavya river

### Water Depth

Water Depth referred to articulates the nearest distance both to the river bottom surface (or land surface) and floodwater water surface level among all points in the river channel or floodplain. Hydrologic Engineering Centre River enough.

$$\text{Depth} = \text{Water Surface Elevation} - \text{Riverbed Elevation.}$$

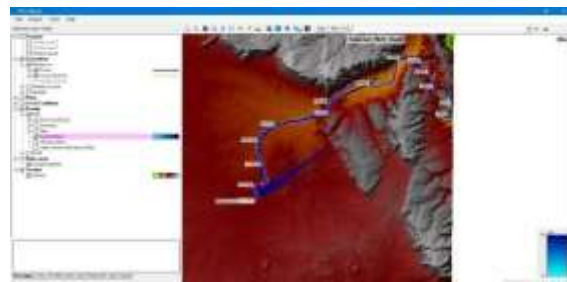


Fig 6.5 Water Depth's visualization view along Mandavya river

It indicates that there are deeper (hazards zone) in Mandavya river in the entire length of the river. The river construction such as bridges, infrastructures etc whatsoever along the cross-section is use full. As a result of the condition of terrain that has been most compromised it must be reflected in colour grading. Fig 6.5 represents the visualization view of Water Depth in Mandavya river.

### WSE (Water Surface Elevation)

Water Surface Elevation (WSE) represents the measurement of water level heights which can be observed at different points across river and floodplain areas. Development of flood hazard

map relies on the measurement of WSE in place and time during floods. Fig 6.6 depicts visualization view of WSE (water surface levels) along Mandavya river.

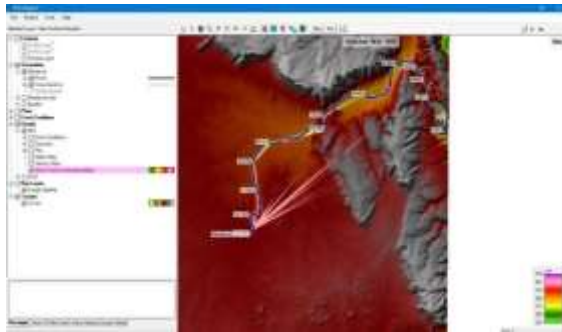


Fig 6.6 WSE (water surface levels) visualization view along Mandavya river

### Different output parameters

#### Cross-sections

The findings demonstrate the increase in river bed and maximum erosion areas along with the visualization of flow information prior to and following the river bed development. Fig 6.7. shows Cross-section view of Mandavya river at cross section 87.571 KM .

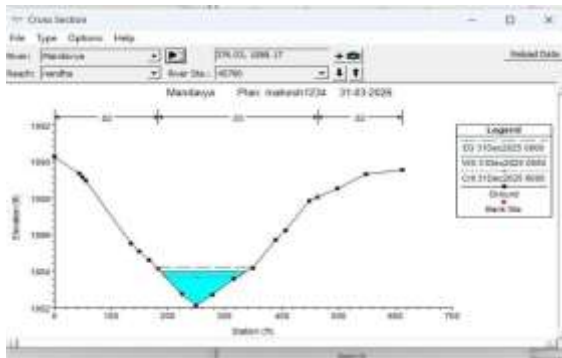


Fig 6.7 River bed of Mandavya river at cross section 45.790 KM

#### Profile plot

The Profile Plot shows WSE or other hydraulic parameter data points across cross-sections at a specific time interval in the course of a flood event. The tool illustrates how the water surface elevations change over time that indicates how the flood waves spread along with the backwater phenomena and the effects of multiple flow regimes along a river or stream. Fig 6.8 shows Profile plot of Mandavya river.

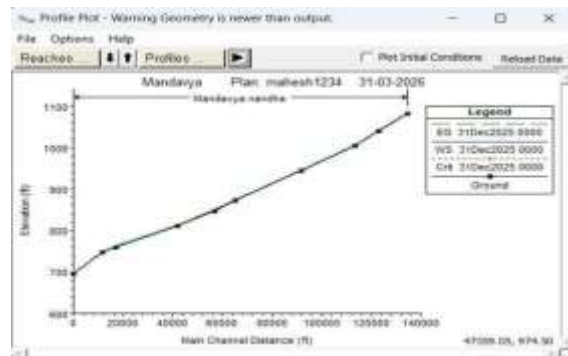


Fig 6.8 Profile plot of Mandavya river

In the plot, cross-section locations are represented with the help of the x-axis to illustrate water surface elevation data and other hydraulic data that are plotted on the y-axis to indicate the data of floodwater movement patterns and peak flow rates and the extent of the flood. The tool is very crucial in the flood risk assessment process and assists in floodplain management, as well as levees or floodwalls infrastructure design.

#### Rating curve

An analytical relationship between river flow rate (discharge) and water surface elevation (stage) at a specific section of the river is given by its cross section, known as a rating curve. The water surface elevation in hydraulic model generated data and related flow rates lead to the development of this plotting. The rating curve represents the alteration of the flow rate with regard to the variation of water surface elevations and it has a model calibration purpose and a flood forecasting task. Under this method, it is possible to make predictions of the river level of discharge at various stages of the river.

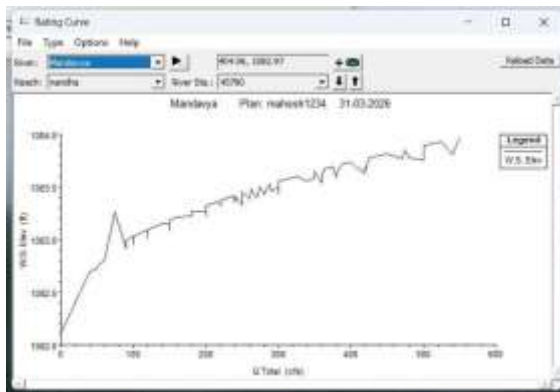


Fig 6.9 Rating curve of Mandavya river Cross-section at 45.7 KM

That causes the need to develop the flood risk assessment and hydraulic structures such as weirs, dams, and bridges. Fig 6.9 shows Rating curve of Mandavya river at all Cross-section.

### Stage and Flow hydrographs

Stage and Flow Graphs permit the visualization of the operations of streams and rivers through

visualizing simultaneous changes in the water surface elevation and the discharge flow rates at key points of monitoring. The stage graph illustrates the measurement of the elevation of water surface in a specific site throughout the flood process. The visualization shows different heights and decreases of flood water throughout the system. Time-based discharge observations generate observable data in the form of flow graphs, which indicate instant change at definite points. The unsteady flow modelling enables the observers to examine the flow dynamics using the system. The stage and flow graph analysis enables the decision makers to apply the flood management and design infrastructure by their capability to reflect the measurements of flood activity and evaluation tools to forecast the success of flood control measures.

### Hydraulic properties

The movement of water in a river is based on hydraulic characteristics that define physical factors that impact on the level of water and the speed of water in the stream. The basic river features to be used in the analysis of water flow include the cross-section shape, width, slope, and the roughness coefficient of Manning that shows the resistance to flow depending on bed and bank materials and vegetation among other factors. These hydraulic properties are essential in the accurate modelling of river behavior when simulating the behavior of a river in unsteady



KM mass in cum 48449 tonnes or volume in cum 1.049x10<sup>6</sup>.

The flood mapping divided three categories, whereas velocity it has for Mandavya river minimum and maximum values are 1 to 8 m/s, depth has minimum and maximum values 0 to 10 m across the river and the water surface elevation has maximum value has 90 m.

### FUTURE SCOPE

Our project was restricted to one-dimensional flow assessment which covers Quasi steady flow and unsteady flow conditions but the entire model involves testing 2-Dimensional flow conditions. There are no bridge/dam/ storage constructions in the Mandavya river project and therefore our software can accept any assignment of pipes network.

The HEC-RAS software application is possible in secondary analysis of dam failures. The software identifies the amount of water needed to cause a dam collapse. Through simulating a sudden water release which happens when a dam fails HECRAS operates as a modelling tool. The analysis process helps the engineers to know the various outcomes that take place following the dam breakage. The software can be used to model bridge and culvert flow by an engineer to develop structures that have adequate flood transportation ability that ensures safe conditions during flooding.

### REFERENCES

1. Hayder Sami Mohammed, Alturfi, U. A. M., and Shlash, M. A. (2018). Analysis of hydraulic analysis with HEC-RAS. *International Journal of Civil Engineering and Technology*, 9(5), 919929.
2. Haghiabi, A. H., and Zaredehdasht, E. (2012). Evaluation of HEC-RAS ability in erosion and sediment transport forecasting. *\*World Applied Sciences Journal\**, 17(11), 1490–1497.
3. Hameed, L. K. (2016). Determining the rate of sediment transport of the Euphrates River in Al-Hindiya City through HEC-RAS model. *Arab Journal of Sciences and Research*, 2(3).
4. Pratama, F., Wulandari, S., Rohmat, F. I. W. (2025). Using HEC-RAS 2D to model the accumulation of sediment in Pare Reservoir: Evaluation of storage capacity at a 10-year time horizon. *\*Results in Engineering\**, 1–13.
5. Parsa, A. S., Noori, M., Heydari, M., & Rashidi, M. (2016). This is the simulation of floodplain zoning by HEC-RAS and CCHE2D models in Sungai Maka River. *Air, Soil and Water Research*, 5562.
6. Shukri, B. H. M., & Talib, S. H. A. (2024). HEC-RAS software was applied to sediment transport in Sg. Muda River. *Recent Trends in Civil Engineering and Built Environment*, 5(1), 294310.
7. Ahmad, H. F., Alam, A., Bhat, M. S., & Ahmad, S. (2016). One dimensional steady flow analysis by HEC-RAS: a case study of river jhelum.
8. *\*European Scientific Journal\**, 12(32). Hameed, L. K. (2014). Hydraulic model (Al-Kufa River case study) Calibration of Manning friction factor of rivers in Iraq.

International Journal of Innovative Science,  
Engineering and Technology, 1(10).

9. Khassaf, S. I. (2013). Upstream modeling of Al-Yaa'o regulator in AlNajaf City. International Journal of Engineering Research and Technology, 2(11).
10. Omran, Z. A., & Al-Mansori, N. J. H. (2024). Upstream Al Kufa Barrage transport of sediment modelling. \*Open Engineering\*.