Less is More in Natural Disaster Prevention But Many Times More is Less in Natural Disaster Correction

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The 80: 20 Principle

Richard Koch, the author "80-20 Principle· the Secret of achieving More with Less" - has done a singular service by unfolding the excitement latent in the 1897 Pareto Principle, named after the Italian economist Wilfredo Pareto The Principle of least effort propounded by George K Zipf, a Professor of Economics at the Harvard, has come as a sister concept. And both put together now leads to how Less can be More!, Koch (1997) According to Koch "the 80-20 Principle asserts that a minority of causes, inputs or effort usually lead to a majority of the results, outputs or rewards Taken literally, this means that, for example, 80 per cent of what one achieves in his or her job comes from 20 per cent of the time spent". He further adds, "the reason that the 80-20 Principle is so valuable is that it is counterintuitive. We tend to expect that all causes will have roughly the same significance. (And more importantly, for this paper), that all customers are equally valuable. That every bit of business, every product and every dollar of sales revenue is as good as any other. That all employees in a particular category have roughly equivalent value. That each day or week or year we spend has the same significance That all problems have a large number of causes, so that it is not worth isolating a few key causes".

The above jacket of ideas fits, without stretching, straight on to the Natural Disaster Reduction Apparatus of the day! The ratio of 'unexpected' to 'expected' problems usually hovers around 80-20! And since we are especially concerned with developing countries, let us not forget that 80 per cent of world population will soon be living in developing countries

And in the developing countries, the people organised to exploit the environment and those committed to protect it are also more or less in 80.20 ratio. The generations of distilled knowledge, give or take a five per cent, can be summed as follows

- 80 per cent of the disasters occur due to 20 per cent of the causative factors.
- 80 per cent of the available resources go in to managing 20 per cent of the natural disasters (e.g., in important urban areas).
- 80 per cent of the results achieved are due to 20 per cent of the resource input
- 80 per cent of the attention is paid to 20 per cent of the problems or events. Further, 80 per cent attention is on dramatic events and quick fix remedies, and only 20 per cent attention goes to equally important events, not dramatic.
- 80 per cent of the lessons are learnt from 20 per cent of the case records.

Less is More and More Can be Less

Of the different types of natural disasters, I will take an example from Landslide Disaster Management, to prove my point. We all know that once any landslide problem becomes intractable, huge sums of money are usually necessary to improve upon stability and revert to the position of safety. Even with very high levels of investments, a hopeless situation is seldom restored to normalcy, and a significant degree of risk continues to persist. The concept of how less is more and more can be less is illustrated in Fig.1. It shows a scale of hazard from a very safe situation as at the zero mark to a highly dangerous situation at the upper end of the scale. On the right hand side of the scale is the curve (outer one) that reflects the exponential nature of increase in risk levels, with the increasing degree of hazard. For instance, at the highest level of hazard, a catastrophe is expected and, therefore, risk is also high. Investments made for achieving safety in such situations do bring down the risk levels but often times, residual level of risks continue to over shadow the minimum limit of safety. On the other hand, when a problem is tackled in its nascent stage, as in Zone 2 of Fig 1, with a judicious mix of preventive and corrective measures, one can achieve more or less.

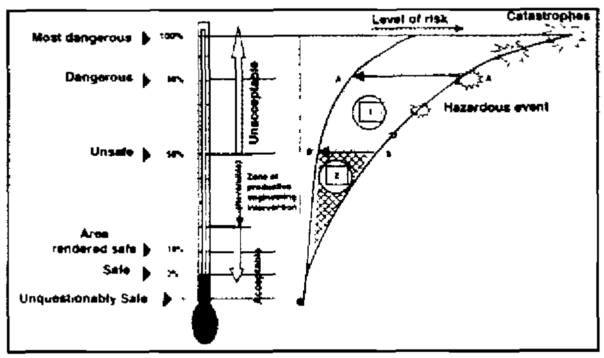

Fig 1 An arbitrary scale on the Barowmeter of Hazard

There are numerous examples, which could be cited to prove that prevention is better than cure Let's take for instance two well-known landslides of India. 1) Major Nashri Landslide in Jammu & Kashmir; and 2) Kaliasaur Landslide in the Garhwal Himalayas The Nashri landslide originated 47 years ago as a small landslip and because of inadequate attention, developed in to a major landslide, with compounding losses Similarly, the Kaliasaur landslide originated nearly eight decades ago and is still growing great guns because of the lack of adequate engineering intervention in time.

The two problems now require funding (for their correction) manifold higher than what was really needed to tame them, in their initial stages The details of the two are provided below:

Major Nashri Landslide of India

Located on the National Highway 1, from Jammu to Shrinagar at km 138, the major Nashri Landslide provides a striking example of the progressive transformation of a slope, which once stood stable for centuries, in to a recurring landslide problem of formidable dimension. The history is summarised briefly as follows

1913	The slopes at Nashri covered with fairly dense forest of Chir, Pine and Oak, stood safe at this location for centuries.
1914	The lush green stable slope (average inclination 30 degree) was cut to provide the Banihal Cart road of 3.6 m width to cater for light traffic.
1914-52	No significant landslide problem occurred during this period of 38 years.
1953	A forest fire occurred at Nashri robbing the slope of its vegetative cover With this the seeds of instability were sown

1954 A small landslip took place at elevation 880 m at the toe of the slope primarily due to under cutting

1956 The landslide by this time involved 40 m width of the road, with crown of the slide some 80 m above.

1956-65 The landslide continued to get reactivated and enlarged during this period eventually involving the road at elevation 1125 m. It became extended many times over in volume as compared to its initial stage in 1954 - 56. The road was widened by blasting

1965-79 The position of the road shifted upslope by 18 m.

1967 The landslide became very active and its condition rapidly deteriorated thereafter.

1972-73 The landslide repeated in a big way Back cutting of about 45 m was done on the road.

1974 The width of the landslide increased 80 m. The debris material extended 119 m above the road level, as against the 165 m in 1965.

1977-83 The hill face between major and minor Nashri slides was rendered highly unstable and signs of slopt distress, were clearly discernible

1979 A patch of about 250 m of the slope sank by about 25 m The subsidence was invariably accompanied by development of cracks and fissures in the neighbourhood of the slide, and at the flanks Back cutting measured 55 m from the 1956 position

1981-82 The landslide got reactivated even more vigorously.

1982 Minor Nashri slide, which developed on the slopes adjacent to the major Nashri slide, acquired the dimensions more or less equal to those major Nashri slides by 1982 Severity of the landslide problem was felt frequently as the road got blocked 13 times The blockage from 23rd June to 5th July, 1982 (13 days) during which a length of 250 m sank by 25 m. In December 1982, 1000 vehicles and 5000 passengers to Kashmir Valley, got stranded for 3 days.

1983 A 250 m length of road sank by 65 m

1984 The Nashri slide measured about 340 m along the slope above the road level and 300 m wide at the road level. The uphill slopes were found to range between 30° and 60° The slope was found to be highly disturbed and cracked. The first crack was 10 to 15 m behind the crown, and the second crack was situated 30 m above the crown The area showed slumping between 30 to 150 cms A package of remedial measures were recommended by Central Rood Research Institute of India.

1987 Relatively quiet for about 3-4 years, the landslide again got activated.

1988 It covered a stretch of about 390 m of the road and eventually acquired a length of about 1 km with the tendency to coalesce with small landslips in the neighborhood.

1993 A package of control measures were recommended

Clearly this is a case of progressive deterioration of a landslide from zone 2 to zone 1 in Fig. 1, attributed chiefly to inadequate engineering intervention over a period of years. At this stage, no matter how much more we do, a certain level of risk will remain, requiring more to be done.

Eight Decades of the Kaliasaur Landslide

Located on the Hardwar-Badrinath road at km.147 in the Garhwal Himalayas, the Kaliasaur landslide captured the public imagination as far back as 1920. The road blockage at this location. especially during the monsoon season, became a common feature. The slide enlarged in its dimensions with every major episode recorded in the years 1952, 1963, 1964, 1965, 1969, 1970, 1971, 1972, 1984 and frequently thereafter.

In the mid 80s, the total slide affected area, above and below the road, was estimated at 86,000 sqm and it was surmised that nearly 100,000 cum of the landslide debris had entered the river by then When the Kaliasaur landslide was inspected on 15th October 1998, it became obvious that the slide has grown further in its dimensions and a huge chunk of rock mass had come down the slope creating an extension of the crown of the slide

Remediation initiatives were never holistic in this case. Therefore, the area has been gradually drifting from zone 2 to zone 1, in Fig 1 It is however satisfying to see that the novel drum diaphragm retaining wall, built at this location by the author in 1987, as a part of remediation package, is still intact Small investment at that time has, by now, paid many times over Clearly, less is more.

The single most important lesson that emerges from the above examples is that prevention is on any day better than cure, and that focus of disaster managers should shift from post-disaster relief, reconstruction and rehabilitation to pre-disaster planning Strategy of prevention has much deeper ramifications normally not obvious in tackling this or that isolated problem. Let us take a situation in which even when stability of individual buildings can be ensured, say for example by retrofitting, by making huge investments, certain catastrophic events can wipe out the advantage. To illustrate the point, let's take a bigger example - that of the Alaknanda Tragedy of 22nd July 1970, described by Bhandari (1999)

The Alaknanda Tragedy

On 22nd July 1970, a flood wave in the river Alaknanda played havoc with human habitat and road infrastructure through its course right from Joshimath to downstream of Shrinagar, Fig. 2. The entire damage on the fateful day was attributed to the surge wave The flood wave was attributed to the breach of the landslide (Fig 3) at the confluence of river Patal Ganga and Alaknanda The breach of dam occurred due to mounting pressure in the reservoir behind it. The dam itself was formed by a huge load of sediments from the river Patal Ganga. The sediments were chiefly due to an enormous degree of mass wasting and erosion on the slopes And such high degrees of erosion could be directly linked with erosion due to long periods of neglect of slopes, non-engineered constructions, cutting of roads and such like activities.

A brief account of the damages is given below

1. A double tube English Bridge of span 40 m at Helang (Km 261) got washed away The Helang slide, located 13 km downstream of Joshimath, occurred on the bank of Karmansa Nala, upstream of its confluence with river Alaknanda The riverbed at this location had already silted upto the bridge deck level.
2. The Langsi bridge at Km 254 was destroyed A kilometre downstream, the Belakuchi slide (km 253) synergised with the flood wave in the Alaknanda valley unleashing what came to be known as the Belakuchi tragedy of July 1970. It is believed to have been initiated by the twin effect of severe slope toe erosion and movement along the foliation plane of a thick talc schist band. As a result, the steel girder bridge got washed away. The Belakuchi Bazaar too was wiped out and so was

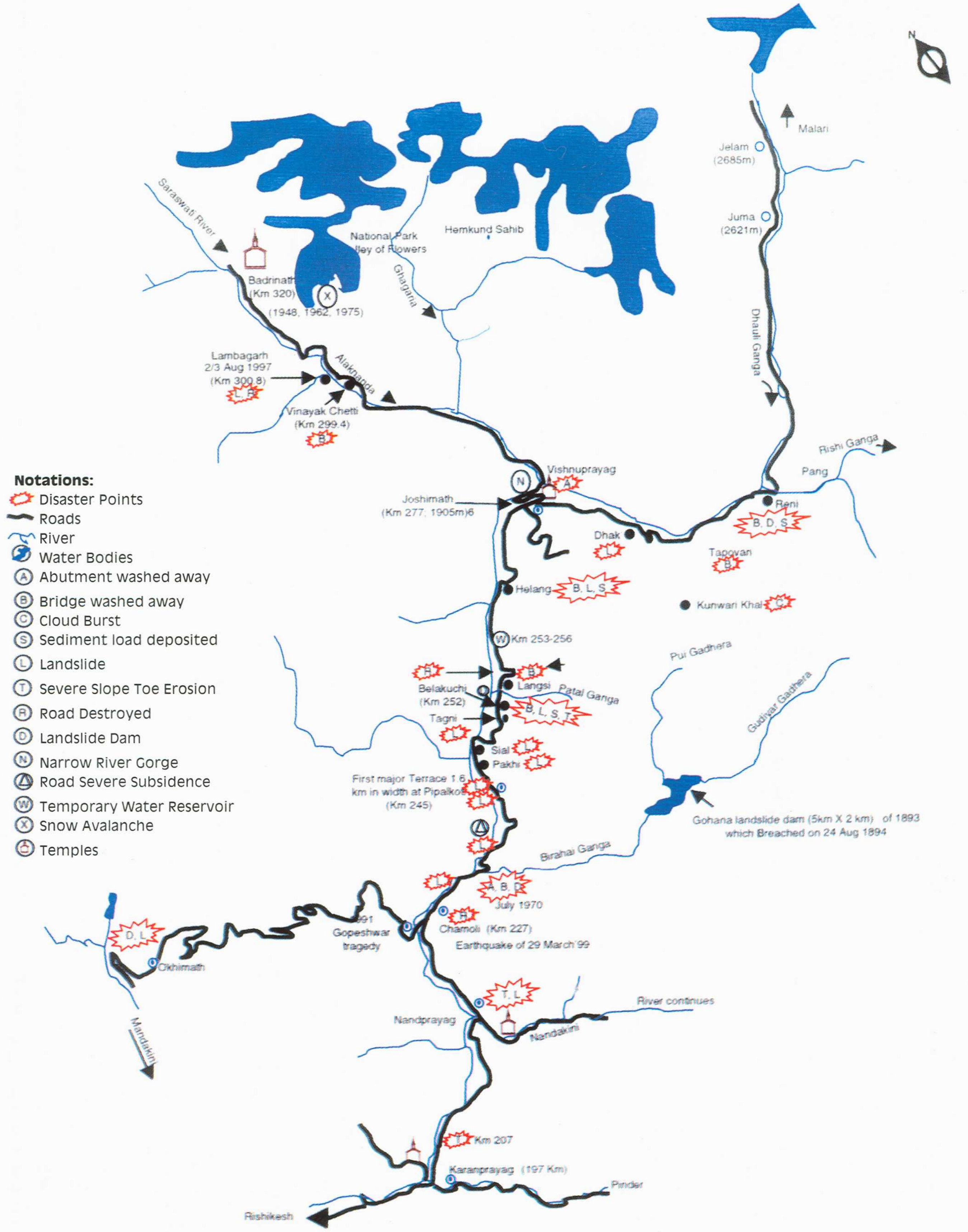

Fig. 2 : Trail of Devastation unleashed by the landslides and the Alaknanda Floods of July 1970

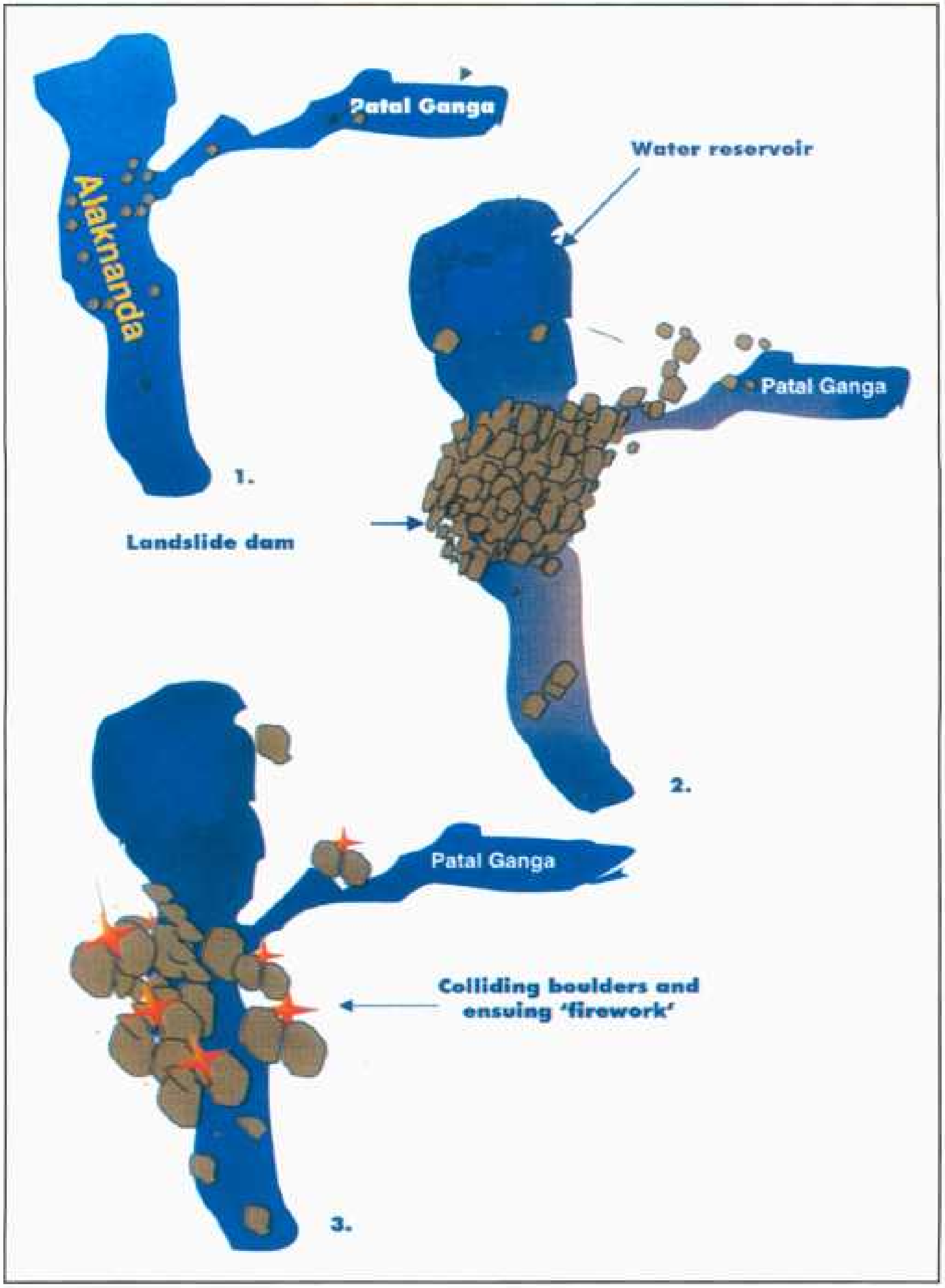

Fig. 3 : Alaknanda tragedy triggered by the bursting landslide dam

7. Flood wave surged further down towards Chamoli (Km 227), a 300 m length of road got completely washed out.
8. Downstream of Chamoli right up to Srinagar, a total of 350 m of road length got breached, more than a km of retaining walls and breast walls were lost, more than 2 km of drains were impaired, and as many as 40 culverts and 5 causeways were lost. After receding of the flood, the road at Srinagar (Km 131) was found to be under 1 to 2 m of silt.
9. The Nandprayag landslide around km 216 in July 1970 measured 200m long and 160m wide. This slide was responsible for the repeated blockades of the road at this location.
10. The river Alaknanda severely eroded its own left bank at Srinagar, and the situation at this location is known to be progressively getting from bad to worse, year after year. At most places the road formation was lost.

On the whole, on 20th of July 1970, within a short span of 45 minutes, a spate of landslides occurred, the most important among them were: Helang, Bela - kuchi, Tangani, Sial, Pakhi, Birahi, and Nandprayag landslides.

the bus terminal. As many as 381 human lives were lost. It did not even spare the GREF camp located at a height of 45.7 m from the riverbed. The other losses included 245 heavy vehicles including buses, 5 taxies and 1 army vehicle. It was here that, between km 253 and km 251, the road completely disappeared and so were 15 culverts and 2 causeways.

3. The Siol landslide located at km 249, occupied an area that measured 300m x 180m. The area at this location settled between 5m and 15m.
4. Pakhi landslide occurred at km 247. A fault zone may have been partly responsible for this slide.
5. The road between Pipal Koti km 245, and Birahi at km 235 underwent widespread subsidence as the trail of devastation travelled further downstream.
6. A major blockade of river upstream of the confluence of Birahi ganga with river Alaknanda in the Birahi gorge resulted in an afflux of 10m and 12m. A 3km long stretch of road got wiped out throwing huge load of debris in to the river. Nearly 500 m of the left bank, and the abatement of the Girder Bridge at Birahi got washed away.

In the Dhauli-ganga valley, besides breaching of the londslide dam formed on the Rishiganga in 1968, the prehistoric Dhak landslide at Kuaripass also got reactivated due to serious toe erosion inflicted by the rather narrow and deep Dhak Nala. A 300 m stretch of the Joshimath Ä Malari road sank by almost 40 m, more or less damming the Dhauliganga with water level rising by 15 m to 20 m. Bridges at Vinayak Cheti, Reni, Helang, Belakuchi, Langsi and Birahi were among those destroyed, and the bridge abatements at Vishnuprayag and Birahi were also washed away. Large lengths of roads were either blocked by the landslides, or got completely breached. Road subsidence was wide spread. Severe toe erosion due to rivers in spate affected the lower parts of the slopes of valleys, provoking numerous new landslides, besides reactivating the old ones. The 1970 flood brought an estimated 9.1 million cubic metre of silt and rock into Alaknanda, eroded largely from the catchments of Patalganga and Garuganga.

References

Koch, Richard (1999): How Less Can be More. SPAN May/June 1999.

Bhandari, R.K. (1999): Natural Disasters in Asia and the IDNDR Stimulus. Eleventh Asian Regional Conference, Seoul, Korea.

Bhandari, R.K. (1999): Two Great Landslide Tragedies of India (under publication).