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# ANALYSIS OF HYDRODYNAMIC BEHAVIOUR OF BRAHMANI RIVER USING HEC-RAS

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## ABSTRACT

*River also known as second mother resource of water present in the earth. Although water coming from ground and rain plays a vital role as main source of water but the role of rivers cannot be ignored. The distribution of water from main sources to sub channels is mostly carried by rivers. In India the behaviour of water flowing through the rivers are not constant as the rainfall depends on the continuously changing climate. Especially the rivers present in Odisha shows an uneven behaviour throughout the year. The present study represents the application of HEC RAS modelling for analysis of hydrodynamic behaviour of the river Brahmani. A particular station is chosen for case study known as Jenapur station. For this analysis, the river discharge data is used which is collected from CWC, DEM file from the Bhuvan site and land use and land cover using ARC GIS has been used. This analysis helps to indentify the profile like velocity profile, water surface profile, water depth, and inundation characteristic of water, energy line, and hydraulic gradient line, wetted perimeter both in tabular and graphical form. This study provides information to water resources engineers for constructing different hydraulic structures, water management, flood control and environmental planning.*

**Keywords:** CBR, geo-grid, reinforcement, sub-grade, clayey soil

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## 1. INTRODUCTION

HEC-RAS which is developed by army corps of engineers- Hydrologic Engineering Center (HEC) (USACE, 2001) is a hydraulic model package. In 1964, the model has been quickly established as hydraulic analysis program and was utilized in the analysis of bridges and ports [1][2][3]. This graphical computer code was developed in visual basics and edges process algorithms of FORTRAN. HEC-RAS computer code, additionally to scheming one-dimensional profile of water surface in stable rivers. The steady-component module calculates water surface profiles from steady input discharge information at associate upstream crosswise, from stream pure mathematics further as surface roughness information for the stream section below examination. The most output variables of this analysis square measure the water surface elevation on the top of a base altitude for the flow speed [4]. Its doable to bit by bit alter the discharge at each outlined cross-section. The analysis module is having the ability to handle not solely single reaches, however whole stream networks. Due to temperature change and variability, water resources square measure these days low in several rivers systems. This penalizes development comes associated with water, like agriculture. Thus, the analysis of the dynamics of the streams flow became a vital step towards the higher understanding of the hydraulic behavior of the river. This will be done by the best style of rivers and hydraulic structures for water resources management. The utilization of mechanics models as call support has become essential [5]. These models use arithmetic to represent a system so as to research the dynamic of stream flows. There are several hydraulic models for stream system flow analysis are present. However, the selection of the model should be created by distinguishing associate acceptable model structure that is in a position to represent accurately. this illustration passes by the computation of the necessary hydraulic parameters of flow like water surface, Froude range water flow speed, slopes, flow area, wetted perimeters, head loss and volume. [6][7].

## 2. STUDY AREA

Brahmani river is the second largest and highly polluted river in Odisha. It is formed by the combination of Sankh and Koel at Rourkela town. The terrain of jenapur village is taken for the study of river flow analysis in this project, which is in Odisha at 20.85 longitudes, 86.0716 latitude. The jenapur is a town which is badly effected due to floods in august 2017 and Dhenkanal, Jajpur and Kendrapara districts are flood prone districts in Odisha,

The level of water was recorded as 179.90 m at Panposh, which is above the danger mark of 178 m. At Jenapur, the river was reached the danger level of 23 m and the river shown a rising trend gradually. At the same time, flood in Brahmani and its tributaries and distributaries inundated some parts of Kuanrunda and Subdega blocks as well as Sundargarh Municipality and Rourkela Municipal Corporation in Sundargarh, and 1,600 people were evacuated and taken to safe shelters in the district.



**Figure 1** Jenapur -brahmani river sattilite view

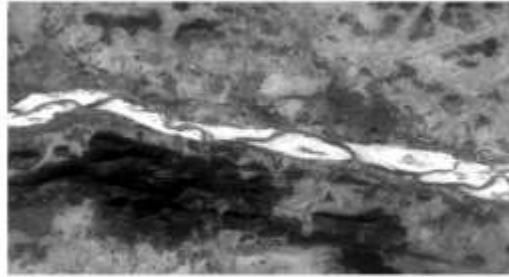


Figure 2 jenapur -brahmani river raster view

### 3. METHODOLOGY

#### 3.1. Importing data from Bhuvan website

In order to import the raster files that are taken by the satellites at different time periods, we need to create an account in Bhuvan website and by clicking OPEN DATA ARCHIVE blog we can select the satellite category then we can select the survey. It is using four methods, they are bounding box, map sheets, tiles, and through interactive drawing, now in the bounding box the longitudinal and latitude ranges are given to obtain the survey area by selecting the images according to the time periods.

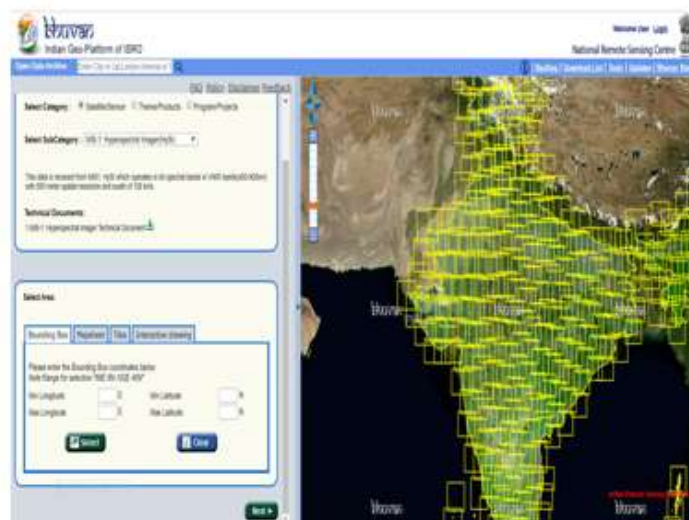


Figure 3 importing data from Bhuvan

#### 3.2. Creating New Project and Merging the Terrain Files

Now by creating the new HEC RAS file and going into the RAS mapper option in the tool bar at the top we can add the file that are downloaded from the Bhuvan website, and by clicking the merge all the inputs option all the terrain files will be merged and will automatically get saved in the terrain folder. This process can also be done directly in Arc GIS without using Bhuvan website and it can be only possible if ArcGIS is a licensed version.

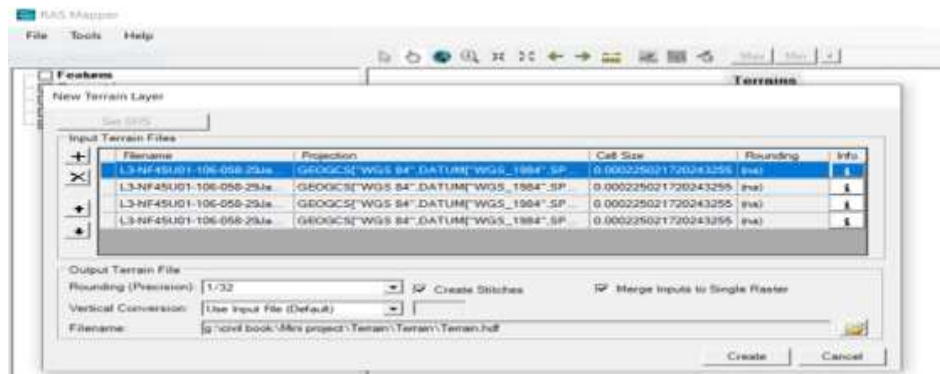


Figure 4 merging terrain files.

### 3.3. Land Use and Land Cover

The merged inputs from the HEC RAS will appear as a black and white raster file when it is imported into the ARC-GIS, so it is required to go for the land use and land cover which includes collecting the samples of different land use land cover items in the terrain like vegetation, agricultural lands, constructed area, water bodies, mountains, rocky lands etc.

And the desired colours are allotted for different category elements in the terrain so that based upon the pixels the ARC-GIS will categories the elements as similar pixel elements as one family. And after the completion of this image classification we convert classify the file into the category of INTERACTIVE SUPERVISED CLASSIFICATION. So that we can obtain the terrain file with our classified colours.

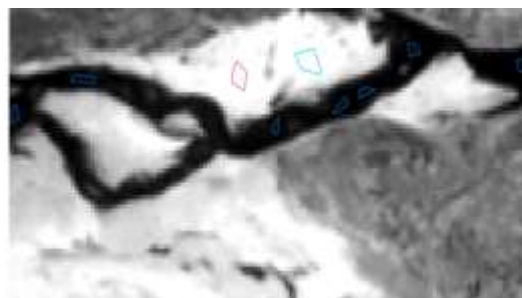


Figure 5 land use land cover mapping

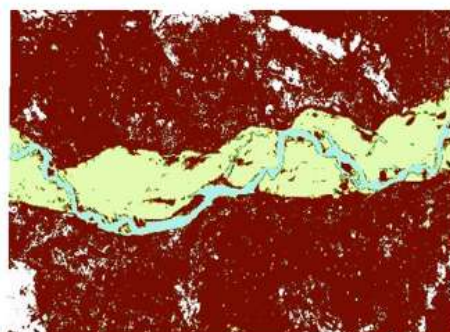


Figure 6 interactive supervised classification.

### 3.4. Plotting Geometrical Data

The interactive supervised classification file should be exported to the terrain file which was created in past and the file should be opened in the HEC RAS software by going into the add terrain option and should be imported for plotting the river path, bank lines, flow lines, and cross sectional lines in the geometry option.

The river path should be mapped exactly through the mid-way of the river channel and by double clicking we can end plotting and by clicking on the stop editing we can come out of the sketching, now similarly the bank lines of the river are plotted as well as flow lines and the direction of flow lines that are drawn should be verified whether they are aligned in the correct direction or not. At last the cross sectionals mapping should be done in such a way that the it should cut all the bank lines river-path line, flow lines and also no two cross sectional lines should intersect with each other. The center blue line is represented as river path line and red lines are represented as bank lines and blue lines as flow line, green lines as cross-sectional lines. The elevation values of the river will be automatically plotted by HEC RAS, but the land on site survey data will give the more accurate values rather than the raster elevation values.

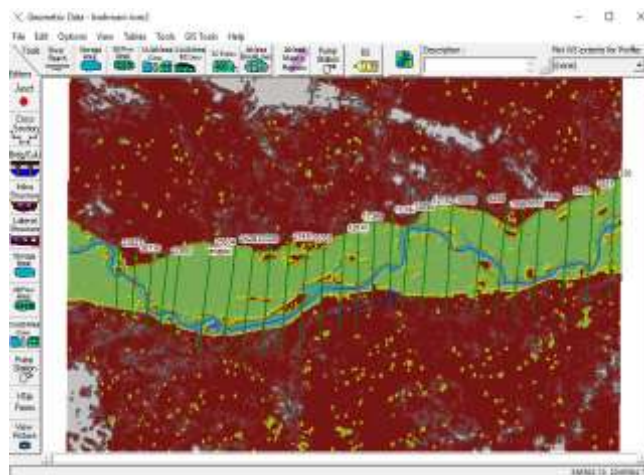


Figure 7 Geometric data

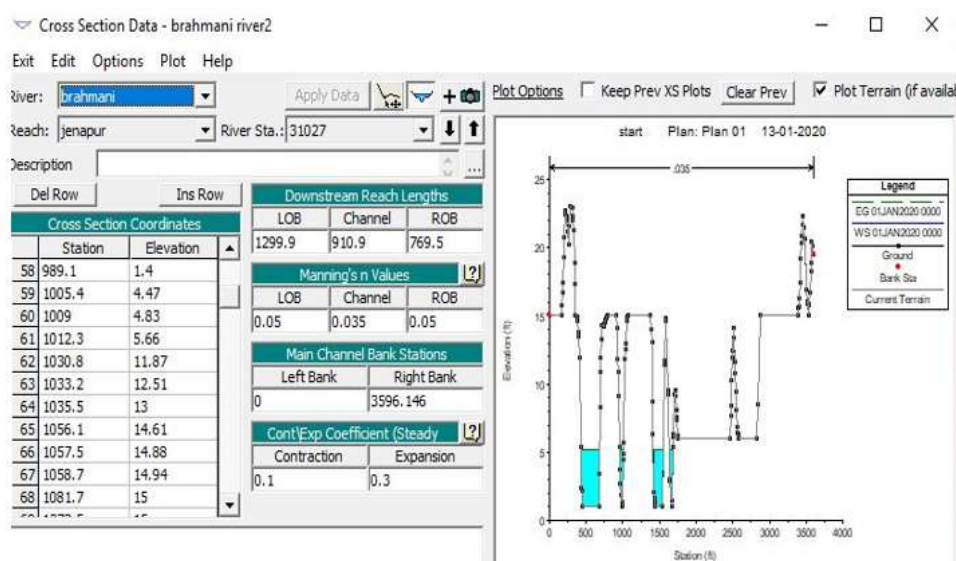


Figure 8 River Cross section

### 3.5. Editing Mannings N or K Values

The Manning's n or k value represents the roughness or friction applied to the flow by the channel. It can also contribute change in the river profile due to the roughness which leads to turbulence. And the manning's theory states that the flow rate is inversely proportional to the roughness coefficient. So if manning's n or k value increases the flow rate decreases. In this study the Manning's coefficient taken as 0.05 for left and right of bank and 0.035 for channel considering the river geomorphologic characteristic.

### 3.6. Editing Unsteady Flow Data

After entering the geometry data, we have to unsteady flow data are entered for the hydraulic calculation. In this study unsteady flow analysis has carried out. For the simulation of unsteady flow, hydrograph values as well as the normal depth values has to be entered. And the hydrograph is nothing but the graph between the flow rate and discharge to the time period. The discharge value has collected from the CWC department and a time period of 3 years has taken from 2017-2020.

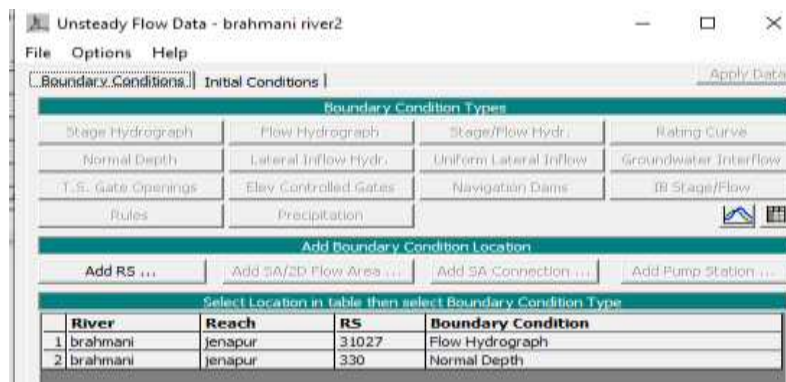


Figure 9 Unsteady Flow data

### 3.7. Performing Hydraulic Computation

After entering geometry data and boundary condition, the hydraulic computation will begin. We have to run the unsteady flow option then compute for result as given in figure below.

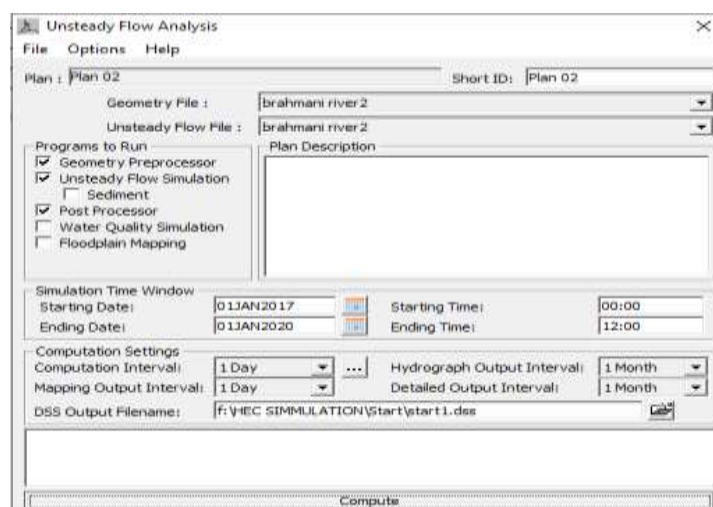


Figure 10 Hydraulic computation

## 4. RESULTS AND DISCUSSIONS

After completion of all computation outputs are available in view option on main window.

The out puts are: cross section plots, water surface profile plots, rating curve plots, X-Y-Z perspective plots, velocity profile plots and hydrograph plots. The results are shown in figure below

### 4.1. Elaboration of the Maps of Jenapur

The quality of hydraulic modeling is highly dependent on the quality of the topographic data. These data depend significantly on two main factors, namely the precision and the resolution. Several acquisition techniques, more or less sophisticated, can be used depending on the objective envisaged by the study and the budget allocated. The resolution presents the mesh fineness of surveys in the field as well as the precision and absolute error on the measurements. The quality differs between the minor bed and the major bed. Indeed, there are two types of surveys, namely the seeding point survey and the cross-sectional survey. When a one- dimensional model is used, the geometry is described by a set of cross-sections that must be chosen wisely in order to cover all features of the longitudinal profile, namely the contractions and expansions of the flow as well as the important details of geometry. For a large-scale hydraulic study, it is necessary to provide very extensive topographic data of fine resolution and high precision. Therefore, it is highly recommended to choose the survey method that offers the best relationship between the quality required by the study on the one hand and the acquisition cost, on the other.

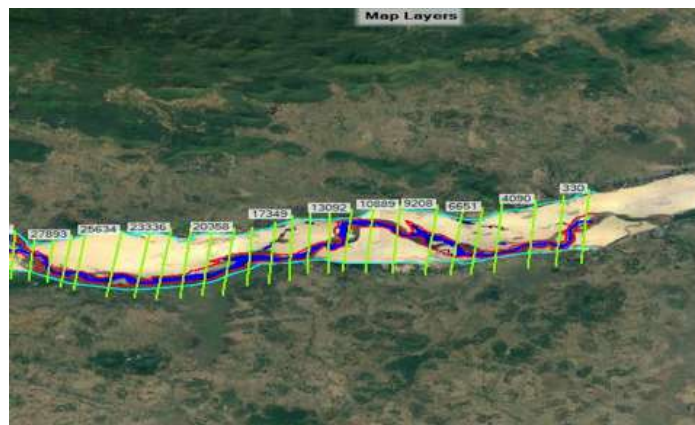


Figure 11 topographic survey extension map of jenapur

### 4.2. Longitudinal and Cross-Sectional Profiles of the Watercourse of Jenapur

It is important to use the same digital elevation model (DEM) employed in the extraction of the cross sections (Figs. 8, 10) in order to get a modeling that is consistent with the mapping report.

HEC-Geo-RAS, the free GIS extension in ARC-GIS, allows the software ArcView to read HEC- RAS export files. This HEC-Geo-RAS program, specifically designed to process the geospatial data, is an interface between HECRAS and ARC-GIS

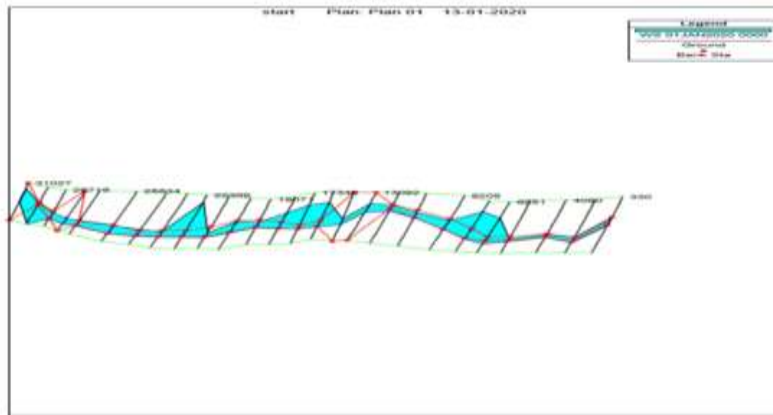


Figure 12 XYZ perspective plot of Jenapur

### 4.3. Wetted Cross Section

Fig13 shows the wetted cross section which indicates the non-uniform water level, decreases from upstream to downstream cross section.

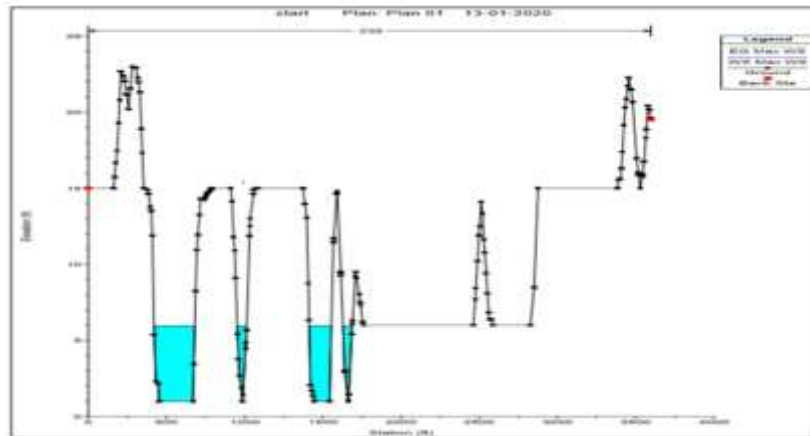


Figure 13 wetted cross section

### 4.4. Velocities Profiles

Fig14 represents velocity profile of the river station. It is indicating the decreasing of velocity towards the downstream. It is observed that the highest velocity at distance 4000m and lowest velocity at 24000m.

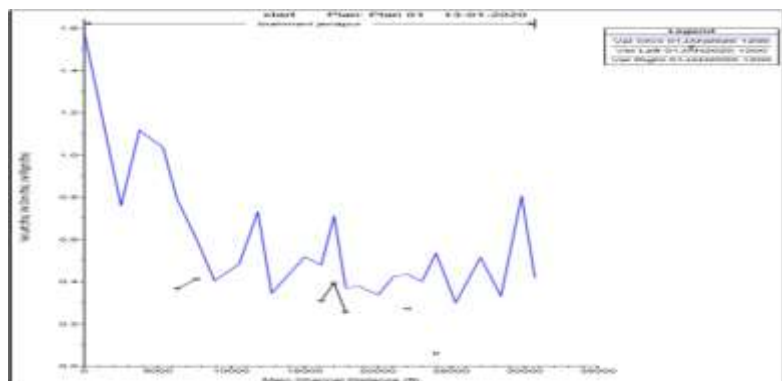


Figure 14 flow velocity's distributions

#### 4.5. Water Surface Profiles

Fig15 shows the water surface profile of river section representing water surface elevation, energy grade line, critical depth elevation and ground surface.

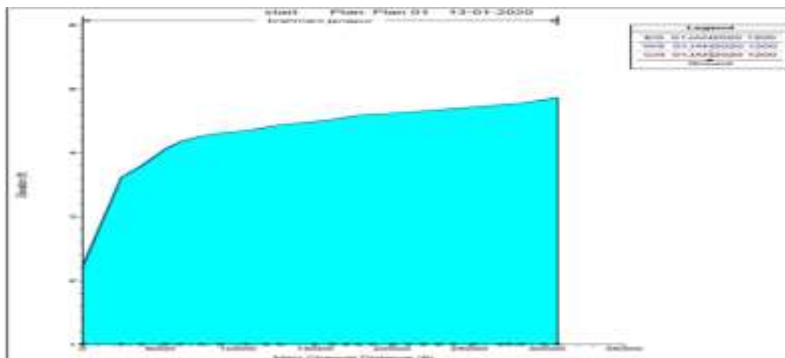


Figure 15: Water surface Profile

#### 4.6. Water depth and velocity distribution by Ras Mapper

Fig16 shows water depth of river water at jenapur station and fig 17 shows velocity distribution. Deep blue colour represents higher depth of water where in velocity distribution lower velocity. Light blue colour shows less depth and deep yellow colour represent higher velocity.

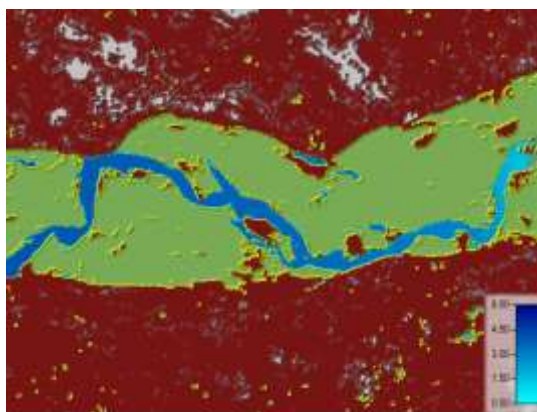


Figure 16 Water Depth

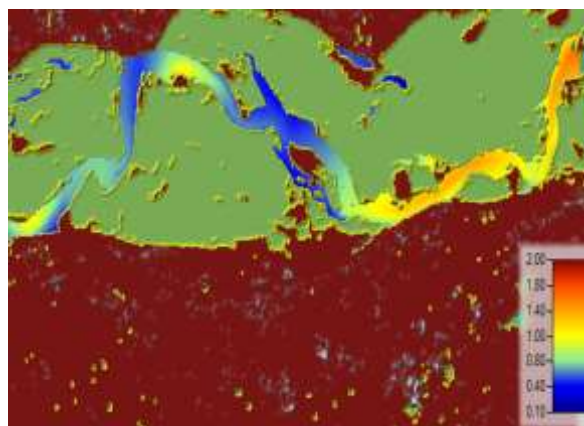


Figure 17 Velocity Distribution

## 5. CONCLUSION

HEC-RAS model is a very useful model for computation of real time hydrodynamic behavior of rivers. This model allows manual as well as Ras mapper for geometric data computation.

It is very easy to compute the water surface profile, elevation, velocity profile, water depth with respect to time and discharge, mass curve which helps to indentify the flood characteristic of rivers. In this study it is found that the flow characteristic and velocity profile changing with changing of season (pre monsoon, post monsoon and monsoon) and cross section. The depth of water found to be maximum in monsoon season and minimum in post monsoon season. The deep blue color shows maximum depth of water which indicates more possibility of inundation of bank. The light blue colour indicates less possibility towards inundation of bank of river. Hence this study is very useful for water resource management people for getting essential information about the Jenapur river station. It will help in environmental planning, flood control and construction of hydraulic structures.

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