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Hazardous Expansion and Underprivileged Disaster Management Ensuing Nature's Fury

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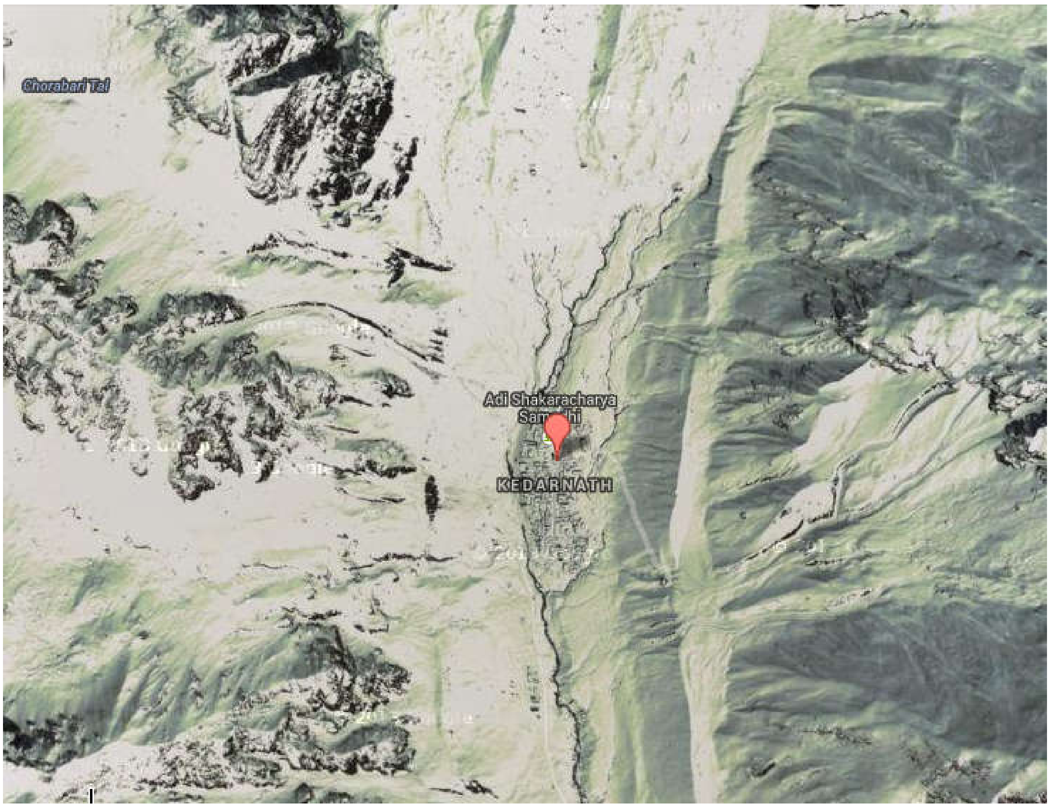
"The Himalayas are world's juvenile mountain range. They are prone to erosion and landslides. Seismic activity and rainstorms lash the region. Monotonous development on this ecologically fragile mountain is one of the prevalent reasons the flood have been devastating in UK (Uttrakhand**)**. Nature has spoken loudly this time and we can't afford not to listen to it any longer."

Recently, there has been a spurt in natural disasters and associated fatalities around the globe, in spite of the significant advancement in hazard prediction and scientific solutions. Though the impact of floods and earthquakes is more severe than landslides, frequent occurrence of landslides in hilly regions causes immense loss of lives and property. In fact, in the hilly regions of India, the cumulative loss of life and property caused by landslides is higher than other natural disasters. Some landslide disasters in the UK Himalayas, in the recent past, have been particularly devastating. Landslides in river valleys have also been accompanied by flash floods from breaching of temporary landslide dams. One of the most severe instances of this phenomenon is the recent flash flood along with debris flow at Kedarnath on 16 June 2013, which has claimed more than a thousand causalities. The exact cause of disaster is yet not ascertained. Researchers hypothesize that this disaster has been caused by excess rain in the catchment associated with landslide events in a higher valley, which became channelized as debris flow. Another hypothesized cause is the breaking of a part of glacial lake situated upstream of Kedarnath. Can a landslide hazard be prevented or minimized? All landslide hazards mayn't be completely prevented but the consequences can be minimized if such events can be predicted and efficient disaster mitigation management and preparedness are adopted. This is particularly important for developing countries, which experience higher population densities and lack of disaster preparedness.

UK is a multi hazard prone state, vulnerable to earthquakes, landslides, floods and soil erosion. Human-induced disasters resulting from unplanned development of land, forests, river basins and flood plains are also on rise in UK. Significant population growth, at the rate > 250% from 1901-1991, has also compounded the pressure of the ecosystem. The state has forests around 64% of its area. Major rivers like Ganges, Yamuna and Kali and their subsidiaries flow in UK, fed by various glaciers. The HKH (Hindu Kush Himalayan) region is one of the poorest regions of the world, inhabited by about 40% of the world's poor, with population density as enough as 180 persons/km^2. 29% of the people leaving near the Indian part of the Himalayas have income below the national poverty line with a annual population growth rate of 1.4% and infant mortality rate of 63/1000 live births. Thus, UK has to be prepared to cope with such disasters, especially when it's not possible to prevent them. The DMP (Disaster Management Plan) for each district has to be prepared involving all the stakeholders. Preparedness also involves the establishment to early warning systems with last mile connectivity. There is need to systematize the visits of tourists of these areas within available technology. There is also a need to establish a SDRF (State Disaster Response Force) for timely comeback to natural disaster. Policy makers need to mainstream the disaster risk reduction in their developmental plans. With climate change, extreme events such as this are expected to increase, which will necessitate community-based sustainable disaster management practices. Early return to livelihood should be the ultimate goal of all these measures.



High intensity rainfall events in the Himalayan region are often localized and have important implications for flash floods. These intense rainfall events, a.k.a. cloudbursts, occur in remote areas as a result of topographic variations. An example of this is the Leh cloudbursts that occurred in 2010. Cloudbursts sometimes even remain unreported due to inaccessibility of the regions where they occur. The frequency and intensity of flash floods, especially in the Himalayan region is increasing. Intense rainfall events occurring in the high reaches of a mountain stream in the unpolluted areas will produce a flash flood affecting the downstream communities, as occurred recently in UK in June 2013. These flash floods started on 15 June 2013 and affected around 8 districts of the state. The situation in UK deteriorated further due to landslides triggered by rainfall and floods. Meteorologists have suggested that though extreme weather events aren't uncommon in UK, a possible cause of the copious rainfall could be the fusion of westerlies, which triggered flooding in Central l Europe, with the south-west monsoon over north India. Countries in the HKH region, including India, lack policies and strategies for specially dealing with flash floods. Most of the existing policies relate to riverine floods or to disasters in general. In India, flood management is organized at the central level provides guidance to the states, which implement flood management at the field level. The NDMA (National Disaster Management Authority) has developed GMF (Guidelines on Management of Floods, 2008) and MUF (Management of Urban Flooding, 2010).

Changing Climate: Foremost Raison d'être of Extreme Rainfall

Change in climate is the utmost threat facing humankind; extreme weather events, drought and rise in diseases have been forecast for many parts of globe over the coming decades. The IPPC (Intergovernmental Panel on Climate Change), the scientific body that advises the UN and governments on global warning, has stated the changes in extreme events (floods & droughts) could affect the frequency of natural hazards such as avalanches and mudslides. As per IPCC, a major predicament related to climate change in hill regions is increased erosion and reduced slope stability. The combination of complex orography (physical geography of mountains and their ranges) with steep slopes, intense rainstorms, and in some regions, frequent earthquakes, causes a high amount of mass movement, which eventually finds its way into rivers as heavy sediment load. In the mountains, climate change and environmental degradation have started showing some profound impacts. Mountain regions from the Andes to the Himalayas are warming faster than the global average under climate change. Changing climate is a threat multiplier for instability to fragile Himalayan regions as well, leading most glaciers in the mountain regions such as Himalayas to recede during the last century and influence stream run-off of Himalayan Rivers. Himalayan glaciers have been in a general state of recession since a long time. As per the report “Snow and Glaciers of the Himalayas: Inventory & Monitoring” released by MoEF (Ministry of Environment & Forests) in 2011, out of 2700 glaciers which are monitored, 2184 are retreating. 4 are retreating. 435 are advancing and 148 glaciers show no change. Existing studies of Himalayan glaciers indicate that many exhibited an increased receding trend over the past few years. Regular monitoring of Himalayan glaciers is important for improving our knowledge of glacier response to climate change. The widespread glacier retreat in the Himalayas has resulted in the formation of many glacial lakes. Glacier retreat and shrinking could form dangerous moraine whose breaching may generate floods.

Vehemence of the Floods

Every year floods play havoc in our country. The magnitude of the flood depends upon the intensity of the rainfall, its duration and also the catchment conditions. Out of the average annual rainfall of India, about 75% of its received during the 4 months of the south-west monsoon season (June to September)… and about 80 hrs out of these 4 months account for most of the rains. The flood problem faced by India is unique in several respects due to varied climate and rainfall patterns in different parts of the country. Also, soil erosion and silting lead to reduction in the carrying capacity of river channels, thus accentuate the flooding. Flash flood is a sudden, localized flood of great magnitude and short duration, typically caused by unusually heavy rain. Most flash floods are local vents relatively independent of each other and scattered in time and space. Although flash floods usually occur over a relatively small area and last only a few hours (sometimes minutes), they have an incredible potential for destruction. Flash floods carry a higher amount of debris than normal floods, and a result cause huge damage to buildings, roads, bridges, hydropower stations, and other infrastructure. Frequent occurrence of flash floods in Himalayan region poses a severe threat to lives, livelihood, and infrastructure, both in mountains and downstream. Typical reasons for flash floods are cloudbursts, an intense rainfall, the outbursts of a landslide dam, the failure of an artificial dam, or a glacier lake outburst.

A cloud burst is a weather event in which heavy rainfall (of order of 100millimeters/ hour or more) occurs over a localized area at very high intensity. In India, cloudbursts usually occur during monsoon season over orographically dominant regions like the Himalayas and the Western Ghats. These can also occur over the plains, but such occurrences are rare. It’s believed that cloudbursts occur because of rapid lifting of clouds by the steep orography of the region. The clouds get vertically lifted and these convective clods can extend up to the height of 15 kilometers above the ground. The process is called “CCC (Cumulonimbus Convection

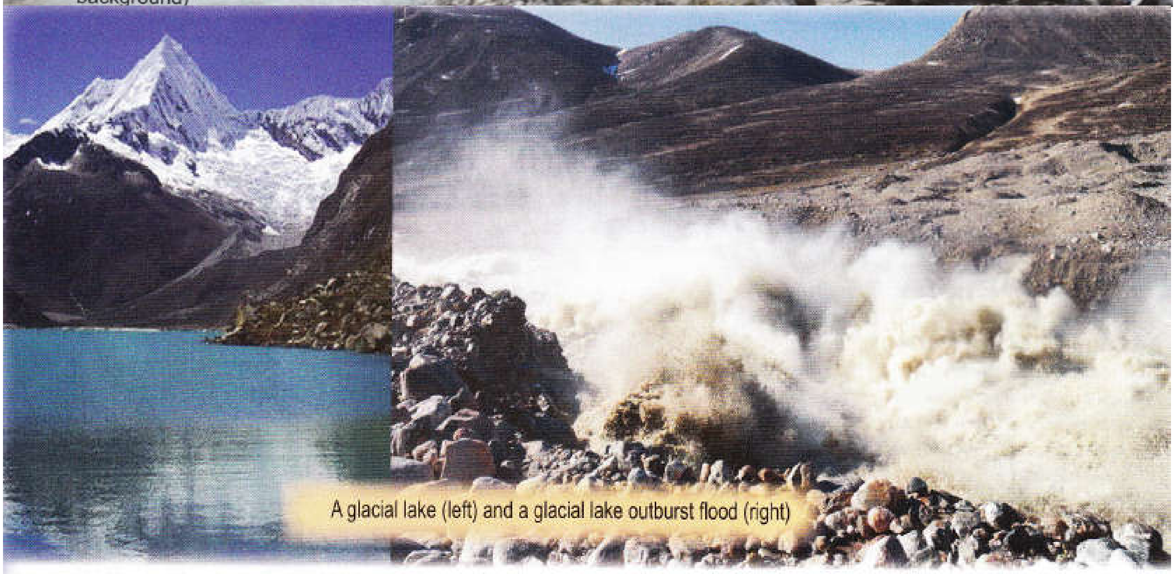
Condition), resulting in formation of towering vertical dense clouds. The lifting is usually dynamic and this cause thermodynamic instability resulting in rapid condensation. It’d also believed that in the Himalayan region, the clods which are being lifted rapidly are also accompanied by soil moistened by earlier precipitation. The soil perhaps acts an additional source of moisture and might also have a role in the frequent outbursts in the region. Cloudbursts are more frequent during the monsoon season. A number of cloudbursts incidents have been reported during the last few years. These incidents have caused huge loss of lives and properties in those areas. In view of increasing frequency of cloudbursts events, demarcation of sensitive areas that are prone to cloudbursts is very much required. Areas that are highly populated have steep slopes and fall in the landslide-prone zone require special attention. No construction should be allowed in the zones where flow from such areas converges or that are close to river banks.

OFFICIAL FIGURES OF THE DEVASTATION IN UTTRAKHAND		
2,052 house wiped out	**147 bridges collapsed**	**1,307 roads destroyed**

Glacial Lake Outburst Floods

A glacial lake is water mass existing in a sufficient amount and extending with a free surface in, under, beside, and/ or in front of a glacial and originating from glacier activities and/ or retreating processes of a glacier.

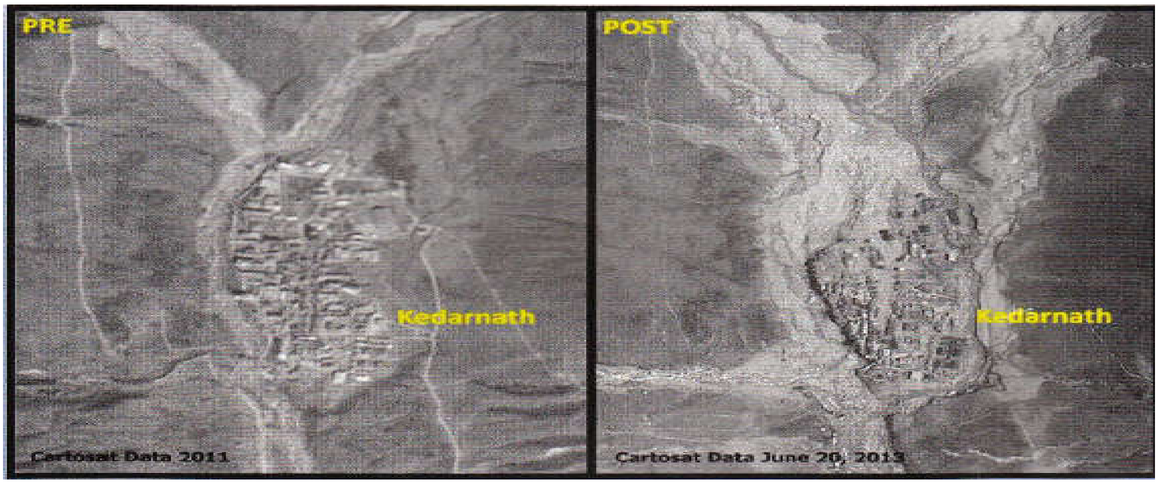
Kedarnath area after the tragedy (loose material can be seen in the background)



A glacial lake (left) and a glacial lake outburst flood (right)

riggering events for an outburst can be moraine failures induced by an earthquake, by the decrease of permafrost (permanent frozen ground) and increased water pressure, or a rock or snow avalanche slumping into the lake causing an overflow. The dominant triggering mechanism of a Glacial Lake Outbursts Flood (GLOF) event depends on the nature of the damming materials, the position of the lake, volume of the water, the nature and position of the associated mother glacier, physical and topographical conditions, and other physical conditions of the surroundings. Interaction between the processes linked to the above factors may strongly increase the vulnerability of the glacial lake to GLOF hazard. The most significant chain reaction in this context is probably the danger from ice avalanches, debris flows, rockfall or landslides reaching a lake and thus provoking a lake burst. Only MDL (Moraine Dammed Lakes), IDL (Ice Dammed Lakes) and IcDL (Ice-cored Dammed Lakes) are considered to be vulnerable from the GLOF point of view. Usually the lakes at risk are situated in remote and often inaccessible areas. To access the possible hazards from glacial lakes, it's essential to have a systematic inventory of such lakes formed at high altitudes. Remote sensing makes it possible to investigate simultaneously a large number of glaciers and glacier lakes in the inaccessible mountain regions. However, high quality remote sensing images are difficult to obtain for mountain regions due to cloud cover during the monsoon season and snow cover during winters.

Besides making a temporal inventory, a repeat monitoring of these lakes is also required to access the change in their nature and aerial extent But sole reliance on remote sensing data is inadequate as it can't furnish the necessary repeat bathymetric information (underground depth of water), changes in the height of the damming moraine, or changes in lake level, which are also needed. Reliable determination of glacial lake instability will acquire detailed glaciological and geotechnical *in situ* field investigation. Since the beginning of the last century, the number of GLOFs has increased in the Himalayas. Studies have shown that the risk of the lake development is highest where the glaciers have a low slope angle and a low flow velocity or are stagnant. The potentially dangerous lakes can be identified based on the condition of lakes, dams, associated mother glaciers, and topographic features around the lakes and glaciers. The criteria used to identify these lakes are based on field observations, processes and records of past events, geo-morphological and geo-technical characteristics of the lake surroundings, and other physical conditions. Identification can also be done, based on the condition of lakes, dams, associated



glaciers, and topographic features around the lakes and glaciers. The Kathmandu-based ICIMOD (International Centre for Integrated Mountain Development) reports that 20 glacial lakes in Nepal and 24 in Bhutan have become potentially dangerous as a result of climate change. As per the ICIMOD report, no glacial lake in UK Himalaya is vulnerable; however, there are 14 lakes in Tista River Basin and 16 lakes in Himachal Pradesh which are potentially dangerous. A number of studies pertaining to GLOFs have been carried out at the NIH (National Institute of Hydrology), Roorkee (UK) for river basins of Tista, Dhauli Ganga (Garhwal Himalaya), Twaing (Arunachal Pradesh) and Bhutan. As per these studies, as such no lake is potentially dangerous in Dhauli Ganga where as some lakes are vulnerable in Bhutan, Tista and Twang Basins.

Damages by disasters triggered by outburst or GLOFs can be considerably reduced by forecasts and clearly warning systems. It appears that in Kedarnath incident, a time lapse of at a few hours was available between the initiation of intense rainfall and the time floods hit the Kedarnath area. If warning about intense rain or incoming flood were available, a large number of lives could have been saves. It appears that the IMD had indeed issued forecasts but nobody acted on these warning in time. Clearly, there is disconnecting between scientific information and its use in decision making. It, therefore becomes necessary to establish active links between disaster forecasting institutes and administration.

Was there cloudburst?

Cloudburst in UK is nothing unusual for weatherman. Moisture-laden clods imploding and dropping large volumes of water over a few village is a common peril in the hill state.

But the events of June 16 were unprecedented; it wasn't a cloudburst but a vicious natural event akin to a gigantic watery bulldozer rumbling down and flattering everything. The cause of calamity is still not clear. Cloudburst was ruled out within few days of the disaster. The few Kedarnath pilgrims who survived called the onslaught Himalayan tsunami. The rocks and the boulders that came down made geologists and glaciologist wonder whether it was GLOFs, a phenomeno9n the Himalayas are becoming prone to because of global warming. But the theory is slowly losing steam.

What has puzzled researchers is that the region didn't receive an extraordinary rainfall to have caused such a huge flood. IMD (India Meteorological Department) doesn't have rain gauze near Kedarnath temple, so it can't say how much rain fell there. Between June 14-18 most places, including the ones that witnessed maximum damage, received what IMD calls " heavy rainfall" – 64.5mm to 124mm in 24 hrs a category below "extremely heavy rainfall" – 124.5mm to 244mm. Tharali in Chamoli district received 173mm rainfall on June 17. That day, in Uttrakashi, Dunda received 185mm rainfall and Purola 165mm, Only Dehradun received "extremely heavy rainfall" on June 17 with 370.2mm.

In accordance with the reports of Meteorologists, monsoon hits the Himalayan state in July. Satellite images of NRSA (National Remote Sensing Agency) show substantial increase in the amount of snow in the area above Kedarnath Temple on July 21, an indication that the area around Chorabari Lake, the snout of the Mandakini received heavy rainfall. Heavy precipitation, both in the form of snow and rain led to large amount of water flowing down the slope. This brought down debris lying on the path to the Kedarnath settlement. The satellite images also show that this precipitation led to release of a lot of water, so much so that new stream was formed in the area. It's uncertain whether the Chorabari Lake also breached leading to huge gushes, although many survivors on pilgrimage to Kedarnath say it did. Nevertheless, the quantum and force of water was enough to wreak havoc. In accordance with the study by J Srinivasan, professor at the CAOSc (Centre for Atmospheric and Oceanic Sciences), IISc (Indian Institute of Sciences) "Heavy and prolonged showers occur in July or August. Heavy rainfall in June has its own significance. It snows heavily in the Himalaya in March, April and May. In June the snow melts, increasing the water levels in rivers and streams. Snow melts faster when it comes in contact with water than air.

Thus, heavy precipitation, which happened this time for days together, led to faster rate of snow melting. All these factors came together to produce such a large amount of water within 2 or 3 days". In accordance with the report of A Kulkarni, a visiting scientist at IISc, Bengaluru, a bit more is added. Kedarnath received 120mm rainfall in 24 hrs before the flash flood on June 16. This is evidence that a small lake was formed during these rains above the Kedarnath town (Satellite image). The 1-hectare lake contained 10million litre water. The lake must have lasted a small duration and its water must have come down along with the water from glacier. The lake burst due to a beach in the blockade. Coupled with heavy rains in the area, this caused flash floods,. Because of the lake there was excessive stream run=off and a third Channel emerged. Comparison of satellite images of Kedarnath taken before and after the event was reported by G S Rawat, senior scientist at ICIMD (International Centre for Integrated Mountain

Development), Kathmandu which shows a right forward shift of the extreme left water channel. The stream, along with other streams, flowed towards the main habitation, leading to disaster.

Landslide Jeopardy; Its Assessment, Monitoring & Early Warning Systems

Landslide occurrence round the globe through the years and the observed climate change pattern suggest that increasing rainfall intensities and frequencies, coupled with population growth in hills has significantly increased landslide associated fatalities. Landslides comprise a wide variety of complex processes that result in downward and outward movements, under gravity of materials on unstable slopes. Some forms of mass movements like flows, falls, spread, subsidence and creep are also considered as part of landslide events. Landslide can be triggered by both natural and human induced changes in hilly regions. Slope instability of a region are governed by geology, geomorphology, thrusts and faults, slope characteristics, topography and land use. These are called preparatory or passive factors whose adverse nature make the slope susceptible for landslides or in other words bring the slopes in a marginally stable condition. However, the main triggering factors that actually initiate landslides are rainfall, and anthropogenic activities.

The Himalayas, one of the youngest mountains, present a dynamic geo-environment with varied rock types, seismically active tectonic zones, rugged topography, steep slopes and intense monsoon rainfall. The weak and fragile rocks along with thick overburden deposits on steep slopes are further subjected to severe weathering and toe erosion by a number of streams. In recent years, slope instability problems have been aggravated due to increased urbanization and haphazard road and hydropower construction activities. Although in India there are many research and academic institutions engaged in different aspects of landslide research, the research outcomes haven't been adequately implemented in the field. There is need to transform research outcomes into engineering practices. Further, it's pertinent to strengthen the landslide database and hazard zonation maps for pragmatic landslide risk estimation.

Landslide risk is a measure of the magnitude of possible hazards and expected damage i. e., the vulnerability of exposed risk elements in the form of population, infrastructure, economic and social activities. Therefore, risk is negligible where there are no risk elements or they are not vulnerable even if potential hazard is high. On the contrary, for a large number of exposed risk elements with high vulnerability, the risk is high even if potential hazard is low. Assessment of landslide hazard and risk is an imperative task in the area of disaster management. A simple way to estimate the hazard is by creating a database of existing landslides. The most scientific way to access the hazard is by landslide susceptibility mapping. Such an effort can produce landslide zonation maps, which will classify the area into various hazard classes of landslide potential zones. Such maps of different regions of India have been prepared by various research and academic institutions. There are different techniques available, primarily depending on the nature of data and mapping scale. Some techniques most widely used are qualitative map combination, information model, bio-variate and multi-variate statistical methods, and soft computing techniques. These maps find applicability for safe land-use planning of hilly regions. However, the maps available in our country are of small scale (1:50,000-1:25,000) and therefore detailed information about the hazards are mostly missing. Remote sensing integrated with GIS (Geographic Information System) is now extremely used for such studies. High resolution remote sensing images also help in providing detailed information about the terrain to produce large-scale hazard maps.

Landslide hazard assessment in a highly susceptible region can also be achieved by delineating the active/potential landslides through field investigations and remote sensing images. Landslide hazard can also be estimated by defining landslide intensity, which primarily depends on landslide type, frequency, volume and expected velocity. Once the hazard is assessed, risk estimation can be carried out by estimating the probable nature and amount of losses as a consequence of a major future event. This in turn requires detailed information of risks elements such as population, properties, infrastructure, and functional activities associated within the landslide hazard area, including its run-out limit. There is significant advancement in instrumentation and sensor technologies for monitoring of natural disasters over the past few years. Valuable data from such technologies help to understand landslide mechanisms, which may help in landslide prediction. This has led to the development of the landslide early warning system. As landslides are a continuous process, conventional monitoring of landslides mayn't be sufficient to detect the initiation of a landslide at the moment it occurs. Real time monitoring, on the other hand, permits sensitive and dynamic understanding of landslides and the data can be transferred from a remote location to a control station where an accurate analysis can be carried out to envisage the landslide scenario. A real time landslide monitoring system is also an effective way to get a lead time to facilitate preparedness to face the hazard.

Data collection and analysis to predict the occurrence of landslides is a challenging task. As majority of the landslides are triggered by rainfall, the most important aspect for development of an early warning system is to know the relationship between rainfall and incidence of landslides in a region. Rainfall induced landslides can be predicted by modeling the landslide events and rainfall. This is accomplished through a close warning alert. The critical rainfall threshold value for landslide occurrence of a specific region should be known. The type of monitoring instruments to be used depends on the landslide type and the parameters to be monitored. The most commonly used instruments for surface and sub-surface monitoring are bore hole and wire extensometers, inclinometers, tilt meters, piezometers along with rain gauzes. When the displacement or deformation data obtained from these instruments exceeds a critical threshold value, a warning signal can be issued. Today, high accuracy GPS as well as SAR (Synthetic Aperture Radar) interferometry in the field of remote sensing is being used for remote monitoring of ground displacement in landslide regions. It's therefore possible to use this technique as a tool for early warning as this can detect the initiation of ground displacement before a landslide activity starts in a region. Rapid advancement of information and communication technology is playing a pivotal role in conveying early warning to the public, decision makers and the scientific community. As SMS alert could be one of the fastest means of communication for early warning.

Buildings on landslide prone slopes compound the disaster vulnerability as their collapse multiplies injuries to the human population. Often, the lack of sturdy foundations or the inherent instability of the landslide-prone slope isn't given due attention by builders. Constructions of already questionable safety can't be bolstered by retrofitting of the super structure if these factors aren't accounted for at the initial building stage. Public facilities like hospitals, government buildings, schools, communication and transport networks, etc. should be protected against landslide hazards. Landslides can destabilize or destroy foundations, walls, and underground utilities. Fast moving debris flows are particularly destructive due to the high velocity, volume of material and lack of notice. Even overlooked slow-moving landslides can completely destroy structures over time. Rebuilding of the damaged area or success of the mitigation measures are often compromised as these landslides continue to move for days after the damage. One of the greatest damage from landslides is to the transportation infrastructure. Common problems along roads and railways include cut-and-fill failures, rockfalls and maintenance problems. The blocking of the road or rail by debris and rocks is a common experience, and hampers commercials activities, tourism, and emergency activities.

Landslide hazards can be minimized by avoiding constructions in landslide prone regions. Suitable land-use policies can be developed based on hazard zonation maps. For instance, no infrastructure development projects should be allowed in landslide-prone regions. Sometimes, avoiding construction on some sites isn't feasible due to the high cost of opportunity and public opposition. This calls for technological solutions to control landslides. To prescribe a suitable remedial measure, thorough understanding of the landslide processes should be developed by an in-depth scientific investigation. Successful landslide stabilization depends on scientific investigation, construction methods and cost evaluation. There are various landslide control measure techniques available today. Since the majority of landslides are triggered by rainfall, drainage is considered to be the primary measure. Drainage measures include surface and subsurface drainages that help to take away the water out of the active landslide area. The lowering of groundwater by sub-surface drainage helps in decrease of pore water pressure, increase of shear strength, and reduction of seepage and erosion. Because of its high stabilization efficiency in relation to cost, drainage is the most widely used and generally the most successfully stabilization method. It's highly recommended that all required measures should be integrated and implemented in one go for a complete solution towards landslide mitigation. Flash flood caused by breaching of landslide dam in river valleys is another catastrophic event which was responsible for many disasters in the Himalayan region in the past. It's very essential to estimate the size of the reservoir and dam and the consequences of dam failure in the down valley before suggesting any remedies. In a common practice, spillways, tunnels and sometimes extensive blasting are used to break the dam in a phased way to release the reservoir water.

Communal Involvement to Manage Disasters

Despite growing scientific and technological innovations, it has been difficult to reduce the impacts of natural disasters. Rather, the frequency and intensity of disasters appears to have increased due to rise in population density, growing migrant population pressure, unplanned development and anthropogenic activities hostile to the environment, neglect of unforeseen hazards, changing climate and so on.. The vulnerability of UK and its population strongly brings out the need for the involvement of the community for success of any result oriented project or work. Further, the NWP (National Water Policy) also emphasize an integrated basin approach to flood management and public participation in the flood management. The empowerment of people through various initiatives like Panchayat Raj institutions can also be a workable solution. A documented case study of simple community-based early warning systems installed in the Jiadhal River of the state of Assam in India shows that the downstream communities can be enabled to prepare better for management of flash floods. Collaboration between upstream and downstream communities through advanced communication technology can further strengthen the early warning. Community-based management will go a long way in helping communities as well as administration in flash flood management. The predictions of the impact of the climate change through modeling studies indicate increase in intensity of rainfall in some areas, though there mayn't be much variation in the annual rainfall. These is need to prepare for these eventualities and involvement of the community in all the initiatives. People-centric disaster management will bring in a sense of ownership which will sustain initiatives. Further, it's observed in most disasters that the community of the affected area becomes the first responders, before help reaches from outside. Often during disasters communication and approachability gets disrupted, hampering access to the area from other undisturbed places, as experienced in the UK flash floods.

Awareness and educational training is an integral part of any disaster management programme. There is a need for providing necessary training to civil engineers and administrators engaged in disaster management. The local community should be aware and prepared for the potential risks present in the area where they live. Local groups can also be identified and trained to discern early warning signs and form another channel of early warning system by informing the appropriate DM office. As the hills are exploited by extensive construction activities, the adverse effects of anthropogenic factors should be stipulated very clearly to engineers, architects abd builders. It's also important to disseminate the knowledge and research outcomes of the scientific community to the Central and State agencies dealing with landslide disaster management. Although disaster mitigation has gained increasing credence in the recent past, most efforts tend to focus towards disaster management of populated and built areas, while hazards in remote and uploaded areas are neglected. The recent flash floods and landslides in the UK have underlined the need for community-based disaster risk management in vulnerable localities. Despite experiencing many natural disasters in the recent past, the memories of these disasters are often forgotten by people in their struggle of existence and livelihood.

An aware, informed and prepared community is better able to resist and cope with the disasters than an unaware, uninformed and unprepared community.

Kofi Annan, Former Secretary General, United Nations

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