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Flood Hazard Mapping and Risk Evaluation Using HEC-RAS and Geospatial Tools in Lower Karnali River of Nepal

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Introduction

- Flood is one of the striking water-induced hazards that hits most of the part of the world.
- Climate change's effects are evident everywhere, including Nepal.
- The IPCC 6th assessment explains that the increase in global surface temperature is 1.09 (0.95 to 1.20) °C in 2011-2020 above 1850-1900.
- More than 50% likelihood that global warming will reach or exceed 1.5°C in the near-term, even in the low greenhouse gas emissions scenario.
- The scientific community predicts that climate change will alter the world's hydrological cycle and increase the frequency of extreme weather events.

Objectives

The main objective of the study is to evaluate the flood vulnerability and risk using HEC-RAS modelling and Geospatial tool with the following specific objectives.

- To prepare flood hazard maps of different year return period of Karnali river.
- To evaluate the risk to communities and infrastructures in the study area

Methodological flow chart of HEC-RAS

- 2D flood model HEC RAS was used
- Streamlines is generated from the DEM using QGIS.
- Frequency analysis was carried out on the peak annual discharge data at the upstream from Chisapani Gauge station.
- The land use map was utilized for assigning Manning's roughness coefficient values to the model input.

Results And Discussion

1.Flood Frequency Analysis

Flood frequencies obtained using Gumbel's distribution for different YRPs are presented using the log chart along with the recorded historical peak discharge for the different year.

Of the three types of extreme value theory, the straight line of Type I was determined as being the most appropriate.

The discharges predicted by Gumbel's distribution were 11076, 13321, 15472, 18256, 20343, and 22422, m^3 /s for the 5-, 10-, 20-, 50-, 100-, and 200-YRPs, respectively.

2. Flood Vulnerability Analysis

This study includes only four wards; 1, 3, 4 and 7.

Highly vulnerable Wards; 1, 3 and 4 and **less vulnerable** Ward 7

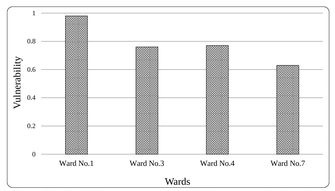


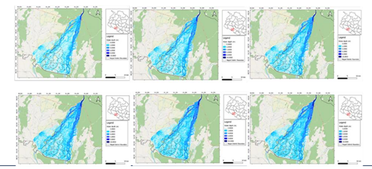
Fig: Vulnerability level of different ward of Rajapur Municipality

3. Flood Hazard Analysis

- The total hazard area is progressively increasing with the increasing return periods.
- The change is more visual before 100 years return period and less visual in subsequent return period after 100 years.
- Among the four wards of Rajapur Municipality ward no. 1 is highly inundated even in 5 years return period with area 9.31 km^2 and in 200 YRP is 11.37 km^2.
- Almost 50% of total area of each wards in 5 YRP gets inundate following 86% in 200 YRP

Table: Inundate area of each ward for different year return period

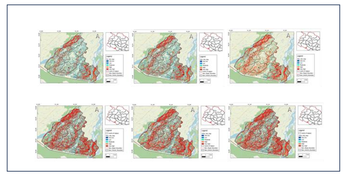
Ward No.	5 YRP (km^2)	10 YRP (km^2)	20 YRP (km^2)	50 YRP (km^2)	100 YRP (km^2)	200 YRP (km^2)
1	9.31	10.05	10.56	10.93	11.17	11.37
3	7.65	8.35	8.84	9.27	9.56	9.78
4	8.05	8.90	9.42	9.81	10.09	10.41
7	4.56	5.19	5.64	5.96	6.133	6.27



4. Flood Risk Analysis

- From this study we came to know that water level reaches up to 10 meter which is considered as high risk to community and infrastructure.
- All wards of study area are at high risk even in 5 YRP of flood.
- The water level in the river rises continuously and pushes the area in high risk of inundation.
- Calculating the risk area of Ward-1, 3, 4, and 7, we found all these four wards are at high risk. Ward no. 1 is at very high risk. About 3.45 km^2 is at very high risk in 5 YRP and 7.53 km^2 in 100 YRP of total area 13.32 km^2.
- During the flood, the river starts eroding in Ward 1, Tigra area of Rajapur Municipality making it at high risk.
- Thus, the settlements and people in the Rajapur Municipality are at high risk due to flood and inundation of late.

Risk maps of different YRPs (5-200 YRPs)



Conclusion

In the Rajapur Municipality, flooding is a common natural disaster that poses a socioeconomic risk and results in significant loss of life as well as damage to agricultural land, food production, private property, and public property.

The level of flood risk in the Rajapur Municipality for different return periods demonstrates that the overall risk in Rajapur rises as the YRP rises.

With the aid of the spatial flooding scenario that was simulated in this study, the community of Rajapur Municipality's Wards; 1, 3, 4, and 7 can get inundated even in a normal flood of 1m and cause danger situation to community.

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