

# Slope Stability Assessment of Most Flash Flood Effectuated Villages Near Uttarkashi Town



**Himanshu Sajwan**

Research Scholar,  
Deptt. of Geography,  
H.N.B. Garhwal University,  
Garhwal

**H. P. Bhatt**

HOD & Dean in School of Earth  
Science.  
Deptt. of Geography,  
H.N.B.G. University, Srinagar  
Garhwal

## Abstract

Flash Floods can be caused by a number of things, but is most often in Hilly area due to Cloud burst, extremely heavy rainfall from thunderstorms. Flash Floods can occur due to Dam or Levee Breaks failures. The intensity of the rainfall, the location and distribution of the rainfall, the land use and topography, vegetation types and density, soil type, and soil water-content all determine just how quickly the Flash Flooding may occur. Flash Flooding occurs so quickly that people are caught off-guard. Their situation may become dangerous if they live on river basin/bank. If people are at their homes, the water may rise quickly and trap them, or cause damage to the property without them having a chance to protect the property.

**Keywords:** Disaster, Cloud burst, Flash Flood, Vulnerability, Mitigation, River Bank.

## Introduction

Slope failures are among the most frequent disasters experienced by the Himalayan terrains. Uttarkashi district lies in Uttarakhand State of India. It is situated in the north and forms the part of the youngest mountain range known as Himalaya. Geographically Uttarkashi district is spread over in 8061sq. kilometers and approx. 329,000 people live here and nearly 93% of total population lives in rural area. Many famous Hindu pilgrimages are situated in this area. Uttarkashi area is also famous for the origin of river Ganga. Uttarkashi Districts have 6 blocks and the district head quarter is situated in Uttarkashi town. In 2012, August 3<sup>rd</sup> and 4<sup>th</sup> night and in June 13-17/ 2018 incidences of cloudbursts occurred in Uttarkashi area. It was around midnight when suddenly people noticed increasing water level with debris in the local rivers. People immediately started shifting from their houses and tried to move to the safer locations. Some people were able to shift with their belongings, but some were not so lucky. Within hours the flow of flash flood washed away hundreds of houses, shops, roads and bridges. The townships Bhatwari and Dunda in Uttarkashi districts are badly hit by this flood disaster. The connectivity between Uttarkashi town and Bhatwari Block is completely destroyed. The bridges collapsed, homes, shops, village path, electricity and water facilities are damaged and hundreds of hectares of agriculture land is destroyed.

The major damage has occurred around Uttarkashi township, which is 210 Km. from state capital Dehradun in Uttarakhand. The national highway from Uttarkashi to Gangotri is completely blocked. The bridge connecting Uttarkashi town and Bhatwari block at Gangori village is collapsed and almost 80 villages are totally cutoff. There is no way to communicate with the people in those areas. Bhatwari is a Block located in Uttarkashi district in Uttarakhand, located in rural area of Uttarakhand; it is one among the 7 blocks of Uttarkashi district. According to the administration records, the block code of Bhatwari is 6. The block has 100 villages Bhatwari Tehsil of Uttarkashi district has total population of 75,056 as per the Census 2011. Out of which 40,164 are males while 34,892 are females. In 2011 there were total 17,529 families residing in Bhatwari Tehsil. The Average Sex Ratio of Bhatwari Tehsil is 869.

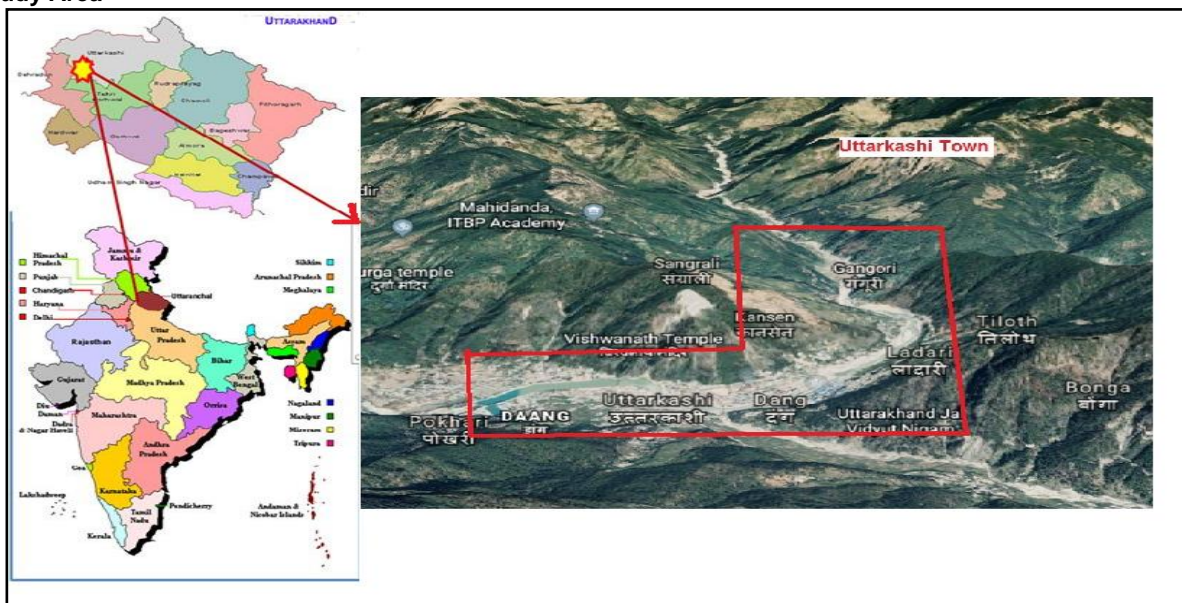
Following is the brief of damage assessment:

1. 34 persons died and some are missing from the area, and 80 villages are totally cutoff.
2. 7 Bridges of vehicle and 6 Bridges of footpath were washed away resulting in no connectivity with Bhatwari area. Electricity supply to these villages is completely erupted and landline and mobile

- Connectivity is also completely down. 60 Kilometers of National highway is damaged at many locations.
- 1700 families are affected from Gangori to Uttarkashi, 922 people of approx. 280 families are living in 13 relief camps in Uttarkashi City established by Government in Joshiyara and Gangori.

- Around a population of 80000 is affected from this disaster.
- Government has assessed a loss of Rs. 600 crores in the area where they have been able to receive damage information.
- Considering the extent of damage, Rs. 20 crores sanctioned by government is nothing.

**Study Area**



**Objective of the Study**

The main objective of this paper is to discuss the effect of flash flood on Villages near Uttarkashi town, situated on the left bank of the Bhagirathi River.

**Review of Literature**

A detailed description with related to disaster management and it's all aspects are wrote by Satendra IFS, 2003, in his book "Disaster Management in the Hills "especially for hill regions, he cover all aspects like vulnerability, management, government policies etc. in Uttarakhand state.

Ramkumar described in his book "Geological Hazards"(2009) about causes due to which disaster happens, Vulnerability of which vary according to the type and intensity in addition to various other reasons such as topography, slop, soil and litho logy etc. Thus, Hazards, disasters, vulnerability, risk and preparedness are the five terms that need to be understood, thus his book contain individual chapter deal with specific geo-hazards, causes, potential impact and mitigation measures for the understanding of general readers.

The India Disaster Report (IDR) 2013, witnessed two major events, the Uttarakhand Flash Floods, mainly affecting the state of Uttarakhand and the Cyclone "Phailin" affecting two coastal states of Odisha and Andhra Pradesh, These events are covered in this report, in detail. Floods are a regular event in our country and the people who live in these flood prone areas have rather adapted to floods and have started 'living with floods', but the flash floods of Uttarakhand have raised several issues about the

forecast of such floods, the causes of such floods, the preparedness and the immediate response required, for which the first responders, who are generally the community, have to be prepared.

Annual Report of NIDM 2016-17- Has information on disaster and development. The Institute regularly brings out a biannual journal, a quarterly newsletter, research highlights, and course modules, recommendations of seminars and workshops, disaster development statistics and various information and education materials.

According to Higashida et al., information processing is a very important task in any emergency situation. It is not sufficient to gather information and data but the challenge is in extracting intelligence and knowledge out of these. They also pointed out that the first task, immediately after a Disaster is to understand the actual Hazard, its impact at Disaster location, its surroundings and damages occurred. They further suggested that thereafter, the plan has to assess - what are the different types of Resources required and to generate their mobilization plan to respond to the Disasters.

**Methodology**

Most of the observations in this study have been based upon intensive field work in the area. The study thus is based on available data and empirical observations, At first the study related maps were collected from different Govt, organization like topographical sheets (53 N/1, 53 J/13, 53 J/5,53 J/6, 53 J/9, 53 1/16, 53 J/10, 53 1/12 etc.) from Survey of India, Dehradun. Data and information were collected

from various Govt., publications and records as for example population related data were collected from Census, meteorological data from Indian Meteorological Department, Pune, Sediment discharge data from IIT, Roorkee, village level land use data from Collectorate House, Uttarkashi. Detailed field investigation was carried out in disaster affected area of Uttarkashi town.

#### **Joshiyara Village**

The Joshiyara village is situated on the left bank of the Bhagirathi River in Tehsil Bhatwari, district Uttarkashi and it is an extension of Uttarkashi town on opposite bank. Joshiyara is a medium size village located in Bhatwari Tehsil of Uttarkashi district, Uttarakhand with total 330 families residing. The Joshiyara village has population of 1343 of which 821 are males while 522 are females as per Population Census 2011. The Bhagirathi River flood plane is quite wide in front of Village. In Uttarkashi district most affected village / town is Joshiyara in which about 60 houses, hotels and religious places have been completely washed out, where as hundreds of commercial buildings, houses, temples, ashrams and others structures are in critical state and situated on the edge of slope of river bank. The citizens are in great trouble due to lack of road network, electric supply, water supply, communication and other essential day to day necessities. The main cause of devastation is heavy and prolonged rains in the catchment area causing high discharge of the order of 1936.04 cumec (17th June 2013) resulting in toe cutting by the river towards left bank. Due to high discharge, the river has shifted its course 50-60m towards left bank. Increase in sediment load in Bhagirathi River, unplanned construction at T0 and T1 level and inadequate protection measures have also aggravated the situation. The maximum construction is on the T1 and T2 terraces. It is also observed that few of the commercial buildings, Ashrams and temples have been constructed in the flood plains of Bhagirathi River.

After flash flood 120m road section leading to Dhauntri-Chaurangi Khal has been damaged completely due to toe cutting as entire reach is occupied with river borne/ slope wash material which is unconsolidated and saturated. Since the area lack proper drainage arrangement and the irrigation canals are very old and damaged and they are blocked at places, as a result there is continuous overflow of water that ultimately saturates the slope wash/ River Borne Material and aggravated the movement of material. Restoration work by the concerned departments has already been initiated and some phase is also completed.

Recommendations are made as mitigation measures.

1. Construction of the well designed RCC wall all along the left banks where habitats are located. The backfilling of the wall should be done with self draining material with adequate number of weep hole at suitable interval.
2. Due to flash floods, river bed level was raised by 2m-3m at many locations due to accumulation of

debris material. Hence, it is suggested to dredge the debris material in a planned way only upto the present water level from Joshiyara upto confluence of Bhagirathi with Asi Ganga near Gangori, so that there are remote chances of shifting of river course in future.

3. Construction of the houses, shopping complex, temples, ashrams, etc. should be strictly prohibited on the river banks and active flood plain.
4. Removal of the construction material from the river bed should be done in a scientific manner by preparing an excavation plan and concurrently stabilization like bank protection, backfilling of the deeper points, check dam near *nala* junctions, etc.
5. Future planning for extension of the town should be done as per geological and topographical conditions of the site considering the high flood level.
6. Drainage system of village to be improved with proper gradient.
7. To avoid further sinking of road, it is advised to improve drainage system, sewerage line and canal and provision of lined toe drain all along the road.
8. The river course should be channelized so that it can flow in the centre to minimize the bank erosion.

#### **Kansen Village**

The Kansen village is located on the left bank of Bhagirathi River at an elevation of 1136m in Bhatwari Tehsil. Kansen is a large village located in Bhatwari Tehsil of Uttarkashi district with total 534 families residing. The Kansen village has population of 2307 of which 1251 are males while 1056 are females as per Population Census 2011. A piece of land 40m x15m was inspected in order to assess the area for construction of houses for the disaster affected families in Bhatwari Tehsil. The area is located on the gentle slope ground occupied with river borne material and slope wash material. A seasonal *nala* is present at about 50m distance and flowing in North direction from this location, the land appears feasible for relocation of the families and there is no direct threat to the proposed land from the *nala*, however, recommendations.

1. The proposed shelter/houses should be light weight and raising the plinth level ~50cm above ground.
2. Proper drainage arrangement back side of the proposed houses to drain the seepage from upslope.
3. Provision of concrete wall of suitable height towards *nala* to divert rain water coming from the higher reaches.
4. Deeping of the already channelized seasonal *nala* and repairing the damaged wall.

#### **Tiloth Village**

The village Tiloth is situated on the left bank of the Bhagirathi River in Tehsil Bhatwari. Tiloth is a large village located in Bhatwari Tehsil of Uttarkashi district, Uttarakhand with total 708 families residing.

The Tiloth village has population of 2994 of which 1618 are males while 1376 are females as per Population Census 2011. The village is situated on the T1 level of Bhagirathi River and being used for inhabitation and cultivation. About 700m stretch along left bank of river has been badly affected due to toe cutting during insistent rain and flash flood. About 70 families are residing in the village; three houses in the village have completely washed out whereas 16 houses have been badly damaged. In the downstream of bridge, store and residential quarters of UJVNL have also been damaged partially. The incidence took place during day time on 17th June, 2013 therefore, there was no human casualty. River bed level is 5m-8m below from the habitants and the

bank protection measures which have been adopted are inadequate. The foot track (> 1km long) which was constructed during the high flood has also been eroded and washed away completely. The right abutment of the only bridge, (constructed in the year 1976) connecting Tiloth village with Uttarkashi town, was also damaged and washed out. River bed level at many locations has been raised by 2m-3m due to accumulation of the sediments in the form of boulders, pebbles, cobbles silt and sand etc. In August 2003, flash flood washed out many buildings located on right bank whereas during the present disaster damage occurred on the left bank due to change of river course.



### Recommendations

1. Immediate restoration of the foot track by constructing concrete wall with deep foundation (below scouring depth) and height should be at least upto high flood level along with weep holes.
2. One row of boulder crate wall towards river side to protect concrete wall in the event of high flood.
3. Further construction practice in the flood plain/ T0 level should be strictly prohibited.
4. Dredging of the river bed in planned way by removing sediments in the form of pebble gravel, cobbles, boulders, etc. which help free flow of discharge during monsoon.
5. In the cultivated land controlled irrigation should be adopted.
6. At the confluence of one unnamed *nala* with Bhagirathi river about 600m upstream, damage to few houses has been noticed. Bank protection along this *nala* is also suggested.

### Siror Village

The village is located on the left bank of the Bhagirathi River in Bhatwari Tehsil, District Uttarakashi. Siror is a medium size village located in Bhatwari Tehsil of Uttarkashi district, Uttarakhand with total 142 families residing. The Siror village has population of 757 of which 382 are males while 375 are females as per Population Census 2011. Height of village from river bed level is about 50m. The area is landslide prone and in every monsoon failure of material has been reported by the villagers and the

crown is receding towards hill side in rainy season causing threat to the inhabitants. The problem of landslide aggravated manifold during monsoon in the month of June 2013 due to toe cutting by the river Bhagirathi and heavy discharge along two seasonal *nalas* on either side of the village. but due to flash flood the discharge of Bhagirathi reached above 5m and started toe cutting resulting failure of material and sliding of few houses towards the river. On the basis of preliminary geological inputs and history of the slide, it is recommended to shift the affected families to a safer place nearby the village because day by day the crown is receding and seasonal *nalas* are engulfing the land from both sides and Bhagirathi is continuously eroding the toe of the land where the village is situated.

District administration is planning to shift the affected families in the Bayana Tok (30°44'28.1"N, 78°29'22"E, Elevation ±1230m, 53J/6) hamlet of main Siror village. The proposed land which is located on the flat terrace on the left bank of the Bhagirathi River (~ 100m SW) and which is presently under cultivation. The location is opposite to famous Naitala landslide and presently the flow of the Bhagirathi River is towards right bank.



Prima facie, the proposed land appears feasible, however, it is advisable to adopt all the stability measures like deep foundation, earthquake resistant structure and good drainage arrangement and isolate the proposed land from adjoining irrigated land to avoid any seepage below the foundation of the houses.

#### Conclusion

The area around Uttarkashi faces serious slope stability and metrological disaster problem during every monsoons months. Landslides occur frequently in Uttarkashi region. This is due to the geology, slope conditions and the high intensity of rainfall that not only contributes to rapid erosion and weathering of rock mass but also increases the ground water level, decreasing the stability of slopes. The increasing anthropogenic activity in the sensitive zones contributes to increase the instability of active slopes in the region. Increases in such incidents and increase in population in the areas and construction on river bank/near river could be the cause of more damage to life and property in future.

Construction of buildings and structures on unstable hill slopes and young flood plains must be restricted.

#### References

1. Google Earth Pro 7.3.2.5495
2. [www.portal.gsi.gov.in](http://www.portal.gsi.gov.in).
3. <https://www.researchgate.net/>
4. [https://www.researchgate.net/publication/291757440\\_A\\_Study\\_on\\_Flash\\_Floods\\_and\\_Landslides\\_Disaster\\_on\\_3rd\\_August\\_2012\\_along\\_Bhagirathi\\_Valley\\_in\\_Uttarkashi\\_District\\_Uttarakhand](https://www.researchgate.net/publication/291757440_A_Study_on_Flash_Floods_and_Landslides_Disaster_on_3rd_August_2012_along_Bhagirathi_Valley_in_Uttarkashi_District_Uttarakhand) [accessed Dec 12 2018].
5. <http://www.iosrjournals.org/iosr-jhss/papers/Vol9-issue3/H0933742.pdf>
6. <http://chimalaya.org/2012/08/09/uttarkashi-flash-flood-2012/>
7. [https://en.wikipedia.org/wiki/1991\\_Uttarkashi\\_earthquake](https://en.wikipedia.org/wiki/1991_Uttarkashi_earthquake)  
[nidm.gov.in/pdf/pubs/india%20disaster%20report%202013.pdf](http://nidm.gov.in/pdf/pubs/india%20disaster%20report%202013.pdf)
9. [http://www.academia.edu/14357573/Landslides\\_and\\_Flash\\_Floods\\_Caused\\_by\\_Extreme\\_Rainfall\\_Events\\_Cloudbursts\\_in\\_Uttarkashi\\_District\\_of\\_Uttarakhand](http://www.academia.edu/14357573/Landslides_and_Flash_Floods_Caused_by_Extreme_Rainfall_Events_Cloudbursts_in_Uttarkashi_District_of_Uttarakhand)
10. <http://www.iosrjournals.org/iosr-jestft/papers/vol7-issue2/H0723345.pdf>
11. Gupta V, Sah MP. 2008. Impact of the trans-Himalayan landslide lake outburst flood (LLOF) in the Satluj catchment, Himachal Pradesh, India. *Nat Hazard*. 45:379–390.
12. Saaty TL. 1980. *The analytic hierarchy process: planning, priority setting, resources allocation*. New York (NY): McGraw-Hill.
13. Sanyal J, Lu XX. 2005. Remote sensing and GIS-based flood vulnerability assessment of human settlements: a case study of Gangetic West Bengal, India. *Hydrol Process*. 19:3699–3716.
14. Agarwal, N. C., Kumar G., (1973): *Geology of the Upper Bhagirathi and Yamuna Valleys, Uttarkashi District, Kumaun Himalaya, Himalayan Geology*, vol. 3, pp. 2-23.
15. Bhattacharjee, D. (2009): *Glacial retreat and their impact on environment of Gangotri region, Uttarkashi district, Indian jr. of Geomorphology*, Vol. 13+14 (1&2), pp. 165-178.
16. Dutta, S.S., Sangewar, C.V., Shukla, S.P., Chitranshi, A., Puri, V.M.K., and Hampaiah, P. (2004): *Some observation on Physiography and Geomorphology of Gangotri Glacier area, Bhagirathi basin, Uttarakhand, Special Publication Number 80, GSI*, pp. 69-77.
17. Naithani, N. P., Bhatt, M (2011): *Geo-environmental hazards around Bhatwari area, district Uttarkashi Garhwal Himalaya Uttarakhand, International journal of current research*, vol. 33, issue, 4, pp.200-205, April, 2011.