

Himalayan communities are under siege from landslides - and climate change is worsening the crisis

Thursday 26 October 2023, by [KUMAR Ashutosh](#), [ROBSON Ellen Beatrice](#), [SANA Eedy](#) (Date first published: 24 October 2023).

Haphazard construction has made the region more vulnerable to increasingly intense rainfall.

Three-quarters of annual rain in the Himalayas arrives in [the monsoon season](#) from June to September. Within this rainy period are sudden and extremely intense cloudbursts, which often “pop” over a relatively small area (akin to a cloud bursting open like a balloon).

As climate change is making these cloudbursts and other forms of heavy rainfall [more intense and more frequent](#) in the Himalayan foothills, the hilly slopes are becoming saturated more frequently, and thus unstable. Rainfall-triggered landslides are already happening extensively across the Himalayas, and things are likely to get worse.

From July to August 2023, the Indian Himalayas, particularly the state of Himachal Pradesh in the northern part of the country, experienced an unprecedented number of cloudbursts which triggered thousands of [devastating landslides](#). The state’s disaster management authority reported that by the end of August, heavy rain and rainfall-triggered landslides had caused [509 fatalities](#), destroyed at least 2,200 homes and [damaged a further 10,000](#). It is estimated that Himachal Pradesh’s losses from this period amount to US\$1.2 billion. Much of the destruction took place during two short periods, one in [mid-July](#) and one in [mid-August](#).



A section of national highway (NH-03) is swept away by flash floods from cloudbursts in the Kullu district of Himachal Pradesh, July 2023. Ashutosh Kumar

The level of damage to buildings, roads and bridges is extremely difficult to comprehend. Several sections of national and state roads have been washed away, a temple in Shimla collapsed and [killed 20 people](#), rural dwellings largely constructed on sloped ground were washed away by rain, and houses are still sliding downhill.

Schools and hospitals have been damaged, posing an ongoing threat to lives. A school in Kullu district was closed for 52 days because the bridge which connected it to a town had been washed away. Local people have had no option but to live in tents with minimal facilities. They are hugely concerned about their safety ahead of a cold and snowy winter.

Four days of heavy rainfall in July 2023 triggered landslides that [blocked around 1,300 roads](#) including five national highways, leaving the state almost cut off from the rest of India. This had huge knock-on effects as [1,255 bus routes were suspended, 576 buses were stranded](#), more than [70,000 tourists had to be evacuated](#), and people could not access key facilities and services. This impeded emergency responders, causing critical delays in search and rescue operations as well as delivery of aid.

Across the whole of India, the summer monsoon and its related cloudbursts are [decreasing](#). But in the Himalayan foothills, they are [increasing significantly](#) - partly because when warm moist air encounters the Himalayan barrier it rapidly lifts and cools, forming large clouds that then dump their rain. With intense rain happening more and more often in the Himalayan foothills, it is likely that 2023's summer of disasters will occur again.

Unnecessarily vulnerable

Although climate change may be to blame for the rise in cloudbursts, in an ideal world rainfall alone needn't lead to disastrous landslides. But the Himalayas have been made [more vulnerable](#) by human actions.

The region has largely been [deforested](#), removing tree roots which reinforce the ground and form a crucial barrier that stops soils washing away. And unplanned developments and haphazard construction have destabilised already fragile slopes.

Initial reports on this year's landslides suggest the worst damages occurred along artificially cut slopes (for roads or buildings), where there has been a lack of proper provisioning for drainage and slope safety. In both India and Nepal, many of the hill roads have been [haphazardly constructed](#), which makes landslides during rainfall [more likely](#). Construction guidelines and building codes are [outdated](#) and have been ignored anyway, and there is little assessment of the link between urbanisation and landslide risk.

One obvious solution is to prevent rain from penetrating the ground, so the slopes avoid losing any strength. However, if the soil is entirely prevented from absorbing any rain, the water will instead run off the surface and cause greater flooding problems further downhill.

One engineering solution is to place an artificial soil layer above the natural soil to temporarily hold water in the surface when it is raining extremely hard, preventing it penetrating deeper within the slope. This "[climate adaptive barrier layer](#)" will then release water back to the atmosphere during a later drying period.

As the heavy rain intensifies, it will be hugely important for the Himalayas to implement new user-friendly and reliable construction guidelines that factor in how the climate is changing. Landslides can't be avoided entirely, and India certainly won't be able to reverse global warming and the increase in cloudbursts any time soon. But these preventive actions should at least make communities more resilient to the changing climate.

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Ashutosh Kumar. Assistant Professor, School of Civil & Environmental Engineering, Indian Institute of Technology Mandi. I am currently working as an Assistant Professor of Geotechnical Engineering in the School of Civil and Environmental Engineering at the Indian Institute of Technology Mandi (IIT Mandi), India. I have worked as a postdoctoral research associate at Durham University UK and I obtained PhD degree from IIT Bombay and am the recipient of the IIT Bombay Best PhD thesis award. I am the recipient of the Royal Society London, United Kingdom International Exchanges Award and IACMAG John Carter Award - 2022 from the International Association for Computer Methods and Advances in Geomechanics (IACMAG), AZ, USA. I am a DAAD fellowship awardee from Germany and also served as a 2016 DAAD Young Ambassador for DAAD India. I have experience working in multi-national teams through the Transport Africa project and Seismic safety of Kathmandu's historic urban infrastructure investigating the causes of the collapse of UNESCO World Heritage sites in Nepal. I have published over 40 papers in various Journals of International repute and various conferences. My research encompasses highly relevant areas of civil engineering:(1) Soil-structure interaction (2) Unsaturated soil mechanics for pavements and landslides (3) Geotechnical Earthquake Engineering (4) Use of sensing techniques for geotechnical engineering applications.

Eedy Sana. I am a doctoral student at the School of Civil and Environmental Engineering, Indian Institute of Technology Mandi. I hold a masters degree in Geotechnical Engineering, which I completed with distinction from the National Institute of Technology Silchar in 2022. My PhD research is focused on the problems encompassing construction of roads in hilly areas particularly in Himachal Pradesh and the analysis of landslides resulting from combined effect of rainfall and non-engineered road cuts. My interest lies in understanding the complex interplay between the environment and civil engineering in the context of hilly terrains. Through my research, I aim to contribute to the sustainable development of infrastructure in these challenging areas.

Ellen Beatrice Robson. Postdoctoral research associate, Durham University. I am a Postdoctoral Research Associate at the Institute of Hazard, Risk and Resilience at Durham University. My research centres around developing stakeholder-focused guidance and methodologies to help mitigate landslides and improve slope stabilisation in lower income countries. The methodologies and guidance are developed by working collaboratively with stakeholders (currently in Nepal and India), using a combination of methods including numerical analyses, geotechnical and geological mapping, and qualitative data collection. I acquired my PhD in Geotechnical Engineering from Newcastle University in 2023, which was sponsored by NERC IAPETUS. My PhD aimed to further understand some of the causes for inadequate road slope stabilisation in lower income country settings, and to develop stakeholder-focused methodologies to aid the planning and design of road slope stabilisation.



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