Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 02 (MAR-APR, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Landslides: Reasons and Response

(*Manisha Tamta[1], Himani Bisht[2], Abhishek Kumar Dubey[1], Kumari Shubha[1], Abhishek Kumar[1], Umesh Kumar Mishra[1] and Sanjeev Kumar[1])
[1]ICAR-Research Complex for Eastern Region, Patna-800 014
[2]ICAR-Indian Agricultural Research Institute, New Delhi-110 012
*Corresponding Author's email: tamtamanisha16@gmail.com

The Himalayas, the highest mountain range on Earth, are the result of the collision of the Indian and Eurasian plates. As the Indian plate moves northward towards China, it continuously stresses the rocks, making them brittle, prone to landslides, and earthquake-prone. Even though it is considered a natural disaster, human activities like building, excavation, population growth, deforestation, and other things make it worse. According to **Nadim et al (2006)**, India is one of the top four countries (along with Nepal, Tajikistan and Colombia) regarding landslide danger, with an estimated annual loss of life per 100 km^2 above one. The North West Himalaya (Uttarakhand, Himachal Pradesh, and Jammu & Kashmir), the North East Himalaya (Darjeeling and Sikkim), the Western Ghats and Konkan hills (Tamil Nadu, Kerala, Karnataka, Goa, and Maharashtra), and the Eastern Ghats of the Aruku area in Andhra Pradesh comprise about 420,000 Km^2, or 12.6%, of India's land that is susceptible to landslides (excluding snow-covered areas) **(Geological Survey of India, 2024)**.

A large portion of landslides, whether large or small, swift or slow, old or recent, are only found in the Himalayas **(Fig 1)**. The Himalayan region is particularly vulnerable to landslides since it is located in Zones IV and V, which are the most seismically active areas. Landslides also severely damage the Northeastern area, which includes the West Bengal Darjeeling district, Sikkim, Mizoram, Tripura, Meghalaya, Assam, Nagaland, and Arunachal Pradesh. These landslides regularly cause economic losses. **Sharma et al (2024)** have developed the Indian Landslide Susceptibility Map (ILSM) at a resolution of 0.001° (100 m) with a sensitivity of 97.08% and accuracy of 95.73%. The map is divided into five classes: very low, low, medium, high, and very high, wherein 86.8%, 1.7%, 3.2%, 3.5% and 4.7% land area of the country falls under these 5 categories, respectively **(Fig 2)**. The top 10 landslide-prone states in the nation are reportedly Sikkim, Uttarakhand, Arunanchal Pradesh, Himachal Pradesh, Manipur, Nagaland, Goa, Mizoram, Meghalaya, and Kerala, with Sikkim having the largest area under the very high susceptible category, the ranking is based on the percentage of area under landslide susceptibility **(Sharma et al, 2024).** In terms of important socioeconomic factors, Rudraprayag district in Uttarakhand ranks as having the highest exposure to landslides out of all 147 districts in 17 states and 02 Union Territories of India **(Jain et al, 2023).**

Fig 1: Image of landslide in Himalayan region

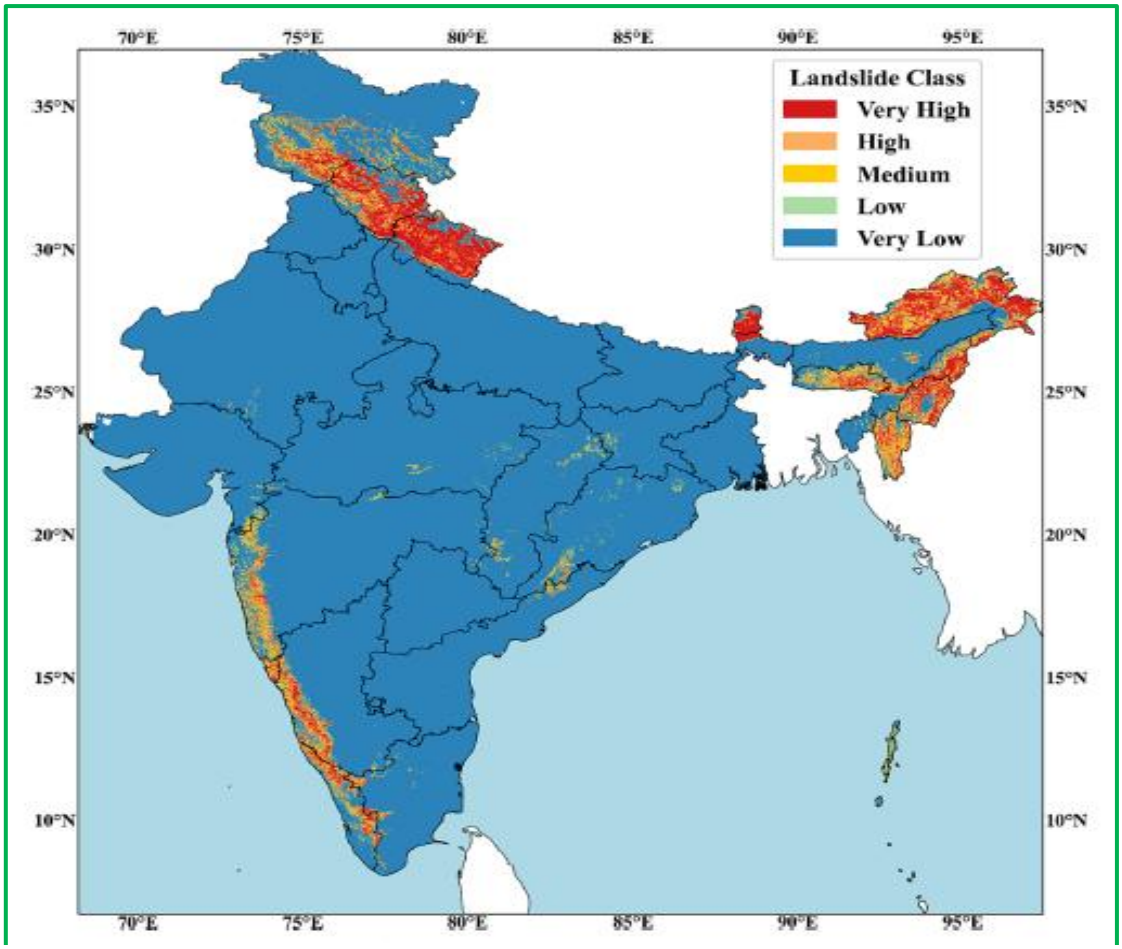

Fig 2: Landslide susceptibility map of India (Source: Sharma *et. al*, 2024)

Landslides

It is described as "a movement of mass of rock, earth, or debris down a slope" by **Cruden (1991)**.

Types of landslides: Landslides are classified as follows-

- **Falls:** The term "falls" refers to the swift motions of rocks and boulders that break off from cliffs or steep slopes along joints, fractures, and bedding planes.
- **Topple:** The term "topple" describes the forward rotation of a rock or debris mass coming off a slope. Usually, the slope failure happens at a location close to the rock block's base.
- **Slides:** The term describes the material's downslope movement along a slip surface.
- **Rotational slide:** In this instance, the slide moves in a nearly circular motion around an axis that runs transversely across the slide and parallel to the ground.
- T**ranslational slide:** In this scenario, the landslide mass rotates or tilts backwards along a planar surface.
- **Lateral Spreads:** This type of movement typically takes place on flat or extremely mildly inclined terrain.
- **Debris flow:** The term "debris flow" refers to the swift mass movement that occurs when slurry, loose soil, rock, and organic matter flow downslope. It is primarily brought on by heavy rains or quick snowmelt. Debris is defined as particles in which 20% to 80% portion is larger than 2 mm size and the remaining portion is less than 2 mm in size.
- **Earth flow:** Earth flow is a type of viscous, fine-grained, water-saturated flow that occurs on a downward slope. It is referred to as earth when 80 percent or more of the particles are less than 2 mm.

- **Mudflow:** Mudflow is the term used to describe a swiftly flowing, wet, viscous fluid mass of both coarse and fine-grained debris down drainage channels. Mud is defined as material in which 80% or more of the particles are less than 0.06mm in size.
- **Creep:** The gradual, constant, downward movement of material across a vast region caused by gravity is called creep.

Reasons of landslides: Landslides can occur either due to natural processes or human activities.

1. **Natural:** Natural landslides are those that occur naturally because they are not controlled by humans, such as those produced by earthquakes, excessive rainfall, flooding, erosion, and sliding rocks. Rainfall-induced landslides arise from the interaction of water with soil, plants, geology, and terrain. This kind of landslides are mostly caused by topographical elements such slope morphology, aspect, and angle; land usage and cover; soil texture and depth; rock weathering; drainage; etc. Complex interplay between geological, geomorphological, hydrological, and meteorological factors result in landslides. Since rainfall's strength and length are the primary environmental factors that cause landslides, the majority of them happen in the windward regions of the Himalayas and Western Ghats. But in contrast to the Himalayas, the western ghats have higher soil depth, which permits more water retention and higher porewater pressure, both of which eventually cause landslides **(Martha et al, 2021).**
2. **Man-made:** The most prevalent causes of man-made landslides include the construction of buildings and roads with inadequate slope grading, the disruption of previous landslides, and ill-planned drainage pattern modifications. Construction and other human activities might raise the possibility of a landslide. Overgrazing by livestock, excavation, filling and cutting of the terrain, excessive development, irrigation, deforestation, and water leakage are some of the prevalent practices that cause a slope to become unstable or weak. The risk of flooding is increased by activities that loosen and remove soil, gravel, and vegetation, such as building, mining, quarrying, and hydropower projects. This lowers the ability of groundwater to retain water. As a result, landslides are caused by excess water or loosening debris after strong rain or earthquakes. An instance of this may be seen in the ongoing construction of the Char Dam Road, which has damaged the delicate Himalayan ecology and triggered new zones of possible landslides in Uttarakhand. In India, over a 13-year period (2004-2016) with over 5,000 landslides, the highest number of deaths worldwide (10,900 deaths across 829 landslides) were attributed to human-triggered landslides, **(Froude and Petley, 2018)**. Road building and development are examples of manmade activities that exacerbate slope instability and raise the possibility of landslides. The majority of landslides in Sikkim happened in urban areas, and these events have been linked to infrastructure development and urbanization **(Singh et al, 2020)**.

Response

Natural landslides are beyond human control; however man-made landslides can be easily managed. Our response to landslides is determined by our strategy for mitigation, preparedness, and adaptation. We cannot prevent disasters, but we can mitigate their damage by adequately preparing for landslides. The preventative measures for landslides are listed below in the form of do's and don'ts-

Do's

1. Any sort of construction should follow the landslide susceptibly/ hazard zonation map or atlas. Identify the landslide zone of the area and proceed for construction accordingly.
2. Retaining wall, Rock anchoring and netting can be done on probable side of hill slope.

3. Plan your travel over hilly regions according to weather forecast generated by India Meteorological Department (IMD) or any other agency for tourism.
4. Move away from landslide path or downstream valleys quickly without wasting time.
5. Regularly inspect drainage channels for and clear of litter, leaves, plastic bags, rubble etc., if any.
6. Grow more deep rooted plants and trees in the vicinity that can hold the soil through roots for reducing the soil erosion.
7. Identify areas of rock fall and sagging of buildings, cracks and muddy river waters indicating possible landslides upstream and move to safer areas.
8. Upon noticing any signals of landslide, contact the nearest Tehsil or District Head Quarters for help.
9. Deforestation should be minimized in the very highly and highly susceptible areas and reforestation should be planned accordingly.
10. Those living or traveling in susceptible areas should stay alert, awake and active for any unusual sounds such as rock fall, moving debris, cracking in trees and in ground, boulders knocking or any other movement.
11. In case of such emergencies, locate and go to shelters, try to stay with your family and companions. Look for people who are hurt or stuck.
12. In forest areas, mark path of tracking back so that you can't be lost in middle of the forest.
13. Attend capacity building programmes conducted by the NDMA to know details and how to give signs or how to communicate during emergency time to flying helicopters and rescue team.
14. Remain composed, call emergency services, assist them, maintain drinking water containers, a first aid kit, and necessary medications on hand, and stay away from residences that are harmed.
15. If you live near a river, keep an eye out for flooding; assist those in need, particularly the elderly, children, and women; and get assistance from the local government on how to reconstruct damaged homes, roads, etc.
16. Report any damage to roads, electricity lines, and telephone lines to appropriate authorities.
17. Every household/ family should keep one **Emergency Kit** ready with them. It includes battery operated torch**,** extra batteries**,** battery operated radio**,** first aid kit and manual**,** emergency food (dry items) and water (packed and sealed)**,** candles and matches in a waterproof container**,** knife**,** chlorine tablets or powdered water purifiers**,** can opener, essential medicines**,** cash, copy of aadhar card and ration card**,** thick ropes and cords and sturdy shoes.

Don'ts

1. Try not to cry out of fear or exhaustion.
2. Try to stay away from building sites and places that are vulnerable.
3. Avoid building homes next to drainage paths or steep slopes.
4. Avoid touching or walking on unsecured objects, electrical wires, or poles.
5. If an injured individual is not in imminent danger, do not transfer them without providing first assistance.
6. Rainwater collected from outside is acceptable to drink, but avoid drinking tainted water straight from springs, rivers, or wells.

NDMA

In order to ensure prompt and efficient response to disasters, the National Disaster Management Authority, the highest authority for disaster management in India, is tasked with establishing the policies, strategies, and guidelines for the field. A GoI Executive Order

established the NDMA on May 30, 2005, and the Disaster Management Act of 2005 was passed on December 23 of the same year. The NDMA's ex-officio chairperson is India's prime minister. It must respond to all calamities, whether they are caused by nature or by humans. Any citizen can access the NDMA's official website (https://ndma.gov.in/) to learn about natural hazards and disasters, as well as guidelines and alerts/warnings linked to them.

Conclusion

Establishing a safe environment for society requires protecting people and property from any disasters. Extreme weather occurrences, human meddling in the environment, and other anthropogenic activities have led to an increase in the frequency of landslides in recent years, which has resulted in a significant loss of life, cattle, and property. In many developing nations, the economic damage caused by landslides is estimated to be as high as 1% to 2% of GDP. Many landslides that are caused by people can be prevented or lessened. In 2009, the NDMA released guidelines for disaster management that must be adhered to in order to ensure the protection of individuals and property. While reducing the risk of landslides is difficult, it is possible if responsible behavior is practiced and regulations about building, forestry, and businesses involving natural resources are followed.

References

1. Cruden, D. M. (1991). A simple definition of a landslide: Bulletin of the International Association of Engineering Geology. Volume 43, 27-29. https://doi.org/10.1007/BF02590167.
2. Froude, M. J. and Petley, D. N. (2018). Global fatal landslide occurrence from 2004 to 2016. Natural Hazards and Earth System Sciences, 18(8), 2161-2181. https://doi.org/10.5194/nhess-18-2161-2018, 2018.
3. Geological Survey of India. 2024. Landslide Hazard. https://www.gsi.gov.in/webcenter/portal/OCBIS/pages_pageGeoInfo/pageLANDSLIDE HAZRD accessed on 3.4.2024
4. Jain, N., Roy, P., Martha, T.R., Jalan, P. and Nanda, A. (2023). Landslide Atlas of India (Mapping, monitoring and advance techniques using space-based inputs). NRSC special publication. NRSC/ISRO. Document number: NRSC-RSA-GSG-GMED-FEB 2023-TR-0002167-V1.0
5. Martha, T. R., Roy, P., Jain, N., Khanna, K., Mrinalni, K., Kumar, K. V. and Rao, P. V. N. (2021). Geospatial landslide inventory of India—an insight into occurrence and exposure on a national scale. Landslides, 18(6), 2125-2141.https://doi.org/10.1007/s10346-021-01645-1.
6. Nadim, F., Kjekstad, O., Peduzzi, P., Herold, C. and Jaedicke, C. (2006). Global landslide and avalanche hotspots. Landslides, 3, 159-173. https://doi.org/10.1007/s10346-006-0036-1.
7. Sharma, N., Saharia, M., and Ramana, G. V. (2024). High resolution landslide susceptibility mapping using ensemble machine learning and geospatial big data. Catena, 235, 107653. https://doi.org/10.1016/j.catena.2023.107653
8. Singh, A., Ranjan, R. K. and Tewari, V. C. (2020). Spatio-temporal Variability of Landslides in Sikkim Himalaya, India. In: Pal, I., von Meding, J., Shrestha, S., Ahmed, I., Gajendran, T. (Eds.), An Interdisciplinary Approach for Disaster Resilience and Sustainability, Disaster Risk Reduction. Springer, Singapore, pp. 219–234. https://doi.org/10.1007/978-981-32-9527-8_13.