Disaster Management In Mountain Regions: With Special Reference To Uttarakhand.

Dr. Nandan S. Bisht*
Miss Renuka Sharma**
Mr Thakur Dev Pandey***

ABSTRACT

Formed in the year 2000 the state of Uttrakhand stretches over an area of 53,483 sq. km and comprising 13 districts and 110 Tehsils, Uttrakhand is a distinct geographical entity in the Western Himalayas because of so many socio-economic and geographical considerations. The Great Himalayas which are considered as the youngest mountains of the globe are very much prone to disaster such as land slides, flash floods, earthquakes due to continuous movement of tectonic plates. Because of its geographical location, disasters are not new for the people of Uttrakhand.

As far as natural disasters are concerned, they are impossible to avoid, however their impact on human can be reduced by taking precautionary measures. A disaster causes damage to life, property as well as to the psychology of the people. So it becomes mandatory to follow those strategies in advance which can minimise the losses in case of any disaster.

Till date Uttrakhand have witnessed a large number of natural disasters, amongst which major disaster includes earthquakes of Uttarkashi (1991) and Chamoli (1999) of magnitude exceeding 6, Himalayan Tsunami of Badrinath and Kedarnath (2013) and many more which have resulted in loss of several lives and caused damages to property worth thousands of crores, this raises the concerns for an apt disaster management policy for the region. This paper deals with the topography of the Uttrakhand and the kinds of disasters that the state is prone to. Further this paper critically examines the strategies the Disaster Management Department of Uttrakhand used in past and present and what are its future plans and the socio-economic implications of these strategies. Finally then concluding the paper with the policy recommendation for the disaster management in Uttrakhand.

Key words: Disaster Management in Uttarakhand, Cycle of Disaster, Environmental Hazards.

II. Introduction:

Uttarakhand is the 27th state formed on 9th November 2000, spread across 53,483 sq km[i]; it is a unique geographical entity in the Western Himalayan terrain and has an altitudinal range of 200 to 7784 meters above sea level. The state is 86% mountainous and 65% is covered by forest. Most of the northern part of the state is covered by high Himalayan peaks and glaciers. The state also shares international boundaries with Nepal in east and China in the north. The State has two administrative blocks which divides the state into two parts namely Kumaun and Garhwal. Kumaun region have 6 districts namely Nainital, Udham Singh Nagar, Almora, Pithoragarh, Bageshwar and Champawat whereas Garhwal region have 7 districts namely Uttarkashi, Dehradun, Tehri Garhwal, Rudra Prayag, Chamoli, Haridwar and Pauri. Out of the 13 districts of the State, 3 are plain districts and the remaining 10 are hill districts.

*Assistant Professor, Department of Economics, D.S.B. Campus Nainital.
**Research Scholar, Department of Geography DSB Campus Nainital
**Research Scholar, Department of Economics D.S.B. Campus Nainital

Fig1: Uttarakhand State

Geographically the state can broadly be divided into three zones, namely—

1. **Upper hills**: Uttarkashi, Chamoli, Rudraprayag, Pithoragarh and Bageshwar.
2. **Middle hills**: Tehri-Garhwal, Garhwal, Almora, and Champawat, the hill regions of Nainital and Chakrata tehsil of Dehradun.
3. **Foothills**: The remaining area of Dehradun, Haridwar, Udham Singh Nagar and the remaining area of Nainital.

The Great Himalayas which are considered as the youngest mountains of the globe are very much prone to disaster such as land slides, flash floods, earthquakes, avalanches, cloudburst, hailstorms, glacial lake outburst floods (GLOFs), flash floods, lightening, forest fires, etc. have been known to cause major loss to life, property, resources and ecosystems in the region and thereby affecting the process of economic development[ii]. In addition to the natural phenomenon, various human activities like – unscientific development and land-use pattern, unwarranted changes of landscape, ecosystem structure and functions, forest degradation and deforestation, increasing pressure of tourism, waste disposal-have also contributed to the vulnerability of the region to hazards. Development of hydropower projects, construction of roads and buildings, river bed mining, are some of the examples, which have direct or indirect but significant impact on landscape, land-use and natural eco-geological systems, resulting into undesired influence on factors governing vulnerability to natural hazard[iii], because, if it turns into a major disaster, it may result in harm to several lives and mental and physical injuries to many. Till date Uttarakhand have experienced several disasters amongst them major one includes earthquakes of Uttarkashi (1991) and Chamoli (1999) of magnitude exceeding 6, Himalayan Tsunami of Badrinath and Kedarnath (2013) and many more which have resulted in loss of several lives and caused damages to property worth thousands of crores.

Each of these events is possible to occur again; in fact their reoccurrence is highly probable. Disasters cannot be avoided but their impact can be reduced, prediction and forecasting will not in themselves prevent catastrophe; local awareness and responsibility are essential to prevent further encroachment into hazardous areas; and the failure to plan land use will only increase the potential for major loss and devastation.

III. Types of Disasters in Uttarakhand:

Uttarakhand is prone to a number of natural as well as man made disasters and the people living in this state are well known to the wrath of these. Ensuring the safety of people is the biggest challenge to the government. Continuous increasing human population in the hills, have made the condition more vulnerable to any imminent threat of disasters.

A. Earthquake:

Earthquakes are caused due to movement in tectonic plates, due to the volatility of Tectonic plates; Earthquakes of low magnitudes are common in Uttarakhand terrains. The state falls into the category of zone 4 and zone 5 of earthquakes[iv]. Northern districts namely Chamoli, Uttarkashi, Rudraprayag, Bageshwar and Pithoragarh falls into zone 5 which is serious cause of concern for formulation of an adequate disaster management strategy[v]. Till date state has experienced several low magnitude as well as magnitude greater than 6 earthquakes with epicentre mostly in northern districts of the state. In the recent history of Central Himalaya it was an unexpected series of earthquakes which caused unprecedented damage to life and property of the people living in Chamoli, Gopeshwar, Nandprayag, Rudrapryag, Joshimath, Okhimath and other parts of the Garhwal and Kumaun Himalaya. According to available reports more than 100 people have been killed and more than 300 people have been injured.

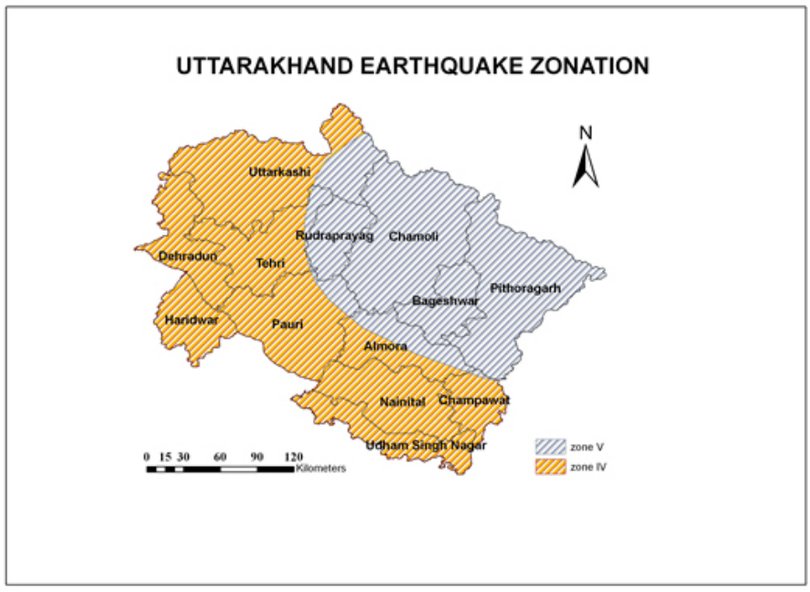

Fig.2: Uttarakhand Earthquake Zonation.

In the district of Chamoli 90% of houses has been totally damaged. It is not only Chamoli district of Garhwal Himalaya; other highly vulnerable areas of Kumaun Himalaya i.e. Munsyari, Dharchula and Bageshwar are also reportedly affected. In Almora and Bageshwar district 29 people are reportedly injured. Keeping in view the high seismicity of the region it is necessary to sensitize the community through preparedness programs. It is therefore imperative that we understand why and where earthquakes occur and do everything feasible to minimize their effects. Further Table 1 shows list of some major earthquakes in Uttarakhand.

Table 1:

List of Major Earthquakes of Uttarakhand[vi]

S. No.	Date of Occurrence	Magnitude	Affected Areas
1.	1st September 1803	9.0	Badrinath
2.	1809	9.0	Garhwal
3.	26th May 1816	7.0	Gangotri
4.	25th July 1869	6.0	Nainital
5.	28th October 1916	7.5	Dharchula
6.	28th October 1937	8.0	Dehradun
7.	27th July 1966	6.3	Kapkot
8.	28th August 1968	7.0	Dharchula
9.	29th July 1980	6.5	Dharchula
10.	20th October 1991	6.6	Uttarkashi
11.	29th March 1999	6.8	Chamoli
12.	29th November 2015	4.1	Uttarkashi
13.	1st December 2016	5.2	Dharchula
14.	6th February 2017	5.6	Pipalkoti

Source: INDIA METEOROLOGICAL DEPARTMENT, 2013. Earthquake Reports, preliminary list of Earthquakes retrieved from http://www.imd.gov.in/section/seismo/dymanic/welcome,htm accessed on 30 September 2017-09-30.

B. Landslide:

Landslide is the sudden erosion of the top layer of soil or more general surficial process known as mass wasting, which is simply the down slope movement of earth or surface materials due to gravity. Landslide is considered dangerous as the velocity of the land mass can vary from a centimetre per year to about 400 km per hour in extreme disaster cases.

In Uttarakhand major landslide zones are located in the north of the state. Districts such as Pithoragarh, Bageshwar, Uttarkashi, Chamoli, Tehri Garhwal and Rudraprayag are severely struck by landslides in the monsoon season[vii].

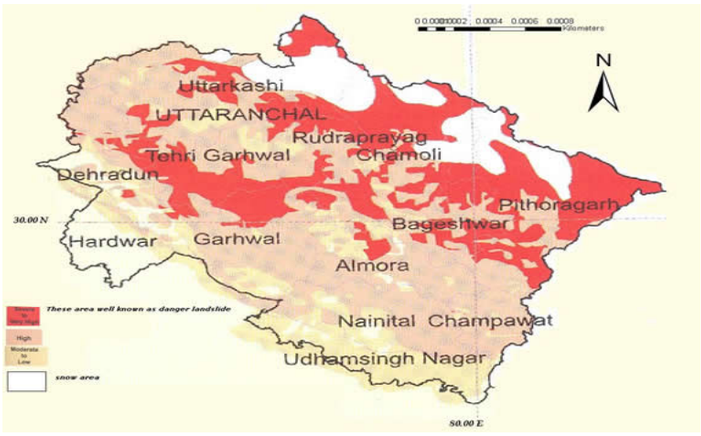

Fig.3: Landslide Map of Uttarakhand.

Table 2:

List of Major Landslides of Uttarakhand[viii]

S.No.	Year	Landslide
1	1816	Pauri Landslide
2	1963	Nainital Landslide
3	1970	Landslides formed an artificial lake in the upper catchment of Alaknanda river: Affected 101 villages, 25 buses of pilgrims were wept away, 55 persons & 142 animals perished. District headquarter of Chamoli district at Chamoli devastated and subsequently shifted to Gopeshwar
4	1998	Massive landslides in Okhimath area formed an artificial lake blocking the course of Madhyamaheshwar river (tributary of Mandakini): 109 people dead, 1908 families from 29 villages affected and 820 houses damaged
5	1998	Malpa Landslide along river Kali on Indo-Nepal border in Pithoragarh district: Wiped out Malpa village killing around 300 people
6	2001	Phata and Byung Gad Landslides: Around 21 persons killed and several houses damaged
7	2007	Village Baram/Sialdhar Landslide, Dharchula: 15 fatalities and loss of livestock
8	2009	Berinag-Munsiyari road landslide: 43 people died due to landslide
9	2010	Ganga-Alaknanda valley landslide: 220 peple died, damages to roads
10	2012	Okhimath, Rudraprayag Landslide: 68 people died.

Source: NDMA, 2009. National Disaster Management Guidelines, Management of Landslides and snow avalanches. National Disaster Management Authority, New Delhi. 130-134 p. http:// ndma.gov.in/ndma/guidelines/ Landslides Snow Avalanches.pdf

C. Cloud Bursts :

Cloud Bursts is the excessive and extreme rainfall in a small radius due to the unprecedented anomalies in the rainfall behaviour of cloud as a result of extreme misbalance in the ionization in the surface of the cloud.

Monsoon season in Uttarakhand region is the time when the state experience cloud bursts. Till date there have been a large number of cloud bursts in the state which have caused loss to several lives and also to the property of both state and people in lakh crores[ix]. Table 3 shows list of some major cloud bursts in Uttarakhand.

Table 3:

List of Major Cloud Burst in Uttarakhand[x]:

S. No.	Year	Location	Damages
1	2007	Pithoragarh and Chamoli	23 people died
2	2009	Munsiyari Tehsil	43 people died
3	2010	Kapkot, Bageshwar	18 school children died and 8 injured
4	2010	Almora	36 people died
5	2012	Chwanni, Mangoli and Kimana villages of Okhimath block in Rudraprayag	Completely inundated over Four villages and eroded two more villages.
6	2013	Kedarnath and Rambara, Rudraprayag	More than 5,000 people died, over 84,000 people affected
7	2014	Tehri Garhwal	4 people died & damages to property.

Source: Cloud Burst: Disaster in Uttarakhand India, 2012. Retrieved from http://chimalaya.org/2012/09/14/cloud-burst-disaster-in-uttarakhand-india-updates-and-photos

D. Flash Floods:

Flash Floods are sudden flood that appears suddenly due to heavy rainfall or cloud burst or either due to breaking of any embankment or medium size lake in hilly region.

Flash floods are considered very dangerous to counter because they hardly give any response time. Till date flash floods have taken uncountable lives of humans as well as animals and have caused damage to large sum of properties. In Uttarakhand flash floods are frequent in occurrence, the Himalayan Tsunami of June 2013 which caused the damage to infrastructure, property and environment with resultant impact on the livelihoods and local economies. More than nine million people were affected by the episodes of flash floods. Five districts, namely, Bageshwar, Chamoli, Pithoragarh, Rudraprayag and Uttarkashi were worst affected[xi]. Further Table 4 shows list of major flash floods in Uttarakhand.

Fig.4: Drainage Map of Uttarakhand

Table 4:

List of Major Flash Floods in Uttarakhand[xii]

S. No.	Year	Location	Damages
1.	1997	Near Neelkanth, Haridwar	18 people died
2.	2001	Near Meykunda, Rudraprayg	27 people died
3.	2009	Munsiyari, Pithoragarh	43 people died
4.	2010	Kot, Pauri	6 people died
5.	2010	Khatima, Rudrapur, Udham Singh Nagar	3 people died
6.	2010	Dehradun	7 people died
7.	2010	Dhari, Nainital	13 people died, 3 injured
8.	2010	Karnprayag, Chamoli	3 people died
9.	2010	Nyalgarh, Pauri	13 people died
10.	2011	Tuneda, Bageshwar	21 people died, 1 injured
11.	2012	Asi Ganga Valley, Uttarkashi District	28 people died
12.	2013	Badrinath and Kedarnath	More than 5000 people died several injured.

Source: SEOC Data, 2011. State Emergency Operation Centre, Disaster Management and Mitigation Centre, Govt. of Uttarakhand, Uttarakhand. Data received from SEOC, Dehradun on 3rd December 2013 through email.

IV. Disaster Mitigation and Management Department of Uttarakhand.

At present Disaster Mitigation & Management Centre is working as autonomous institute under the Department of Disaster Management Government of Uttarakhand and Disaster Mitigation and Management Centre(DMMC) is the apex centre in the field of Disaster Mitigation & Management in

Uttarakhand, to protection of the community and the environment from the over whelming destruction caused by disasters[xiii]. DMMC, located in the Uttarakhand secretariat compound, is to generate the sense of worth amongst common people and the government authorities in formulating appropriate policies and strengthening their capabilities to cope up with all aspects of disaster management.

The centre has undertook the responsibility of training communities and community based organizations and through them develop a strong regional knowledge base towards disaster policy, prevention mechanisms, mitigation measures, preparedness, and response plans. The centre has also undertook the responsibility of training communities and community based organizations and through them develop a strong regional knowledge base towards disaster policy, prevention mechanisms, mitigation measures, preparedness, and response plans. Perhaps the most important need at the State level is to strengthen and develop capacity to undertake disaster mitigation strategies.

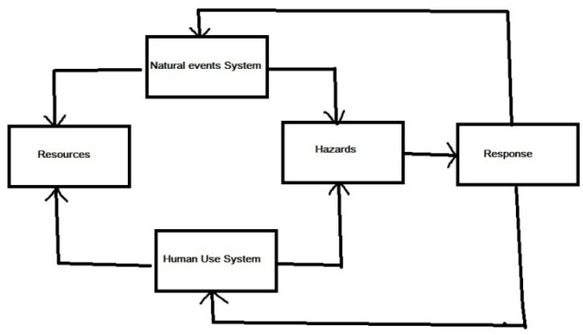

Fig.5: Environmental Hazards

They basically work according to the calamities that have taken place and take action in well coordination with various other rescue teams which involves army, air force, navy, local people and NGOs. The exploitation of resources involves both perks and risks, perks in the sense of economic development and risks in the sense of disturbing the ecosystem. Both the Natural events as well as Human Use system of these resources involve hazards at some point of time. Thus, it becomes imperative to figure out the optimal responses for these hazards in or before the occurrence of any such hazard. The Disaster Management Strategy therefore involves the steps which are concerned with:

Pre Disaster Scenario: This scenario involves **"PPM"**, i.e., Preparedness, Planning and Mitigation of any upcoming disaster

Post Disaster Scenario: This scenario involves **"Three R_s"**, i.e., Reduction, Relief and Rehabilitation of the occurred disaster.

Disaster Cycle:

If we critically examines the occurrence of any disaster we find out that human nature is itself responsible for excessive loss during any natural or manmade disaster. Great Classical Political Economist Thomas Robert Malthus (1776-1834) describes the disasters as **Malthusian Catastrophe**, according to which, ***"The power of population is indefinitely greater than the power in the earth to produce subsistence for man. Disasters occurring as a consequence of population growth outstrip the resources"*** Which means that population growth has direct correlation with the increasing number of disasters.

If we critically analyse time series of any natural or man made disaster, it follows certain steps, nothing happens over night. If we understand these critical steps we may be able to prevent many disasters in the future, we have termed these steps as The Cycle of Disaster.

The Cycle of Disaster follows following steps:

Fulfilling basic needs. In this stage human fulfil their basic needs like subsistence forestry, agriculture, fishing with the use of traditional techniques, without any produce left in surplus for trade.
Enjoying fruits of nature. In this stage human improve their techniques of agriculture, forestry, fishing and mining, and with the improvement in techniques, he/she starts having small surplus for storage and also engages in marginal trade.

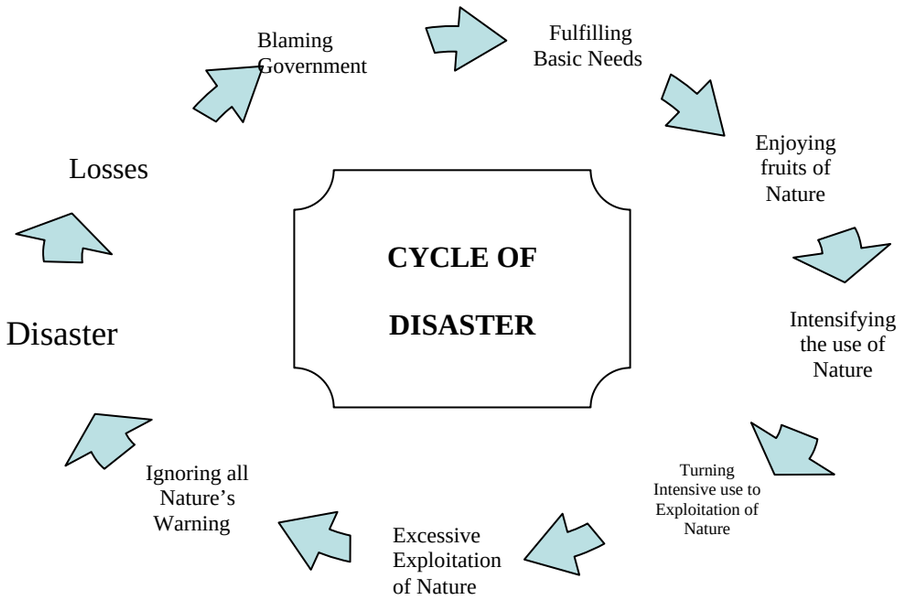

Fig.5: Cycle of Disaster

Intensifying the use of nature

In this stage there is more technological advancement and the land, water use pattern changes. Forestry, mining and fishing becomes more intense and its impact starts on surrounding environment which results in damages to the local flora and fauna.

Turning intensifying use into exploitation of nature

This stage there is excessive exploitation of nature, forests are cleared for timber, new agricultural land is developed which uses excessive chemicals causing damages to the soil, mining become so intense that surrounding environment get permanently damaged, rivers and their tributaries dies due to changed land-water use patterns. Local flora and fauna suffer to the extreme that they fall into the verge of extinction and it is that stage when climate starts showing strange behaviour due to change in ecosystem.

Excessive exploitation of nature

This stage is characterized by excessive pollution level, mass extinction of various flora and fauna and this causes various changes in climatic condition. In this stage exploitation of nature is on its peak, excessive deforestation, mindless mining and several other uncountable crimes against nature takes place.

Ignoring all nature's warning

This stage is characterized by significant number of distress in the nature, droughts, famines, floods, landslides and various other small scale disasters takes place. In this stage nature gives small picture of a probable big scale disaster, but unfortunately humans don't try to realise how big the warning is and generally continue to exploit the nature to the extreme.

Disaster

This is the stage when human crosses all the thresholds of the nature and then nature loose patience and show its wrath to all living being irrespective to their cast, creed or wealth. Till date we find that excessive nature's exploitation have resulted in floods, landslides, avalanches, flash floods, cloud bursts, and even earthquakes.

Losses

Disaster of any form whether natural or man made cause unavoidable losses to humans, animals, forests, as well as to the property of individual as well as the Government. Today if any disaster takes place, priceless human capital is lost, along with that huge amount of resources is invested to rejuvenate the population as well as the infrastructure, along with that the survivors of any disaster bear psychological damages which again requires significant amount of time to be treated. Thus, these hazards give loss to humans in all possible directions.

Blaming Government

In present time when we live under well civilized and democratic Government, when any disaster takes place and there is huge loss of life and property, people starts blaming government for its incompetence. But what appears from the picture is that, affected people transferring their incompetency to the various State Government departments and these State Government department start blaming Central Government for their failures. As they claim they lack funds for proper disaster management.

Repeat

In this stage, after a disaster has already taken place, the nature gets normalized, i.e., back to its primitive state, population in the region again have declined to some extent, then human again starts the cycle of disaster from the first step, i.e., fulfilling the basic need, then so on and so forth.

B. Strategies implemented by the Disaster Management Department of Uttarakhand

In order to overcome resource constraints and to be effective and sustainable, the action plan for disaster reduction is to be incorporated in the overall economic and social development plans. No matter what loss-reduction strategy is used, major reductions in losses of life and property come only when the emphasis shifts from reaction to anticipation. That is, the emphasis must be on proactive pre-disaster measures rather than post-disaster response.

Disaster Mitigation and Management Centre (DMMC) expected to function as a think-tank for the Ministry/Department, will look into, and incorporate prevention, preparedness and mitigation aspects for all projects.

In the past The Disaster Management Department of Uttarakhand has headed several operations in coordination with SDRF (State Disaster Response Force) and NDRF (National Disaster Response Force) during various calamities in the state.

V. Socio-Economic Implication of These Disasters

In every part of the Uttarakhand, several natural phenomena such as earthquakes, landslides, floods, droughts and famines have had their impact on environment.

In Uttarakhand, there is a need for sustainable growth, i.e., growth which is not harmful to environmental degradation. The State has been primarily runs on agrarian back bone where more than 75% of the population has been dependent on the primary sector. The economic condition of the population in most parts is not very good. It is a critical attribute increasing vulnerability of the people, which pushes them to move and settle in more backward and vulnerable areas. Lack of road connectivity, irrigation facilities, food storage facilities, credit / banking institutions in the rural hilly areas of the State also increases vulnerability of the people during disasters. As per the Vulnerability Atlas of India[xiv], about 56% of the houses in the State are constructed using mud, un-burnt brick walls and stone walls; 37.9% using burnt brick walls; and 2.1 % of concrete and wood walls. Majority of these houses are more vulnerable and likely to get severely damaged or collapse during moderate intensity earthquake, landslide and flood[xv].

Table 5:

Per Capita Income of districts that are more prone to the disasters and those districts those are less prone to disasters. [xvi]

S. No.	District	Per Capita Income in Rs.
1.	Bageshwar	22709
2.	Rudraprayag	24474
3.	Uttarkashi	25379
4.	Pithoragarh	28596
5.	Chamoli	32038
6.	Almora	28896
7.	Champawat	27374
8.	Pauri Garhwal	28139
9.	Udham Singh Nagar	33815
10.	Tehri Garhwal	33999
11.	Nainital	41180
12.	Dehradun	43521
13.	Haridwar	50227

Source:
www.planningcommission.gov.in.(2012). *Uttarakhand Budget 2012-13*. [online]

Available at:
http://planningcommission.gov.in/plans/stateplan/Presentations12_13/uttarakhand2012_13.pdf [Accessed 28 Sep. 2017].

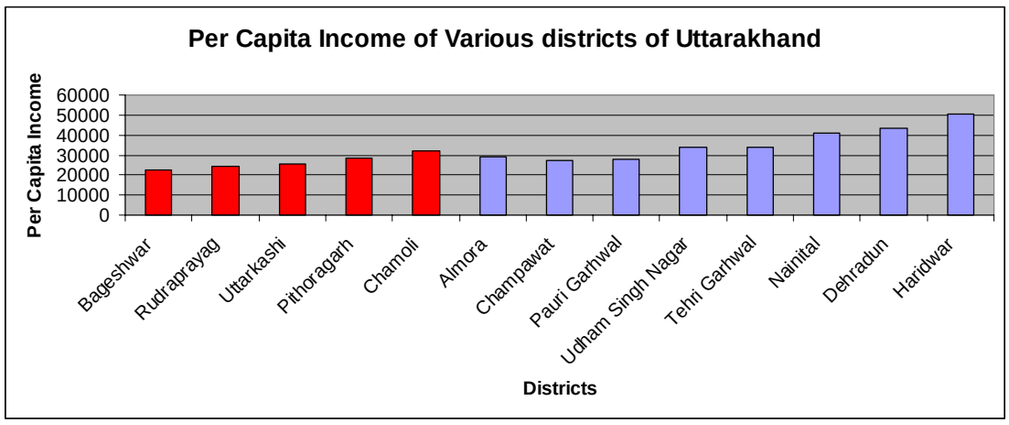

Fig.6: Per Capita Income of disaster prone districts and less disaster prone districts of Uttarakhand

Fig.6 clearly shows that per capita income of districts that are more prone to disasters is comparatively less then other districts that are less prone to these disasters. This means that these disasters have serious socio-economic effects in the vulnerable areas.

Efforts are going on for the environmental management. At all levels of education, provisions have been made for the knowledge of environment and its conservation. In the state many centres are providing special training for disaster management. The programmes of disaster awareness have been launched through media. India is an active member of international organizations concerning environment. Several programmes are going on under UNEP. The government has recently started emphasizing the combined use of regulatory and economic instruments for improving environmental quality. This will be more effective for improvising environmental quality. This will be more effective if enforced systematically. The environmental audit introduced in 1993 is a measure to deal with this problem through improved self-regulation. The use of GIS (Geographical Information Systems) will be useful for effective planning. There is a need for coordination between government agencies, NGOs and the public for the proper management of environmental quality in the country.

Conclusion

One cannot deny that the development strategies in the Himalayan region have led to environmental degeneration, because the projects located here have merely been based on technologies and patterns of production and consumption which brought out changes in life-style, rapid resource exploitation and production of waste. Man develops technology to utilise environmental resources according to his own ambitions, perceptions and preferences; and in this process, he introduces certain changes in the ecosystems which disrupt the normal functioning of the ecosystem and, thus, degrades the environmental qualities. As a result, a number of Himalayan basins are in process of acute imbalance in ecosystem and this is leading to the disaster.

The entire Himalaya in general and Uttarakhand in particular suffer from the natural disasters of cloudburst, mass movement and seismicity. These disasters would remain in times to come and one has to find out ways not of evading these disasters but to combat or at least reduce their disastrous consequences. Earthquakes, hail storms, lightening and avalanches are common in Uttarakhand. Our ability to mitigate these hazards is limited at present because at present scientific knowledge is limited to predict them. In case of earthquake, sensitive zones are well known. However, in case of hailstorms, lightning, avalanches and other events the forecasting is a bit difficult. So it is the time we should strengthen our technology and come up with new and innovative ideas for:

Predicting possible earthquakes,
Designing earthquake resisting shelters,
Prohibiting careless constructions in sensitive earthquake and landslide zones,
Improving land and water use pattern,
Developing technology for efficient suppressing hail storms and lightning by cloud seeding
Biological and physical methods for landslide control.
Promoting General awareness for frequent disasters.

Bibliography:

About Us". Government of Uttarakhand. Retrieved 30 Sep. 17

Kala, Chandra Prakash. "Deluge, disaster and development in Uttarakhand Himalayan region of India: challenges and lessons for disaster management." *International journal of disaster risk reduction* 8 (2014): 143-152.

Rana, Naresh, S. P. Sati, Y. P. Sundriyal, Madan Mohan Doval, and Navin Juyal. "Socio-economic and environmental implications of the hydroelectric projects in Uttarakhand Himalaya, India." *Journal of Mountain Science* 4, no. 4 (2007): 344-353.

Oliver, Jack, and Bryan Isacks. "Deep earthquake zones, anomalous structures in the upper mantle, and the lithosphere." *Journal of Geophysical Research* 72, no. 16 (1967): 4259-4275.

Thakur, V. C. "Active tectonics of Himalayan frontal thrust and seismic hazard to Ganga Plain." *Current science* 86, no. 11 (2004): 1554-1560.

INDIA METEOROLOGICAL DEPARTMENT, 2013. Earthquake Reports, preliminary list of Earthquakes retrieved from
http://www.imd.gov.in/section/seismo/dymanic/welcome,htm accessed on 30 September 2017-09-30.

Sati, S. P., Y. P. Sundriyal, Naresh Rana, and Surekha Dangwal. "Recent landslides in Uttarakhand: nature's fury or human folly." *Current Science(Bangalore)* 100, no. 11 (2011): 1617-1620.

NDMA, 2009. National Disaster Management Guidelines, Management of Landslides and snow avalanches. National Disaster Management Authority, New Delhi. 130-134 p.
http:// ndma.gov.in/ndma/guidelines/ Landslides Snow Avalanches.pdf

Mishra, Ashutosh. "Cloudburst and landslides in Uttarakhand: a nature's fury." *Mausam* 66 (2015): 139-144.

Cloud Burst: Disaster in Uttarakhand India, 2012. Retrieved from
http://chimalaya.org/2012/09/14/cloud-burst-disaster-in-uttarakhand-india-updates-and-photos/

Pande, Ravindra K. "Flash flood disasters in Uttarakhand." *Disaster Prevention and Management: An International Journal* 19, no. 5 (2010): 565-570.

SEOC Data, 2011. State Emergency Operation Centre, Disaster Management and Mitigation Centre, Govt. of Uttarakhand, Uttarakhand. Data received from SEOC, Dehradun on 3rd December 2013 through email.

Goutam Pal, S. (2017). *About Us: DISASTER MITIGATION AND MANAGEMENT CENTER , Government Of Uttarakhand, India*. [online] Dmmc.uk.gov.in. Available at:
http://dmmc.uk.gov.in/pages/display/2-about-us
[Accessed 29 Sep. 2017].

Arya, Anand Swarup. Report of the Expert Group on Natural Disaster Prevention, Preparedness and Mitigation Having Bearing on Housing and Related Infrastructure:

Vulnerability atlas of India. Vol. 2. Building Material & Technology Promotion Council, Ministry of Urban Affairs and Employment, Government of India, 1997.

National Institue of Disaster Management. (2017). *Uttarakhand Disasters 2013*. [online] Available at: http://nidm.gov.in/PDF/pubs/ukd-p1.pdf
[Accessed 29 Sep. 2017].

www.planningcommission.gov.in. (2012). *Uttarakhand Budget 2012-13*. [online] Available at: http://planningcommission.gov.in/plans/stateplan/Presentations12_13/uttarakhand2012_13.pdf
[Accessed 28Sep.2017].