



A CRITIQUE ON THE NON- SCIENTIFIC CONSTRUCTION OF KEDARNATH AND POST DISASTER RECOVERY AFTER FLASH FLOODS 2013

¹Anas Ahmed

¹Architect

¹Architecture & Construction

¹New Delhi, India

Abstract: Kedarnath, one of the twelve Jyotirlingas, is an important Hindu pilgrimage. Kedarnath temple is believed to have been constructed in the 8th century. On 16 June 2013, the Uttarakhand State suffered a mega-disaster. The entire State was hit by very heavy rainfall and flash floods and among the 13 districts Bageshwar, Chamoli, Pithoragarh, Rudraprayag and Uttarkashi were the worst affected witnessing huge loss of lives, property and infrastructure. The reason for the destruction was claimed to be natural but it was evident that its non-scientific construction is equally responsible for the disaster. This paper aims at revealing the causes of the disaster and the recovery done by the government during and post-disaster.

Index Terms – Vulnerability Assessment, Torrential Rain, Westerlies, Glacial Lake Outburst Flood, Disaster Recovery and Reconstruction, Ecology

1. Introduction

India, with its unique geophysical setting and socio-economic conditions is highly vulnerable to disasters. The country is prone to disasters due to number of factors, both natural and human induced, including adverse geo-climatic conditions, topographic features, environmental degradation, population growth, urbanization, industrialization, flawed development practices, etc. As far as the geographic dimensions of the country are concerned, the five distinctive regions of the country i.e. Himalayan region, the alluvial plains, the hilly part of the peninsula, and the coastal zone have their own specific problems. While on one hand the Himalayan region is prone to disasters like earthquakes and landslides, the plain is affected by floods almost every year. The desert part of the country is affected by droughts while the coastal zone is susceptible to cyclones and storms. If we analyze the layers of vulnerability statistically, out of 35 States and Union Territories in the country, 27 of them are disaster prone. [1]



Fig 1. Damage due to Disasters

1.1 Vulnerability profile of India:

- India is vulnerable in varying degrees to a large number of natural as well as man-made disasters.
- Over 40 million hectares (12 per cent of land) is prone to floods and river erosion.
- 58.6 per cent of the landmass is prone to earthquakes of moderate to very high intensity
- Of the 7,516 km long coastline, close to 5,700 km is prone to cyclones and tsunamis.
- 68 per cent of the cultivable area is vulnerable to drought and hilly areas are at risk from landslides and avalanches.
- Further, the vulnerability to Nuclear, Biological and Chemical (NBC) disasters and terrorism has also increased in the past years. [2]

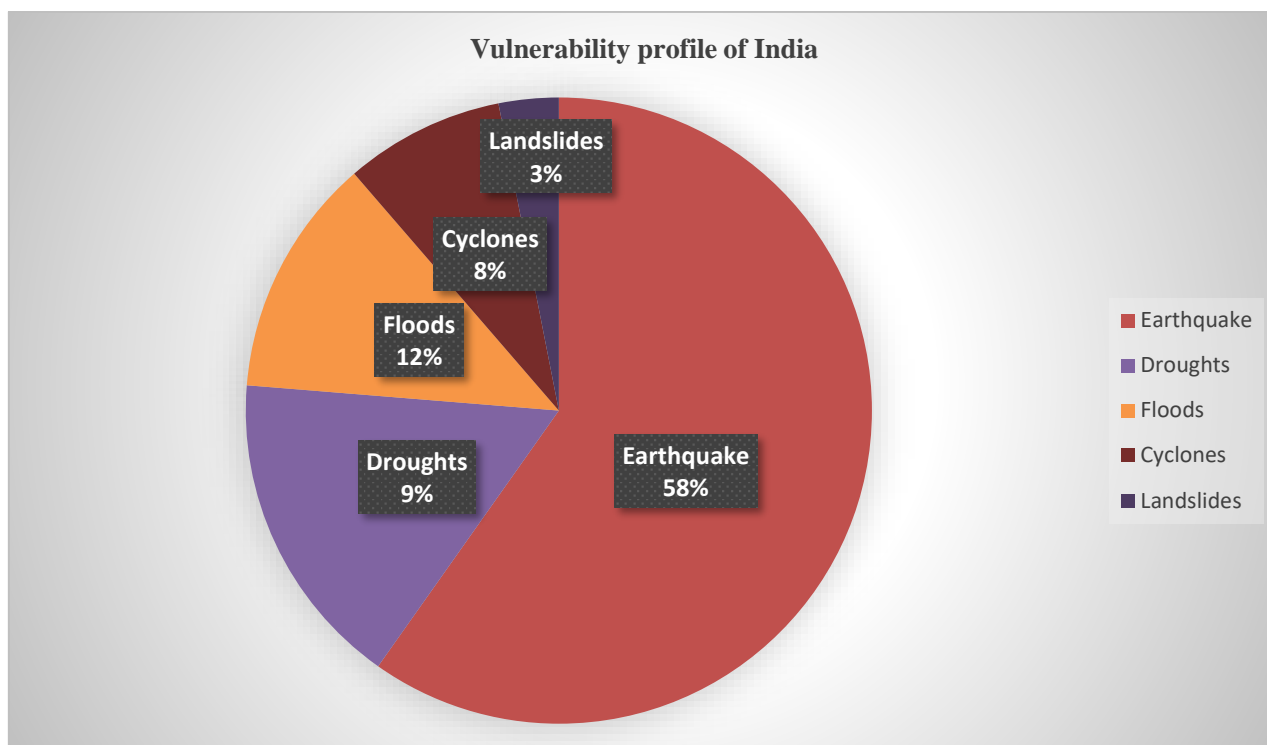


Fig 2. Vulnerability profile of India (NIDM)

1.2 Major disasters in India in the past two decades:

Natural disasters are events of the Nature which cause sudden disruptions to the normal life of the community. It eventually cause damage to the lives and property to such an extent that normal social and economic mechanism that are locally available to the community become inadequate to restore normalcy. About 80% of India's land often faces natural Disasters like earthquakes, landslides, floods, cyclones, drought, lightening, avalanche, summer dust storms, hail storms Forest fires, coastal erosion etc. India ranks 4th in the list of countries that were most hit by natural disasters in the year 2006. A large number of manmade disasters such as biological (pest attack, epidemics etc.); industrial and technological; Environmental (air, water and land pollution); fire, road and railway accidents etc, are also cause severe setbacks to the Community. [3]

Table 1. Major disasters in India in the past two decades [4]

Region	Cause	Deaths
Kashmir Floods Disaster, 2014	Continuous torrential rainfall and swelling of Jhelum River	550+
Uttarakhand Flash Floods, 2013	Heavy rainfall, massive Landslides	5700+
Bihar Flood disaster, 2007	Heavy rainfall	1287+
The Indian Ocean Tsunami 2004	Tsunami	230000+
Mumbai Catastrophe 2005	Rainfall	5000+
Indian Heat Wave 2002	Intense Heat Wave	1000+
Gujarat Earthquake, 2001	Earthquake	20000+
Super Cyclone, Odisha, 1999	Cyclone	15000+

2.1 Kedarnath flash floods: The Disaster

In June 2013, a mid-day cloudburst centered on the North Indian state of Uttarakhand caused devastating floods and landslides, becoming the country's worst natural disaster since the 2004 tsunami. The rainfall received that month was far greater than the rainfall the state usually received. Debris blocked the rivers, causing major overflow. [5]

Though all the thirteen districts of the State were hit, five districts, namely Bageshwar, Chamoli, Pithoragarh, Rudraprayag and Uttarkashi were the worst affected. The disaster coincided with the peak tourist and pilgrimage season, significantly enhancing the number of the casualties and adversely affecting the rescue and relief operations. The impact of disaster was most pronounced in the Mandakini valley of the Rudraprayag district. Torrential rains, coupled with the probable collapse of the Chorabari Lake, led to flooding at the Kedarnath Shrine and the adjacent areas of Rambara, Agastyamuni, Tilwara, and Guptkashi. Other pilgrimage centers in the region, including Gangotri, Yamunotri and Badrinath, which are visited by thousands of devotees during the summer season, were also affected. People in important locations, such as the Harsil, Roopkund and Hemkund Sahib, were stranded for days together. Over one lakh people were stuck in various regions of the State due to damaged roads, landslides and flash flood-induced debris.

As per the latest report made available by the State Government on 09 May 2014, a total of 169 people died and 4021 people were reported missing (presumed to be dead). [6]



Fig 3. Pictures from Kedarnath

2.2 Impact of the Disaster:

As per report made available by the State Government, a total of 4,200 villages were affected, 11,091 livestock were lost and 2,513 houses were fully damaged. More than 70,000 tourists and 1,00,000 local inhabitants were stranded in the difficult mountain terrain of the upper reaches of the Himalaya. The damage was so enormous and extensive that it was also termed as Himalayan Tsunami by the media. The extent of damage as reported by State Government is depicted in Table 2.

The suddenness of the flash floods coupled with the high velocity of flow laden with heavy sediment, including boulders washed away pilgrims and locals. Apart from flash floods, people were also reported to be killed by landslides, which buried them alive under huge debris and rock falls. The difficult terrain and blockage of roads made it difficult to provide necessary relief to the survivors stranded at isolated locations. The harsh weather conditions i.e. continuous rainfall, chilling cold and non-availability of proper shelter/clothes contributed to the misery endured by the survivors of the disaster. [6]

Table 2. The extent of damage as reported by the State Government

S. No	Item	Details
1	Number of affected districts	13
2,3	Number of dead and missing persons (Presumed to be dead)	(169 + 4021)
4	No. of houses damaged :-	2119
	(i) Fully damaged pucca houses	3001
	(ii) Severely damaged pucca houses	11759
	(iii) Partially damaged pucca houses	394
	(iv) Fully damaged kuchha houses	360
	(v) Severely damaged kuchha houses	1676
	(vi) Number of kuchha houses partially damaged	471
	(viii) Cowsheds damaged	361
5	Animals lost :-	
	(a) No. of big animals lost	3280
	(b) No. of small animals lost	7811



Fig 4. Damage done by Uttarakhand 2013 Flash Floods

3. Causes of the Disaster:

3.1 Natural Causes:

The disaster essentially occurred due to wide spread heavy rains during the period 14-18 June, which resulted in flash floods in all the major river valleys in the State. Heavy rains triggered major landslide at numerous locations causing severe disruption in surface communications.

The heavy rainfall in the region was the result of convergence of the southwest monsoon trough and westerly disturbances (Figure 5), which led to the formation of dense clouds over the Uttarakhand Himalaya.

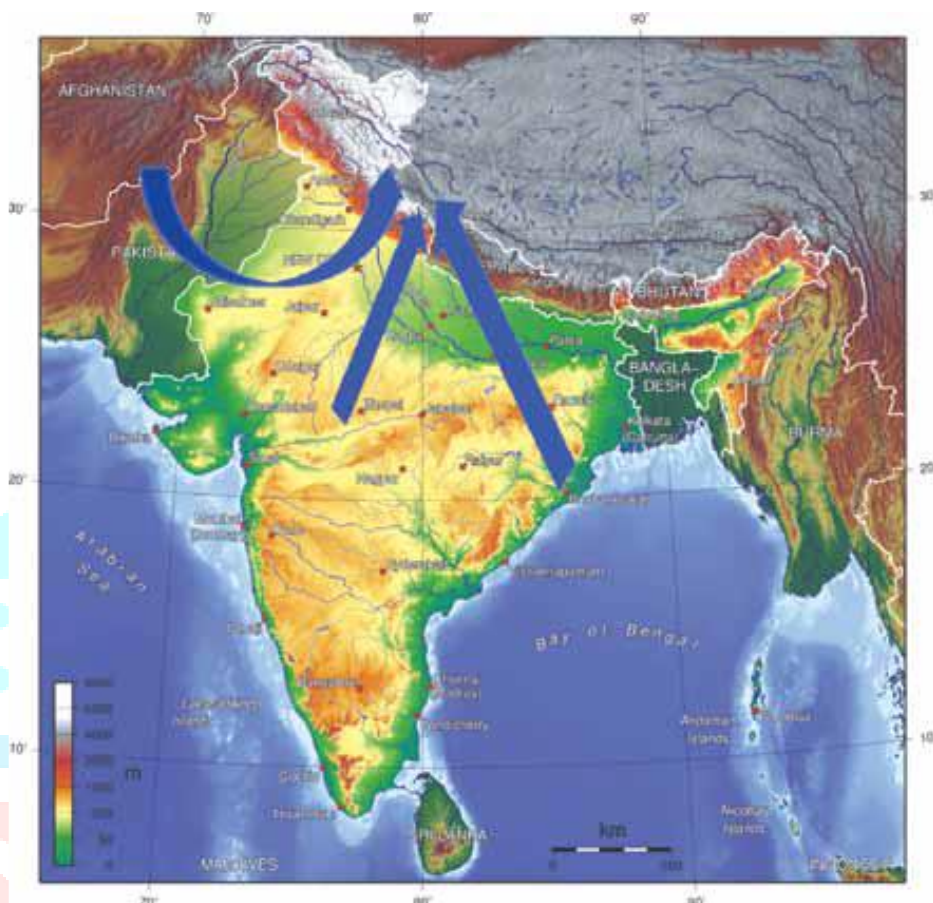
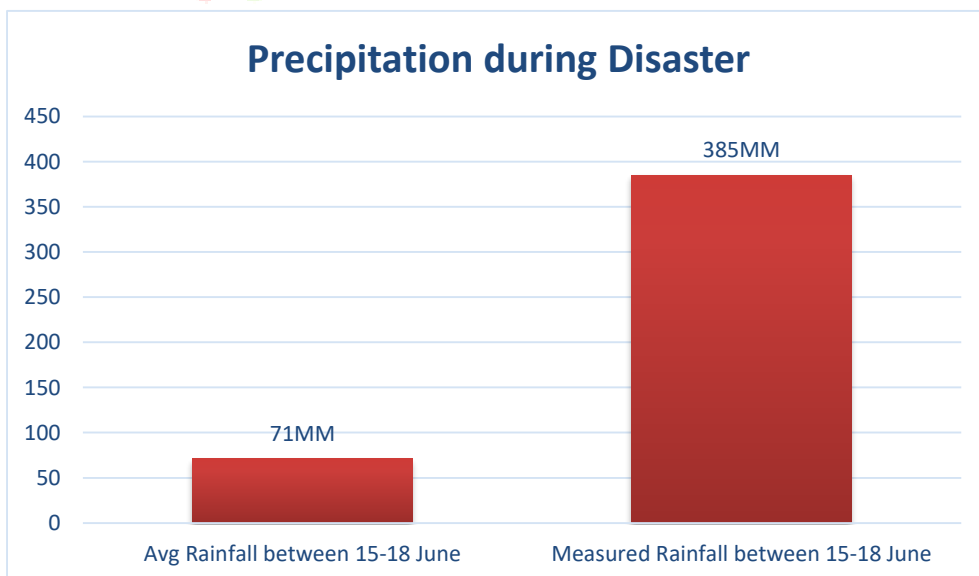


Fig 5. Map showing fusion of Westerlies and Monsoon clouds in June 2013

As per the Indian Meteorological Department (IMD), the rainfall in the State between 15 June and 18 June 2013 was measured at 385.1 mm, against the normal rainfall of 71.3 mm, which was in excess by 440 per cent. Thus, it can be inferred that the disaster was the result of extra precipitation in a very short duration of time, which resulted in heavy water discharge in various rivers and streams.

Table 3. Showing the rainfall comparison on flood day



The worst impacted settlements was:

- Kedarnath shrine area (Gaurikund to Kedarnath),
- Mandakini valley,
- Alaknanda valley (at Gobindghat and upstream),
- Pindar valley, and along the banks of the river Kali in Dharchula area.

The Kedarnath area in particular was impacted the most as it suffered unprecedented devastation with very heavy loss of life and property. Kedarnath Dham Township is located at an altitude of 3583m on the banks of the river Mandakini, which originates from the Chaurabari glacier - about 4 kilometers upstream. It is connected by a motorable road from Rudraprayag up to Gaurikund (40 kms) and thereafter through a mule track (14 kms), running along the Mandakini river.

A satellite view of the Kedarnath area, showing the Chorabari Lake, drainage system and the township is given at Figure 6. The river Mandakini joins river Alaknanda at Rudraprayag.



Fig 7. Satellite view of Kedarnath showing drainage system, glaciers, lake and township

The likely causes for the disaster in the area of Kedarnath have been a subject of several assessments. As per the Geological Survey of India (GSI), heavy rainfall, which was about 375 per cent more than the benchmark rainfall during normal monsoon, caused the melting of Chorabari Glacier at the height of 3800 metres. This resulted into eruption of the Mandakini River causing heavy floods in the Rudraprayag district and adjacent areas. It was also observed that the heavy rains between 15 and 17 June resulted in exceptionally high rise in the river discharges. The rise in the river level was of the order of 5 - 7m, where the valley was wide and 10 – 12m where the valley was narrow. In the upper stretches of the Mandakini river the stream gradient is high and valley profile is mostly narrow. The gush of water running down from Kedarnath and Rambara areas brought mammoth sediment load which consisted of huge rock boulders with diameter ranging from 3 - 10m. The heavy sediment load along with big boulders acted as a tool of destruction and obliterated everything that came in its way. The enormous volume of water also induced toe erosion along all the river valleys, which in turn, triggered landslides at a number of places.

As per the eye witnesses and technical inputs received from various agencies, the possible causes of the disaster could be summarized as:-

1. Collision of western disturbances with monsoon easterlies.
2. Glacial Lake Outburst Flood (GLOF)
3. Excessive precipitation in very short span of time.
4. Heavy erosion and the accumulation of large volume of water and sediment accumulation in major river beds due to excessive rainfall.

5. Run - off of loose debris, moraine and boulders with excessive force washing off all that came in its way.

CARTOSAT-1 image showing pre-flood situation



CARTOSAT-2A image of 20-June-2013 showing post-flood situation

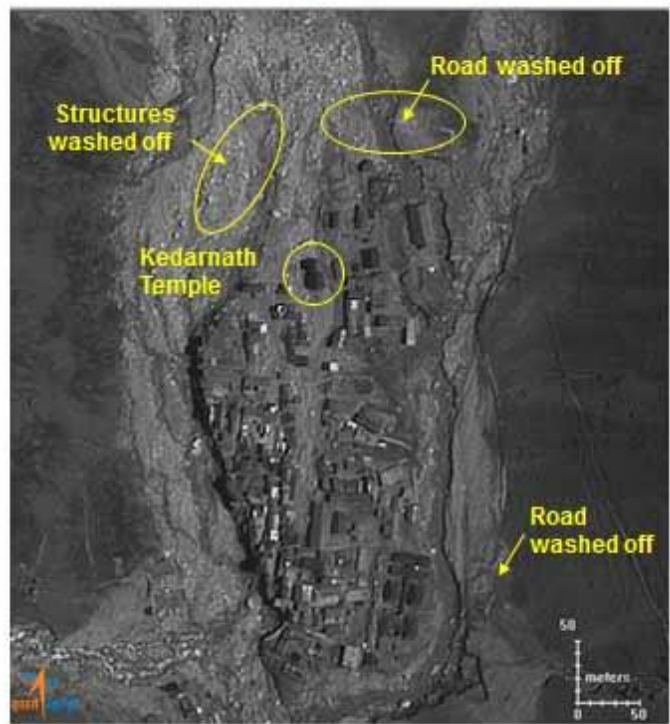


Photo courtesy: National Remote Sensing Centre, Indian Space Research Organisation

Fig 8. Satellite view of Kedarnath before and after flashfloods

3.2 Man-made Causes:

3.2.1 Ecology disturbance due to Non- scientific Construction

Haphazard, unregulated construction of roads and bridges was allowed on crumbling, landslide-prone ridges and steep slopes, ignoring the region's fragile geology and high earthquake vulnerability. Forests were destroyed on a large scale. Hundreds of buildings were constructed in the flood plains of rivers, their "natural" terrain, which should be no-go areas. Riverbeds were recklessly mined for sand. As construction debris accumulated, land contours and flows of streams and rivers changed.



Fig 9. Construction debris and activities along Mandakini River near the base from where the trek to Kedarnath begins

Indiscriminate building of hydroelectric dams was the worst culprit. These involve drilling huge tunnels in the hills by blasting rocks, placing enormous turbines in the tunnels, destroying soil-binding vegetation to build water channels and other infrastructure, laying transmission lines and carelessly dumping excavated muck. Many dams have been built on the same river so close to one another that they leave no scope for its regeneration. Dams steal water from local people. They alter the hydrological cycle and natural course of rivers. Uttarakhand's 70 completed large dams have diverted more than 640km, equivalent to half the length of its

major rivers. They have profoundly destabilised its ecology. Yet another 680 dams are reportedly in various stages of commissioning, construction or planning, mainly by private companies, which would be largely unaccountable. [7]



Fig 10. Vishnuprayag Hydroelectric Project on the Alaknanda River damaged by the flashfloods

The 400-megawatt Vishnuprayag Hydroelectric Project on the Alaknanda River was buried in mud & boulders, turning its backwater area for water storage into field of rubble. It took five months to dig this much of the dam out of the pile of boulders. [8]

3.2.2 Heavy rainfall warning ignored by Uttarakhand Government.

The warning from the meteorological centre in Delhi, which caters to the meteorological requirements of seven states of north India started to pour in for Uttarakhand from June 13. The 24-hours advance prediction of rather heavy rains (35.6-64.4 mm) on the first two days changed to heavy rains (64.5-124.4 mm) by June 15. For June 16 and 17, the centre issued warning for extremely heavy rains (more than 244.5 mm). These were the two days when Uttarkashi and Chamoli district witnessed maximum rains and the resultant disaster. [7]

3.2.3 Ignorance of fault lines during road construction:

The seismic fault lines were not kept in mind while building roads. These faultlines, which are active and seek back and forth movements have been cut in many places by roads. As a result, tiny seismic movements in the faultlines weakens the rocks at the base of the roads making these stretches susceptible to cave-ins and slides.

3.2.4 Drainage negligence:

Buildings have been constructed over old drains and streams, blocking the natural pathways of rainwater. One of the reasons for the devastation at Kedarnath was the people had constructed houses on the west stream of the Mandaki River that had been dry for decades. When the river returned to its old course following the deluge, these constructions were washed away. Another transgression was construction on river flood ways. “In places along Alakananda/Ganga such as Karnaprayag and Rishikesh, constructions have taken place on the lower terraces which are part of the flood way. [9]

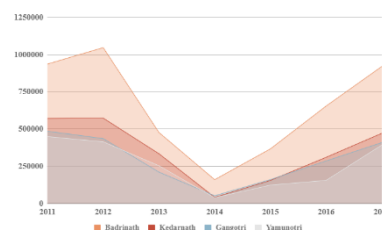
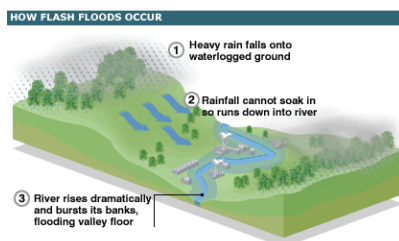


Fig 11. Illustration showing how floods occur

Fig 12. Chardham Tourism Data from 2011 to 2017

3.2.5 Huge tourist influx from India and around the world

Hill state Uttarakhand is not only geologically unstable but also ecologically sensitive. The state’s economy is majorly based on tourism. The number of people visiting the state as tourists is huge. To cater to tourists, deforestation, mindless construction of hotels and lodges on river edges, widening of narrow lanes is happening on a large scale. These activities are cutting right into the

toes of the delicate slopes of the state, thereby adding to the destabilizing process and exposing the state to nature's fury. According to the draft tourism policy 2017 of the Uttarakhand government, the number of tourists visiting Uttarakhand has consistently increased from around 11 million in 2000 to 28 million in 2012.

Following the 2013 disaster, it saw a dip but by 2015 the number was near 25 million. In 2018, it is expected to break all previous records and cross 30 million tourist arrivals – almost three times the population of Uttarakhand itself. By 2026 the number of tourists is expected to touch a whopping figure of 67 million.

4. Disaster Recovery:

4.1 Rescue and Relief:

Government of India supported the State Government in carrying out its evacuation and relief operations by providing support of armed forces and paramilitary forces, including National Disaster Response Force (NDRF).

- NDRF deployed 14 teams for the operation and rescued more than 9,044 persons.
- Indian Air Force had deployed about 45 helicopters and rescued more than 23,500 persons.
- Indian Army had deployed 8,000 personnel including 150 Special Forces
- Nehru Institute of Mountaineering, Uttarkashi, formed five rescue teams of 20 instructors and local youth, and evacuated more than 6,500 stranded persons.
- More than 1.35 Lacs persons were evacuated from the affected areas in the shortest possible time, despite widespread destruction of roads, difficult terrain and extremely hostile weather.
- All the essential supplies like food, drinking water, medicines, kerosene oil, solar lamps, etc. were continuously provided by air dropping as well as by surface means.
- A total of 69 relief camps were run, where 1,51,629 pilgrims/ local residents were looked after. Some camps continued operating beyond the emergency phase for the local residents. Approximately 900 trucks of relief material were received from other states and dispatched to the affected districts from a nodal/ relief centre, set up at Dehradun.
- To restore the communication, 105 satellite phones were distributed by the Government of India to various Central and state agencies. Besides, the efforts of BSNL towards restoration of communication were closely monitored by the National Crisis Management Committee. [8]



Fig 13. Rescue operations during and after flashfloods

4.2 Recovery and Reconstruction:

- The government devised a two-pronged strategy to restore the Kedarnath temple area. In the first phase, the government would construct protection walls behind the 800 year old Lord Shiva temple, re-channelizing Mandakini and Saraswati rivers and taking flood control measures at Kedarnath area. The restoration work of the Kedarnath shrine will only be done by the Archaeological Survey of India (ASI).



Fig 14. Sunken Samadhi Sthal of Shri Adishankaracharyaji



Fig 15. Retaining wall along Mandakaini River

- As part of the overall master plan for the Kedarnath, river edge protection is to be developed along this 350+ meter long river edge on eastern bank of river Mandakini. The proposed river edge Mandakini river will help in multiple ways; defining the flow of the river, protecting the soil from further erosion and providing platforms for views as well as providing Infra and Services path on the Western side of Kedarpuri. [10]
- In the second phase, the government would develop a new township at Lyncholi near Kedarnath and also a ropeway from Lyncholi to Kedarnath. All those buildings that have been declared unsafe at Kedarpuri will be demolished. The work for the stabilization of slopes will also begin.
- Construction of 9km long road across Mandakini river

4.3 Kedar Valley Projects:

There is greater vision of development of Kedar valley with multiple interventions along with the development of Kedarpuri. The flow of Mandakini River and topography of Kedarpuri give the favorable conditions for the formation of Ghats at the confluence point with Saraswati River. This development will allow the pilgrims to perform any religious ceremonies, adding strength to the values of Kedarnath Dham

- Maun Gufa / Meditation Caves along the Tirth yatra route (5 nos.)
- Smriti-van Memorial at foothills
- Road widening and Construction of Rambara to Garudchatti (5.25km - 1.9km Existing, 3.9km New)
- Road widening and Construction of GarudChatti to Kedartown (3.6 km)
- Saraswati Ghats & Retaining wall (JSW funded Project)
- Mandakini Ghats & Retaining Wall (Government Funded Project)
- Kedarpuri Central Approach Street widening & Grading (ONGC Funded Project)
- Shri Shankaracharya Samadhi/Virtual Museum (JSW funded Project)
- Guest Houses (8 nos.) on Saraswati & Mandakini River-banks
- Kedarpuri Infrastructure Project: Storm Water, Solid Waste Management, Water Supply, Electrification, Lane Cabling & other Sustainable Solutions.
- Balance 70 Houses for Tirth Purohits in Kedarpuri 12. Laser/Light and Sound show on mountain slopes

However the government has not shown keen interest and very few is done as compared to what's there in the proposal for the valley post the flashfloods. The construction of sunken Shri Adishankaracharya Samadhi Sthal behind the Kedarnath Temple is a matter of concern as it will become a catchment area for the snowfall and will put pressure on the valley. The deforestation for widening of roads and settlements may disturb the ecology and should be counter strategically by the executing bodies and the government as cutting of 33000-43000 of trees have already been given approval by the environmental ministry.

5. Conclusion:

1. The rising number of tourists in Uttarakhand is only going to intensify violations of construction laws as there will be competition to provide resources for them. The state government should ensure to enforce building by-laws to regulate constructions along the river banks.
2. Trained the local people on how to reduce the impacts of the disasters and build the disaster resilient towns.
3. Heavy buildings should not be constructed over glacier debris.
4. Non-scientific constructions which make the area more vulnerable to floods should be avoided.
5. Deforestation should be avoided as it may disturb the ecology as well as can lead to the landslides in the future.
6. Proper management of construction waste materials should be done or else the waste will be dumped in the rivers polluting the water.
7. An integrated solid waste management plan should be prepared keeping in mind the natural drain.
8. There is a need to move towards an environment friendly construction approach to use the resources in a sustainable manner.
9. A community participatory approach should be used to make the new township as it will help in rehabilitating as well as providing livelihood to the flood victims.

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