

An Investigation on the Relationship of Rainfall, Temperature and Landslides in the Dhauladhar Region of Himachal Pradesh

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Abstract: The state of Himachal Pradesh reflects hilly region and is known for pleasing weather at some stage in the yr. It even reviews heavy blizzard in the course of the wintry weather months. The climate of Himachal alters with the change of altitude. Landslides can occur in H.P and mountains during the monsoon season, deforestation, road slicing, terracing, and changes in agricultural output vegetation increased the hazard of geologically young and now not so strong steep slopes in various Himalayan grades at a rapid rate in recent years. In the present study the investigation was conducted on the four-lane NH- 154 Pathankot to Mandi and number of landslides was observed. It was found that Rainfall causes the majority of landslides, according to research. The largest no. of landslides were recorded in winter season in Kangra followed by Joginder Nagar. Dharamshala is more prone to landslides whereas in Post monsoon highest landslides were recorded in Mandi. The present study shows the relationship between rainfall, temperature patterns and landslides. It also focuses on the preventive measure that government should take in order to prevent such hazards.

Keywords: Landslides, Kangra, Padhar, Mandi, National highway.

1. Introduction

The Himalayas are the source of the state's name. Himachal means "country of snowfields" in Hindi. The Himalayas are a magnificent mountain range that stretches over 2,500 kilometers from north to south, with a width of 250 to 300 kilometers. The Himalayas are among India newest mountain ranges, estimated to be 40 million years old. Landslides can occur in H.P hills and mountains during the monsoon season, as well as after high-intensity earthquakes. Unrelated deforestation, road slicing, terracing, and changes in agricultural output vegetation requiring more regular watering, among other things, have increased the hazard of geologically young and now not so strong steep slopes in various Himalayan grades at a rapid rate in recent years (Champati et al., 2007).

Landslides are well-known for wreaking havoc, causing death and destruction. Landslides are common in west and east ghats, as well as Jammu and Kashmir, Himachal, and Uttaranchal. components are well-known in the field of landslides. Determining landslide-prone locations necessitates a huge data set. Sinks, debris or rockfalls, debris falls, or

rockslide are all examples of landslides (Singh et al., 2006). Slope steep slope, saturation from rainstorms or melting snow and ice, rock tremors, excessive weight from embankments, fills, and garbage dumps, changes in water contents, frost effect, weathering of rocks, effect of floor water, and trades in vegetative cover are all elements that influence landslides. There are various reasons of the landslides due to different situations.

Geological causes which include weathering of substances, substances that have been sheared, materials that are jointed or fissured, discontinuities with an asymmetrical orientation, Rainfall and a blizzard, Earthquake Morphological causes includes Slope angle, Uplift, Rebound Erosion of the riverbed, Erosion caused by waves, Erosion of the glacial margins, Erosion of the lateral margins etc. Human factors include, deforestation, management of water resources (floor water draw down and water leakage), the usage of land (Creation of roads, houses) quarrying and mining and pollution (Choudhury et al., 2006).

In case you actually have the slightest feeling that the place where you stay is liable to landslides its higher to get into action into movement and installed all of your attempt to keep away from this disaster. As we cited earlier soil erosion is one of the maxima not unusual motive of landslides, and consequently stopping it can assist you reduce the risk of landslides with the aid of an extensive quantity if not removed all of it altogether. Several studies have been to prevent landslide which includes planting of trees and small shrubs at the slope. As those bushes and shrubs develop their roots preserve soil together and help in lowering erosion of soil which is probably to make the slope unstable in course of time (Sharma et al., 2006). In truth there exist pretty a few species of plant life with shallow roots which can be specifically used to protect the pinnacle layer of the soil in mountainous location. Pandey, A. C., Nathawat, M. S. and Singh, g. (2006) studied how remote sensing and geographic information systems can be utilized to evaluate the impact of geo aspects on land slide in Himalayan terrain. In the Himalayan region, where vital aspects of the landscape are unreachable, far off sensing is a critical and efficient aiding instrument in geological-geomorphological mapping. Remote

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sensing snap photos provide a variety of information that can be used to assess regional geological formations, lithological, discrimination, and landform distribution. Sati, S. P. and Sundriyal, Y. P. (2007) researched on the interaction between slides and flora and focused on the importance of flowers in maintaining slope equilibrium. They discovered that all types of plants are incompatible with slope balancing. The effect of diverse tree species in the Garhwal Himalayan forests on slope instability is the subject of current research.

Many localities in Himalayan hill municipality, are showing indicators of impending tragedy. These settlements are experiencing active waste, which will take a significant toll on human activity throughout the monsoon season, and the article proposes investigating this issue. The Present research focuses on the concentrations, and vulnerable areas, as well as possible landslide locations, so that Thai development activities can be planned to optimize hazard avoidance. It also focuses on the landslide damages at different places during different times. To avoid the likelihood of any mishap in the area, it is advised that a series of prevention and mitigation. Measures (both structural and non-structural) be adopted with the participation of the local community. This paper emphasizes the need of catastrophe management.

2. Materials and Methods

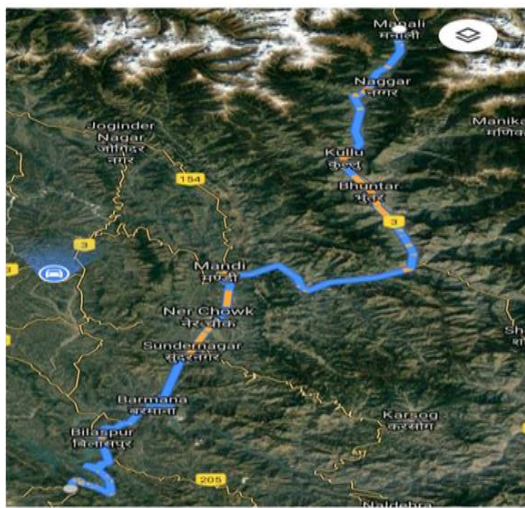


Fig. 1. Pathankot- Mandi Highway (A nightmare for travellers)

During the site visit, the investigation will be conducted on the four-lane NH- 154 Pathankot to Mandi. The road was previously two-lane; however, as the traffic volume on this road

has increased, a four-lane highway is needed. During the tour, a number of landslides was observed, as well as some retaining wall failure. The Joginder nagar highway is a national region that connects Manali, Lahol Spiti, and Leh in Upper Himachal Pradesh. The highway also serves as a connection between Kangra, Kullu, Manali, and Padhar are all connected by this highway. The highway is undergoing reconstruction. The task is being carried out by the National Highway Authority of India, which was formed by the Indian government. The entire highway is being reconstructed as a four-lane highway with better bitumen pavement, modern traffic sign boards, foot paths, tax toll offices, traffic signals, and the addition of new tunnels with the smallest number of road crossings possible. On a bike, the entire stretch of road from Pathankot to Mandi was surveyed, noting the areas where landslides would have taken places. The roadside strata were studied, and failures was addressed with the road site in charge. The highway no. 154 runs for 33.00 kilometres from its intersection with NH-154 in Chakki, Dhar in Punjab, linking Banikhe and Chamba, and concluding at Bharmour in Himachal Pradesh.

3. Results and Discussion

Area studied for landslides

1. landslides in Sunder Nagar
2. Landslide in Padhar
3. Landslides in Kangra

1) Landslides in Sunder Nagar

Sunder Nagar is located 22 kilometres from Mandi on National Highway 21 and is very well by road to other locations. The motorway is being reconstruction. The work is being conducted out by the National Highway Authority of India, which was established by the Indian government. The entire expressway is being reconstructed as a four-lane highway with improved bitumen surface, new traffic sign boards, footpaths, toll booths, and traffic lights. Following severe rain, the road adjacent to the BBMB canal was turned into a pool of water, causing traffic congestion on National Highway 21. Rapid and significant soil erosion, as well as frequent landslides, occur when there is a lot of rain.



Fig. 2. Landslides in Joginder Nagar

2) Landslide in Padhar

Lack of road connection has made life difficult for people of Bhatwar and Ghron wards, which are part of the Ropa Padhar gramme panchayat in Mandi district's Joginder Nagar assembly

sector. The road quality over the last 6-7 kilometres is a little rough, with some potholes. The landslide, which happened around night had damaged the Mandi-Pathankot national route 154 in Padhar, Mandi district, happened near Kotrupi village. Since 1988, this is the third significant tragedy in Himachal Pradesh. Previously, in 1988, 45 bus passengers were buried in a landslide near Matiyana in Shimla district, and in 1994, 42 travelers were trapped in a landslide near Luggar Hati in Kullu district.



Fig. 3. Landslide in Padhar

3) Landslides in Kangra

Sections of this hilly state, such as Kangra Valley, which sits at the foothills of the Himalayas and sees a lot of landslides every year in various places. During monsoons and high-intensity earthquakes, some portions of District Kangra, including hills and mountains, are prone to landslides. Owing to inappropriate human activity such as forest loss, road cutting, terracing, and soil health crops requiring more intense watering, the vulnerability of the geologically young and not so stable steep slopes in various Dholadhar, Chamba Dhar ranges has been increasing at a rapid rate in recent decade. The Dharamshala region of India's Kangra valley is among the fastest-growing Himalayan cities, and it is prone to landslides virtually all year. The rapid speed of development necessitates landslide susceptibility zonation research to try to provide maps that architects and engineers may utilize to build projects in more secure sites.



Fig. 4. Landslides in Kangra

The majority of landslides were discovered to occur in a variety of locations, primarily on the uphill side. Landslides are caused by a variety of factors, the most common of which being heavy rainfall.

Table 1
Winter Season, Rainfall and Landslides

Places	Annual Rainfall	No. of landslides
Kangra	1800–3000mm.	25
Mandi	1876 mm	15
Joginder Nagar	1,851 millimetres	20

Table 2
Post monsoon, Rainfall and Landslides

Places	Annual Rainfall	No. of landslides
Kangra	1500mm	10
Mandi	1120mm	20
Joginder Nagar	1750mm	10

Table 3
Average temperature during winter and post monsoon

Places	Annual temperature winter	Post monsoon
Kangra	0-20°C	20-25°C
Mandi	6.5-12.7°C	20-25°C
Joginder Nagar	4-12.5°C	19.6-24°C

Table 4
Monthly Rainfall and landslides data of Mandi (2021)

Months	Rainfall	No. of landslides
January	102	5
February	140	4
March	74	3
April	38	2
May	129	1

Table 5
Monthly rainfall and landslides data of Kangra (2021)

Months	Rainfall	No. of landslides
January	22.7	5
February	46.5	2
March	28	5
April	32.7	2
May	13.4	1

Table 6
Monthly Rainfall and landslides data of Joginder Nagar (2021)

Months	Rainfall	No. of landslides
January	5.20	3
February	15.4	5
March	14.2	5
April	20.5	4
May	16.2	3

Rainfall causes the majority of landslides, according to research. The highway passes through Joginder Nagar, Padhar, Mandi. It was discovered that rainfall in Mandi district fluctuates from 102 mm to 129 mm throughout a five-month period, from January to May. The wettest month is February, and the hottest month is May. In Kangra, however, rainfall ranges from 46.5 mm to 32.7 mm in winter season. In Joginder Nagar however, rainfall ranges from 5.40 to 16.2. The wettest month is April and very less rainfall occurred in January.

The largest no. of landslides were recorded in winter season in Kangra followed by Joginder nagar in which Dharamshala is more prone to landslides whereas in Post monsoon highest landslides were recorded in Mandi .

The highest temperature was recorded in Kangra which varies from 0-25°C. The increase in temperature also led to increase in chances of rainfall. There is a close relationship between temperature and rainfall.

4. Conclusion

1. The highway starting from its junction with NH-154 near Pathankot in the State of Punjab connecting Nurpur, Palampur, Jogindar Nagar, Mandi (Padhar), Sundar Nagar.
2. Maximum landslides occurred in Mandi area in Post monsoon season and minimum in Kangra.
3. Maximum landslides occurred in Kangra area in winter season among which Dharmshala is most prone to landslides.
4. Maximum temperature was observed in Kangra which varies from 0-25°C in post monsoon and minimum was recorded in Joginder Nagar.

Recommendations measures to control the landslides:

1. Neighborhood government ought to record continuously landslide statistics associated with road damage and site visitor's density information. Consequently, information may be used to decide the landslide threat zones and calculate the landslide impact on street.
2. If you want to reduce landslide susceptibility, authorities have to behavior tree plantation drive with deep root plant life. Due to the fact the maximum of landslides befell in vicinity have low plant life density and shallow-fiber root trees.
3. Provision of wire internet on the slope's toe in order to divert the current day of the river and control talus toe-erosion. A minimum of a 5ft. (1.5m) broad beam in the middle of the slope, with a covered drain on the hillside that discharges into the river.

Due to the limited space available between the street and the river, the supply of beam may require steepening at the slope above the beam. As a result, the toe of this steepened slope may

require additional safety, such as trapping the particles behind stone packed wood cribs or through a masonry breast wall.

Landslide on river bank:

The military officials have erected check walls in a short portion of the hill to seal the gaping fissure with stones. Because of the slump kind of soil collapse, filling the crevices with stones and loading the top of the slide with check walls may not be effective in checking the slide. In fact, loading the slope that is affected is unfavorable. Because the immediate cause of the failure is most likely oversaturation of the soil caused by significant precipitation or snowfall, it is thought important to take steps to drain the soil initially. If none of these methods work, unload the top of the slide and provide constraint at the toe using a retaining wall.

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