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16/17 June 2013 disaster of Uttarakhand, India and lessons learnt

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Abstract

Early arrival of monsoon, its collision with westerlies, ensuing abnormally high precipitation, resultant fast melting of fresh snow accompanied by breach of a glacial lake, Chorabari Tal; stage was thus set for a major hydro-meteorological disaster in Uttarakhand in June 2013. With no specific warning a disaster of this magnitude was not anticipated and everyone was taken by surprise. The incidence coincided with the peak of the tourist season when pilgrims, tourists and others from across the country and abroad had gathered in the disaster-affected region in large numbers. The incidence thus resulted in a major tragedy of recent times in which human death toll surpassed 4000. The disaster was a major setback for the economy of the state to which tourism and pilgrimage contribute a major chunk. Burden on public exchequer was further exacerbated by tax waiver and assistance provided to disaster-affected population even on losses that are not generally covered by State Disaster Response Fund. Important lessons were however learnt in managing this disaster and these would go a long way in strengthening the disaster management system not only in Uttarakhand but also elsewhere.

Keywords: *Uttarakhand • Kedarnath •Mandakini • Higher Himalaya •Monsoon • Landslide • Toe erosion • Flash flood • Glacial lake outburst.*

Introduction

Even after more than three years what exactly transpired in Uttarakhand, particularly in Kedarnath area on 16/17 June 2013 remains to be convincingly settled and hypothesis of various sorts are often put forth and keenly debated even today, not only by scientists and researchers but also by environmentalists, media personnel and masses (Dobhal et al., 2013; Rana et al., 2013; Rautela, 2013; Uttarakhand Flood Disaster, 2013; Bandyopadhyay and Sekhar, 2014; Chopra, 2014; Dube et al., 2014; Expert Committee Report, 2014; Kotal et al., 2014; Allen et al., 2015; Chattoraj and Champatiray 2015; Singh et al., 2015).

Environmentalists often attribute this tragedy to anthropogenic interventions; particularly hydropower projects (Uttarakhand Flood Disaster, 2013; Chopra, 2014; Expert Committee Report, 2014). The script of the disaster was however written in sparsely populated Higher Himalayan region of Uttarakhand that is bereft of anthropogenic pressure of any sort. Moreover, Forest Conservation Act, 1980 and other related legislations prohibit human interventions in major

portion of the disaster-affected region. Despite being strategically important this region at the same time has limited road connectivity and large portion of the region remains snowbound, particularly during winters when the inhabitants of the frontier villages retreat to lower elevations.

Most people are aware of devastation in Mandakini valley, particularly Kedarnath which is attributed to high media coverage due to massive loss of human lives. Entire Higher Himalayan region of Uttarakhand from Kali river valley in the east to Yamuna river valley in the west was however devastated by this disaster and 5 of the 13 districts of the state, namely Rudraprayag, Chamoli, Uttarkashi, Bageshwar and Pithoragarh were worst hit (Fig. 1). This disaster manifested itself in the form of flashflood, landslide, debris flow and toe erosion that are owed to excessive rainfall in the Higher Himalayan region that generally receives major portion of precipitation in the form of snow.

In 2013 monsoon arrived early and there was excessively heavy rainfall right in the beginning. As per the Indian Meteorological Department (IMD) the rainfall in the state between 15 and 18 June 2013 was 385.1 mm against the normal of 71.3 mm; augmented by 440 percent. This is attributed to the confrontation of the SW monsoon front with the westerlies (IMD, 2013).

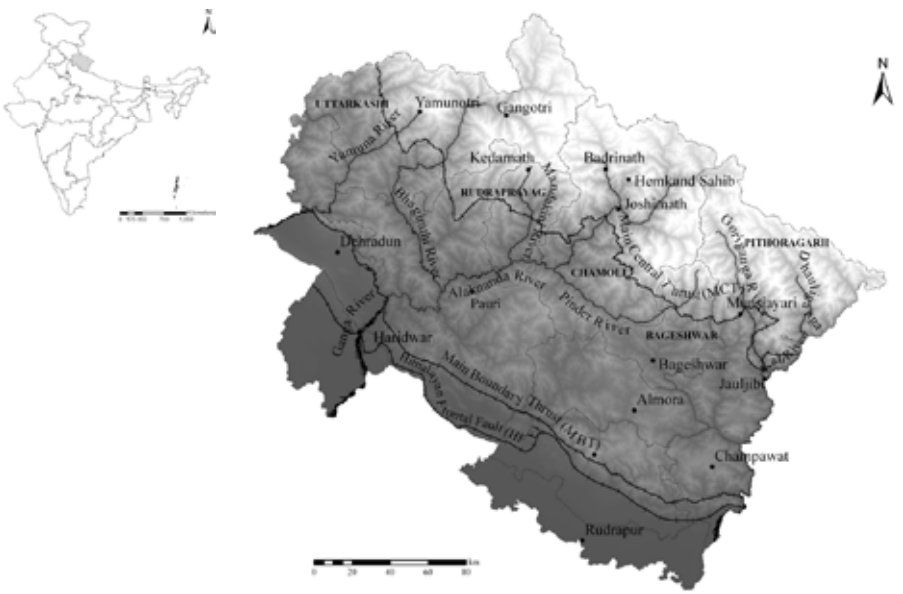

Fig. 1: Map depicting the location of the disaster affected districts of Uttarakhand

Heavy rainfall in the upper reaches resulted in water levels of all major rivers to rise and fast melting of winter snow due the impact of falling rain drops only

worsened the situation. Major devastation was largely caused by toe erosion by fast flowing debris laden mountain rivers.

Disaster affected area and its vulnerability

Major portion of the state of Uttarakhand is located in the Himalayan terrain and has altitudinal range of 200 to 7784 meters above sea level (asl). The state shares its border with Nepal in the east and Tibet (China) in the north and has 2 administrative divisions, Garhwal and Kumaun, and 13 districts. Of these 5 northern districts namely Bageshwar, Pithoragarh, Uttarkashi, Chamoli and Rudraprayag were worst affected by the disaster of 2013 (Fig. 1).

Geologically the disaster affected area falls in Lesser Himalaya, Central Crystallines and Higher Himalaya. Main Central Thrust that is a major tectonic discontinuity of the Himalaya traverses through the state along which the Central Crystallines are juxtaposed against Lesser Himalaya along a N-NE dipping tectonic discontinuity. The area has particularly high relative relief that promotes mass wastage and erosion. Except for Uttarkashi, some portion of which falls in Zone IV all the disaster affected districts fall in Zone V of Seismic Zonation Map of India (IS 1893, 2002). Geological set up, ongoing tectonic activities and high relative relief coupled with peculiar meteorological characteristics make the area vulnerable to a number of hazards of which earthquake, landslide and flash flood are common.

The disaster-affected region has a number of picturesque tourist destinations that include Joshimath, Auli, Chopta, Gopeshwar, Bageshwar, Chaukori and Munsyari. The area also houses a number of sacred shrines and pilgrimage routes. Besides Chota Kailash-Kailash-Mansarovar and Hemkund Sahib these include Chardham route leading to Badrinath, Kedarnath, Gangotri and Yamunotri that is the biggest and most cherished Hindu pilgrimage circuit of the country (Fig. 1). Being located in Higher Himalaya the duration of the Chardham pilgrimage is restricted between June and November; exact dates of opening and closing of the sacred shrines are decided according to Hindu tradition. People from across the country and abroad thus visit the area in large numbers. Tourism and pilgrimage are thus a major source of income for the people of the area as also for the state.

This region is also source to major glacier-fed Himalayan rivers that include Alaknanda, Bhagirathi, Mandakini, Yamuna, Kali, Dhauli and Pinder. Alaknanda and Bhagirathi confluence at Devprayag and thereafter the river is known as Ganga. Mandakini valley of Rudraprayag district that was hit the hardest by the disaster of June 2013 houses sacred Hindu shrine of Kedarnath that is dedicated to lord Shiva, the God of death and destruction. The temple township (Fig. 2) is located on glacial outwash deposits at an altitude of 3581 meters asl. For

reaching Kedarnath one had to trek upstream along the course of Mandakini from Gaurikund for a distance of 14 kilometers (Fig. 3).

Fig. 2: View of the temple township of Kedarnath, with camera looking east

Originating from Chorabari glacier Mandakini river forms the western boundary of the temple township while abandoned channel of Saraswati, that had confluence with Mandakini to the south of the temple forms the eastern boundary. Dudh Ganga meets Mandakini to the south of Kedarnath and thereafter till Gaurikund, Mandakini maintains a tectonically controlled NNE–SSW course (Fig. 3).

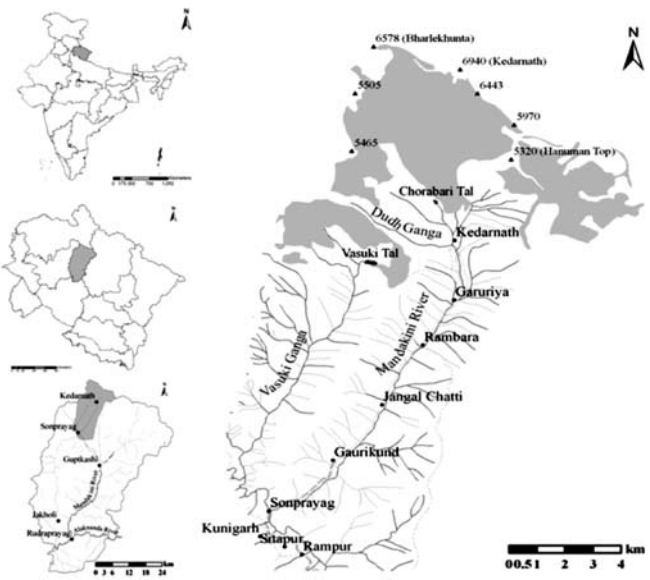

Fig. 3 Location map of Kedarnath area. To the left are maps of India, Uttarakhand and Rudraprayag district

A moraine dammed lake, Chorabari Tal, was present little downstream of the snout of Chorabari glacier. This lake was located in the depression formed in the glacial material to the west of the right lateral moraine and was fed by the seepage of the glacial melt. The lake did not have a well-defined outlet and its water used to seep out along the moraine slope to the NNW of Kedarnath. Even though the depression was around 200 meters long, 100 meters wide and 15–20 meters deep, not more than 2–3 meter water used to be there in the lake.

Table 1 Disruption of major highways due to landslides and toe erosion during the monsoon period between 2010 and 2015 (Data source: State Emergency Operations Centre, Uttarakhand)

Sl. No.	Highway	Year	Number of days when traffic was disrupted on the highway					Road disruption (in percent)
			June (30 days)	July (31 days)	August (31 days)	September (30 days)	Total (122 days)	
1.	Rishikesh – Badrinath (NH 58)	2010	1	17	25	9	52	42.6
		2011	2	13	14	10	39	32.0
		2012	2	6	18	7	33	27.1
		2013	15	20	17	13	65	53.3
		2014	1	5	4	4	14	11.5
		2015	5	15	17	0	37	30.3
		Total	**26**	**76**	**95**	**43**	**240**	**32.8**
2.	Karnaprayag – Kedarnath (NH 109)	2010	3	12	9	15	39	32.0
		2011	5	9	17	4	35	28.7
		2012	5	8	6	5	24	19.7
		2013	13	21	18	13	65	53.3
		2014	2	11	2	5	20	16.4
		2015	5	12	5	0	22	18.0
		Total	**33**	**73**	**57**	**42**	**205**	**28.0**
3.	Dharasu – Yamunotri (NH 94)	2010	0	7	40	19	66	54.1
		2011	5	5	14	12	36	29.5
		2012	4	5	16	13	38	31.2
		2013	12	20	22	18	72	59.0
		2014	1	10	4	5	20	16.4
		2015	0	4	2	0	6	4.9
		Total	**22**	**51**	**98**	**67**	**238**	**32.5**
4.	Rishikesh – Gangotri (NH 108)	2010	1	9	38	19	67	54.9
		2011	7	14	16	19	56	45.9
		2012	5	4	22	10	41	33.6
		2013	17	16	18	17	68	55.7
		2014	0	19	7	3	29	23.8
		2015	1	4	6	0	11	9.0
		Total	**31**	**66**	**107**	**68**	**272**	**37.2**

Both landslide and flash flood are common in the region during the monsoon period, rainy season over the India sub-continent, which extends between mid-June and mid-September. This period coincides with the ingress of both pilgrims and tourists in large numbers. Road connectivity in the region is often disrupted for long periods during this time due to landslides and toe erosion by the rivers (Fig. 4; Table 1). It is a cause of inconvenience, discomfort and misery for pilgrims, tourists and others who are often forced to change their travel plan. It at the same time is a major concern for the state that has to resort to extraordinary measures for evacuating the stranded people and ensuring supply of essential items in the cut off areas.

Fig. 4 View of road disruption in June, 2013 due to bank erosion in the proximity of Tawaghat, Pithoragarh (left) and debris slide in Dharali, Uttarkashi (right)

The disaster of 16 / 17 June 2013

There was heavy rainfall in the entire state with the onset of monsoon that arrived early in 2013. This is attributed to the clash of the SW monsoon front with the westerlies. Prolonged and unprecedented heavy rainfall between 14th and 18th June 2013, over a large area, resulted in flash floods and landslides at many locations, which eventually turned into a massive disaster.

Table 2 Precipitation as recorded by IMD stations in the disaster-affected areas between 14 and 18 June, 2013 (Data source: India Meteorological Department, Government of India)

Sl. No.	Location	Precipitation (in mm)				
		14 June	15 June	16 June	17 June	18 June
1.	Bhatwari	20.0	18.0	35.0	70.0	50.0
2.	Barkot	10.0	15.4	112.6	20.0	20.0
3.	Chamoli	1.0	40.0	58.0	80.0	100.0
4.	Jakholi	30.0	70.0	121.0	110.0	70.0
5.	Joshimath	0.0	31.4	41.9	113.8	80.0
6.	Karnaprayag	8.2	7.0	88.0	90.0	82.3
7.	Munsyari	4.0	25.0	44.0	85.0	75.0

Sl. No.	Location	Precipitation (in mm)				
		14 June	15 June	16 June	17 June	18 June
8.	Pithoragarh	0.0	0.0	11.2	90.0	120.0
9.	Purola	30.0	40.0	170.0	60.0	104.0
10.	Rudraprayag	4.0	11.8	89.4	92.2	59.2
11.	Tharali	0.0	15.0	58.0	173.0	80.0
12.	Uttarkashi	15.0	50.0	130.0	162.0	19.0

The rainfall in the state between 15th and 18th June 2013 is measured to be 385.1 mm against the normal of 71.3 mm, which is in excess by 440 percent. In the period of 5 days between 14th and 18th June, the state received approximately 2000 mm of rainfall, which is more than what it receives during the entire monsoon period (Table 2). Percent deviation in rainfall clearly shows that the rainfall during the week ending on 12th June (6th to 12th June 2013) was more than 100 percent in all the districts except Pithoragarh. The rainfall however increased enormously in the subsequent week when it was measured to be 997 percent higher than normal over the state. Except for Pithoragarh and Rudraprayag deviation from normal in other three districts was more than 1000 percent in the week ending on 19th June (Table 3).

Table 3 Weekly percentage deviation of actual rainfall from normal in the disaster affected districts of Uttarakhand in June – July 2013 (Data source: India Meteorological Department, Government of India)

Sl. No.	District	Percent deviation in rainfall in the week ending on						
		12 June	19 June	26 June	3 July	10 July	17 July	24 July
1.	Bageshwar	137	1387	- 58	59	127	- 45	- 22
2.	Chamoli	185	1302	111	37	187	96	96
3.	Pithoragarh	13	238	- 41	- 50	- 4	49	- 10
4.	Rudraprayag	213	580	74	- 35	- 21	- 51	16
5.	Uttarkashi	112	1356	- 1	- 12	- 22	- 12	24

Fast melting of fresh show due to rainfall impact added to the discharge of the streams and rivers that crossed the danger level. The level of Mandakini at Rudraprayag was 7.5 meters above the danger level on 18th June 2013 and around this time most rivers in the region were flowing well above their normal levels (Fig. 5). Gushing debris laden water through the high-gradient mountain streams thus breached the banks and washed off roads, bridges, habitations and other infrastructure on their way.

Devastation was particularly severe in the Mandakini valley, particularly in Kedarnath-Rambara-Gaurikund area. This is attributed to the breach of

Chorabari Tal that had accumulated enough water to force the moraine barrier to give way (Dobhal et al., 2013, Rautela, 2013).

Fig. 5 View of the motor bridge over Alaknanda at Rudraprayag in April, 2013 (left) and on 17 June, 2013 (right) with camera looking NNW

Late in the evening of 16th June 2013 debris brought down by Dudh Ganga blocked Mandakini river in the proximity of Kedarnath. The embankment on the left bank of the Mandakini soon gave way and the abandoned channel of Saraswati to the east of Kedarnath became active. This resulted in washing off of some people in the evening of 16th June 2013 from Kedarnath, that thus became water locked. Sankaracharya Samadhi, Jal Nigam guest house and Bharat Seva Sangh Ashram were also washed off in this event. Rising level of the landslide dammed lake forced the barrier to give way and the ensuing floods late in the evening of 16th June 2013 completely washed off Rambara and devastated Gaurikund. All connectivity with the area was thus snapped (Rautela 2013).

Persistent heavy rains caused the level of water in Chorabari Tal to rise continuously. With the recession of the glacier the lake had a weak moraine barrier that could not withstand mounting hydrostatic pressure. Stage was thus set for a major disaster in Kedarnath and the barrier ultimately gave way around 7 AM on 17th June 2013. The volume of water was enormous and it carried with it huge glacial boulders and outwash material that choked the course of Mandakini and the flow of water and debris got diverted towards the temple township that was thus ravaged (Fig. 6).

There was absolutely no warning and most people were taken by surprise and had no time to respond. Besides Kedarnath this event caused devastation in Gaurikund, Sonprayag and other places.

Fig. 6: View of the Kedarnath township ravaged by the flood of June, 2013 with camera looking south

Human congregation in Kedarnath

Higher Himalayan shrines of Uttarakhand witness high influx of devotees in the beginning of the pilgrimage season due to (i) pleasant weather conditions, (ii) less of rains and road disruptions and (iii) summer vacations in schools and collages. Pilgrimage was late to start in 2013 and Kedarnath and Badrinath shrines opened to public on 14th and 16th May respectively while Gangotri and Yamunotri both opened on 13th May. This delay of almost a fortnight resulted in congregation of large number of people who wanted to finish the pilgrimage before the onset of rains.

The number of people that had gathered in the Gaurikund–Rambara-Kedarnath area when the disaster took place on 16/17 June 2013 was unusually high by all standards. Due to Uttarakhand High Court order on the issue of sanitation on pedestrian route to Kedarnath movement of horses and mules was temporarily suspended in 2013. This slowed the pace of movement and people who could have easily travelled back to Gaurikund on mule or horse back were forced to stay overnight at Kedarnath or Rambara.

Moreover routine helicopter service from Guptakashi to Kedarnath was suspended a couple of days before the disaster due to continuous rainfall resulting in poor visibility. The ones intending to travel by air thus had no option but to travel on foot and stay overnight at Kedarnath or Rambara.

Apart from this continuous heavy rainfall severely slowed down the pace of movement and many people were forced to change their travel plan and stay overnight at Kedranath or Rambara.

It was the peak pilgrimage season and Gaurikund–Rambara–Kedarnath area was highly overcrowded. With no provision of registration in place at that time no one really has an idea as to how many people were actually there in this stretch when the disaster struck.

Losses

Landslides, flash flood and toes erosion induced by incessant heavy rainfall in the Higher Himalayan region led to massive loss of human lives, infrastructure and property. The details of the same are summarized in Table 4. It is to be noticed that apart from loss of human lives other losses in the disaster-affected districts are comparable. It is due to the loss of human lives in Mandakini valley that most people consider 2013 disaster to be restricted to Rudraprayag district.

Table 4 District wise losses incurred in the state due to the disaster of June 2013 (Data source: State Emergency Operations Centre, Uttarakhand)

Head	Rudraprayag	Chamoli	Utarkashi	Pithoragarh	Bageshwar	Total
Persons dead	30	33	14	19	4	100
Persons missing	3998	0	0	21	0	4019
Persons injured	71	31	29	49	3	183
Farm animals lost	2771	1119	474	5263	665	10292
Fully damaged houses	445	566	249	702	25	1985
Severely damaged houses	374	647	527	340	130	2018
Partially damaged houses	905	2188	1967	397	133	5590
Silted agriculture land (in hectares)	1	379	341	12	8	741
Agricultural land lost (in hectares)	4279	242	339	5575	234	10669
Crop loss (in hectares)	8	245	103	113	28	497

Besides direct losses and cost of search, rescue and evacuation the state incurred heavy loss of revenue due to the disaster. Economy of the state is highly dependent upon pilgrimage and tourism and there was steep decline in the number of people visiting the state on the aftermath of the disaster (Table 5). Resumption of normal pilgrim and tourist inflow is sure to take some time and this would require dedicated effort to convince the potential visitors that Uttarakhand is safe to visit.

On the aftermath of the disaster the state waived off tax dues, particularly on tourism, hospitality and transport industry. Electricity and water dues of the masses in the disaster-affected area were also waived off. Moreover in view of severity of the disaster impact the state extended relief on items that are not generally covered by State Disaster Response Fund (SDRF). The quantum

of admissible relief was also increased by many times. In order to help them sustain during this crisis relief was also provided to commercial enterprises that are not generally covered by SDRF norms.

Table 5 Pilgrim footfall over major shrines in the disaster affected area in the period 2011–14 (Data source: Uttarakhand Tourism Development Board, Uttarakhand)

Name of place	Month	Number of pilgrims				
		2011	2012	2013	2014	Average fall in percentage in the year 2014
Badrinath	May	225558	4138812	238116	53798	96.5
	June	398260	358662	251808	42676	87.3
	July	43952	55383	-	7560	77.2
	August	48473	43366	-	3368	89.0
	September	132794	54916	-	17070	72.7
Kedarnath	May	245821	298182	149689	13823	94.0
	June	249386	196830	182551	14091	93.3
	July	29216	27712	-	3041	84.0
	August	11759	11496	-	944	87.8
	September	20746	12823	-	3796	66.1
Gangotri	May	146870	195618	105617	20193	86.5
	June	233190	175272	104136	15656	90.8
	July	57355	40124	-	6857	78.9
	August	9229	416	-	675	79.0
	September	21843	3970	-	3337	61.2
Yamunotri	May	170126	206545	115786	15316	90.7
	June	196833	142182	136997	13709	91.4
	July	44864	34312	-	3725	85.9
	August	16396	1001	-	612	89.4
	September	32083	5231	-	2393	80.8
Hemkund Shahib	May	-	-	12430	4071	1.7
	June	257133	178049	61867	19466	88.3
	July	137253	57879	-	6907	89.4
	August	92653	27658	-	2213	94.5
	September	40430	29175	1753	3075	87.1
Total		**2862223**	**6295614**	**1360750**	**278372**	**92.1**

Aftermath of the disaster

Though there was general forecast of heavy rains over the entire state none had expected such a large area to be affected in one go. Communication was hit hard and there was literal information vacuum and no one had the slightest clue as to what had transpired. This caused confusion and delayed response and resource mobilization, particularly in the initial phase. There was severe disruption of surface transport network and almost all the major highways of the state were blocked due to landslides and washing away of roads. More than 150000 persons were thus stranded at various places across the state.

Magnitude of human loss together with large number of persons stranded at various places in Mandakini and Alaknanda valleys; particularly at Kedarnath, Bhimbali, Gaurikund, Hemkund Sahib, Ghagharia, Govindghat and Badrinath resulted in high media attention in these areas. Relief and rescue efforts were thus focused on these areas. Concentration of aerial rescue operations facilitated easy entry of media personnel even to the remotest areas. This in turn encouraged media to focus attention on this very region. All rescue and relief efforts were thus initially focused on Mandakini and Alaknanda valleys and the people in the other disaster-affected regions of the state could not get immediate and adequate attention.

All communication links with Mandakini valley were snapped in the evening of 16th June 2013. Adverse weather and terrain conditions did not provide opportunity of resorting to alternative probes. The outside world as also the district administration therefore remained unaware of the events in Mandakini valley till 18th June 2013.

With improved weather and visibility aerial rescue operations were initiated in early hours of 18th June 2013 and 2007 persons were evacuated on the same day from Kedarnath. Realising the constraints being faced in aerial rescue operations 69 permanent and temporary helipads were quickly activated across the state and besides 17 civilian choppers hired by the state government 54 Indian Air Force (IAF) choppers and fixed wing crafts, 7 Army Aviation choppers and 4 choppers of other states were pressed into service (Fig. 7). Due to limited stock of aviation turbine fuel (ATF) in the disaster affected area and inability to immediately move in bowsers due to road disruption precious time was however lost in refueling. Despite constrains of various sorts more than 39165 persons were evacuated by air alone and this proved out to be the biggest aerial evacuation ever attempted.

Fig. 7 View of the aerial evacuation of pilgrims stranded on Rambara - Kedarnath track by Indian Air Force

Ground search and rescue operations were slightly delayed due to washing off of motor roads as also pedestrian track leading to Kedarnath and Hemkund Sahib at many places. Despite best efforts and intentions terrain conditions made it difficult even to airdrop food and water at many locations and this added to the sufferings and trauma of the affected persons. Besides civil administration and state Police National Disaster Response Force (NDRF), Indo – Tibetan Border Police (ITBP), IAF, Indian Army and Indian Navy joined rescue operations.

The evacuated persons from Mandakini, Alaknanda and Bhagirathi valleys were first brought to then operational road head at Guptakashi, Joshimath and Chinyalisaur respectively. 586 buses and 1440 taxies were requisitioned for evacuation and 71 relief camps were organised across the state that catered to food, shelter, medical and other needs of 151629 persons for different durations.

Large number of evacuees had lost all their belongings and did not have resources to manage their journey back home. Arrangements were therefore made for the return journey of the evacuated persons who were also provided cash assistance to cover their in-journey expenses.

Despite best efforts evacuation could only be completed on 23 June 2013. Rescue operations were however not risk free and 4 choppers crashed during rescue operations. 48 persons engaged in rescue operations including 5 of IAF, 9 of NDRF, 6 of ITBP and 28 of State Police, Administration, Forest and Civil Aviation lost their lives while engaged in rescue operations.

Lessons learnt

Every disaster exposes the shortcomings of the system and highlights key elements of the vulnerability of the affected community. It thus provides an opportunity to plug the holes and be better prepared for the next disaster. Sharing of these experiences is vital as taking lead from these effective and context specific measures can be planned and implemented for strengthening resilience and avoiding disaster induced loss, misery and panic. Issues related to the same are discussed in the sections below.

Telecommunication: All communication links with the disaster-affected area, particularly in the Mandakini valley, were disrupted in the evening of 16th June 2016. The last received message from Gaurikund-Rambara-Kedarnath area was hurriedly communicated through Police wireless network at Rambara before its being washed off. It certainly indicated an emergency situation but what exactly had transpired could not be fully comprehended from it. Mobile towers in the area also became dysfunctional soon due to electricity disruption, shortage of fuel to run the generators and other technical snags. Moreover batteries of most mobile phones were drained off while still trying to search the network.

Communication having been disrupted there was no information coming to State Emergency Operations Centre (SEOC) from the disaster-affected area. Besides delaying response this added to the confusion as different versions started being aired by the media due to lack of authentic information.

Steady inflow of updated, authentic and reliable information is vital to effective management of any disaster. There thus has to be a mechanism for ensuring regular inflow of updated information from the disaster-affected area under all circumstances. The communication system should therefore be robust and reliable with at least triple redundancy so as to ensure functional alternative communication under all circumstances.

Disruption of communication at the same time adds to panic and trauma of disaster-affected people and therefore alternative power arrangements have to be put in place for running mobile towers. The mobile service providers should therefore be persuaded to maintain adequate stock of fuel to operate the generators and install solar power back up facility, particularly in the remote and disaster prone areas. Solar powered mobile recharging facilities should at the same time be created, particularly in areas that are visited by people in large numbers. At the same time people venturing to these areas should be educated on ways of delaying discharge of mobile battery through awareness campaigns.

Though facing information blackout SEOC was flooded with requests for updated information from officials, media and next of kin of the persons who had come over to Uttarakhand. To cope up with this situation a number of new telephone

lines were hurriedly activated at the SEOC. Many telephone numbers, including some personal mobile numbers of the officials, thus got circulated through various modes and this amounted to confusion.

SEOC should therefore have a single telephone number with multiple lines and with capability of being upscaled during major disaster incidences. Dedicated four-digit toll-free number of SEOC (1070) should be utilised for this purpose. For the convenience of the masses this number should be publicized through various modes. Use of one number would be convenient for all concerned. Mobile numbers of disaster management officials should not be made public as this distracts their attention from other important tasks they have to handle during disaster situations.

Media briefing: Arrangements for media briefing and providing information to next of kin of disaster-affected persons were not in place. This resulted in overcrowding at the SEOC and often disrupted its routine functioning.

After any disaster media personnel are under immense pressure to report the latest updates and lack of information from authentic sources often results in rumors that add to the trauma of affected population. This at the same time demoralizes the ones engaged in post–disaster operations.

Special care therefore needs to be taken for briefing of media persons at regular intervals by duly authorized persons having access to authentic and updated information. The media personnel should at the same time be provided assess to video feeds and photographs of the disaster affected area, particularly those depicting progress of rescue and relief measures. Besides satisfying the next of kin of the affected persons this would boost the morale of the persons engaged in rescue and relief operations. If possible arrangements should also be made for taking the media personnel to the disaster-affected area.

The persons involved in operations should not be overburdened with the responsibility of interacting with media. Media should at the same time be discouraged from venturing into the SEOC.

Public information: Responding to public queries, particularly from the next of kin of the persons perceived to be present in the disaster-affected area overburdened the SEOC. Large number of callers had come to know of the incidence through media and not being conversant with the geography of the state they were not sure as to which area was actually affected by the disaster and in which area their next of kin were present. Most callers were in an emotionally disturbed state and required counseling and consoling. Talking to them was no less than a trauma for people manning the SEOC. Moreover large number of callers could not communicate either in Hindi or English.

On the aftermath of any disaster it is normal for next of kin of the affected persons to seek information on the welfare and whereabouts of their loved ones. Separate arrangements have therefore to be made for responding to their queries. If possible persons with special tele-counseling and psychologically consoling skills should be engaged for this. Special care should be taken in incidences where there is possibility of linguistic differences between the potential callers and the ones responsible for responding to public queries. This becomes particularly pertinent if the disaster-affected area is routinely visited by people from other states or nations in large numbers. In such cases people conversant with the language of the potential callers should be engaged. Assistance of pre-registered volunteers could be taken for this purpose.

Information management: After a while the information being received at the SEOC from different sources became so voluminous that it became difficult to process, segregate and use it for decision making, planning and resource mobilisation. Moreover both officials and non-officials soon started to seek synthesized and specific information on various aspects of the disaster. It often became difficult to respond to their queries.

SEOC should therefore be adequately manned and have the required information handling and processing capabilities so as to ensure that the information received is quickly analysed and used for decision making, particularly relating to response and resource mobilization. The information received at SEOC has also to be segregated so as to promptly address any specific information requirement.

Relief and rescue: Though highly specialized, professionally trained and well equipped, the response forces called in for search and rescue on the aftermath of the disaster were not conversant with local terrain and weather related peculiarities. They at the same time did not have knowledge of alternative routes, locally available resources and hardships likely to be faced while undertaking rescue. Moreover induction of rescue workers in the disaster-affected area was not easy due to transport disruption coupled with bad weather conditions.

Knowledge of local ground realities is often critical to the success of search and rescue operations, particularly in the mountainous terrain. Local people therefore enjoy a distinct advantage and in almost all disaster incidences local people and other survivors are the first responders. It is therefore necessary to train local people in search and rescue and provide them required equipment so that they are better prepared to face emergency situations and help their community as also others.

The specialized response forces being raised by the states should at the same time be exposed to local ground realities through regular ground familiarization exercises. This would ensure their effectiveness in the event of a disaster.

Governance: On the aftermath of the disaster taking clue from the Comptroller and Auditor General report (CAG, 2010) the issue related to ineffectiveness of the State Disaster Management Authority (SDMA) was repeatedly highlighted by the media. Besides maligning the image of the state government it adversely affected the morale of the officials engaged in post-disaster operations.

For effective disaster governance it is therefore a must to strengthen and empower institutions responsible for disaster risk reduction; particularly SDMA, State Executive Committee (SEC) and District Disaster Management Authorities (DDMA). Most states are not paying due attention to the very fact that the Disaster Management Act, 2005 requires all executive actions to be taken either by SEC or DDMAs with SDMA being a policy making and supervising institution. Adequate attention is therefore required to strengthen and empower SEC and DDMAs in the spirit of DM Act, 2005.

Disaster management being a multi–departmental affair, coordination and unity of command are critical to the success of post–disaster response. Apart from state administration, police and different state government departments a number of other agencies were involved on the aftermath of the disaster. These included Army, IAF, NDRF, ITBP and Indian Navy. The uniformed services have their peculiar command structure and reporting procedure due to which problems were faced in information exchange and coordination.

SOPs and protocols pertaining to command structure, reporting formats, procedures and information exchange have to be therefore laid down, circulated and rehearsed well in advance to rule out possibility of lapses and confusion on the aftermath of any disaster.

Registration of tourists/pilgrims: Estimating the number of persons involved in the disaster of June 2013 was a major challenge and there were varying claims from various quarters that added to the confusion. It is therefore required that the pilgrimage be regulated and persons be registered. Besides keeping track of exact number of visitors this would help in communicating with them in case of any exigency.

It however needs to be appreciated that the pilgrimage circuit of the state has its peculiarities; (i) there is no single entry point and one can access the circuit from a number of entry points, and (ii) there are habitations all along the route till the very end and local people travel through the circuit in large numbers which makes differentiation of pilgrims and tourists difficult and registration challenging. It might therefore be hard to totally regulate the entire pilgrimage but adequate registration and other measures have to be necessarily implemented in areas where people have to trek; Kedarnath, Gomukh, Hemkund Sahib, Yamunotri and Chota Kailash-Kailash-Mansarovar. In these areas only a specified number

of persons should be allowed beyond the last road head at Gaurikund, Gangotri, Govindghat, Janki Chatti and Tawaghat after duly registering their details.

People visiting high altitude shrines have often been facing health related emergencies and a number of people, particularly on Gaurikund-Kedarnath trek, die every year due to various ailments. Health check up should therefore be made mandatory for all persons wishing to venture in these areas and only physically fit should be allowed. These persons should also be briefed on the terrain and weather conditions together with other associated hazards that the terrain might offer.

Support for evacuees: Large number of disaster-affected persons had lost all their belongings and had no resources to manage their journey back home. Having come over from long distances these people at the same time had no acquaintances around to look for help. Standard relief guidelines issued by Ministry of Home Affairs, Government of India has no mention of such situations.

In view of special circumstances the state government made arrangements for the return journey of the evacuated persons and also provided special cash assistance for covering en route expenses. It is therefore required that provision for catering to such situations be standardized, particularly for areas that are routinely visited by people from far and wide in large numbers. This would ensure prompt dispatch of the disaster-affected persons to their destinations.

Surface connectivity: Blockade of motor roads due to landslide and flash flood is common in the hills. Most tourist and pilgrim destinations in the Higher Himalaya have single road connectivity and blockade of the same often results in persons being stranded in large numbers. Providing logistics support to the stranded persons and ensuring their early evacuation thus becomes a major concern of the state.

After the disaster of June 2013 more than 150000 persons were stranded at different places across the state due to road blockade caused by landslides and washing off of road stretches at many places. Despite best efforts major roads of the disaster affected area could only be opened for light vehicles in September–October 2013. Large number of stranded persons had to be therefore evacuated by air. Constrains put forth by availability of airspace, helipads, refueling and weather conditions thus delayed evacuation.

It is therefore required that surface connectivity in the region be improved and alternative motor roads be planned and developed so as to ensure alternative connectivity during disaster incidences. In the disaster of 2013 most motor roads in the proximity of rivers and streams were washed off due to bank

erosion. Wherever possible the alignment of new roads should therefore be kept sufficiently away from rivers and streams.

Aerial evacuation: Due to prolonged disruption of roads aerial evacuation of the stranded pilgrims and others was the only available option. Large number of helicopters were therefore mobilised for this purpose. These however could not be optimally utilized due to the constraints put forth by limitation of airspace and helipads. Moreover adequate refueling facilities were not available in the disaster-affected area and bowsers could not be moved in immediately due to road disruption. Valuable operational time was thus lost in refueling of the choppers.

In view of the terrain conditions helipads with adequate stock of ATF should be developed in the hills at strategic locations. This would make disaster response prompt and effective. This would at the same time facilitate tourism and adventure sports that in turn would boost the economy of the region.

Linguistic issues: Apart from foreign nationals the disaster involved people from more than 23 states of India. The disaster-affected persons thus exhibited distinct linguistic diversity and large number of them could not communicate in a language that is commonly understood by the people of the state; Hindi and English. These persons generally come on pilgrimage in large groups where a few persons who can communicate in Hindi or English facilitate interaction. When dissociated from the group communication for most persons, particularly women became a big challenge. This put forth numerous problems for both rescue workers and relief providers. People responding to public queries also faced similar problems.

On the aftermath of a disaster involving people from different linguistic backgrounds, communication with disaster affected persons could became a problem. It is therefore required that the relief camps be adequately staffed with persons who are conversant with the language of the potential evacuees. For this volunteers could be registered and their services could be mustered as the requirement arises.

Missing persons: Large number of persons went missing in the disaster of June 2013. Legal procedure in India for declaring a missing person dead requires the missing person to be unheard of for a minimum period of 7 years by the ones who would normally have information on his/her whereabouts. Moreover ex-gratia relief admissible out of SDRF can only be provided to the next of kin of those deceased in the disaster incidence. The SDRF guidelines have no mention of the persons missing in disaster incidence.

Besides claiming relief the next of kin of the missing persons required death certificate for settling various familial, societal, official and legal issues. At that

time there existed no guidelines for declaring missing persons as being dead. Due to this disbursement of relief and death certificates was delayed. This added to the trauma of the family members of the missing persons. This issue could only be resolved after the Registrar General of India issued fresh guidelines on 16 August 2013 and prescribed procedure to be followed for declaring missing persons as being dead and issuing death certificates.

This arrangement however was specifically for the disaster of 2013 and cannot be applied to other disasters in future. It is therefore required that standardized guidelines and procedures be put in place for declaring persons missing in disaster incidences as being dead so that the next of kin of the deceased persons are not unnecessarily traumatized.

Evacuation: Injured, ill, elderly, women and children are generally accorded priority in evacuation and this thumb rule was followed on the aftermath of this disaster as well. This went on well till there were injured and ill around but after that people declined to be dissociated from their group.

It was soon realized that the people had come over in close knit groups to the disaster affected area from far and wide for pilgrimage and had no familiarity with the area. In many such groups only 1-2 persons could speak and understand Hindi or English and for the females taking to strangers, particularly males was taboo. Disassociation from the group, that too after experiencing such a major disaster thus added to their trauma and infused sense of insecurity.

The ones evacuated alone in the initial phase thus denied to leave till others in the group were evacuated. This added to the burden of ones engaged in relief and rescue operations. Taking clue from the experience it was later decided to evacuate people in groups rather than segregating them on the basis of age and sex. It is therefore necessary that the evacuation priorities be decided only after fully understanding the composition of the affected population.

Needs assessment: Large volume of relief supplies that reached the disaster-affected area was not actually required and handling of the same only added to the burden of the officials. Packaged water and old clothes were amongst such items; former was not required and only added to trash while the latter was not socially acceptable.

It is therefore a must after any major disaster to quickly undertake a needs assessment. The requirements so assessed should necessarily be widely publicized so that people do not send material that is not required. At the same time items that are not acceptable to the people in due to religious or cultural reasons should also be publicized. Particular attention should at the same time be paid towards safe disposal of the packing material and other waste.

Balanced response: High media attention in Kedarnath-Hemkund Sahib area resulted in initial concentration of rescue and relief efforts in this region. Ease of access for the media personnel to the center stage of post-disaster operations due to concentration of aerial rescue effort in this area further strengthened this trend. To the ones following the disaster through media it seemed if the disaster was restricted to the Mandakini valley.

The assistance coming from civil society groups and corporate houses was thus concentrated in this region. This region therefore had excess of relief supplies as also other assistance while disaster affected areas of Pithoragarh and Bageshwar did not receive much attention. Moreover even within this region the stranded persons attained high attention while the affected local population was not adequately catered during the initial response phase.

It is therefore necessary to plan response on the basis of assessed impact and needs and all affected areas should be equally catered to. Mechanism also needs to be put in place for ensuring even distribution of the efforts put in by civil society groups and corporate houses.

Personal effects: On the aftermath of the disaster it was observed that large number of persons who had ventured to the high altitude areas did not have adequate clothing and footwear. Persons visiting the region often do not have prior experience or knowledge of climatic conditions in the mountains where temperatures could drop drastically after rains, even in summers. Moreover coming from plains where temperatures go quite high in summers it is hard for the visitors to contemplate need of carrying woolen clothing. Together with this many people particularly women are not used to wearing shoes. Walking on the hilly track with slippers or sandals often becomes painful and cumbersome. This often slows down the pace of movement.

Information on the weather related peculiarities of the region together with clothing and footwear related requirements should be made available to the potential visitors through various modes. The ones proceeding on high altitude trekking routes should necessarily be advised to carry woolen clothing, sturdy footwear and raincoat/umbrella. These items should at the same time be made available en route on sale.

Logistic support for visiting officials: The disaster involved people from more than 23 states of India and officials from most states were deputed to take care of specific requirements of the persons of their state. There were however no arrangements in place for the briefing of these officials that required information on geography, terrain, weather conditions, approach, efforts being made for search and rescue and whereabouts of the evacuated persons. Arrangements for extending logistics and secretarial support to these officials

were also not in place. All this added to the workload of the personnel manning the SEOC and carrying out other disaster management related duties.

Based upon the composition of routine visitors specific arrangements catering to the needs of the officials likely to come from different states/nations on the aftermath of any major disaster have therefore to be incorporated in the concerning SOP.

On the aftermath of the disaster there were visits of a large number of politicians and other high-ranking officials. Arrangements had therefore to be made for briefing of the visiting officials. Visits of this nature should be discouraged, if not curbed. Protocol related formalities that are attendant to the visit of such officials should necessarily be formally waived off for disaster situations so that the officials engaged is post-disaster functions are not unnecessarily occupied with protocol related arrangements that are hard to manage, particularly in disaster affected and remote areas.

The national government should enact suitable legislation on this important issue and waive off all protocol related formalities during disaster situations. Provisions pertaining to the same could be incorporated in DM Act, 2005.

Relief and rescue personnel: In view of the magnitude of the disaster large number of personnel from different state government departments were deputed to the disaster-affected and other areas for taking care of various emergency support functions. Unlike unformed services the civilian departments do not have a culture of working in shifts as also that of rotation of persons undertaking stressful duties. These persons had therefore to carry out functions entrusted upon them continuously for long periods without any break. This had distinct adverse impact on the psychological and health condition of these persons that had distinct adverse impact on their performance. This was distinctly visible in the behaviour and attitude of these persons.

It is therefore required that the working hours of the persons engaged in post-disaster functions both in the disaster affected area and at SEOC be fixed and the ones engaged in stressful tasks be rotated after a pre-determined interval. This should necessarily be incorporated in the relevant SOPs. As the post-disaster relief and rescue period could extend for a long period it is necessary to pay particular attention towards psychological, mental and physical health of the relief and rescue personnel as deterioration in the same could adversely affect quality and effectiveness of the functions being discharged by them. In the stressful post-disaster conditions particular care also needs to be taken to ensure that these personnel get proper rest and quality time for entertainment and exercise.

Demobilization of resources: On the aftermath of the disaster of 2013 large number of personnel and resources were requisitioned from uniformed forces as also various departments of the government. These were often put under the control of the administration of disaster-affected districts. As there were to protocols or SOPs in place for the demobilization of resources these were not relieved even after they had discharged functions assigned to them and there existed no specific assignment for them.

In the absence of protocols and SOPs the district administration was reluctant to certify that there was no role whatsoever for these resources in the district and therefore some of the resources were kept waiting for long periods. This was observed to be a cause of discontent for the organisations that had spared these resources at the time of exigency.

Moreover it needs to be appreciated that in view of the emergency situation resources provided by various organisations are often pulled out of deployment at some other location. Over the passage of time these might well be required at some other location. This is particularly relevant for the resources of the uniformed forces as there are basically meant for catering to security and strategic requirements and should necessarily be demobilized at the earliest after these have served their purpose.

It is therefore required that protocols and SOPs be put in place for the demobilization of resources. Ceremonial or official demobilization with words of appreciation and thankfulness would further help in building better understanding and relations between the organisations.

Briefing and debriefing: Unlike uniformed forces the civilian departments do not have a culture of routine briefing and debriefing of personnel engaged in different tasks. After the disaster of 2013 large number of persons deputed by different departments were therefore inducted on duty without formal briefing on their roles and responsibilities. This often resulted in disrupted communication or chain of command. The personnel were at the same time relieved without debriefing which often resulted in vacuum and disrupted continuity of functions. Formal documentation of important lessons learnt was also missed due to this.

It is therefore necessary to put in place SOPs for routine briefing and debriefing of the personnel engaged in post-disaster functions. This should preferably be organised at the time of change of shift or duty so that the outgoing party could provide information on the ongoing tasks, problems being faced, plan of work, and targets set for the coming period. The party taking charge should at the same time be briefed on the chain of command together with reporting format and procedures.

Media awareness: On the aftermath of the disaster it was observed that the media personnel, in their bid to make the news sensational and salable, often resorted to reporting of personal routine and eating habits of the relief and rescue personnel. This often resulted in personal embarrassment besides demoralizing the relief and rescue personnel.

Media is therefore required to be educated that good mental, psychological and physical health of relief and rescue personnel engaged in stressful and tiring tasks is inevitable for effective and smooth discharge of their functions and for this they have to be provided healthy diet and recreational opportunity. To add to it the media personnel should understand that the ones engaged in relief and rescue functions are in no way deprived of their right to personal liberty guaranteed by the Constitution of India and the same needs to be respected and honoured under all circumstances.

Though in limited number unauthenticated, fabricated and inflammatory stories were reported while positive stories pertaining to acts of personal bravery, compassion and empathy together with societal engagement were often not reported. Media persons have therefore to be educated on their role in encouraging and facilitating the masses to act and proceed in the right direction by maintaining right proportion of positive new items.

Legal issues: Soon after the disaster of 2013 a number of Public Interest Litigations were filed in the apex court alleging non-performance on the part of the state and seeking immediate judicial intervention for providing relief to disaster-affected people. There were at the same time probes by the delegations of various quasi-judicial statutory bodies that included State and National Human Rights Commission, National Commission for Women, National Commission for the Protection of Child Rights and National Commission for Scheduled Castes and Scheduled Tribes. These often sought specific information pertaining to the affect of disaster on their interest group and measures taken by the state to cater to their requirements.

No arrangements were in place for addressing legal issues and the data was also not specifically segregated to cater to the queries of the various commissions. Therefore the ones responsible for other disaster management related functions and having familiarity with the sequence of events and progress of relief measures had to share the responsibility of preparing counter affidavits and replies.

It is therefore necessary to have an overview of the legal issues that could spring up on the aftermath of a major disaster incidence and accordingly manpower should be put in place for addressing these. Apart from knowledge of legal issues the person entrusted with this responsibility should have familiarity with ongoing post-disaster efforts and initiatives.

The national government has also to take a call on this important issue and enact suitable legislation to disallow judicial interference immediately after a major disaster when the state machinery is engaged in addressing other important, vital and pressing issues. Provisions pertaining to the same could be incorporated in DM Act, 2005.

Warning generation and dissemination: Despite claims of advance warning of the incidence the information received at SEOC from India Meteorological Department (IMD) was nothing more than a general forecast of particularly heavy rainfall all through the state. With location specific and definitive warning of the impending disaster many precious lives could have been definitely saved. The disaster of June 2013 thus reiterates the need of having a reliable and robust warning generation and dissemination infrastructure.

Reliable warning and its effective communication in a decipherable manner to the population likely to be affected by the incidence is the key to saving human lives and mitigating losses. To be effective warning should however have sufficient lead-time and be precise in space, time and magnitude.

With the present state of scientific knowledge and technological advancement it is possible to generate and disseminate warnings of hydro-meteorological events well in advance. Sufficiently dense network of meteorological observatories with real time data transmission capability is however a precondition for this, particularly in the Himalayan terrain where weather parameters are highly variable over short distances. Such a meteorological network could be integrated with rainfall threshold based flood and landslide models to generate reliable warnings well in advance. A system capable of immediately communicating these warnings to the grassroots level, in a manner that suggests actions to be initiated by people at large, has to be an integral part of the warning infrastructure.

As the region is visited by tourists and pilgrims in large numbers, mobile messaging service with provision of automatic delivery of multilingual warning to all active mobile phones in the area likely to be affected by the said warning could be a viable option for this. At the same time warnings have to be displayed at places where people gather in large numbers; bus/railway stations, taxi stands, transport registration offices, tourist information/registration centers, prominent road diversions and the like. Warnings should also be aired through FM, community radio and other radio networks as also telecasted through television channels. Provisions of the Disaster Management Act, 2005 should be utilized for ensuring overriding priority to these warning messages.

It however needs to be understood that it is not easy for the masses to understand the implications of the warning received in their specific context. Moreover the warning received is of little use if the recipient is unaware of the course of action

to be followed. For the effectiveness of the warnings it is therefore necessary to undertake highly visible and aggressive mass awareness drive.

Settlement pattern: Most losses caused by the disaster were generally observed to be restricted to the proximity of rivers and streams. Traditionally the people of the area maintained safe distance from streams and settled down over middle or higher slopes of the hills. Alignment of motor roads along the rivers together with ease of construction and associated commercial incentives in the proximity of road have lately induced people to settle down close to the streams and rivers.

On the aftermath of the disaster it is required that landuse zonation be undertaken and anthropogenic activities in close proximity of rivers and streams as also in identified hazard prone areas be banned.

Aggradation: The issue of fast pace of aggradation in the disaster affected area and ensuing enhanced vulnerability of many low-lying areas in the proximity of rivers and streams has often been highlighted after the disaster of 2013. Uttarkashi, Bageshwar and Sonprayag are amongst the settlements facing this problem. Reduced transport and erosion capacity of the rivers and streams due to arrested and regulated flow due to the construction of barrages and dams and increase in the debris production due to enhanced pace of developmental initiatives, landslides and surface erosion in the hills are held responsible for this.

Debris production cannot be ruled out while undertaking developmental works in the hills but it needs to be appreciated that the present practice of rolling down the debris aggravates mass movement and deforestation besides degrading soil and water quality. It often overruns productive agricultural lands, water sources and other assets. All the loose material ultimately reaches the riverbed and enhances the pace of aggradation and adversely affects productive life and storage capacity of the reservoirs.

It is therefore required that the practice of unscientific disposal of debris be discontinued and a policy be enacted for ensuring safe and systematic debris disposal with adequate punitive measures for non-compliance.

Risk transfer: The disaster derailed the economy of the region that is largely dependent upon pilgrimage and tourism. Large number of persons engaged in hospitality, transport, tourism and related sectors faced severe hardships due to sudden and unexpected downfall in the number of pilgrims, tourists and others visiting the area.

In a bid to infuse new vigor into the economy the state resorted to waiving off state dues besides enhancing the rate of relief admissible to disaster victims and

bringing losses of almost all categories under the umbrella of relief. Thus relief also covered losses incurred to commercial establishments. All this amounted to massive burden upon public exchequer.

It is therefore required that risk transfer (insurance) be made a precondition for operating any commercial establishment and the same be linked to licensing of these establishments. Risk transfer measures should also be promoted amongst general public and financial institutions, particularly banks should be persuaded to ensure insurance of all assets created with their assistance. Besides reducing the burden upon public exchequer in case of a major disaster incidence this would better compensate the disaster-affected population. Risk transfer at the same time has the potential of compensating indirect loss incurred to enterprises due to disaster incidences.

Risk informed decision-making: Post-disaster review of the situation brought forth the issue of risk assessment, risk communication and risk informed decision-making. All these were observed to be missing and therefore risk of any of the hazards was not being taken note of even while taking planned organizational decisions. Unaware of the potential risk masses were observed to do what suited them best. It was also observed that despite a strong tradition of disaster risk reduction people were not following the age old and time-tested principles that ensured safety of their community in this hazard prone terrain all through. Lately the people had started to settle down dangerously close to rivers and streams and over riverine terraces that were traditionally left for agriculture alone. The people were also observed to have discontinued traditional earthquake-safe construction practices (Rautela, 2005, 2013, 2015, Rautela et al., 2008, 2009). All this is attributed to (i) status attached to modern infrastructure, (ii) social stigma attached to traditional practices that are considered backward, (iii) peer pressure and (iv) emulation. These are held responsible for enhanced vulnerability of the masses in the hills.

It is therefore required that detailed risk assessment be undertaken and the results of the same be made available to the masses in an easily decipherable manner. Together with this appropriate, site specific and simple risk reduction options should be made available and popularized. At the same time it is required that the traditional disaster risk reduction practices of the people be researched, improvised and amalgamated with modern science and technology so as to come up with socially acceptable, economically viable, innovative and sustainable disaster risk reduction solutions.

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