



The Impact of Torrential Rainfall in Kedarnath, Uttarakhand, India during June, 2013

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Abstract

Sometime due to major accident and leakage the situation become worst for the nearby peoples. Kedarnath is a town located in the Indian state of Uttarakhand and has gained importance because of Kedarnath Temple located at the latitude of 30.73 and the longitude of 79.06. This region is seismically and ecologically very sensitive and delicate, even a minute changes (anthropogenic or natural) can create a dangerous disaster. A natural hazardous has been happened in Kedarnath valley due to torrential rainfall during 16 and 17 June 2013. After viewing this disaster due to torrential rainfall an attempt has been made to utilize the high resolution satellite data of before and after the incident of the recent devastation in Kedarnath of Rudrapratap District, Uttarakhand. The objective of this study is to fundamentally focus the intercession of human being in nature and their consequences in terms of human's life. In our article we tried to focus the impact of this natural hazardous over the region of Kedarnath.

Keywords: Anthropogenic; environment; livelihood; Satellite data

Introduction

Kedarnath is one of the ancient and famous pilgrims place situated in Uttarakhand, India. It is located in the snow cover area of Himalayan region at the height of approx 3,583 meter above sea level in the Mandakini valley of Rudraprayag District, Uttarakhand. Due to very decisive weather condition it is not possible to visit this Holy place for all of the years so only from May to October it is safe to visit there. The race between tourism industries, population growth, several hydroelectric projects are in the fast track in Uttarakhand district. After the constitution of Uttarakhand as State there is an increment of approx. 141% in population of Uttarakhand. Now a day's lots of residents and villagers have started to live near the temple and commercialize this holy region by building different hotels, shops and markets in this valley. It is clear that there is tremendous growth in infrastructure during last few decades and proportionally the number of pilgrimages has been increased to a greater extent. This region is seismically and ecologically very sensitive and delicate even a minute changes (anthropogenic or natural) can create a dangerous disaster. The fragile nature of oldest crystalline basement of the Himalayan is very sensitive in case of landslides and any disaster. Basically the frequency and magnitude of landslides depend on the underlying structures, physiographic setting, type and condition of vegetation and anthropogenic pressure of the location. Mehraj Pandit, one of the environmentalists of Delhi University said that the elevated use of concrete and cement in place of wood and stone the temperature of the local area has started to increase during the night time. Instead of this, huge number of infrastructure development has been taken there to fulfil the need of the

tourists. The development of hotels has been done at the place of river which was left after the flood or some times by changing the path of the rivers. Currently there are 558 hydroelectric power projects are in pipe line those will affect to Bhagirathi (80%) and Alaknanda (65%), as per the statement of Sunita Narayan, Director, Centre for Science and Environment. Due to development of roads and Dam in between mountain, the incident of landslides has been inclined. The Rudraprayag district where Kedarnath is situated has already faced the problem of natural disasters 8 times for last 34 years. During 1953-1980, 764.48 million peoples have been suffered only due to flood and natural disaster. The population of Uttarakhand can be examining by the increasing number (700%) of car registration from 2001 to 2012. The problems become more provoked during monsoon period (mid-June to mid-September). Uttarkashi town, Chamoli to Badrinath road sector, Narainbagad, Mandakini Valleys etc are the critical areas in terms of landslides¹⁻⁷. Since early 1970's, satellite remote sensing techniques are an important approach for detecting and analyzing temporal changes and dynamic phenomena on the earth's surface. Due to lack of advance techniques and limitation of the spatial resolution of satellite data, it was critical to map individual landslides and quantify the damage at the desirable scale. Remote sensing technology in managing the natural hazard has two significant functions, like real time monitoring and mapping the changes or the dynamics of the process. There are a number of practices that can be used for mapping perilous zones. The preference of methods depends mainly on the type of hazard, parameters to be studied and the extent of mapping⁸⁻⁹. In year of 2012 Okhimath area of Rudrapratap as also witnessed unprecedented damage to the life and property, infrastructure

and landscape during September 13 to 16 due to torrential rainfall and cloud burst accident. Kedarnath is situated on a glacial outwash plain bordered by impenetrable green forest, with a waterfall nearby, the tiny village of Rambara. Rambara which is the most popular resting place for devotees, trekking to Kedarnath from Gaurikund. As per the different news agencies it was reported that nothing is left there, just nothing. The entire area, which housed around 100-150 shops and five hotels, to serve the needs of the ever swelling number of pilgrims, was completely washed away leaving no trace of the once lively rural community situated at an altitude of 2591 metres halfway on the 14 km long track to Kedarnath.

Material and Methods

Uttarakhand was created by joining a number of districts from the northwestern part of Uttar Pradesh and a portion of the Himalayan Mountain Range. The name of the state was formally altered from Uttaranchal to Uttarakhand in 2007. Basically this state is famous for its charming features and prosperity of the Himalayas. The study area lies in between 30.390 to 30.480 latitudes and 79.10 to 79.20 longitudes from Gaurikund to Kedarnath in the Mandakini Catchment of Rudraprayag district situated at Uttarakhand state. The upper part of this area is flanked by two glaciers i.e. Chaurabari and Companion. The Chaurabari glaciers covered around 4.23 sq.km area and length of this glacier cover 7 km approx. and companion Glacier covered around 3.59 sq.km and length of this glacier is around 5.97km¹⁰. The study area is basically situated at an altitude (2000 m at Gaurikund to 6500 m. at upper reaches) and most of this area is covered by snow-glaciers.

Bhuvan - A Geoportal of ISRO, India, configured with Multi-sensors, providing satellite data and products for download to study the earth surface. The pre and post images of the Kedarnath incident have been studied which was basically captured with the help of some of the satellite of NRSC, Hyderabad.

Results and Discussion

The upper part of Kedarnath which is situated at Mandakini Valley of Rudraprayag district is glaciated with two glaciers i.e. Chaurabari and Companion (figure 2). The presence of U-shaped valley as well as moraines indicates the past existence of glacier in this region. The past observation of the Mandakini valley shows that in the quaternary Period, this valley has witnessed large fluctuations of climate effecting glaciations due to their retreat. Channels of Mandakini River initiate from Chaurabari and Companion glaciers and enclose this plain to meet below the township. The attrition by the torrent has been such that it has cut through the water table in the upper part of the plain. Thus steady expulsion of water has made the place muddy.

Table-1

Satellite	LISS IV and Carosat Merge	Quick bird	Landsat 8	Resourcesat 1 A WiFS
Resolution	2.5 m	0.65 m	15 m	58

Pre and post-disaster satellite data also proves that Gandhi Sarovar (also called Chaurabari Lake) is seasonal in nature. The pre image shows that the water moves along thin channels and there is an existence of different nearby residents and local community of Kedarnath valley but just after the event occurred during 16-17 June 2013 the water level of the lake increases to a dangerous level due to continuous rain, triggering the stream and lake to overflow, saturating the moraines and captured the nearby area of the region and we can see that most of the part of the city has been covered under the debris flow of the Mandakini river.

It has been observed that huge rainfall drenched the area (figure 3) and suddenly exceeds the limit on 16th and 17th June which is one of the reasons for commencement of landslides and exploded flood in the region that has caused huge damage to lives and property in the Mandakini valley. According to the USAC report¹⁰, eighty per cent of the 14-km route between Gaurikund and Kedarnath has been damaged in the disaster. NASA satellite used high resolution (15m) remote sensing for post-satellite imaginaries over the Kedarnath area. The high velocity of fragments due to high gradient slopes from Kedarnath to Rambara and Gaurikund led to colossal damage to infrastructure, lives and property in the downstream which created widespread damage. The images show that Rambara, where maximum casualties took place, has disappeared from the map. The report states: "Antecedent rainfall saturated the area and suddenly exceeded the limit on 16th and 17th June, which is one of the reasons for the activation of landslides and flash floods in the region that has caused huge damage to lives and property in the Mandakini valley."

Conclusion

As per the Satellite data analysis we can conclude that there was no high signature of Glacier changes in the Chaurabari and Companion, these glaciers are still intact in the valley and only one middle moraine debris has washed out by stream due to heavy rainfall. Due to this heavy rain approx 14 km pedestrians' route in between Gaurikund and Kedarnath has been washed out. Maximum damage due to this accident has been observed in Kedarnath, Guiaya, Lenchuri, Ghindurpani, Rambara, Gaurikund and downstream area up to Rudraprayag. Further there is a need of detailed investigation of the area for evaluation of actual damage and cause and future rehabilitation planning of Kedarnath Dham, nearby area and downstream of Mandakini valley.

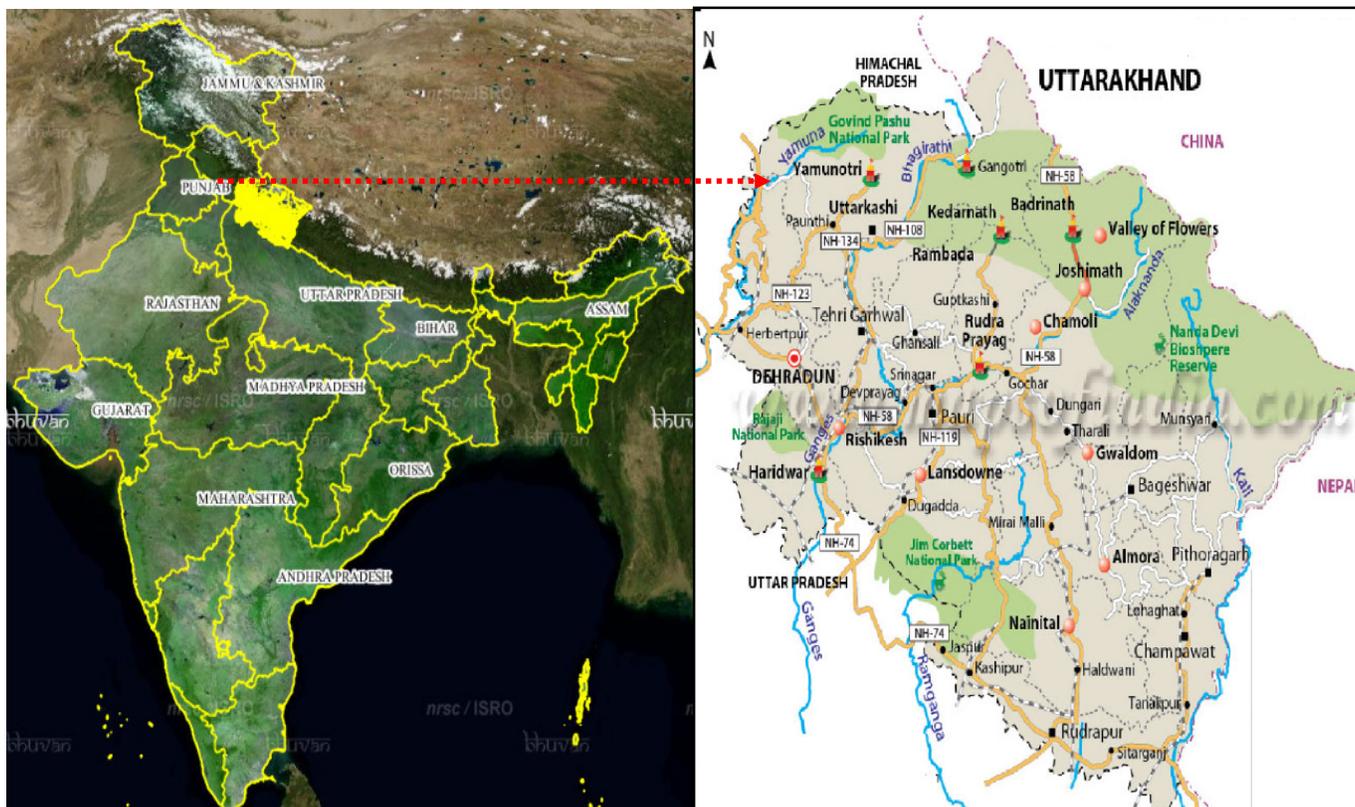


Figure 1
Showing the location of the study area

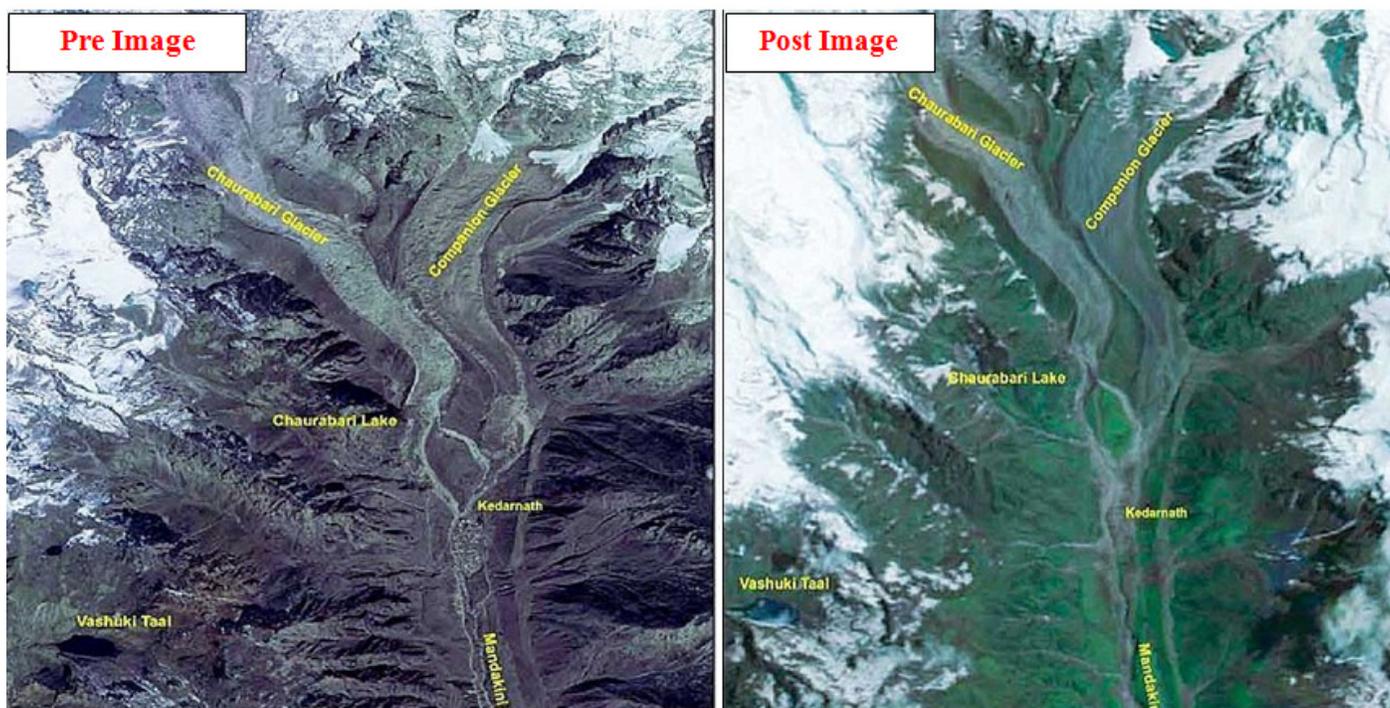


Figure 2
Pre and Post Satellite Images showing Chaurabari and Companion Glaciers, downstream Kedarnath and Mandakini River



Figure 3

Pre and Post Satellite Images Indian satellites of National Remote Sensing Centre (NRSC) showing the status at Kedarnath valley with downstream overflow of Mandakini River

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