Dark clouds of disaster over Uttarakhand and the silver lining

It was the monsoon season of 2016 and, as expected, Uttarakhand was once again in the news for a spate of killer landslides and floods. For the people of Pithoragarh and Chamoli – some of whom are yet to recover from the pain of the earlier disasters – the events of Friday, 30 June 2016 were only familiar messengers of death, destruction and mourning. If the trend of the last couple of decades is any indicator, every monsoon season is certain to cause floods and landslides, load rivers, bury people alive, block roads and highways, and bring life in the state to a grinding halt.

The damages caused by the recent landslides and floods, including those on the Methane–Chamoli and Chamoli–Gopeshwar highways are significant, but nothing in comparison with the events of 16 and 17 June 2013, when the township and Kedarnath temple were hit by a massive debris avalanche, which killed about 4000 people, affecting nearly 3 million of the local population and more than 100,000 pilgrims and tourists. Additionally, about 8000 km of motorable road, 200 bridges and 30 hydro-power projects were damaged and more than 5000 hill villages and 30 urban clusters were in distress.

It is now obvious that we did not learn from the devastating events of 2010, 2011 and 2012. On 19 August 2010, 18 children were killed and more were 30 trapped in the rubble when a school building collapsed in the Bageshwar district. A month later, the Garhwal and the Kumaon regions were struck by floods and landslides killing 37 people and trapping thousands of tourists and pilgrims on the Char Dham Yatra routes. Barely two months later, NH-58 between Srinagar and Rudraprayag had to be closed for more than a month because the notorious Kaliasaur landslide struck yet again, killing three people.

In 2011 also, landslides killed 15 people disrupting traffic at several locations on the Rishikesh–Badrinath National Highway. During 13 and 14 September 2012, Okhimath area in the Mandakini valley, 37 km away from Rudraprayag, was hit by a spate of landslides, and so were Kirora Malla and Timli villages of Jakholi tehsil on 16 September 2012.

Despite the loss of 69 lives and widespread damage in the villages of Jua, Kimara, Bamankholi, Premnagar, Dangwari, Mongolia, Chunni, Salami and Gurgaon, nothing much was done to eliminate vulnerabilities, develop capacity and empower people to look after their own safety. Why has a powerful country like India, which recently launched 20 satellites simultaneously in just about 26 min, failed to prevent disasters for years? This is because, unlike the well-defined mandate of Indian Space Research Organisation, there are neither time-bound mission-mode programmes nor accountability for disaster mitigation.

According to Soren Kierkegaard, the Danish philosopher: 'There are only two ways to be fooled. One is to believe what isn't true; the other is to refuse to believe what is true.' It is high time to admit that the disasters we face are more man-made than natural. Every time, ritualistically blaming cloud burst alone for flood and landslide disasters can never be justified. A cloud burst is no more than a triggering factor – the last straw that breaks the camel's back. Extreme weather events such as cloud bursts do provoke floods and landslides, but the real blame must go to our failure to stop plundering the environment, unplanned urbanization, non-engineered constructions, and indiscriminate and often illegal mining of natural resources. The 2016 floods in River Mandakini have also been influenced by shifting of its course at Sonprayag, Sitapur, Banswada, Chandrapuri, Vijay Nagar, Gonda and Pondar by several metres, breaching of its banks and by widespread landslides.

The challenge for Uttarakhand to bounce back from the landscape of devastation to the culture of safety is no doubt daunting. There is no silver bullet in our armory for an instant remedy. In fact, the dark clouds of disaster have so far prevented us from seeing the silver lining of peoples' power and modern technology in which lie the apt answers to our otherwise intractable problems.

First and foremost, there is an urgent need to appreciate that disasters which strike different parts of Uttarakhand are not individual events insulated from the fragile eco-system of the Himalaya. The palliatives and piecemeal solutions will therefore be of limited value and may even be wasteful. The switch-over to a holistic approach requires multi-disciplinary initiative with multi-institutional coordination. It will be essential to collect, collate and analyse big data from a multitude of sources so as to see the patterns and trends hitherto invisible, manage situations otherwise chaotic and replace subjectivity with objectivity in decision-making. Lasting relief can come only by concurrent nursing of the cultures of strategic thinking, prevention, preparedness and quick response as four main pillars of safety for sustainable development. The state must resolve to demonstrate by example, the paradigm shift from the relief-centric approach and integrate disaster management with development planning.

For preventing disasters, Uttarakhand must develop tools and capacities of anticipating disasters first. India's supremacy in satellite technology can put Uttarakhand ahead in providing its people a set of high-resolution, user-friendly and reliable multi-hazard maps and make them fully aware of the dangers they face. None of the hazard maps and atlases prepared so far has reached and benefited the end-user. The task can be achieved in a time-frame of no more than 2 years on the strength of high-resolution satellite maps, ground surveys and the available knowledge base.

The greatest regret is that frequent disasters leave hardly any time for preparedness, prevention and mitigation, driving us to prescribe remedies even without pathological studies. The truth will continue to elude us so long as we do not make a thorough study of every major disaster (by a multi-disciplinary team of well-known experts) mandatory and implement all vital recommendations in a time-bound manner. The recent floods and landslides of the Alaknanda valley can neither be scientifically understood, nor effectively managed without understanding the fragile ecology of the tectonically active, geologically vulnerable, physically abused and technologically neglected mountain–river systems. Let us hope it will happen this time because no further proof is required to establish that relief-centric approach and the practice of palliative remediation has not worked.

The ongoing war against disasters in Uttarakhand can be won by combining peoples' power with the power of

technology. The technological breakthrough in weather forecasting, timely early warning, high resolution hazard and vulnerability mapping and management of big data for swift decision-making bring new hope. Some of the exciting possibilities are introduced below.

As meteorological forecasts are becoming more accurate, soon enough it should be possible to even modify the weather for dealing with disasters such as drought and forest fires. In February 2016, Uttarakhand suffered from forest fire for over 88 days, destroying 3000–8000 acres of land. Rather than waiting for rainfall to extinguish the fire, Uttarakhand should have taken recourse to cloud-seeding technology to convert clouds into giant sprinklers. In 2008, Los Angeles County officials used silver iodide to seed clouds over the San Gabriel Mountains to ward-off fires. The same year, China employed cloud-seeding technology to bring some rain and clear the air before the Beijing Summer Olympics.

Unmanned Aerial Vehicles (UAVs) including drones are also finding applications in disaster management, and Uttarakhand can immensely benefit from their effective use, especially for real-time mapping, video-filming, damage assessment and monitoring of the progress of remedial works.

Thanks to the National Remote Sensing Centre, every disaster victim from Uttarakhand can now be empowered to report his/her location, situation and send photographs to a Command Centre. The data can then be collated, analysed, classified and posted on big screens for everyone to see in real time and respond. Empowered and trained people will be able to generate instant maps and effectively communicate as never before. This would be one of the most cost-effective ways for the Government to locate and rescue stranded tourists and pilgrims.

It is time Uttarakhand promotes a two-way communication between victims and the Command Centre to ensure prompt access to the nearest safe heavens, hospitals and public utilities. The Indian Railway Management Applications make it possible to report first-hand information, videos and photographs which helps disaster-scenario-building in GIS environment. The volume, veracity, velocity and variety of big data can be managed in the times of peace for easy retrieval in the times of crisis. Next time when floods destroy bridges and landslides destroy roads in different parts of Uttarakhand, it should be possible to instantly recall all the related information for improved decision-making. Technology now enables us to fix landslides permanently.

There are numerous other examples to illustrate that simple ideas have cracked difficult problems. British paramedic Bob Brotchie showed that it is possible to identify and report causalities in the aftermath of a disaster. As far back as 2005, Brotchie had asked every smartphone user to store telephone numbers of those whom they would like to be contacted in the case of emergency. The new generation of smart phones is able to retrieve information even from locked cell phones.

Effective switch-over to intelligent transportation systems, telecommunication networks, vehicular ad hoc networks, and mobile and cloud computing technologies too will make a world of difference in disaster prevention and response, provided effective networking, multi-institutional coordination and cyber security could be ensured. By introducing community-based traffic applications, the drivers can now share real-time data on traffic flow, road accidents, disaster-related information and suggested rerouting and locate the nearest safe parking. Also, by field instrumentation and monitoring it is possible to ensure the safety of evacuation areas, police, and fire stations and hospitals.

Given the political will, clear mandate, functional institutional mechanisms, adequate resources and holistic, multi-disciplinary approach with the long-range strategy in view, Uttarakhand has the potential to bounce back to the culture of safety within the next decade.

Received 4 July 2016; accepted 12 August 2016

R. K. BHANDARI

Forum on Engineering Interventions for Disaster Mitigation,
Indian National Academy of Engineering,
Gurgaon 122 018, India
e-mail: rajmee@yahoo.com

Unique pollen reception in *Tephrosia purpurea* (Linn.) Pers., a tropical weed of family Papilionaceae

Flowering plants display a spectrum of breeding systems ranging from obligate xenogamy practiced by dioecious and self-incompatible taxa, to strict autogamy in species with cleistogamous flowers[1,2]. Studies done on related species in different genera and families clearly depict selfing to be a derived condition[3]. The reason for this includes assurance of seed-set, particularly in conditions of pollen or pollinator limitations[4–7]. Several features are known to facilitate this transition from out-crossing to selfing, recent addition to which is the unique stigma and stylar movements.

Many legumes practice selfing which is mediated by the close proximity of sex organs and their nearly simultaneous maturation[8–11]. Here we report an interesting mechanism imposing selfing in a patchy legume weed, i.e. *Tephrosia purpurea* (Linn.) Pers. belonging to the Papilionaceae family. The plant forms isolated, small populations of 1–20 individuals in subtropical, dry and sandy wastelands of the Kandi belt, Jammu Province, Jammu & Kashmir (J&K), India (34.44°N, 74.54°E). Flowering and fruiting of this species span a period of 5–6 months (April to October) when temperature in the area ranges from 25°C to more than 45°C.

Though a weed, *T. purpurea* forms an important ingredient in several herbal medicines prescribed for diseases of the stomach, heart, liver, lungs, skin, blood, and even diabetes and cancer[12–16]. *T. purpurea* is a small, profusely branched, perennial herb attaining an average