



## **FLOOD-PLAIN MAPPING FOR SELECTED STRETCHES OF DUDHGANGA RIVER BASIN USING HEC-RAS**

*Manohar Sankadal<sup>1</sup>, Chandrashekar Hiremath<sup>2</sup>,*

**Manohar Sankadal, Chandrashekar Hiremath**

Dept of Civil Engineering, R.T.E. Society's Rural Engineering College, Hulkoti, Dist : Gadag,  
Karnataka, INDIA, 582205

**Charles Ruskin Kumar**

IES College of Engineering, Thrissur, Kerala, India

### **ABSTRACT**

Natural hazards are synonym for Floods that influencing severe economic damages and cause impact to human lives and properties. It is always necessary to estimate scenarios of flood for accurate temporal and spatial information on the risks of floods and its potential hazards.

This study includes two main objectives; during the worst flood event the flooded area cover along Dudhaganga River to be calculate and to produce floodplain map of flooded areas. In order to achieve these objectives, hence the HEC-RAS hydraulic model were used to simulate flood inundation map for 25yrs, 50yrs and 100yrs return period under steady condition for the river stretch. As a result, the watershed area of the Dudhaganga basin has been successfully modelled and map showing the flooded areas for various return periods.

**Keywords:** *HECRAS Hydraulic model, Flood plain ,Return periods.*

### **1. INTRODUCTION**

Indian topography is the most diverse topography which has mountain ranges, plains, plateaus and costal line. The climate of India is very unpredictable, so they usually say that monsoons of India are regularly irregular.

Krishna River is the second largest river in Peninsular India which drains eastward and which covers Maharashtra, Karnataka and Andhra Pradesh. The basin covers an area of 2,58,949



**Volume 8, Issue 12 - December 2020 - Pages 1-9**

Sq.km, which is almost 8.2% of the total Indian geographical area. Western Ghats ranges receives maximum rainfall of about 6350 mm annually and towards East, In past years Krishna River Basin has undergone heavy rainfall and associated floods of different intensities. These floods have both the good as well as adverse impacts on the people and the properties. To predict the flood in advance and to mitigate the damages caused by overflow of adjacent river banks floodplain mapping comes in action. It determines extent of flood and loss caused by flooding. Flood damages can be mitigated by two major ways: construction of protection wall or by giving warnings. Following are the list of methods followed in the field. Detention Basins, Bunds ,Reservoirs, Diversion Structures, Temporary flood defence Walls, Placing Sand Bags, Flood line Markings, Flood managing Computer models, Dry and Wet Proofing.

In this study, the attempt has made to map the flood prone areas of Dudhganga River basin which comes under upper Krishna river basin. Flood magnitudes were determined for various return periods. These return period flow values are used as input data for a hydrologic model HEC-RAS “(Hydrologic Engineering Centre – River Analysis System)” is been used to estimate the water spread area and HEC GeoRAS is used to generate Flood inundation map.

## **2 MATERIALS AND METHODS:**

### **2.1 Data Requirement:**

HEC-RAS model requires various data for its execution and to evaluate the water surface profiles. The following data required are:

- **Discharge Data:** The discharge data for sadalga Station (outlet point) was downloaded from WRIS (Indian Water Resource) site. The sadalga station’s daily discharge was available from 1981 to 2002’  
Source:( <http://india-wris.nrsc.gov.in/HydroObservationStationApp.html>).
- Manning’s roughness coefficient of the river.
- Boundary conditions.
- HEC-RAS input files are created from HEC-GeoRAS which also helps in post processing of the HEC-RAS data in GIS Environment.



**2.2** The details of the steps used in methodology are as follows:

- Discharge data are collected for the available gauge station (Sadalga) in the study area from WRIS, Central Data Commission, Govt of India.
- The collected discharge data will be used for frequency Analysis (either using Gumbel or Log –Pearson Type III Distribution method) to determine the peak flood discharge for different return period.
- Digital Elevation Model (DEM) will be used to extract geometric data (Area cross section) using HEC-GeoRAS tool.
- Next the geometric data and flood discharge data will be used to carry out flood modelling using HEC-RAS program.
- HECRAS simulates the annual peak flood for various return periods giving results in form of water surface profiles for various return periods.
- Results are then imported to HEC-GEORAS to obtain flood plain map.

## **Model setup and execution**

### **2.3 HEC-GeoRAS:**

HEC- GeoRAS consists of set of tools, utilities and procedures for processing geospatial data in ArcGIS. Input data is prepared using this HEC-GeoRAS software which is imported to HEC-RAS. The calculated or simulated results from this HEC RAS are then transferred or exported to HEC GeoRAS to generate flood inundation maps.

### **2.4 HEC-RAS:**

HEC-RAS is a hydraulic model developed by the Hydrologic Engineering Center (HEC) of the U.S. Army Corps of Engineers. In 1964, HEC released the HEC- RAS computer model to aid hydraulic engineers to assist in stream channel analysis and floodplain determination.



### 3. RESULTS AND DISCUSSION

In this section, a brief description of Flood frequency analysis results are shown and Flood mapping using HEC-GeoRAS and HEC-RAS model outputs have been explained. And Flood maps for different Return period are displayed.

**3.1** The regression co-efficient value ( $R^2$ ) value for Gumble's Distribution was 0.963 and for Log Pearson Type-III Distribution was 0.966, so the highest value was selected as the best method for frequency analysis Log Pearson Type-III Distribution with regression co-efficient value ( $R^2$ ) of 0.966 was selected, and the discharge value for the return period for 25yrs, 50yrs, 100 yrs was selected as the input for the HEC-RAS model simulation.

**3.2** Generation of cross section of the river consists of following steps:

- DEM data of the study area which will be in Raster format is projected to the coordinate system and then converted to Triangulated Irregular Network format (TIN)
- Have to add RAS layers → Go to RAS geometry ⇨ Create RAS layer (Stream centre line, Bank lines, Flow path line and XS cut lines)
- Digitization of the RAS layers done one after the other for the shapefiles
- River code and river reach are assigned to the stream centerline and left flow path and right flow path are assigned with respective flow direction.
- Stream centre line and XS lines are attribute from RAS geometry.
- Export the RAS data from HEC-GeoRAS to HEC-RAS.

#### Generation of Inundation Maps

- **Plotting Flood Inundation for the selected stretch of Dudhganga:**
- The HEC-RAS model was simulated for the Dudhganga river stretch after the model validation, steady state condition were carried to simulate the discharge values for various return periods. And the water spread area extent for the various return periods of 25 years is 22,298.05 km<sup>2</sup> and for 50years is 24,366.892 km<sup>2</sup> and for 100 years it is 26338.731 km<sup>2</sup> area and the mapping was carried out using HEC-GeoRAS tool.

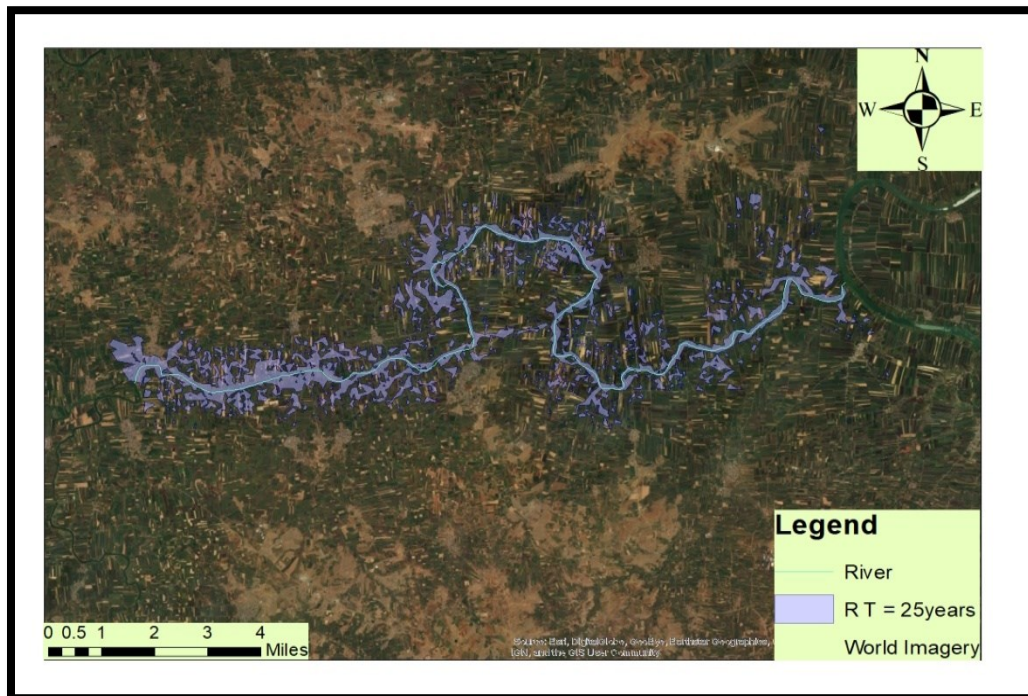


Fig 3.1

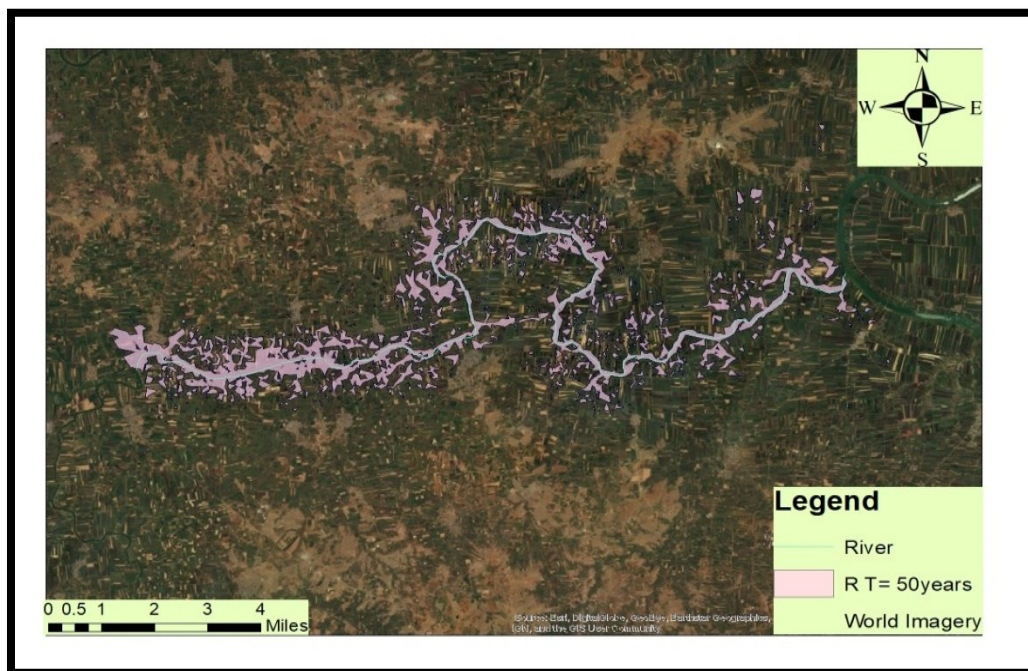
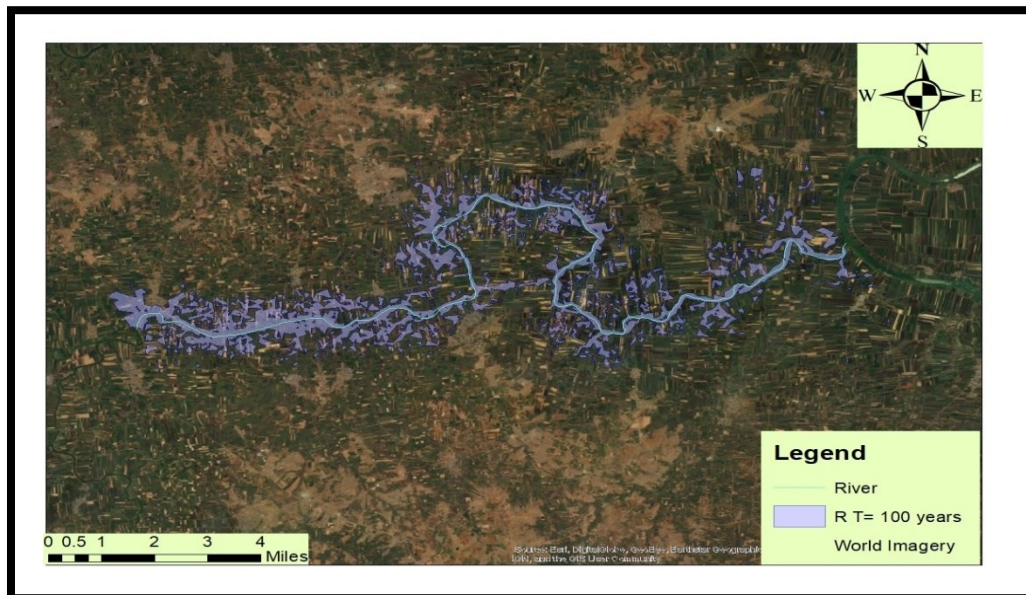


Fig 3.2



**Fig 3.3**

- These images shows the extent of the flood water over the various villages at the bank of the Dudhganga river, the villages affected by the flood caused by the Dudhganga river are Baravada, Boja, Karadaga, Shiradavada, Bedakihala, Janawada, Shamanewadi, Sadalga, Boragaon, Malikavada, Kallola etc.

#### **4. CONCLUSIONS**

The above study shows the generation of flood inundation maps using HEC-RAS model. One – dimensional hydraulic model HEC-RAS was used to generate water surface profiles for various return periods. Flood frequency analysis was carried out in present case for the simulated annual peak flood values on Dudhganga watershed using two methods viz., Gumbel’s Extreme Value Type-I and Log Pearson Type-III Distribution.

From the above two methods Log Pearson’s Type III Distribution fits well for the simulated data as compared to Gumbel’s Extreme Type I Distribution for the selected river stretch. Hence flood magnitudes for various return periods were estimated using Log Pearson’s Type III distribution.

Hence HEC-RAS model is used to simulate flood inundation map for 25yrs, 50yrs and 100yrs return period under steady condition for the river stretch and the maps have been developed. Also the water spread area was found out for the river stretch for various return periods.



## 5. ACKNOWLEDGEMENT

I thank management R.T.E. Society's, Rural Engineering College, Hulkoti, Gadag and Principal and **my Parents** for their support, without them this project would not have been completed.

It is a genuine pleasure to express my deep sense of thanks and gratitude to my guide **Chandrashekar Hiremath** Assistant Professor, Dept. of Water and Land Management, CPGS, VTU Belagavi.

It's my pleasure to thank all those who have rendered their help during the period of my project work directly or indirectly

## 6. REFERENCES

1. Alam, F., & Islam, (2016). A hydrodynamic flood modelling of Poshur River using HEC RAS and sources of its uncertainty. Proceedings of International Conference on *Civil Engineering for Sustainable Development (ICCESD 2016)*, KUET, Khulna, Bangladesh (ISBN: 978-984-34-0265-3)
2. Al-Zahrani, M., Al-Areeq, A., & Sharif, H. (2016). Flood analysis using HEC-RAS model: a case study for Hafr Al-Batin, Saudi Arabia. In *E3S Web of Conferences*, EDP Sciences, Vol. 7, 04024.
3. Duvvuri, S., & Narasimhan, B. (2013). Flood inundation mapping of Thamiraparani river basin using HEC-Geo RAS and SWAT. *International Journal of Engineering Research and Technology*, 2(7), 1408-1420.
4. Farooq, M., Shafique, M., & Khattak, M. S. (2018). Flood frequency analysis of river swat using Log Pearson type 3, Generalized Extreme Value, Normal, and Gumbel Max distribution methods. *Arabian Journal of Geosciences*, 11(9), 216.
5. Golshan, M., Jahanshahi, A., & Afzali, A. (2016). Flood hazard zoning using HEC-RAS in GIS environment and impact of manning roughness coefficient changes on flood zones in Semi-arid climate. *Desert*, 21(1), 24-34.
6. Hosurkar, A. A., Shivapur, A. V., & Madhusudhan, M. S. (2016). Estimation of Flood Magnitudes for Various Return Periods for Selected Stretch of Dudhganga River.



**Volume 8, Issue 12 - December 2020 - Pages 1-9**

*International Research Journal of Engineering and Technology (IRJET)*, 3(6), 1659-1662.

7. India's water wealth (2011). Water Resources at a glance report, CWC, New Delhi. Available at: ([http://www.indiawris.nrsc.gov.in/wrpinfo/index.php?title=India%27s\\_Water\\_Wealth](http://www.indiawris.nrsc.gov.in/wrpinfo/index.php?title=India%27s_Water_Wealth)). Accessed on 18th October 2015.
8. Reddy, P. J. (2014). "A textbook of Hydrology", New Delhi: University of Science Press
9. Kardavani, P., & Qalehe, M. H. (2013). Efficiency of Hydraulic Models for Flood Zoning Using GIS (Case Study: Ay-Doghmush River Basin). *Life Science Journal*, 10(2), 915-924.
10. Kute, S., Kakad, S., Bhoje, V., & Walunj, A. (2014). Flood modeling of river Godavari using HEC-RAS. *Int J Res Eng Technol*, 3(09), 81-87.
11. Madhusudhan, M. S., & Shivapur, A. V. (2016). Demonstration of Estimating Flood Submergence Area for a Selected Stretch on Bennihalla River by Integrating HEC-RAS with SWAT. *International Research Journal of Engineering and Technology (IRJET)*, 3(6), 1098-1104.
12. Mujiburrehman. (2013). "Frequency Analysis of Flood Flow at Garudeshwar Station in Narmada River, Gujarat, India." Environmental Engineer, Saudi Arabia. *Universal Journal of Environmental Research and Technology*, 2013, 3 (6), 677-684.
13. Millington, Nick; Das, Samiran; and Simonovic, Slobodan P., "The Comparison of GEV, Log-Pearson Type 3 and Gumbel Distributions in the Upper Thames River Watershed under Global Climate Models" (2011). *Water Resources Research Report #077*.
14. Manandhar, B. (2010). Flood plain analysis and risk assessment of Lothar Khola. Master of Science Thesis in Watershed Management. Tribhuvan University Institute of Forestry Pokhara, Nepal.
15. National Disaster Management Authority, Government of India (2015). Available at: (<http://www.ndma.gov.in/en/media-public-awareness/disaster/naturaldisaster/floods.html>). Accessed on 20th October 2015.
16. SDMA, State Disaster Management Authority, Karnataka. Accessed on October 2015.





**Volume 8, Issue 12 - December 2020 - Pages 1-9**

17. Grag S. K., (2015). "Irrigation Engineering and Hydraulic Structures. (Volume 11) 30<sup>th</sup> Revised Edition, Delhi, Khanna Publication.
18. Singh, S. (2011): Environmental Geography, Prayag Pustak Bhavan, Allahabad.
19. Tests of Statistical Significance, PPA 696 Research Methods. (<https://web.csulb.edu/~msaintg/ppa696/696stsig.htm>). Assessed in February 2016.
20. USACE, "HEC-GeoRAS, GIS Tools for Support of HEC-RAS using ArcGIS User's Manual Version 4.2", HEC, September 2009.
21. USACE, "HEC-RAS River Analysis System, Applications Guide Version 5.0," HEC, February 2016.
22. USACE, "HEC-RAS River Analysis System, Hydraulic Reference Manual Version 5.0" HEC, February 2016.
23. USACE, "HEC-RAS River Analysis System, User's Manual Version 5.0," HEC, February 2016.
24. USACE, (2002). HEC-RAS River Analysis System, Hydraulic Reference Manual, U.S Army Corps of Engineers (USACE). Hydrological Engineering Center, Davis, California. Accessed on 10th August 2015.
25. USACE, (2009). GIS Tools for support of HEC-RAS using ArcGIS, HEC-GeoRAS User's Manual, U.S Army Corps of Engineers (USACE). Hydrological Engineering Center, Davis, California. Accessed on 25th August 2015.