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GUEST EDITORIAL

Challenges of the Devastating Indian Landslides

It is all in the books that landslides are among the major hydro-geological hazards that affect large parts of India, especially the Himalayas, the northeastern hill ranges, the Western Ghats, the Nilgiris, the Eastern Ghats and the Vindhyas, in that order. In the Himalayas one could find landslides of every name, fame and description. India's northeastern region, the Darjeeling district of West Bengal, Sikkim, Tripura, Meghalaya, Assam, Nagaland and Arunachal Pradesh are all landslide-prone. In Uttarakhand also, it would therefore be inappropriate to see the Kedarnath tragedy of 16–17 June 2013, as merely an isolated event frozen in time and space.

Whenever landslide disasters strike, we rush to lean on fixed ideas in our minds. From the school days we are tutored that events like landslides and earthquakes are only to be regarded as nature's safety valves because we live on the surface of an unfinished planet. The fragile ecology, immature geology, meandering rivers, snow bodies, climatic variations and cloudbursts of the Himalayas are after all our inheritance without choice. For centuries, landslides have come and gone, and these can be explained by recounting a long list of causative factors. If and when our justification is not good enough, there is climate change to buttress our argumentation. But, by ignoring human violence against nature, we only speak the *half truth*. Let us always remember that 'a scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it' [Max Planck].

Those who make off-the-cuff conclusions must know that the science of landslides has no contract with their way of thinking. It demands honest and comprehensive scientific studies. We can understand landslides only by elucidation of landslide boundary-shears, concurrent monitoring of time-dependent piezometric pressures, surface and subslope displacements and mapping of ground deformations and shear zones, plus behavioural studies of associated human settlements form an integral part of the landslide investigation. Sadly, success will continue to elude us so long as scientific landslide investigation does not precede landslide remediation. We have not been able to fix the landslides not because of lack of expertise or technology, but because we never had the will or direction to do so.

It has almost become ritualistic to name cloudburst to explain away cataclysmic floods and devastating landslide events, without even attempting to understand the slope dynamics in the ecological theatre of nature. We did so to explain the great Alaknanda tragedy of 20–21 July 1970 in Uttarakhand on the premise that the previous maxima of 200 mm rainfall recorded at Joshimath on 28 September 1924 was crossed by a new high of 212.8 mm. Further probe removed a layer to show that the tragedy was caused by the bursting of a landslide dam. The formation of the landslide dam on Alaknanda was then traced to the enormous sediment load brought by Patalganga. And this huge sediment load was in turn traced to numerous landslides in the Patalganga valley. Further, it became evident that these landslides themselves were the result of neglect, misuse and abuse of our lands for decades on end. But for the ecological neglect, the Alaknanda floods would not have hit the headlines.

We are yet again stumped by the ghastly Kedarnath tragedy and cajoled by the very same reason – cloudburst, which is in fact no more than the most visible trigger at the tipping point. Could we have anticipated the trouble? The answer is no, because we had neither fail-safe instrumentation nor real-time vigil on our glaciers, glacial lakes, moraine accumulations, dormant and active landslides, rivers and their tributaries and unsafe housing stock. We plead for zero tolerance against mindless urbanization, but suffer it instead. We have mapped landslide hazards on the pilgrim routes many times over, but never placed a single user-friendly validated map in the hands of disaster managers. We should do it now.

We should not continue to ignore the gross disconnect between our scientific discourse and our approach to hazard-mapping. In scientific discourse, we dread factors such as climate change, exceptional rain, receding of glaciers, bursting of glacial lakes, poor road alignments, non-engineered constructions, earthquake-induced landslides, and overtopping of dams. However, in the case of hazard-mapping, we disregard all these factors and only account for lithology, structure, slope morphometry, relative relief, land use/land cover and hydro-geological condition[1]. India needs large-scale, validated and user-friendly hazard maps based on a scientific understanding of the multitude of factors, both natural and human-induced.

The main reason why the natural landslide hazards are turning into man-made disasters is because people have not only moved in large numbers to the remotest of the mountain slopes where no one ever lived before, but the violence they have unleashed against nature is unprecedented. There is a Chinese saying that 'a man who removes a mountain begins by carrying away small stones'. We have been removing, not small stones, but mountains of rocks for building townships, roads, dams and reservoirs. Many of the landslides we know are the result of these very actions, and they in turn remove from slopes incredibly large amount of sediments[2], loading rivers, silting reservoirs and creating new land masses in the sea. Little do we realize that when a slope gets robbed of one inch of its soil cover, Nature may take nearly 1000 years to replenish it! It is time therefore to revive the Chipko Movement and reverse the trend of slope degradation.

One vexing question which often haunts us is whether a landslide can be predicted and a landslide disaster averted? In Uttarakhand, some of the landslides occur annually. We do not need any rocket science to predict them; simple slope instrumentation and monitoring would do. Similarly, mountain slopes supporting human habitat with visible signs of instability like tilting of trees, bulging of retaining walls and widespread ground subsidence are already on the verge of failure. What more early warning do we need to predict a landslide in such situations? It is a scientifically proven fact that even the first-time landslides are predictable provided we probe deep enough to arrive at the bottom of the truth, through studies, instrumentation and monitoring. Like human beings, a slope also has a heart that beats! Let us recall Terzaghi, who more than six decades ago said that 'If a landslide comes as a surprise to eye witnesses, it would be more accurate to say that the observers failed to detect the phenomena which preceded the slide.'

Today, we have the knowledge, tools and experience we need to predict and avert most, if not all, landslides. By tapping the phenomenal power of geotechnology, instrumentation, remote sensing, integrated GPS and information communication systems, we can monitor unstable areas in real time even during unfavourable weather conditions. It is time therefore to launch selected mission-mode projects to initially cover timely prediction of (a) possible reactivation of major old, dormant and seasonal landslides, (b) landslides and floods due to bursting of glacial lakes, (c) flash floods due to bursting of landslide dams, (d) first-time landslides in urban and strategically important areas falling in the zone of exceptional landslide hazard and (e) rockfalls. But, why is this not happening?

The criteria for early warning against landslides we use must be credible. The direct connection between 'incidence' of a landslide and 'rainfall' may look both obvious and simple, and may even work in cases where ground conditions are already bad enough and rainfall exceptional. There is a strong case to position monitoring stations to advance on-line rainfall forecasting procedures using digital radar data and an on-line run-off forecasting procedure based on space techniques to enhance lead time. The early warning criteria we aim should be rooted in holistic and concurrent interpretation of real-time rainfall records, seismic records, spatial piezometric variations, slope surface and subsurface movements and movement rates on discrete boundary shears, runout effects and other collateral threats in the catchment and on the higher slopes. We should refrain from over-simplifying the criteria for early warning to minimize bogus forecasts and it must be continuously put to test. We must prepare ourselves to effectively utilize every second of the available lead time.

We have all agreed time and again that landslide disaster management should be integrated with development planning. The vast potential for hydro-power in Uttarakhand is in a sense a big blessing, but the way it is being exploited is a curse as hydro-power schemes are no longer environment-friendly and power generation is no longer based on natural flows and sound engineering. Unless safety issues appear continuously on RADAR, mega projects like the Tehri dam will always keep us on tenterhooks.

Dozens of landslides in India, like the one at Kaliasaur on the Srinagar–Rudraprayag highway, are quite old. We should fix them once for all. A township on a landslide-infested mountain slope can be best tackled by looking at the stability of the mountain as a whole rather than flittering away the resources in fixing landslides affecting individual buildings.

We need breed the culture of truth-seeking rather than data-seeking nature of landslide investigations. Our reports and papers by hindsight reflect more of perceptions inspired by loyalty to the accepted trends than science. In many cases, truth eludes us because vital field evidences get erased even before landslide investigations begin.

1. Geological Survey of India report.
2. It annually approaches 16.5 ha m/100 km^2 of the catchment area.

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