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Developing Methodology for Effective Study and Risk Analysis of Disasters in Uttarakhand

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Abstract

Since a lot research work has been carried out to study the geoenviromental area at Uttarakhand but a complete study needs to be carried out to identify and assess the natural hazards, vulnerability and capacity and risk, each has the risk assessment but the combined vulnerability assessment and hazard assessment has not been carried out. There is no methodology been found to study impact of a disaster and to rank it. It is also required to establish the relationship between disaster impact rank and risk. This paper basically deals with the impacts of development activities on the natural hazards and vice versa. The main aim of this paper will be to do the risk analysis and to find alternative potential solutions for reducing the potential risk from natural disaster and development activities.

Keywords: *Geoenvironmental, Uttarakhand Disaster, Natural disaster, Earthquakes*

INTRODUCTION

The mountainous region of Uttarakhand is part of the Himalaya, which are among the youngest mountain ranges in the world. Natural hazards like earthquakes, landslides, avalanches, cloudbursts, hailstorms, glacial lake outburst floods (GLOFs), flashfloods, lightning, and forest fires etc. have been a cause of major loss to the region and the society. These include unscientific development and land use pattern, poor socio-economic conditions, forest degradation and deforestation, increasing population and tourism pressure etc. Development of hydropower projects, construction of roads and river bed mining are the main developmental activities, which directly or indirectly enhance the vulnerability of the region to natural hazards. The Himalayan state of Uttarakhand is located between 28° 43’ - 31° 27’ N latitude and77° 34’ - 81° 02’ E longitude and is divided into two

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divisions i.e. Garhwal and Kumaon and 13 districts. It consists of 76 towns and 95 developmental blocks as shown in Figure1.

Due to its geo-climatic and socio-economic conditions, Uttarakhand is one of the most disaster-prone states in the country. The entire State of Uttarakhand is one of the most unstable and sensitive zones of the world. Natural hazards in the region are pronounced due to its tectonic activity, litho logical and structural settings and topography. Various tectonic features, like thrusts, faults, shear zones etc. are very common in Uttarakhand. In addition to these natural phenomenons, various human induced causes like unscientific development are also major contributing factors towards the remarkable increase in vulnerability of the state to natural hazards. Thus most of the disasters are natural in origin but the intensity and impact of these disasters are significantly amplified by human induced activities.

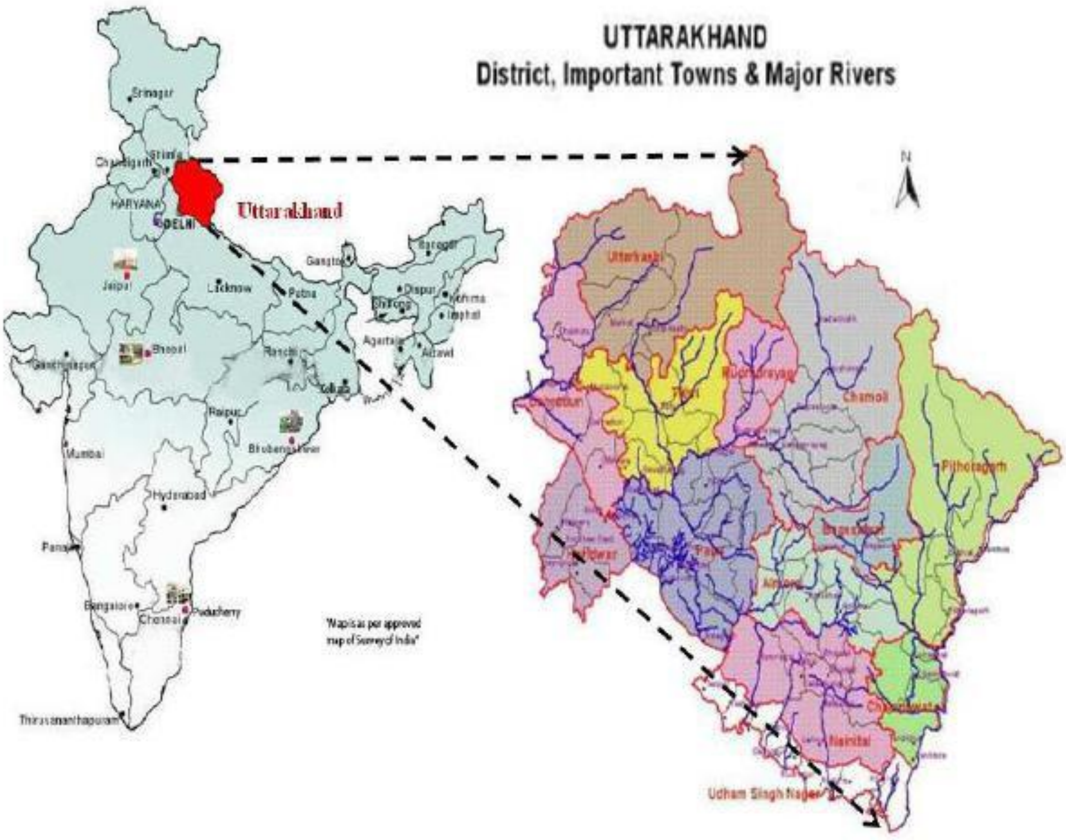


Fig. 1: Uttarakhand

DISASTERS IN UTTARAKHAND

Earthquakes

As per earthquake zonation map of India, the entire State can be divided into two zones, i.e. Zone V and Zone VI. The State has experienced many earthquakes of small and large scale with their epicenters located within the Himalayan region. The State has witnessed two major earthquakes in the recent past i.e. the Uttarkashi earthquake in 1991and the Chamoli earthquake in 1999. About 768 people died in Uttarkashi and 106 died in Chamoli earthquake 7. The districts of Bageshwar, Chamoli, Pithoragarh, Rudraprayag and Uttarkashi, which were most severally affected in the 2013 flash floods, also fall within the Seismic Zone V8. Table 1 shows the major earthquake of Uttarakhand.

Table 1: Earthquakes of Uttarakhand

S No	Date of occurrence	Magnitude	Affected area
1	1st September 1803	9.0	Badrinath
2	1809	9.0	Garhwal
3	26 May 1816	7.0	Gangotri
4	25 July 1869	6.0	Nainital
5	28 October 1916	7.5	Dharchula
6	28 October 1937	8.0	Dehradun
7	27 July 1966	6.3	Kapkot, Dharchula
8	28August 1968	7.0	Dharchula
9	29 July 1980	6.5	Dharchula
10	20 October 1991	6.6	Uttarkashi
11	29 March 1999	6.8	Chamoli
12	1 February /2006	5.2	Indo - China Border
13	14 March 2006	5.0	Indo - China Border
14	27 October 2006	3.8	Bageshwar
15	31 March 20006	3.1	Chamoli
16	5 August 2006	5.0	Indo - Nepal Border
17	26 September 2006	4.1	Indo - Nepal Border
18	27 October 2006	3.8	Bageshwar
19	5 February 2007	3.5	Indo - Nepal Border
20	27 March 2007	3.2	Uttarkashi
21	22 July 2007	5.0	Uttarkashi
22	7 August 2007	3.5	Uttarkashi
23	3 November 2007	2.7	Uttarkashi

Landslides

During the rainy season, the landslides are very common and frequent, which take a considerable toll of human lives and cause irreparable loss to roads, agricultural land and damages to buildings, houses and other built-up structures. Problem of landslide is very common and frequent in Uttarakhand. Almost every year, this region is affected by one or more major landslides.

The frequency of landslides has increased in the recent past due to extensive road construction and other haphazard developmental activities. Landslide hazards zonation map of the State showing areas vulnerable to landslides is given as Figure 2 shows the major landslides of Uttarakhand.

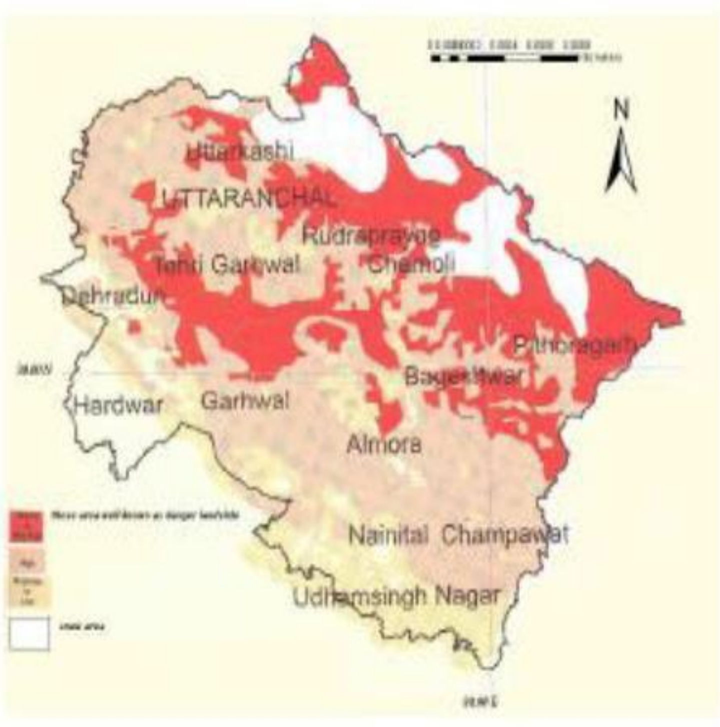


Fig. 2: Landslide Hazards Zonation Map

Floods and Flash Floods

The average rainfall in the State is 1229 mm, with rainy season normally from late April to September. Higher rainfall during the periods varying from June to September results into floods in low lying areas and erosion of land. Increase in soil erosion in hilly region of the state has reduced the carrying capacity of rivers resulting into swallowing of river beds leading to floods in the plains. The low lying areas are more prone to both flood and flash flood hazard. Flash Floods are very common hydro-meteorological hazards due to excessive rainfall or snowmelt, bursting of dams, cloudburst, etc. Major flash flood events in the Uttarakhand took away everything in its way. A view of major flash flood events given in the fig 3.

Fig. Major Flash Flood

LITERATURE REVIEW

The literature review was carried out in following areas:

1. Studies, simulation, modeling or the methodologies related to disasters (landslide, earthquake or flash flood).
2. Risk Analysis of disasters.
3. Integrated management of disasters.

Studies, Simulation, Modeling or the Methodologies Related to Disasters (Landslide, Earthquake or Flash Flood). Anbalagan R. et al. have presented a new quantitative approach for hazard prone areas based on major causative factors of slope instability [1]. A case study of landslide hazard zonation in the Himalaya, adopting a landslide- hazard evaluation factor (LHEF) rating scheme. Anbalagan R. et al. have studied pre and post earthquake remote sensing data has been used to prepare landslide inventory [2]. Bhattacharya et al. explains a system to assess automatically vulnerability due to landslide on socio-economy of a region by categorizing landslide hazard using spatial as well as temporal causative factors Nautiyal and Bhandari Present investigations were carried out on the Disaster Management Action Plan of Uttarkashi district (Garhwal Himalaya) [3, 4]. Onagh et al. has carried out Multiple Linear Regession analysis where the parameters of slope, aspect, lithology, land cover, rainfall, and distance from fault, distance from river, and distance from road were used as variables [5]. ILWIS 3.31 Academic, Arc GIS 9.3, Global Mapper 13.0 and Excel softwares have been used for zonation, and statistical analyses respectively.

Risk Analysis of Disasters

Rajendran et al. presented their observations made during the during the post earth quake survey around Chamoli, and addresses some issues regarding the seismic hazard and risk assessment [6]. Melgarejo and Tobia have developed and applied an integrated assessment of public infrastructure serving as temporary shelter in case of extreme weather events Eiser et al. reviewed relevant literature with the aim of developing a conceptual framework to guide future research in this area [7, 8]. We stress that risks in the context of natural hazards always involve interactions between natural (physical) and human (behavioural) factors. Aven has made several attempts to establish adequate risk and vulnerability analyses tools and related management frameworks dealing not only with accidental events but also security problems Kristensen et al. has discussed Renn and Klinke's approach for risk evaluation and selection of risk management strategies [9, 10]. The main focus in the discussion is the foundational basis and the understanding of what risk is, and how a different foundational basis may simplify and improve the characterization of risk. Johansson and Henrik have studied that the technical infrastructures of the society are becoming more and more interconnected and inter-dependent, i.e. the function of an infrastructure influences the function of other infrastructures [11].

Xiaoyan et al. have studied that with the growth of population and urbanization, the regional natural disaster has become a more critical problem [12]. Based on risk theories, in this paper, elements of natural disaster risk are classified. According to this, they set a conceptual risk model for regional natural disaster which briefly separates assessment course into three procedures: hazard analysis; vulnerability assessment and risk assessment. Abulnor et al. Have given a concept of disaster management enables the appropriation of actions in complex and confusing disaster scenarios [13]. In Egypt, the situation calls for the adoption of efficient disaster management policies which take into consideration the attentive allocation of resources to alternative and competing demands. The main aim of this paper is to investigate routes to a better management of disasters in Egypt. The paper then focuses on investigating the concept of disaster management.

Integrated Management of Disasters

Sudharshan has given a study of disaster management of large cardamom decline [14]. He found that Even the technologies are available for the sustainable production of largecardamom, the unusual and prolonged dry weather, climate change in recent years coupled with the outbreak of new fungal blight disease, conversion of land to non-agriculture purposes, blooming of tourism, eco-tourism which has diverted the rural man power from cardamom cultivation resulting in the neglect of cardamom plantations has resulted in the decline of area and production of large cardamom, which is a cause of concern.Tingsanchali described the concepts, policy, plan and operation on integrated urban flood disaster and risk management [15]. In most developing countries, flood disaster management activities are handled by government... Strategic framework on integrated flood disaster management includes four cyclic steps namely: 1) preparedness before flood impact such as flood forecasting and warning; 2) readiness upon flood arrival; 3) emergency responses during flood impact and; 4) recovery and rehabilitation after flood impact. Examples on urban flood disaster and risk management in Thailand are illustrated and discussed. Conclusions and recommendations for further improvement are provided. Nagarajan R. studied the ground failures, such as landslide and the liquefaction of soil induced by earthquake and/or rainfall, not only pose a threat to human settlements but also degrade the environment [16]. In order to be as prepared as possible, prior knowledge of the spatial distribution of areas vulnerable to these natural hazards and the critical locations for different degrees of risk is required. Parkash focused his study mainly on the soft infrastructure, with particular emphasis on landslide risk reduction related to development, maintenance and management of hard infrastructure in hilly terrains [17]. It is well known fact that unplanned and unscientific developments have aggravated the incidences and impacts of disasters/landslides on the society as well as environment in hills, resulting in huge losses. According to an economic estimate, India loses about Rs.100 billion annually on an average due to landslides. Parkash presented a study which indicates that most parts of the Indian Himalaya fall in seismic zone V and IV, indicating a high degree of susceptibility to earthquakes [18]. It has been observed globally that many casualties during an earthquake in a hilly terrain are attributed to the incidences of landslides triggered by the earthquake and the response actions are also hurdled by the rockfalls/landslides along the highways.

Parkash presented disaster management, public safety and sustainable development initiatives in areas with hilly terrain have identified capacity development for landslides risk reduction as one of the essential components of the planning, policy and decision making process at different levels in all sectors [19]. Uniyal and Prasad presented an attempt to bring bring forth importance of incorporating the disaster management component into the local developmental planning. Naitwar Bazar in the Upper Tons valley Indian Himalaya (Uttarkashi district of Uttaranchal in India) has showing signs of an impending disaster [20]. This settlement has witnessed active mass wastage during rainy season of 2003 which has caused damage to infrastructure (crucial road link), hospital (i.e. the sole health facility) and residential cum commercial area. Uniyal discussed on the prognosis and mitigation of one of the major landslide in Uttarakhand i.e. Varunavat landslide, Uttarkashi. The paper also state that, there should be minimum anthropogenic activity in the form of slope cutting for road or building construction in Himalayan habitations such as Uttarkashi.

It has been seen through the extensie literature reiew that there are many studies has been carried for the effects of disasters and risk analysis but the combined study yet has not been carried out. Therefore a study of the disasters and there developments has been carried in the present work.

PROPOSED METHODOLOGY

Qualitative Analysis

i. Analysis that uses words rather than numbers to describe and measure the magnitude of potential consequences and the likelihood that those consequences will occur. These scales can be adapted or adjusted to suit the circumstances, and different descriptions may be used for different risks.

ii. Qualitative indicators are preferred as a way to engage as many parties as possible. In addition they may be used:

- As an initial screening activity to identify risks which require more detailed analysis
- Where this kind of analysis is appropriate for decisions, or
- Where the numerical data or resources are inadequate for a quantitative analysis

iii. Qualitative analysis should be informed by factual information and data where available.

Semi-Quantitative Analysis

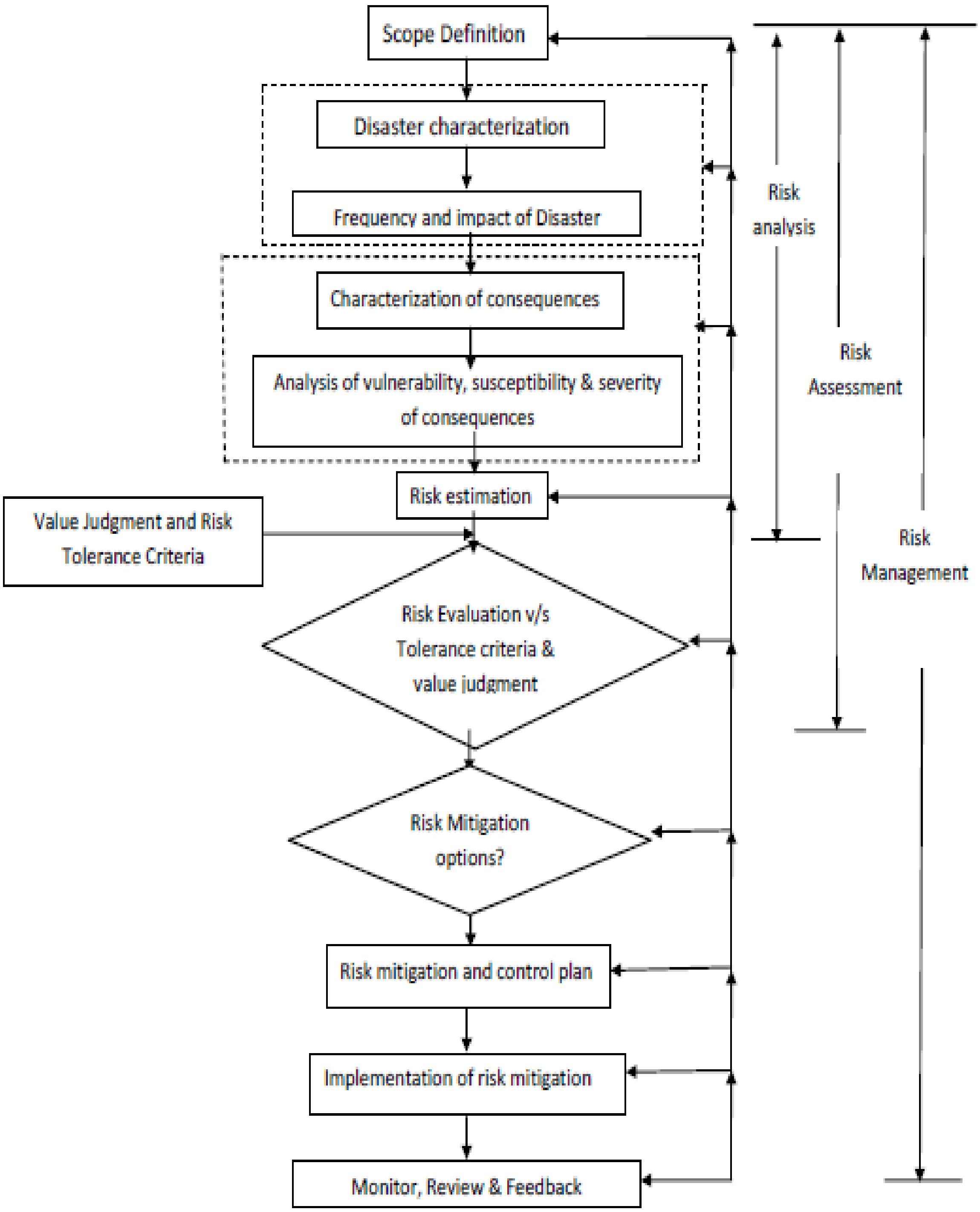
i. In semi-quantitative analysis, qualitative scales are given values. The objective is to produce a more expanded ranking scale than is usually achieved in qualitative analysis, not to suggest realistic values for risk such as is attempted in quantitative analysis. However, since the value allocated to each description may not bear an accurate relationship to the actual magnitude of consequences or likelihood, the numbers should only be combined using a formula that recognizes the limitations of the kinds of scales used.

ii. The limitations of the approach are that the numbers chosen may not properly reflect relativities and this can lead to inconsistent or inappropriate outcomes and semi-quantitative analysis may not differentiate properly between risks, particularly when either consequences or likelihood are extreme.

Quantitative Analysis

i. Analysis that uses numerical values (rather than the descriptive scales used in qualitative and semi-quantitative analysis) for both consequences and likelihood. The quality of the analysis depends on the accuracy and completeness of the numerical values and the validity of the models used.

This complete methodology for risk analysis can easily be understand by following flowchart.



CONCLUSION

There is no methodology has been found to study impact of a disaster and to rank it. It is also required to establish the relationship between disaster impact rank and risk which will again be one of the aspects of the study. Also by using statistical tool we can easily calculate the invariables for risk analysis and risk management.

REFERENCES

1. Anbalagan R. "Landslide hazard evaluation and zonation mapping in mountainous terrain". Engineering Geology 01/1992; DOI: 10.1016/0013-7952(92)90053-2. 1992.

2. Anbalagan R., Kumar R., Parida S. et al. "GIS based post earthquake landslide hazard zonation mapping of Lachung Basin, Sikkim". International Journal of Emerging Technology and Advanced Engineering. 2014; 4(1).

3. Bhattacharya D., Ghosh J. K., Boccardo P. et al. "Automated geo-spatial system for generalized assessment of socio-economic vulnerability due to landslide in a region". European Journal of Remote Sensing – 2013; 46: 379–399p.

4. Bhattacharya D., Ghosh J. K., Boccardo P. et al. "Automated geo-spatial system for generalized assessment of socio-economic vulnerability due to landslide in a region". European Journal of Remote Sensing – 2013; 46: 379–399p.

5. Nautiyal H., Bhandari, S.P. "Ddmap, district disaster management action plan for hill district Uttarkashi, (Uttarakhand)". International Journal of Scientific & Technology Research. http://www.ijstr.org/paper-references.php?ref=IJSTR-0712-5272. 2012.

6. Onagh M., Kumra V.K., Rai P. K. "Landslide susceptibility mapping in a part of Uttarkashi district (India) by multiple linear regression method". International Journal of Geology, Earth and Environmental Sciences. 2012; 2(2): 102–120p.

7. Melgarejo, Tobia have developed and applied an integrated

assessment of public infrastructure serving as temporary shelter in case of extreme weather events.

8. Rajendran K., Rajendran C. P., Jain S. Murty C.V. Arlekar J. N. "The Chamoli earthquake, Garhwal Himalya: Field observation and implications for seismic hazard". Current Science. 2000; 78(1): 45–51p.

9. Luis-Felipe Melgarejo, TobiaLakes (In Press) "Urban adaptation planning and climate-related disasters: An integrated assessment of public infrastructure serving as temporary shelter during river floods in Colombia" International Journal of Disaster Risk Reduction(in press).

10. V. Kristensena, T. Aven, D. Fordc. "A new perspective on Renn and Klinke's approach to risk evaluation and management" Reliability Engineering and System Safety 91 (2006) 421–432. 2006.

11. Jonas Johansson a,c,n, Henrik Hassel. "An approach for modeling interdependent infrastructures in the context of vulnerability analysis" Reliability Engineering and System Safety 95 (2010) 1335–1344. 2010.

12. DU Xiaoyan, LIN Xiaofei. "Conceptual model on regional natural disaster risk assessment" Procedia Engineering. 2012; 45: 96–100p.

13. Adham Hany Abulnour (in Press) "Towards efficient disaster management in Egypt" HBRC Journal (2013).

14. Sudharshan M.R. "Large cardamom Decline –A Disaster and its management." http://articles.economictimes.indiatimes.com/articles_2011_03_00000.xml

15. T. Tingsanchali. "Urban flood disaster management" Procedia Engineering. 2012; 32: 25–37p.

16. Nagarajan R. "Rapid assessment procedure to demarcate areas susceptible to earthquake-induced ground failures for environment management – a case study from parts of northeast India". Bulletin

of Engineering Geology and the Environment May 2002. 61(2): 99–119p.

17. Parkash S. “An overview of the national guidelines for management of landslides with particular reference to infrastructure projects”. Journal of Water and Energy International. 2012; 69(3): 29–37p.

18. Parkash S. “Earthquake related landslides in the Indian Himalaya: experiences from the past and implications for the future”. Landslide Science and Practice. 2013; 327–334p.

19. Parkash S. “Capacity development for landslides risk reduction in India”. Landslides: Global Risk Preparedness. 2013; 369–383p.

20. Uniyal A. “Prognosis and mitigation strategy for major landslide-prone areas: A case study of Varunavat Parvat landslide in Uttarkashi township of Uttarakhand (India)”. Disaster Prevention and Management. 2008; 17(5): 622–644p.