

IIT Delhi team makes first hi-res landslide risk map for India

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The map data is available for free; the researchers have also created an online portal for people to explore the map

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A view of a landslide in Krishna Nagar ward, in Shimla, on August 19, 2023, after heavy rains. | Photo Credit: PTI

In late 2023, torrential rain during the northeast monsoon triggered heavy floods and landslides in multiple States in North India, killing hundreds of people. Given the number of fatalities due to landslides in India, a national landslide susceptibility map can help identify the most dangerous areas and help allocate resources for mitigation strategies better.

Unfortunately, India didn't have a landslide susceptibility map at the scale of the whole country then – so Manabendra Saharia, an assistant professor in the civil engineering department and head of the HydroSense Lab at IIT Delhi, wanted to make one.

Data with 'latest techniques'

Landslides are a unique and deadly problem in India. Unlike floods, they're less widespread and harder to track and study with satellites. Landslides happen in very localised areas and affect only about 1-2% of the country. As a result, there is much less data of sufficient quality for typical machine-learning models to work with.

"We wanted to build a national landslide susceptibility map that not only uses the data but also uses the latest techniques," Dr. Saharia said.

So his graduate student Nirdesh Sharma first collected the data of known landslides in the country. He obtained nearly 1.5 lakh such events via the Geological Survey of India (GSI) and other, including global, sources.

Then, the duo collected information on the factors that rendered an area susceptible to landslides. Some of them are soil cover (or the type of soil in the area), the number of trees covering the area, and how far it is from any roads or mountains. The fewer trees there are in a place, the closer it is to road-building activity, and the steeper the local slope, the more unstable the place will be and thus more prone to landslides.

The two researchers gathered information from across the country on 16 such factors, which they called landslide conditioning factors. They said GeoSadak, an online system that has data on the national road network in India, was particularly helpful because it displayed data on roads even outside cities.

"Most of the landslides don't happen in cities, they happen in far off areas where we can't see them," according to Dr. Saharia.

The researchers were particularly interested in landslide susceptibility in areas for which there was no data about known landslide events. Some of these places were just too uninhabitable or inaccessible, like the treacherous sides of mountains without roads.

An ensemble of models

Finally, they had two things in hand: 150,000 data points for known landslide events and 16 factors that, in their estimate, rendered an area susceptible to landslides. Mr. Sharma had been able to collect information about these factors for the whole country.

He and Dr. Saharia decided to use ensemble machine learning methods to analyse the data. Ensemble machine learning is when multiple machine learning models are used together to average out an oversize impact from any one model.

Once the models were ready, the researchers used them to make projections for all the areas for which there wasn't any landslide data. That is, even if a landslide hadn't (yet) occurred at a particular place, the ensemble could estimate its susceptibility to one based

on the 16 factors and patterns in the data.

‘An excellent contribution’

After all the analyses, and with the help of GSI’s extensive collection of landslide data, they developed a high-resolution landslide susceptibility map. Here, they could plot the susceptibility at a resolution of 100 m. That is, they estimated the susceptibility for each 100 sq. m parcel across the whole country.

This map, which they called the ‘Indian Landslide Susceptibility Map’, is the first of its kind by virtue of being on a national scale, leaving out no locations in the country. The map and the researchers’ study will be published in the journal *Catena* in its February 2024 issue. The authors will include G.V. Ramana, also of the civil engineering department in IIT Delhi.

“The *Catena* paper is an excellent contribution,” Madhavan Rajeevan Nair, former Secretary of the Ministry of Earth Sciences, said in an email. “For the first time, the authors have mapped the entire country for landslide probabilities, that too at high resolution. The map will help the policymakers to assess vulnerability and take appropriate measures for mitigation.”

Early warning system

The map acknowledged some well-known regions of high landslide susceptibility, like parts of the foothills of the Himalaya, the Assam-Meghalaya region, and the Western Ghats. It also revealed some previously unknown places with high risk, such as some areas of the Eastern Ghats, just north of Andhra Pradesh and Odisha.

News reports have described landslides in this area in the past, but the GSI hasn’t had data from there.

The researchers said they want to build on data from the map and develop a ‘Landslide Early Warning System’ for India. The map is also expected to be useful for organisations involved in investigating and mitigating landslides, like the GSI, the Ministry of Mines, and the National Disaster Management Authority.

Map available online

Dr. Saharia and his group are also in the process of building an infrastructure vulnerability map – a cartogram that will depict the stretches of roads, railways, and buildings that are particularly vulnerable to landslides.

He is also keen that people use the data from the paper, which is being made available for free via a web-based interface. This way, he said, people will be able to look through the map themselves and explore regions of interest to them. When a user clicks anywhere on

the map, in any district or state, the interface will display how much of that place is susceptible to landslides.

“The map is publicly available and accessible; one doesn’t need technical knowledge to interact with the data,” Dr. Saharia said.

Rohini Subrahmanyam is a freelance journalist.

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