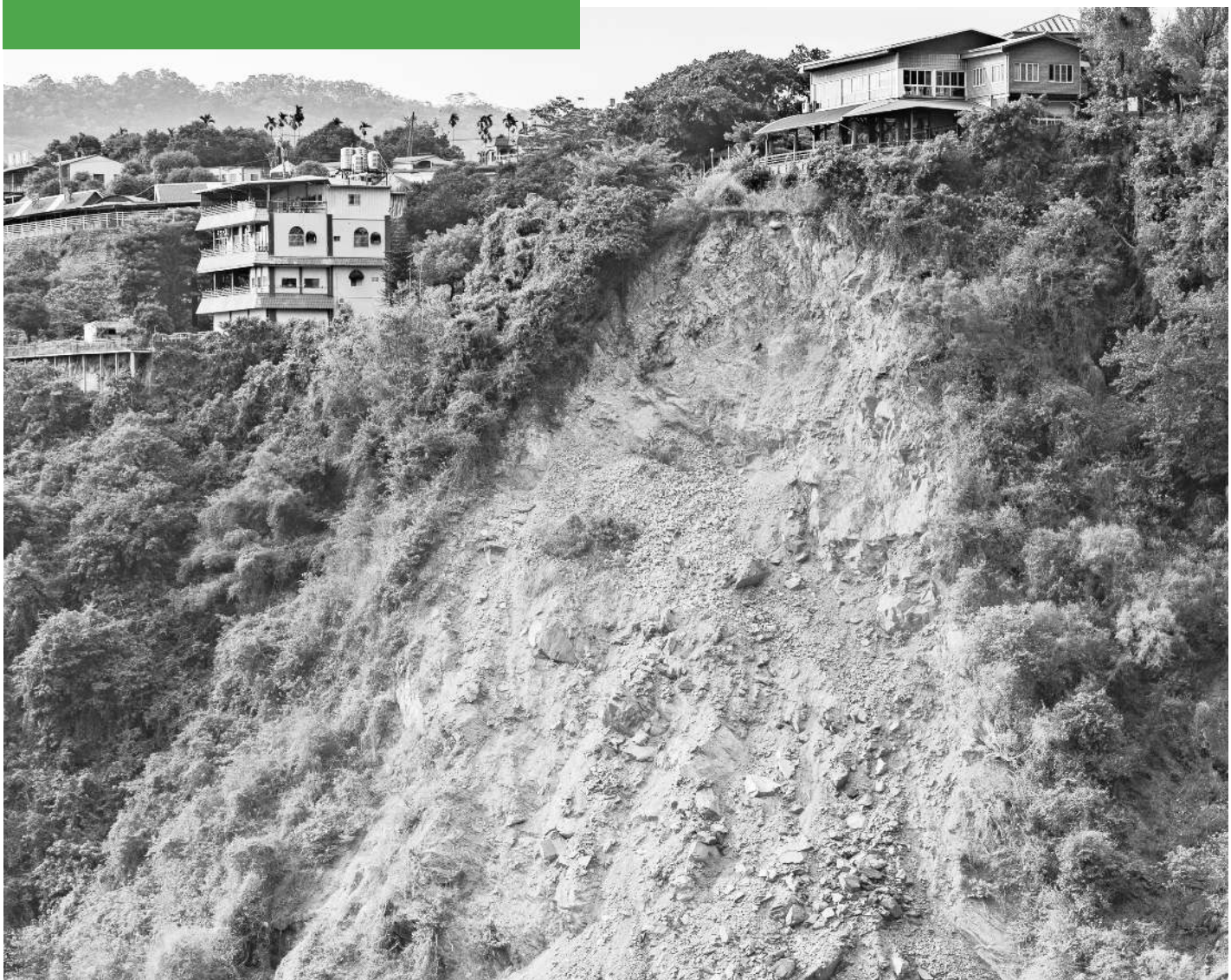
Climate Software Lab

LEVERAGING TECHNOLOGY TO MITIGATE LANDSLIDE RISK IN INDIA



01. A Concept Note

Landslides and avalanches are among the major hydro-geological hazards that affect large parts of India besides the Himalayas, the North-Eastern hill ranges, the Western Ghats, the Nilgiris, the Eastern Ghats, and the Vindhyans, in that order, covering about 15 % of the landmass.

A quick internet search over Google would throw up a host of results about landslides in India. The most evident is the newspaper headlines on how landslides have resulted in tremendous loss of human life in the North-Eastern states of Manipur and Uttarakhand in June 2022, along with reports on how Jammu-Srinagar's national highway was blocked by landslides. A point to be noted here is that all of these were caused by bursts of heavy rains that happened over a short period.

According to the World Health Organization (WHO), landslides, as a calamity/natural disaster are more widespread than any other geological event. Added to this, climate change and rising temperatures are now expected to trigger a lot more landslides, especially in the cold mountainous regions that are covered with snow and ice.

Landslides are an annual feature in India, which become more prominent during the South-West monsoon period that generally lasts for three months beginning from June. They cover most of the country starting from the Southern State of Kerala on the west coast and then traveling across the Indian subcontinent. Particularly vulnerable to landslides are the Western Ghats, the Himalayan States, and the North-eastern States, all of which are ecologically fragile. Landslides are usually caused by bursts of incessant and heavy rainfall over a short period, leaving behind a trail of death and destruction, causing untold human misery and suffering. Globally today, landslides are the third-biggest set of natural disasters.

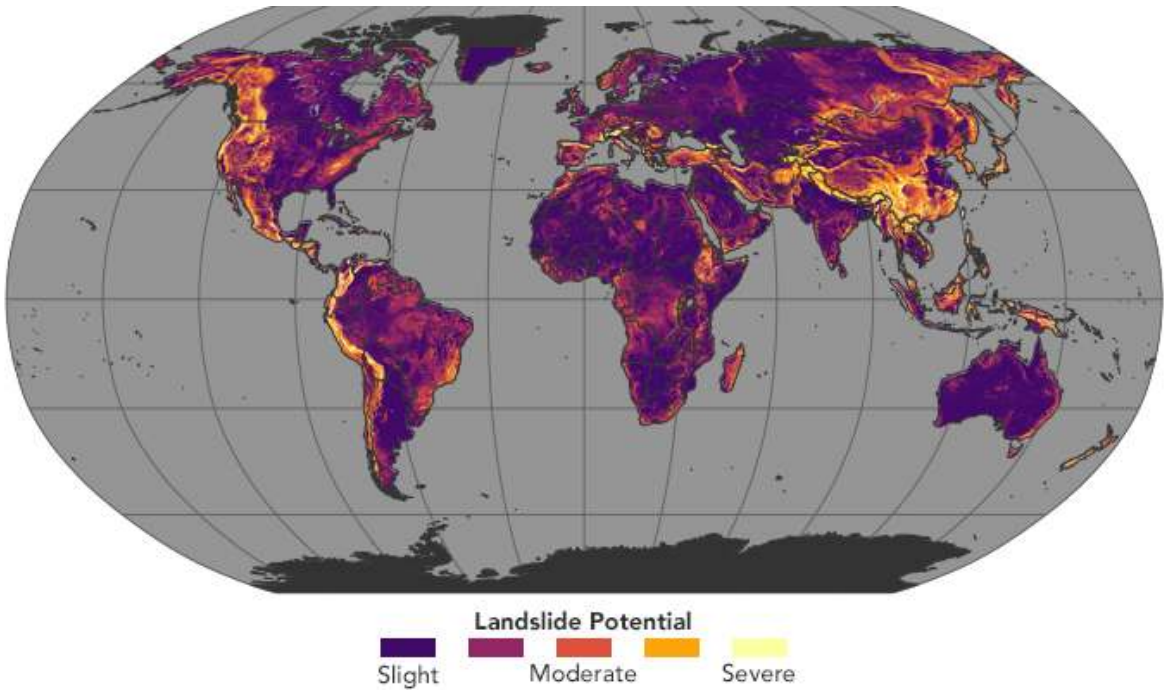
02. Landslide Risk And Impact In India

12.6% or **0.42 million sq. km.**, of India's land area is susceptible to landslides. Its affects **1-2 % GDP** of the country's economy.

According to the Geological Survey of India (GSI), nearly 12.6 percent, or 0.42 million sq. km., of India's land area is susceptible to landslides. Of this, 0.18 million sq. km. falls in the North East Himalayan region, including Darjeeling and Sikkim Himalayas; 0.14 million sq. km. in the North West Himalayan region covering Uttarakhand, Himachal Pradesh, and Jammu & Kashmir; 0.09 million sq. km. in the Western Ghats and Konkan hills that include the states of Kerala, Tamil Nadu, Karnataka, Goa and Maharashtra, and 0.01 million sq. km. in the Eastern Ghat region of Araku area in Andhra Pradesh. To make matters worse, the Himalayan terrain, which is prone to landslides, falls in the maximum earthquake-prone zone as well.

The official numbers as far as deaths due to landslides are concerned, may appear to be small given the nature of the disaster, since landslides are short-duration but severe hazards that cause substantial human and financial damage. It is estimated that, on average, landslides claim about 500 lives annually apart from causing damage to property estimated at ₹ 300 crores every year. There are also estimates that the economic loss due to landslides may amount to 1 to 2 percent of the Gross National Product in many developing countries, and nearly 80 percent of the reported deaths owing to landslides take place in developing countries.

Added to the increasing population in hilly areas, which are already ecologically sensitive and fragile; construction activity happening today at a frantic pace also leads to a higher risk of landslides. Besides, over the last few decades, there has been a greater focus on infrastructure and hydropower projects in these areas, particularly in the Himalayan and North-eastern regions. The heightened construction activity in these regions brings with it the problem of ecological imbalance resulting in landslides and other disasters - taking a huge economic toll, not to mention the loss of hundreds of lives every year.



03. Government Intervention For Mitigation Of Landslide Risk

> The Geological Survey of India's (GSI) Landslide Susceptibility Map divides the country into three zones based on how landslide-prone they are; namely, low, moderate, and high.

It is next to impossible to prevent landslides. Hence, the task before policy planners, scientists, and administrators are to use the latest technology to identify hazard-prone areas, categorize them based on hazard profiles and ensure that the local government authorities are prepared and equipped to meet any eventuality. Various arms of the government must work in unison and the Government should also rope in the private sector to help in disaster preparation and mitigation.

At the national level, National Disaster Management Authority (NDMA) is the apex body for disaster management and is headed by the Prime Minister, while all States have set up State-level disaster management authorities. Apart from the NDMA, there is the Nation Disaster Response Force (NDRF), which has been tasked with responding to disasters and rescuing lives across the country.

The Geological Survey of India (GSI), a Government of India agency, has been conducting landslide susceptibility mapping since the 1980s. The National Landslide Susceptibility Mapping (NLSM) initiative of GSI covers all susceptible areas and today provides a macro level map of scale, 1:50,000. According to GSI's website, the agency conducts susceptibility studies as part of its regular field season programs. It conducts landslide susceptibility mapping on different scales based on requests from user agencies and also does landslide inventory mapping. As part of its post-disaster study, the GSI carries out a detailed site-specific study to identify the causes and thereafter, suggests the best possible remedial measures. GSI appears to have done a lot of susceptibility mapping and modeling over the years.

The NDMA on the other hand has generated Meso-level maps and landslide maps for the different landslide-prone corridors, particularly in the Himalayan region; along with the involvement of other Government agencies and departments.

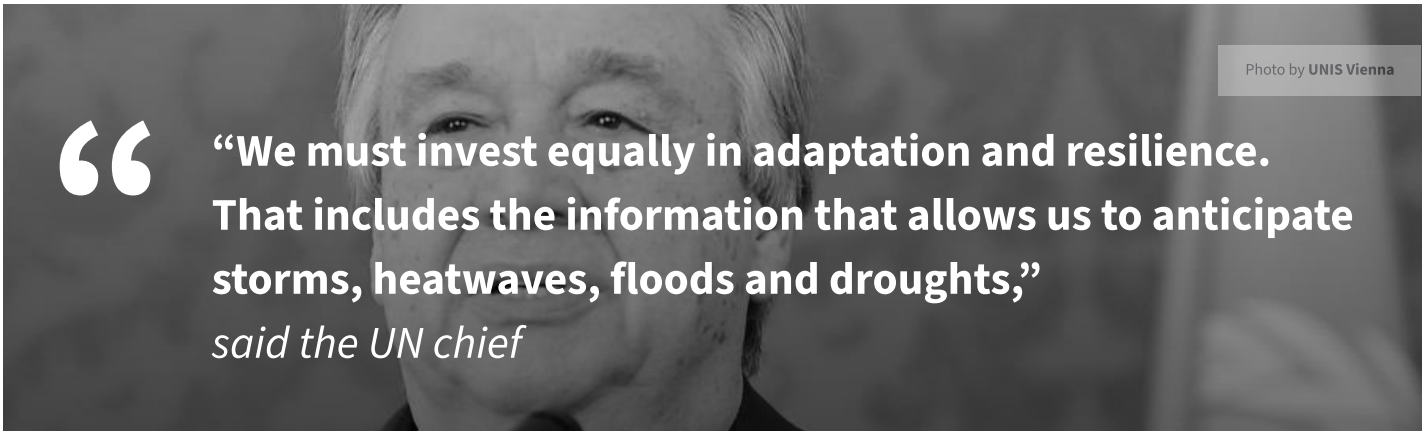
As the NDMA points out, landslides and avalanches are major hydro-geological hazards that affect large parts of India, apart from the Himalayas, the North-eastern hill ranges, the Western Ghats, the Nilgiris, the Eastern Ghats, and the Vindhyas. The NDMA prepares Landslide Hazard Zonation (LHZ) maps at 1:50,000 scale and progressively larger scales for particular areas. The National Remote Sensing Centre (NRSC) has come out with an atlas on select corridors of Uttarakhand and Himachal Pradesh. The Department of Science and Technology has funded more than 30 such projects across the country being done by various academic institutions.

NRSC's geo-hazard studies are focused on landslides, earthquakes, and volcanoes. It uses high-resolution satellite data to assess the damage after a disaster and also prepares an inventory of landslides. It has studied major landslides such as the one in Kerala-Karnataka-Tamil Nadu (2018), Mizoram-Tripura (2017), and Sikkim (2016). The Centre has prepared Landslide Hazard Zonation (LHZ) maps along major tourist and pilgrimage routes in Himachal Pradesh and Uttarakhand and these maps have been integrated with the rainfall forecast data to develop and issue landslide early warning signals through a portal.

04. Global Need For An Early-Warning System

Unlike other natural disasters such as floods and cyclones, it is difficult to predict when and where landslides will occur, rain is often a trigger event for a landslide. Hence, the task before policy planners, scientists, and administrators is to use the latest technology for mitigation strategies.

United Nations Secretary-General, António Guterres, recently highlighted the importance of early warning systems against natural disasters to save human lives. “Early warnings and action save lives,” he was reported to have said in March 2022 on the occasion of World Meteorological Day, which is observed on March 23. The World Meteorological Organization will spearhead an initiative to ensure that early warning systems protect all citizens on the globe within five years. The WMO will come up with an action plan in November at this year’s UN climate conference (COP 27) slated to be held in Egypt.



05. Building Landslide Early Warning System For India

One of the problems, according to experts, is that most States depend on old and low-resolution susceptibility maps to draw up landslide prediction models. These maps do not narrow down the risky areas which will allow for targeted intervention. The maps also do not consider the changing rainfall patterns.

A global initiative here is NASA’s Landslide Hazard Assessment for Situational Awareness (LHASA) which provides landslide predictions every 30 minutes across the world. The real-time landslide prediction model is built on a worldwide landslide susceptibility map and Global Precipitation Measurement data updated every 30 minutes. It provides a narrow cast of landslide susceptibility across the world.

Satellite data, according to NASA, helps in identifying conditions under which landslides occur and can be used to monitor the hazard, with models used for predicting them. The point is that researchers need accurate and timely rainfall information to understand and model where and when calamities such as floods and landslides may occur. NASA developed the global Landslide Hazard Assessment for Situational Awareness (LHASA) model to provide situational awareness for a wide range of users. The model combines near real-time rainfall data with a global landslide susceptibility map to estimate when and where landslides triggered by rainfall are likely to occur.

Landslide Prediction Systems Can Be Improved By Integrating Machine Learning Models With Geospatial Technologies.

The CSL team is building an India-specific narrowcast of landslide risk.

There is, however, also a need to tweak the NASA model to create a more localised susceptibility model with the help of additional data layers. Local data can be used to fine-tune threshold parameters, thus improving prediction models.

Climate Software Lab (CSL) of GPS Renewables is working on developing a localised early warning system for landslide-prone Indian regions. As the first step, CSL has developed a susceptibility map for two regions of India – the Western Ghats and North East India. Leveraging on Geological Survey of India's data set of past landslide locations and other recently published global datasets, CSL has developed its own localized landslide susceptibility model, with susceptible areas covering nearly 40 Lakh population in the Indian subcontinent.

The CSL model has customized the NASA model to build a more localized susceptibility map through additional data layers. By training our ML model with historical data from GSI and fine-tuning threshold parameters based on local data, we have improved the prediction and spatial accuracy for more targeted disaster response interventions.

The CSL model focuses on local parameters such as slope, local relief, forest loss, tree canopy height, and similar relevant parameters for improving accuracy.

The Susceptibility map enables policy-makers to identify vulnerable populations and important assets such as schools that are present in the risk zones. Classifying regions based on different risk levels makes planning for risk mitigation a lot more efficient and targeted. Moreover, Data and the methodology are published so that collaboration for further improvement is possible, as well.

- **Landslide Susceptibility Map for Western Ghats and North East India1. ~40 Lakh population covered.**
- **Based on NASA's Landslide Hazard Assessment for Situational Awareness (LHASA).**
- **Leveraging new datasets such as Hansen Global Forest Change(years :2000-2020), Human Modification Index.**
- **Landslide points, Lineament and faults based on GSI data.**

06. Looking Ahead

The CSL team is currently working on an India-specific narrow cast of landslide risk based on rainfall estimates from the Global Precipitation Mission by NASA. As further steps, it also plans to develop a data visualization platform that would indicate the rainfall pattern across India. Visuals that are accessible to policy-makers will be attempted as they can be very critical information for developing local-level disaster response strategies.

There must be open access to climate-related data in India, as it is available in most other countries. Also, the private sector should be given a greater role in analyzing the data using machine learning and other modern technological tools. Climate-focused firms such as GPS Renewables, and other start-ups should be in a position to come up with innovative solutions for climate adaptation with the availability of such datasets. Climate change today poses an existential threat to humans which needs collective action.

NITI Aayog's National Data and Analytics Platform (NDAP) is a step in the right direction in terms of making data accessible. The platform proposed by NITI Aayog, the Government of India's think-tank, should help solve that problem. The NDAP aims to improve access and use of published Government data. We believe an emphasis to release climate-related data through the platform will be a step in the right direction to achieving climate resilience.

About Climate Software Lab

Climate Software Lab is an initiative of GPS Renewables that leverages Information and Communication Technologies with the objective of addressing challenges posed by Climate Change. Using technologies such as Machine Learning, Geographic Information Systems and Data Visualization, the lab develops various climate solutions for potential climate NAPs (National Adaptation Plans). Currently, the lab is working in the area of disaster management and ESG data management.

About GPS Renewables

GPS is one of India's leading biofuels technology and project execution companies. The company has setup many landmark projects in the sector, including Asia's largest SSO based bioCNG plant in the city of Indore. GPS is supported by leading impact funds across the world, including the Neev Fund with whom the GPS team works closely on climate policies.

About Neev Fund

Neev is a climate and sustainability focussed fund, and managed by SBICap Ventures. The Fund currently has global and domestic investors including the EIB, FCDO (Govt of UK), JICA, SIDBI, SRI Fund (Govt of India) and the State Bank of India Group as sponsors. Neev is a shareholder in GPS Renewables since early 2022, via the Neev II Fund.

References

- Landslides, World Health Organisation
- 'Landslide kills 14 in eastern India, nearly 50 others feared dead' – Reuters, June 30, 2022.
- 'Uttarakhand: Landslide in Pauri triggered by heavy rain disrupts Kedarnath Yatra' – Hindustan Times, July 1, 2022.
- 'Jammu-Srinagar National Highway: Massive landslide hits NH44; JCB machine swept away into the river' – Times Now News, June 22, 2022.
- National Crime Records Bureau.
- Geological Survey of India.
- UN weather agency to spearhead 5 year early warning plan, boosting climate action.
- National Data and Analytics Platform.
- National Disaster Management Authority.
- Kerala State Disaster Management Authority.
- National Remote Sensing Centre.
- 'Impact of anthropogenic activities on landslide occurrences in southwest India: An investigation using spatial models,' by Sheelu Jones, AK Kasthurba, Anjana Bhagyanathan and BV Binoy, Indian Academy of Sciences.
- Cover photo by **Timo Volz**

Climate Software Lab

Powered by

GPS Renewables Pvt Ltd

++

For more information, write to

csl@gpsrenewables.com