iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 Issue: VIII Month of publication: August 2026

DOI: https://doi.org/10.22214/ijraset.2026.84582

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VIII Aug 2026- Available at www.ijraset.com

Flood Risk Assessment of Kanhan River Using HEC-RAS and QGIS

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Abstract: Floods are among the most destructive natural hazards, threatening lives, infrastructure, and economies. The Kanhan River in Maharashtra, a tributary of the Wainganga, experiences recurrent flooding due to monsoonal rains, unregulated floodplain development, and land-use changes. This study conducts a flood risk assessment using Geographic Information Systems (QGIS) and the Hydrologic Engineering Center's River Analysis System (HEC-RAS). High-resolution DEMs, LULC data, rainfall records, and river cross-sections were processed in QGIS to generate inputs for hydraulic modeling. HEC-RAS simulated unsteady flows for multiple return periods, with outputs integrated into QGIS for floodplain mapping. The combined approach enabled spatial visualization of inundation extents, depths, and velocities, highlighting vulnerable zones. The resulting hydraulic model has 0.4036% error which provide actionable insights for disaster management, including early warning systems, embankment reinforcement, and land-use regulation. This integrated framework demonstrates the value of geospatial and hydraulic tools in enhancing resilience and guiding flood mitigation strategies in data-scarce regions.
Index Terms: Flood, HEC-RAS, Hydraulic model, QGIS

I. INTRODUCTION

A. General

Flooding is one of the most frequent and destructive natural hazards, causing widespread disruption to human settlements, infrastructure, agriculture, and ecosystems. In India, the monsoon season contributes significantly to riverine flooding, especially in regions with inadequate floodplain management and unplanned urban expansion. Among the river systems affected is the Kanhan River, which has increasingly become a subject of concern due to its seasonal flooding and the growing vulnerability of communities living along its banks. The river is characterized by a dendritic drainage pattern and receives water from several small tributaries such as the Pench, Kolar, and Jam rivers. During the monsoon months (June to September), the Kanhan often experiences sudden rises in water level due to intense rainfall in its catchment area. This has led to frequent flooding, particularly in low-lying and densely populated regions. Furthermore, rapid urbanization and encroachments along the riverbanks have reduced the river's natural flood-carrying capacity, increasing the flood hazard in the region.

Given this background, the objective of this project is to conduct a flood risk assessment for selected parts of the Kanhan River in Maharashtra using a combined geospatial and hydraulic modeling approach. QGIS, an open-source Geographic Information System (GIS), is used for spatial data processing, terrain analysis, and map generation. HEC-RAS (Hydrologic Engineering Center's River Analysis System developed by the U.S. Army Corps of Engineers, is used to simulate river flow dynamics and predict flood extents.

B. Aim of study

This study aims to create flood risk assessment of a region of Kanhan river by integrating HEC-RAS with QGIS for accurate floodplain mapping and risk analysis.

C. Objectives

1) The objective of this research is to develop a comprehensive flood risk assessment model of parts of Kanhan river region by integrating HEC-RAS with QGIS for effective floodplain delineation, hazard mapping, and decision-making.
2) The study aims to analyze flood-prone areas, assess the extent of inundation, and provide insights for flood mitigation planning for the surrounding area.
3) To delineate the flood-prone areas along the Kanhan River using Digital Elevation Models (DEMs) and river geometry data.
4) To delineate the flood-prone areas along the Kanhan River using Digital Elevation Models (DEMs) and river geometry data.
5) To simulate river flow and flood inundation under various return periods using HEC-RAS.

D. Study Area

The study focuses on the Kanhan River in Nagpur district, Maharashtra, particularly the stretch between Saoner and Kamptee. This region is strategically important due to its proximity to Nagpur city and its role in agriculture, industry, and transportation.

Key features of the study area:

1) Geographical Coordinates: Approx. 21.3°N to 21.5°N latitude and 78.8°E to 79.2°E longitude.
2) Topography: The terrain varies from gently sloping plains to moderately hilly areas, with low-lying zones near the riverbanks highly prone to waterlogging and flood inundation.
3) Land Use: A mix of agricultural land, urban settlements, and industrial zones.
4) River Characteristics: The Kanhan River has a meandering channel, with moderate to steep banks and several seasonal tributaries joining along this stretch.
5) Climate: The region has a tropical climate with heavy rainfall during the southwest monsoon (June–September), often leading to flash floods and river overflows.

II. LITERATURE SURVEY

The study titled *"Flood Modeling and Flood Forecasting Using HEC-RAS"* focuses on analyzing the flood-carrying capacity of the Mutha River between Mhatre Bridge and Joshi Bridge in Pune, Maharashtra, using HEC-RAS software. Given Pune's recurring flood issues during monsoon due to dam releases and reduced river capacity from encroachment and siltation, this study models river behavior by simulating water surface elevation, velocity, and depth through cross-sectional data. It emphasizes the importance of 2D flood modeling for disaster management and flood risk mitigation. The methodology includes creating river geometry, assigning flow parameters, running steady flow analysis, and interpreting various hydraulic outputs like profile plots and XYZ perspective views to assess flood-prone zones. Results showed that the current river basin cannot handle extreme floods, and the study recommends structural modifications such as increasing the retaining wall height and expanding the river channel to mitigate future flood risks.

The study *"Assessment of Irrigation Water Quality Parameters at Upstream and Downstream of Kanhan River"* by Sandeep K. Shukla focuses on evaluating the suitability of Kanhan River water for irrigation by analyzing various physicochemical and bacteriological parameters at two monitoring stations—Ramakona (upstream) and Satrapur (downstream)—over five water years (2014–2019). Given the river's critical role in supplying water for agriculture and industry across Madhya Pradesh and Maharashtra, the study emphasizes the need for regular water quality assessments, especially in light of growing pollution pressures. Parameters such as pH, electrical conductivity (EC), sodium percentage, boron content, sodium adsorption ratio (SAR), residual sodium carbonate (RSC), and coliform levels were compared against national and international irrigation standards. Results indicated that while most EC values were within acceptable limits, there were concerns regarding sodium, boron, and fecal coliform levels. The review also highlights various physical, chemical, and biological treatment methods, including phytoremediation, as viable approaches to improving irrigation water quality in cost-effective and sustainable ways.

In the study *Flood Hazard Mapping by Using Geographic Information System and Hydraulic Model: Mert River, Samsun, Turkey* by Demir and Kisi (2016), flood hazard maps were developed for the Mert River Basin using Geographic Information Systems (GIS) and the HEC-RAS hydraulic modeling software. The methodology involved digitizing topographic data to create a Digital Elevation Model (DEM) using ArcGIS, simulating flood flows for return periods of 10, 25, 50, and 100 years with HEC-RAS, and integrating these results to produce flood risk maps. The study was motivated by a severe flood in 2012 that caused significant property damage and loss of life. The results showed that flood risk increases notably with return period, with up to 60% of urban areas affected during a 100-year flood event. The maps also revealed that industrial zones near the river were particularly vulnerable. This integrated GIS-HEC-RAS approach provided a detailed and effective tool for flood risk management and urban planning in the Samsun region.

Flood modeling studies using HEC-RAS and other hydrodynamic tools have been widely applied to assess flood risks in river systems globally, with several studies focusing on the Yamuna River in India. These studies utilize various modeling techniques to simulate flood inundation and water surface profiles, as well as to evaluate the vulnerability of critical infrastructure such as bridges and barrages. For example, research has been conducted to simulate floods in the Delhi segment of the Yamuna River, with studies emphasizing the calibration and validation of models using observed flood data. Key inputs for these models include geometric data, hydraulic parameters, and flow data, with models typically employing the Saint-Venant equations to simulate one-dimensional flow. Applications of HEC-RAS have also extended to global rivers like the Euphrates, Red, and Indus, providing valuable insights into flood behavior, peak discharge estimation, and risk mitigation strategies for both developed and developing regions.

III. METHODOLOGY

This chapter explains how to perform hydraulic analysis study with the HEC-RAS software. It describes the methodologies used in performing the two-dimensional flow calculations within HEC-RAS. Steps for performing unsteady flow analysis of Kanhan river basin have explained below. The terms used in software have explained in user manual of the HEC-RAS software. User manual gives the clear idea about what parameter is to enter in which block.

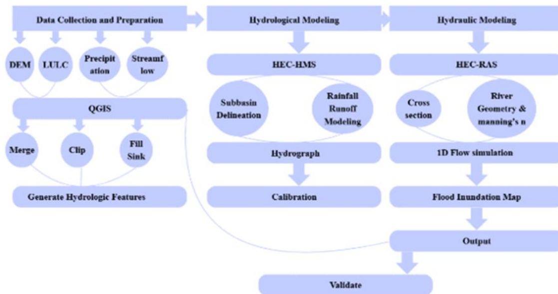

Figure 1. Flowchart of methodology

1) Step 1: To start a new HEC-RAS paper. In the main window, open HEC-RAS click on the File, then click on New Paper. In the window of New Paper, type in Title and File name then click OK.

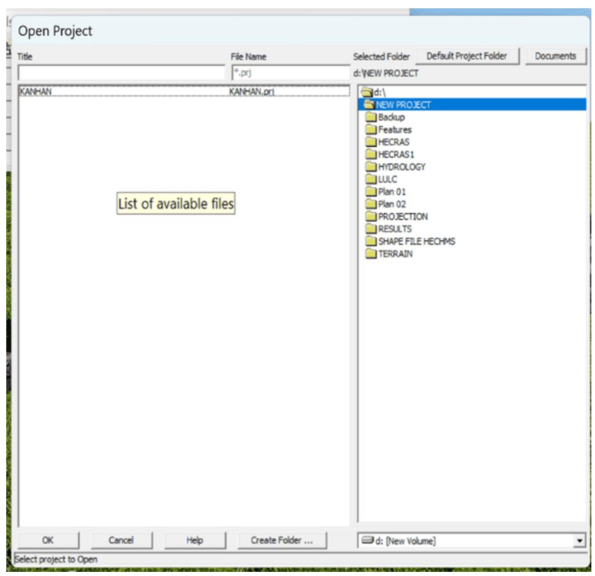

Figure 2. Hec-Ras project title window

2) Step 2: In main window, click on Raster Mapper.Check Reaches, Basins and Break Points

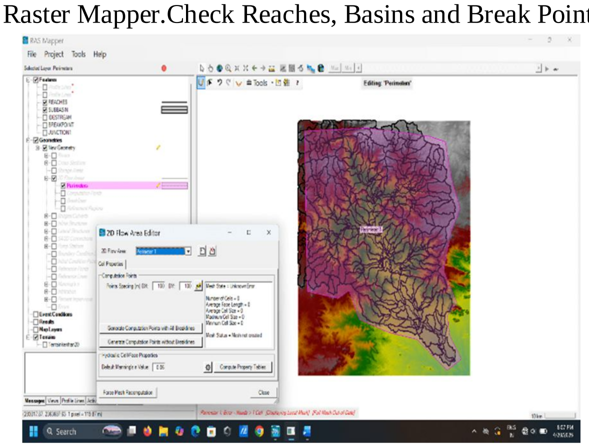

Figure 3. Ras Mapper window

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3) Step3: In main window, click on Geometric Data

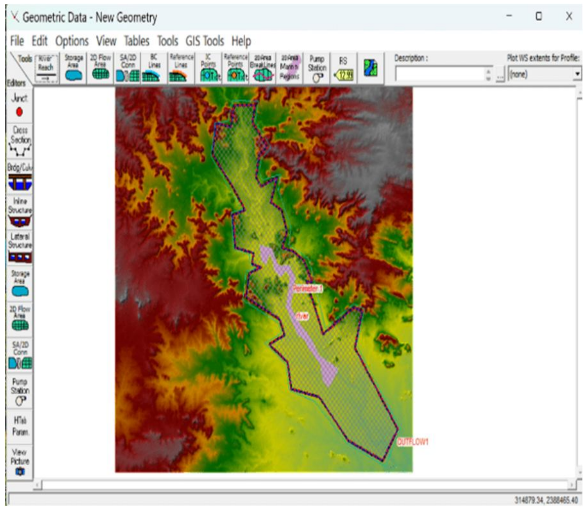

Figure 4. Geometric Data window

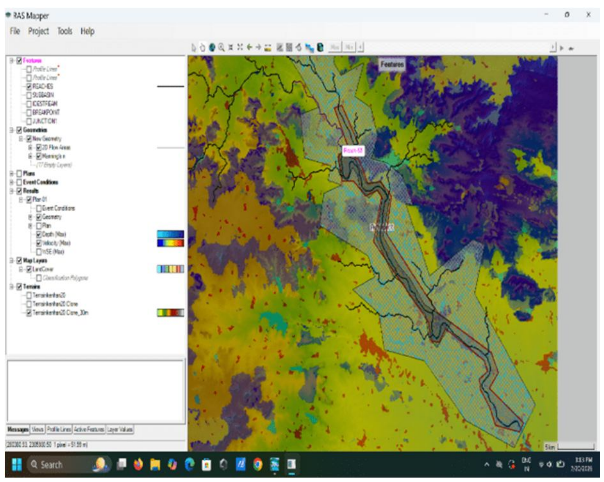

Figure 5. 2D Flow Area of Basin

4) Step 4: Rainfall Data

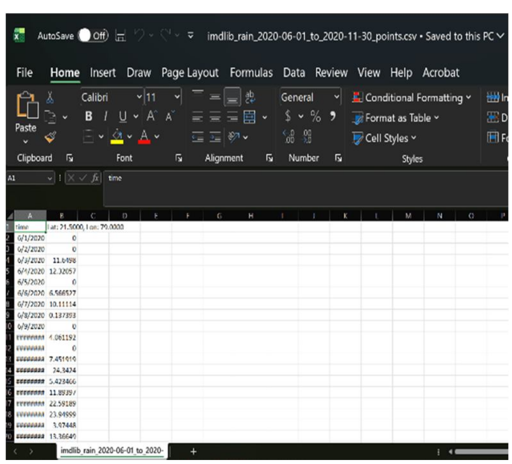

Figure 6. IMD rainfall data

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5) Step 5: Rain Grid Analysis

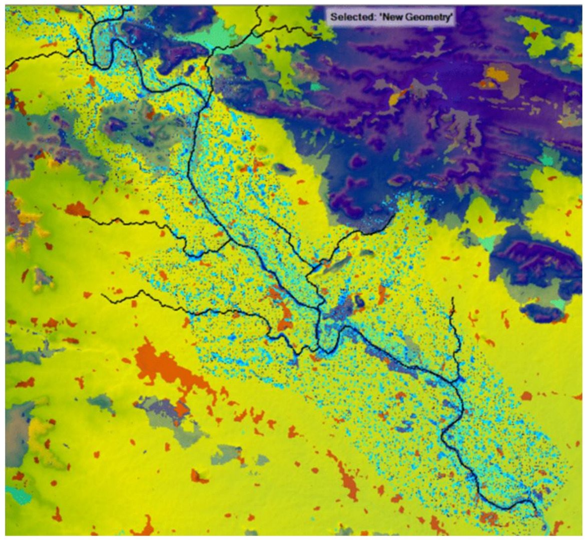


Figure 7. Rain grid of perimeter

6) Step 6: Unsteady Flow Analysis

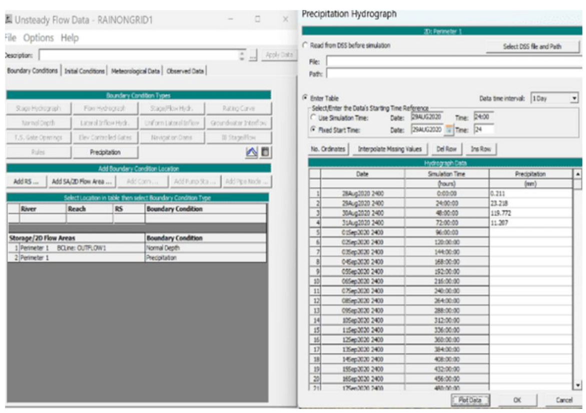
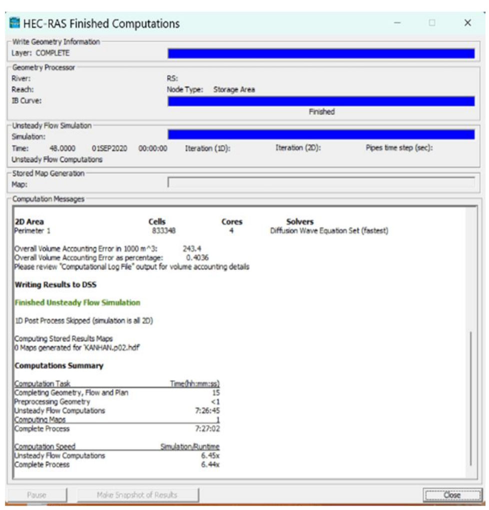


Figure 8. Unsteady Flow data

7) Step 7: View Output



Figues 9. Computation window

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Click on View option on main window. There will be various options as follows:
- Cross Sections
- 3D View
- Detailed Output Table
- Profile Lines Table
- Summary Error, Warning, Notes

IV. RESULT

Results of the study consist of various properties like outflow, velocity and XYZ perspective view which we can rotate to any desired angle. From this result, we can assess the river basin area situation as per requirements.

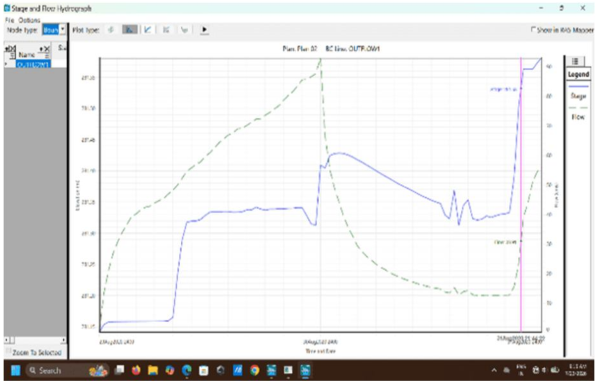
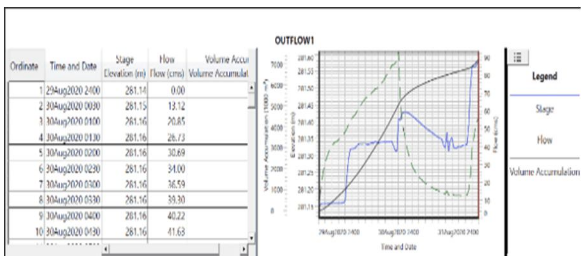


Figure 10. (a)Flow Hydrograph



Ordinate	Time and Date	Stage Elevation (m)	Flow Flow (cms)	Volume Accu Volume Accumulat
1	29Aug2020 2400	281.14	0.00	
2	30Aug2020 0030	281.15	13.12	
3	30Aug2020 0100	281.16	20.85	
4	30Aug2020 0130	281.16	26.73	
5	30Aug2020 0200	281.16	30.69	
6	30Aug2020 0230	281.16	34.00	
7	30Aug2020 0300	281.16	36.59	
8	30Aug2020 0330	281.16	39.30	
9	30Aug2020 0400	281.16	40.22	
10	30Aug2020 0430	281.16	41.63	

Figure 11. Outflow

The software can generate profile plots also called long sections or longitudinal profiles of the HEC-RAS steady flow and unsteady flow computational results, displaying the water surface elevation, energy grade line elevation, critical depth elevation, channel invert, bank stations, structures and more. But mostly 2D flow area uses mesh while 1D uses profile.

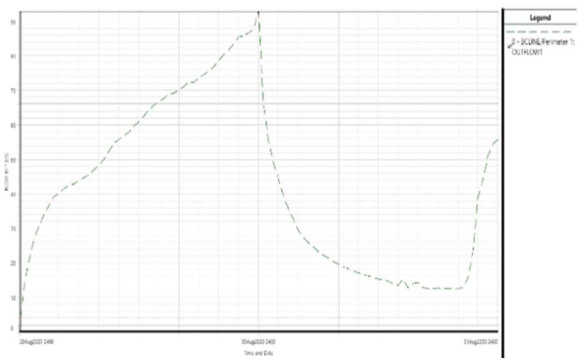


Figure 10. (b) Outflow

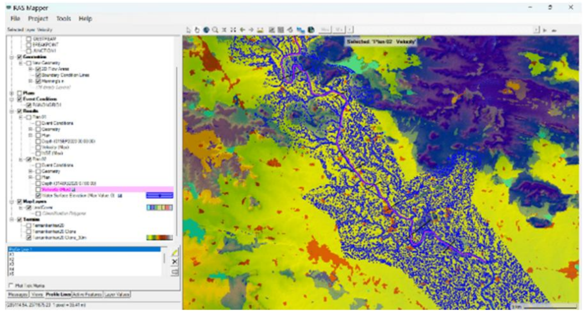


Figure 12. Water surface elevation

Table 1. Volume Accumulation

Ordinates	Time And Date	Stage Elevation(m)	Flow (cms)	Volume Accumulation(1000m^3)
1	29Aug2020 2400	281.14	0	0
2	30Aug2020 0030	281.15	13.12	11.81
3	30Aug2020 0100	281.16	20.85	42.39
4	30Aug2020 0130	281.16	26.73	85.21
5	30Aug2020 0200	281.16	30.69	136.89
6	30Aug2020 0230	281.16	34	195.11
7	30Aug2020 0300	281.16	36.59	258.65
8	30Aug2020 0330	281.16	39.3	326.95
9	30Aug2020 0400	281.16	40.22	398.51
10	30Aug2020 0430	281.16	41.63	472.18
11	30Aug2020 0500	281.16	42.47	547.87
12	30Aug2020 0530	281.16	42.84	624.65
13	30Aug2020 0600	281.16	43.89	702.7
14	30Aug2020 0630	281.16	44.74	782.47
15	30Aug2020 0700	281.16	45.45	863.63
16	30Aug2020 0730	281.16	46.97	946.81
17	30Aug2020 0800	281.17	48.27	1032.52
18	30Aug2020 0830	281.23	49.98	1120.95
19	30Aug2020 0900	281.29	52.3	1213

V. CONCLUSION

The flood risk assessment of the Kanhan River, carried out using HEC-RAS and QGIS, demonstrates a high level of model accuracy with an error percentage of **0.4036%**, indicating reliable hydrodynamic simulation and spatial analysis. The integration of DEM data, hydraulic modeling, and GIS-based floodplain mapping provided a comprehensive understanding of potential inundation zones.Results reveal that the study area is predominantly under **low flood risk**, with limited zones experiencing minor vulnerability. This suggests that while the Kanhan River exhibits seasonal variability, the overall flood hazard remains manageable under current hydrological conditions.

Above results can be used for further study of the area for early warning sysyems and future planning.

VI. ACKNOWLEDGMENT

Acknowledgements We sincerely acknowledge the hydrological data provided by the Central Water Com mission (CWC) and the Indian Meteriological Department (IMD)for this study.

REFERENCES

[1] "Flood Modeling and Flood Forecasting Using HEC-RAS," 2025, Author Avanti Waghchaure1, Aarti Patil2, Pragati Bachhav3, Rajashri Bodhai4 , Journal of Hydrological Engineering.

[2] "Assessment of Irrigation Water Quality Parameters at Upstream and Downstream of Kanhan River," 2019, Sandeep K. Shukla, Water Quality Journal.

[3] "Flood Hazard Mapping by Using Geographic Information System and Hydraulic Model: Mert River, Samsun, Turkey," 2016, Demir and Kisi, Flood Risk Management.

[4] "Flood Risk Analysis Using HEC-RAS and Hydrodynamic Tools for the Yamuna River," 2025, Author Azhar Husain1,*, Mohammed Sharif1, Mohammed Lateef Ahmad2, Environmental Engineering Journal.

[5] "GIS and Hydraulic Modeling in Flood Hazard Mapping: Global Practices and Case Studies," 2023, Various Authors, Journal of Geospatial Research.

[6] "Flood Risk Assessment in Kolhapur District, Maharashtra Using Remote Sensing and GIS," 2025, Otsubo et al., Environmental Management Journal.

[7] "Flood Risk Studies on the Kosi River: Causes and Solutions," 2024, Author R. Sinha . G.V. Bapalu . L.K. Singh . B. Rath, Water Resources Management.

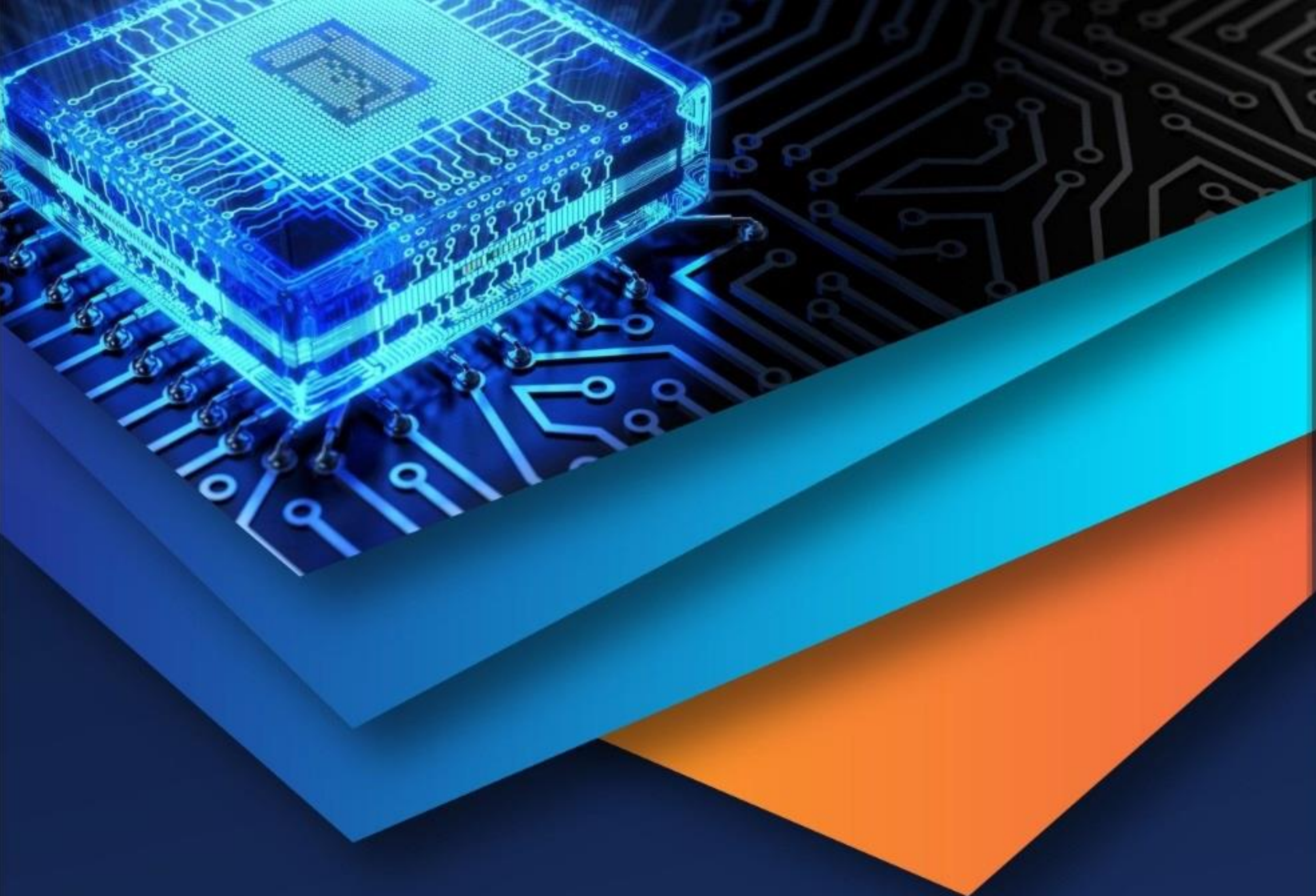
[8] "Prioritization of Sub-Watersheds in Kanhan River Basin Using Remote Sensing and GIS," 2023, Author Alpashi Sadawarti, Shubham Masurkar, Journal of Hydrology and Environmental Research.

[9] "Sediment Transport and Reservoir Sedimentation Modeling Using HEC-RAS," 2024, Campos et al., Sedimentology and Hydrology Journal.

[10] "Open-Source GIS Tools for Flood Hazard and Risk Mapping: A Comprehensive Study," 2025, Author Catalin Ioan Cimpianu1, Alin Mihu-Pintilie2, Geospatial Data and Modeling.

[11] "Quantitative Risk Measures for Flood Hazards: A Global Perspective," 2023, Author S.N. Jonkmana,b,□, P.H.A.J.M. van Gelderb, J.K. Vrijlingb, Risk Analysis Journal.

[12] "The Role of Manning's Coefficient in River Modeling for Flood Dynamics," 2025, Author Unknown, Hydraulic Engineering Journal.
[13] "Flood Hazard Mapping and Risk Assessment in Assam Using GIS and Remote Sensing," 2024, Author Unknown, Journal of Environmental Science and Technology.
[14] "Flood Modeling with HEC-RAS for Risk Management in River Systems," 2025, Kamble et al., Hydrological Risk Assessment.
[15] "Flood Risk Analysis and Forecasting: Methodologies and Trends," 2020, Various Authors, Flood Risk and Management Journal.
[16] "Flood Modeling and Risk Assessment Using HEC-RAS: A Case Study on the Godavari River," 2023, Patel et al., Journal of Hydraulic Engineering.
[17] "GIS-Based Flood Risk Mapping in Urban Areas: A Case Study of the Mithi River, Mumbai," 2024, Singh and Sharma, International Journal of Urban Planning and Development.
[18] "Assessment of Flood Inundation Extent and Vulnerability in the Narmada Basin Using HEC-RAS and QGIS," 2022, Yadav et al., Water Resources Management Journal.
[19] "Integration of Remote Sensing and GIS for Flood Risk Mapping in the Krishna River Basin," 2023, Mehta et al., Geospatial Research Journal.
[20] "Hydraulic Modeling for Flood Risk Assessment in the Tapi River Basin," 2025, Desai and Joshi, Journal of Water Resources and Hydrology.
[21] "Flood Hazard Mapping in Coastal Regions Using HEC-RAS and GIS Tools," 2022, Gupta et al., International Journal of Coastal Research.
[22] "Application of HEC-RAS for Flood Risk Management in the Cauvery River Basin, India," 2024, Reddy et al., Journal of Flood Risk Management.
[23] "Hydrological Modeling and Flood Risk Analysis of the Yamuna River, Delhi," 2021, Kaur et al., Indian Journal of Hydrology.
[24] "Flood Risk Assessment in the Bhagirathi River Basin Using HEC-RAS and Satellite Imagery," 2023, Singh and Bansal, Journal of Environmental Engineering.
[25] "Flood Risk Modeling Using HEC-RAS for Urban Flood Management in Pune City," 2024, Sharma et al., International Journal of Flood Management.



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