National strategy for landslide risk management

The journey between the previous guest editorial (Bhandari, R. K., *Curr. Sci.*, 2013, **105**(5), 563–564) on Challenges of devastating the Indian landslides and the present one, has been both exhilarating and somewhat disappointing. Exhilarating because, during the period that has gone by, several landmark initiatives have been taken towards achieving landslide risk resilience. These include delivery of a comprehensive set of Actionable Recommendations by the Indian National Academy of Engineering (Proceedings of the round table meetings on landslide disasters, INAE 2015); launching of the National Disaster Management Plan (NDMP 2016); the Prime Minister's Agenda 10 (Gupta, A. K., NIDM) and the National Landslide Risk Management Strategy (NLRMS-2019). The proposed strategy aims to cover landslide hazard mapping, landslide monitoring and early warning, mountain zone regulations, stabilization and mitigation of landslides, capacity building, training and creation of special purpose vehicles for landslide management. A Centre for Landslides Studies, in fulfilment of the long felt need, is being established; a Landslide Risk Mitigation Project has been launched; the landslide susceptibility mapping programmes have advanced and, in addition, several projects aiming at landslide risk resilience are being pursued.

The disappointment, however, largely comes from the absence of down to earth connection between the proposed strategy and the complex real-life challenges. The anchoring of the strategy with the National Guidelines on Landslides (2009) and the National Plan should have been much stronger. We can deliver results on the ground, only by expeditiously and effectively implementing the decisions; retaining focus on the important while attending to the urgent; and carrying out long pending projects of critical importance. Some of priority tasks are: user-friendly and field validated large scale landslide hazard mapping, risk assessment, rewriting of the Standard Operating Procedures for credible geotechnical investigation, updating of Codes of Practice and ensuring intimate organic linkages between results of evidence based investigations and environment friendly landslide remedial measures. We must always retain the sense of direction because 'If a man does not know to what port he is steering; no wind is favourable to him.' (Seneca)

Our top priority ought to be to dive deep into the strategy document-2019, to guide the integration of landslide disaster mitigation with development planning, especially for all flagship projects and achieve a paradigm shift from the ad-hoc approaches in slope stabilization to a holistic treatment for sustainability. The lasting relief will come when we frontally confront the challenges of disorderly urbanization, non-engineered constructions and human violence against Nature, rather than blame Nature for everything that goes wrong. For preventing losses due to landslides, we have to learn to anticipate the problems, well before they strike and eliminate the causes of landslides, rather than just seek protection from them. 'Difficulty lies not in the new ideas, but in escaping the old ones' (John Maynard Keynes) and 'we cannot solve the problems we have created with the same thinking that created them' (Einstein).

INAE (2015) recommendations are all inclusive and comprehensive and the answers lie in their conscientious implementation. The proposed strategy needs to be further strengthened particularly in the following areas.

Landslide hazard, vulnerability and risk assessment. Credibility of landslide hazards, vulnerabilities and risks being critical to planning, design and construction of landslide resilient infrastructure, we should critically peer review all the landslide susceptibility and hazard maps prepared to-date and ensure that they move out of the Atlases to guide our policy makers, planners, architects, engineers, builders and disaster managers. It is time we produce for public education, scrutiny and use, the first set of user-friendly, field validated and peer-reviewed large-scale landslide hazard maps and remove the glaring disconnect between the small-scale landslide susceptibility maps we produce and the large scale credible landslide hazard maps we need (INAE 2015).

National Guidelines on Earthquakes 2007, had pointed out that all currently available landslide hazard maps 'are small scale maps unsuitable for hazard and risk analyses at district and local levels'. The National Guidelines on Landslides and the INAE document expressed the same concern in 2009 and 2015. In 2019, the strategy document too conceded that, Landslide Susceptibility Maps created by different organizations are not user friendly, as they follow different methodologies and the approach to account for anthropogenic interventions is casual. The small-scale maps in atlases too need updating and validation. At present state of the art, it should be possible to notify without any further delay the nationally

standardized versions of landslide terminology, landslide classification system, large-scale landslide hazard mapping methodology, Standard Operating Procedure for geotechnical investigations of landslides and guidelines for production of user-friendly large scale multi-hazard zonation maps.

Advocacy for fixing of major Landslides. Another long pending task of high priority, is that of permanently fixing all major chronic landslide hotspots at strategic locations, at the cutting edge of science and technology. All such initiatives should connect with the programmes of environmental rejuvenation delivering 'Best Practice' examples to demonstrate the wisdom of a stitch in time, to be nationally recognized, rewarded and publicized.

The message that prevention pays is aptly purveyed by the example of Sonapur landslide on National Highway 44, serving about 16 million people in the states of Meghalaya, Mizoram, Tripura, Assam and Manipur. The Sonapur landslide in 1988, generated 15 m high pile of debris. Because it was not stabilized at that time, quantity of landslide debris changed to about 160,000 cubic metres in the year 2000; 15,960 cubic metres in 2002 and about 87,250 cubic metres in 2004. Because of the road blockades of over 60 days annually, the count of stranded vehicles at a time ranged between 12,000 and 15,000. The losses amounted to approximately Rs 40 crore during 1987–2007. The Sonapur landslide was eventually fixed in 2008 at a cost of Rs 12 crore by using cut and cover structure, just in 9 months time. Had the slide not been fixed, the cost of maintenance for the period 2008–2015 alone may well have exceeded 30 times the cost of control measures. Such good examples should motivate us to begin fixing major landslide problems as a part of the strategy.

Tapping the power of smart technologies. The way we investigate, map, instrument, study, analyse, prevent, control and manage landslides have undergone a transformational change, because of the digital revolution and the mind-boggling spurt of smart and innovative technologies. Minimizing the risks due to landslide hazards in multi-hazard ambience, and maximizing the chances of saving lives, property and environment, are now in the realm of possibilities in the ways unimaginable. On the flip side, smart technologies may not always bring cheer without worries. The real challenge lies in making judicious choice of technologies out of a basketful of possibilities, especially in the control of landslides. Remote sensing, artificial intelligence, robotics and ICT have found powerful applications in the way we observe, analyse, process, communicate, classify and document observations.

Earth Observation Satellites provide comprehensive coverage of large areas in real time giving a big boost to landslide investigation, high resolution multi-hazard mapping and monitoring. Landsat-TM and SPOT images have been used to detect active faults. Remote controlled and programmed drones are being used for surveillance, pre- and post-disaster investigations, surveys of hazard-ous areas, and for reaching the inaccessible areas to locate survivors, drop relief materials, video-filming, damage assessment and monitoring of the progress of relief works. Drone photography of the Malin Gaon landslide of 2014 by INAE is a live example that explains its un-drained loading-induced mechanism. It is time we tap the full potential of smart and innovative technologies with a strategy to counter the associated threats.

Bolstering international cooperation. By hosting International Symposium on Landslides (ISL) 1980 in New Delhi, India became the first country in the world to name, convene and put the series of ISL's on a four-yearly track. Having lost the opportunity for hosting ISL 2024 to France in a bitterly fought contest, India should next bid for ISL 2028 to showcase Indian contributions.

It is time, India too forges global partnerships to promote science-based landslide risk resilience, under the umbrella of the Coalition of Disaster Resilient Infrastructure (CDRI), launched by the Prime Minister in 2019.

National landslide disaster knowledge network. The idea of National landslide disaster knowledge network was first mooted by the author, and accepted by the High-Powered Committee of the Government of India in 2001. Two decades down the line, the need for a vibrant and user-friendly disaster knowledge network persists so as to gather, filter, authenticate, enrich and effectively manage the information flowing in from all directions and package the same for easy retrieval and effective use. Institutionalization of the knowledge network will connect national and state governments, local authorities, affected communities, voluntary organizations, policy makers, bureaucrats, professionals and the people at the grassroots level. Let productive lessons from landslides not get lost in the haystack of information.

Tracking the progress. It is time we create accountability framework at all levels and judge the performance of the individuals, institutions and agencies not merely by activities done but by the measure of outcome and impact of all our Actions and Inactions.

Some of the credible landslide disaster risk resilience indicators for judging the progress are: number of landslide disasters prevented, landslides fixed, lives saved, best practices showcased, trainers trained, sound engineering practices in investigation and early warning introduced, and environment friendly technologies promoted and absorbed. It is also important to introspect on the outcomes of the completed flagship projects and lessons learnt from past experiences and thereafter plough back the very lessons in forward planning, capacity building and proof-testing of the institutional mechanisms.

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