

# Environmental Hazards, Vulnerability & Risk Assessment of Indian Himalayas



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## Abstract

This project aims to assess the environmental hazards, vulnerability and risk in the Indian Himalayas. In hazard, we have considered earthquakes, elevation, landslides and floods as they are very frequent in the Himalayan region and in vulnerability, we have considered roads, railways, population and dams. The vulnerability of the region is evaluated by analyzing the social, economic, and environmental factors that contribute to the susceptibility of the population to environmental hazards. The risk assessment is based on the probability and potential consequences of hazards, which are mapped using geographic information systems (GIS) and remote sensing technologies. The findings of this study can be used to develop effective policies and strategies for disaster risk reduction in the Indian Himalayas.

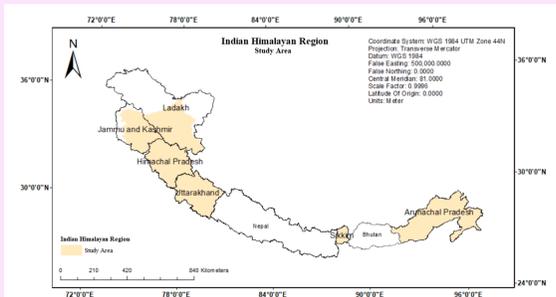
## Introduction

The Indian Himalayan region is known for its fragile and sensitive ecosystem and is one of the most disaster-prone areas in the world due to its geological and topographical characteristics. The region is susceptible to a range of environmental hazards, such as landslides, floods, earthquakes, and glacial lake outburst floods. The occurrence of these hazards has adverse effects on the socio-economic and environmental conditions of the region. Therefore, assessing the environmental hazards, vulnerability and risk in the Indian Himalayas is crucial for the development of effective policies and strategies for disaster risk reduction.

## Objective

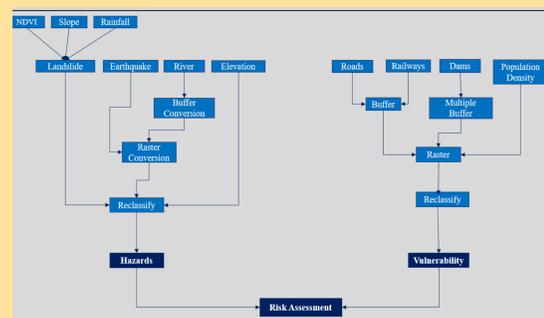
- Geographical significance  
Comprehensive analysis of the hazards and risks in the region, which is crucial for developing effective mitigation strategies.
- Human impact  
By identifying the areas that are most vulnerable to hazards, the study can assist in the development of strategies to minimize the impact on human life.
- Disaster management  
Disaster management authorities to prioritize their response efforts and allocate resources effectively during emergencies.
- Future research: Risk Assessment

## Study Area



Study Area for Hazards, Vulnerability and Risk Assessment

## Flow Chart



Flow chart of the methodology used for landslide hazard, vulnerability and risk analysis

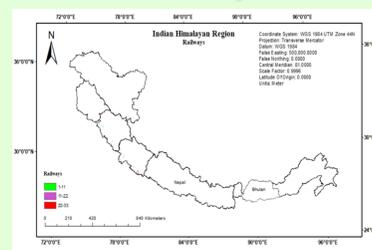
## Data Source

ID	Data Source	Spatial Resolution/Scale	Year of Acquisition	Purpose of the Data used
1	Earth Explorer	30 meters	2014	Digital Elevation Model / Slope
2	CRU TS Dataset	-	2011-2019	Rainfall
3	MODIS	250 meters	2020	NDVI
4	ZENODO	90 meters	2022	Dams
5	DIVA GIS	1 km	2023	Road / River / Railway / Study Area
6	USGS	30 meters	2010-2020	Earthquake / SRTM Data
7	Census 2011 (MHA, Govt of India)	-	Census, 2011	Population

## Vulnerability Assessment

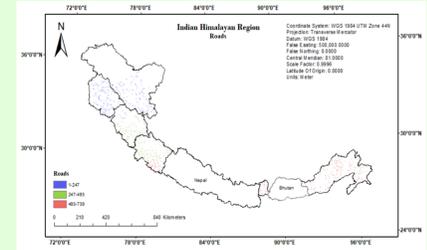
Vulnerability refers to the degree to which a person, community, or system is susceptible to the negative impacts of a hazard. Vulnerability can be influenced by a range of factors, including social, economic, political, and environmental conditions, as well as access to resources, infrastructure, and technology.

### Railways



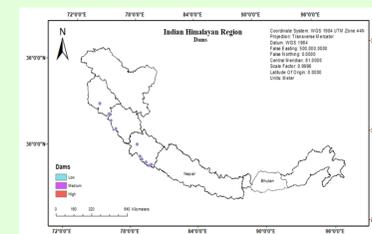
Map of Railways in Indian Himalayan Region

### Roads



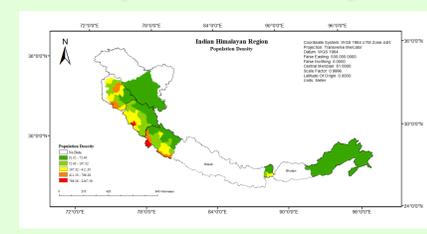
Map of Roads in Indian Himalayan Region

### Dams



Map of Dams in Indian Himalayan Region

### Population Density

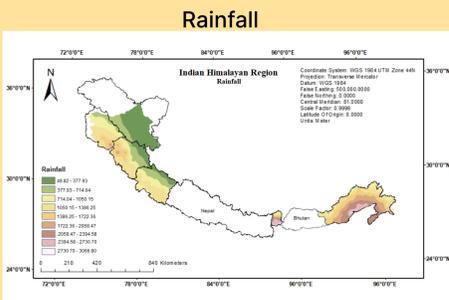


Population Density Map of Indian Himalayan Region (Census 2011)

## Hazard Assessment

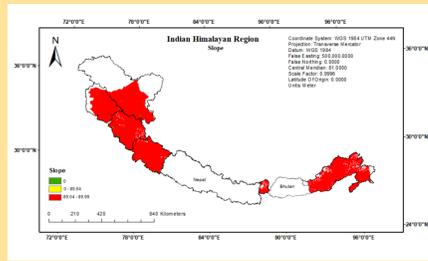
Hazards refer to any natural or man-made phenomenon or event that has the potential to cause harm, damage, or destruction to humans, infrastructure, and the environment. We make our hazard map assessment using a raster calculator where we use formulas, (Hazard = Landslide + Earthquake + River + Elevation).

### Landslide



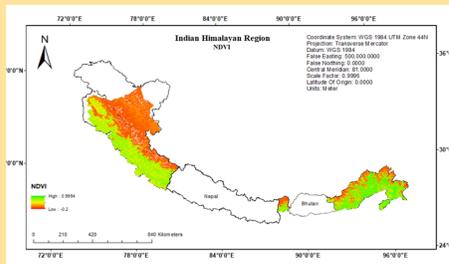
Rainfall Map for year 2020 of Indian Himalayan Region

### Slope



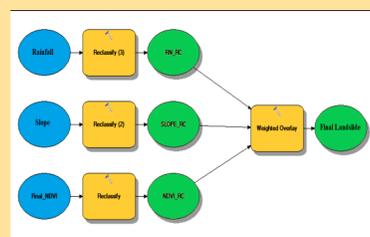
Slope Map for year 2014 of Indian Himalayan Region

### NDVI



NDVI Map for year 2020 of Indian Himalayan Region

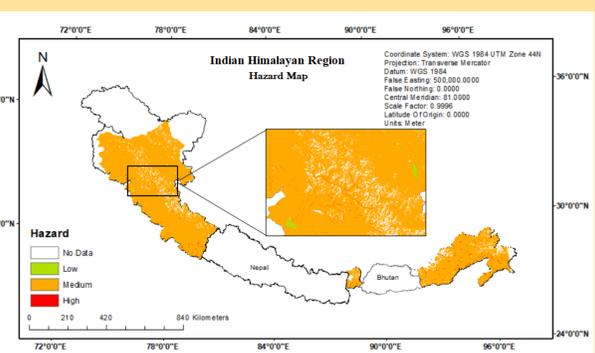
### Landslide Model



Landslide Final Map workflow using Model Builder

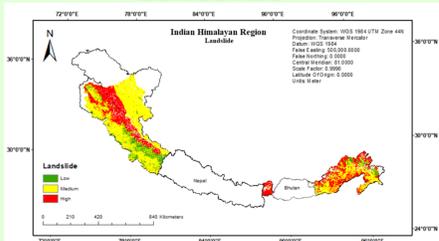
## Result and Discussion

The hazard map generated for our study reveals that the majority of the study area is classified as having a medium risk of hazards, as indicated by the predominant yellow color. However, there are also a few locations with the high risk (represented by the red points) and very low risk (represented by the green points). The distribution of these risk levels provides valuable information for disaster management and prevention measures in the study area.



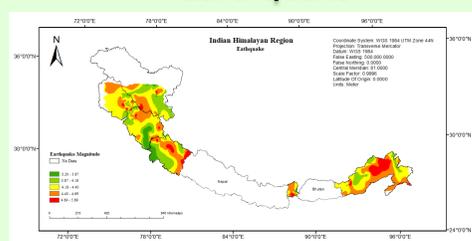
Hazard Map Of Indian Himalayan Region

### Landslide



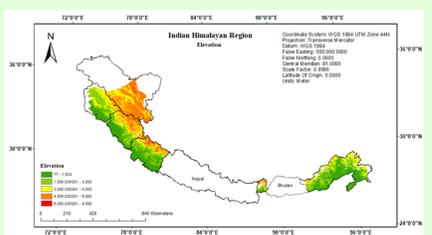
Landslide Map: Classified into three parameters: Low, Medium and High

### Earthquake



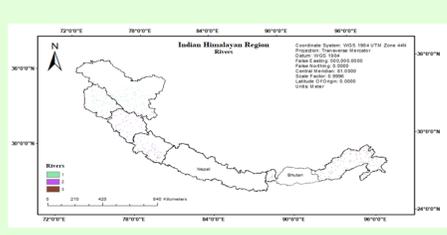
Earthquake Magnitude Map of Indian Himalayan Region for year 2010-2020

### Elevation



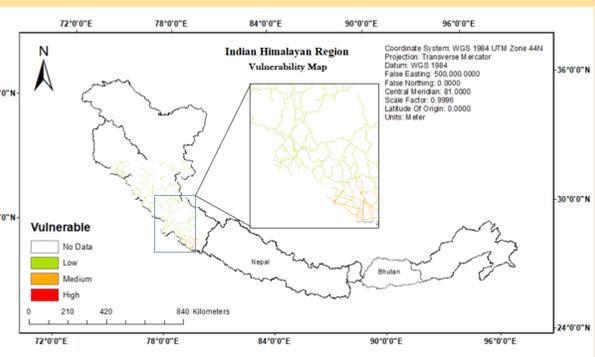
Elevation Map of Indian Himalayan Region of 2014.

### River



River Map of Indian Himalayan Region

The vulnerability map presented here represents our study area, displaying various colored points distributed throughout the region. The map shows different levels of vulnerability, with the colors yellow, red, and green indicating medium, high, and very low vulnerability, respectively. The red color denotes the areas with the highest vulnerability, while the green color shows the areas with the lowest vulnerability.



Vulnerability Map Of Indian Himalayan Region

## Conclusion

The analysis revealed that the region is highly vulnerable to landslides, earthquakes, and floods due to various natural and anthropogenic factors. The study provides valuable insights into the environmental hazards, vulnerabilities, and risks in the Indian Himalayas and can serve as a basis for policymakers, local authorities, and other stakeholders to develop effective strategies to reduce the impact of natural disasters in the region.

## Future Work

- Incorporating social vulnerability
- Developing a risk map
- Conducting field surveys