

# Mapping of Affected Areas by Extreme Weather Events in *Kanda Tehsil* of *Bageshwar* District by GIS and RS Technique



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**Abstract** *Uttarakhand* has seen a wide range of extreme weather events over the years. *Bageshwar* district of *Kumaon Himalaya* has suffered disasters due to these extreme weather events. These extreme weather events and their impacts have been studied in *Tehsil Kanda* of *Bageshwar* district. In *Tehsil Kanda*, the villages affected by these extreme weather events from 2005 to 2015 have been mapped with GIS (Geographical Information System) and RS (Remote Sensing) technical support. The use of GIS and RS technology in disaster mapping and disaster management has been very effective with the help of demarcation and mapping of disaster-affected areas. With the help of these techniques, a zoning map of the villages affected by the most extreme weather events of *Tehsil Kanda* has been prepared. With the help of these maps, the most affected villages of *Tehsil Kanda* can be identified, thus helping in disaster management and reducing disaster risk before the disaster.

**Keywords** GIS (Geographical Information System) · RS (Remote Sensing) · Extreme weather events · Disaster management

## 1 Introduction

Uttarakhand is a mountainous state, which is mostly covered with mountains, due to being a mountainous part, many types of natural disasters are seen here. Uttarakhand has been continuously affected by many natural disasters at different times. The damage caused by natural disasters is also quite common here, mainly due to high-intensity cloudbursts, earthquakes, landslides, rupture of glaciers, etc. Major natural disasters are frequent. These natural calamities also include extreme weather events, including events such as high rainfall and cloudburst, due to these events, there is an increase in landslides in the mountainous parts which causes great loss of life. Extreme weather events are special conditions in the atmosphere that cause disaster conditions as well. Uttarakhand has been continuously affected by these extreme

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seasonal events. Bageshwar district of Kumaon Himalaya has also been affected due to these extreme weather events. The impact of these extreme weather events in Kanda tehsil of Bageshwar has been studied in this research paper.

Geographic Information Systems (GIS) and Remote Sensing (RS) are advanced technologies used, which assistance can be taken in disaster management. Many researchers have used GIS and RS technology in disaster management. C. J. Westen has used Remote Sensing (RS) and Geographic Information Systems (GIS) for natural disaster management and has described the GIS and RS technical utility in natural disaster mitigation in the world in his research paper (van Westen 2010). Varun Joshi and Ashok Kumar Sharma in their research paper have used Remote Sensing and Geographic Information Systems in Disaster Management in Gangtok, Sikkim has used more ARS techniques for disaster management (Sharma and Joshi 2016). Phong Tran, Rajib Shaw, Guillaume Chantry, and John Norton have done flood risk mapping and disaster management in Vietnam with GIS technical support (Tran et al. 2009). In his research paper, Remote Sensing and Disaster Management, Antoanetta Frantzova studied how RS and GIS can be used in disaster management and how useful this technology is for disaster management (Frantzova 2010).

## 2 Research Methodology

In this study, disaster-affected village of Kanda tehsil of Bageshwar district has been studied, secondary data has been used in this research paper. Secondary data has been collected from the Tehsil office in Kanda. GIS and RS techniques have been used in this study, under which, Arc GIC software has been used for disaster-affected villages mapping and Google Earth and Bhuwan software have been used for location determination of disaster-affected villages. In this research paper, after analyzing the secondary data, a map and zoning of the affected areas with GIS and RS technical assistance have been done so that assistance can be taken in disaster management.

## 3 Study Area

Bageshwar is a district situated in the Lesser Himalayas of Uttarakhand, which has 6 tehsils, one of which is Kanda tehsil, which has been studied in this research paper. Kanda is located at 29.85° North and 79.85° East. It is located in the eastern part of Bageshwar district, in its east is Berinag tehsil, Kapkot in the north, and Gangolihat in the south. It has an average elevation of 1600 m above sea level. There are 160 villages in Kanda tehsil.

## 4 Findings/Results

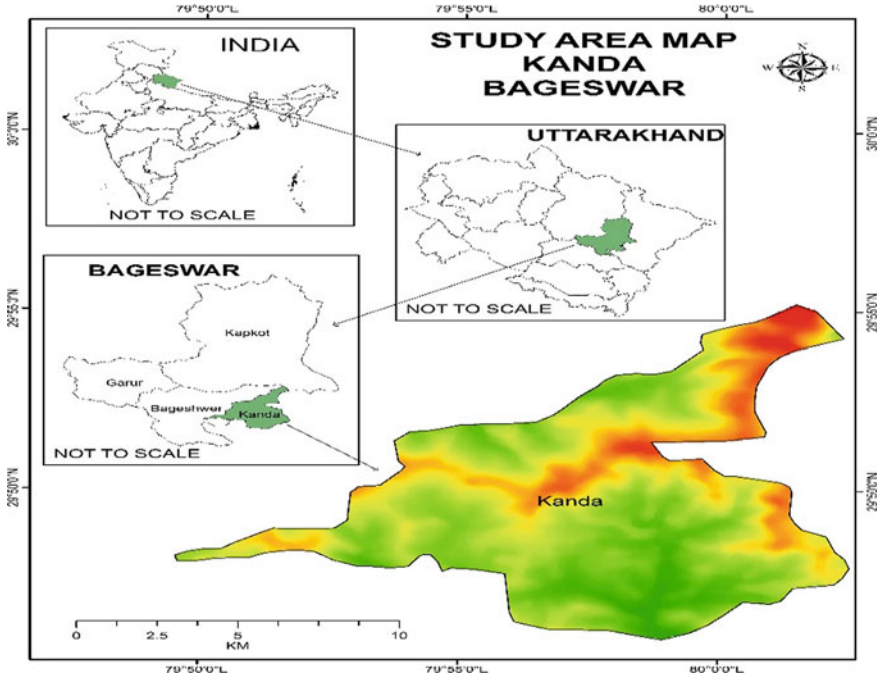
### 4.1 Damage Assessment Due to Extreme Weather Events in *Kanda Tehsil*

In this paper, a study of the villages affected by the disaster and the damage caused by the disaster have been recorded in Kanda tehsil from 2005 to 2015, and on the basis of this study, mapping of the affected villages has been done. The studied areas have suffered a lot due to the extreme weather events in the past years, in which there has been a lot of damage to human beings, animals, houses, and crops. In these extreme events, heavy rains and cloudbursts are the major events, due to which landslides, flash floods, and land erosion disasters are seen in the study area. The damage caused by extreme weather events in the study area in the previous years is shown in Table 1 and in Fig. 1 this damage is shown through the figure as well.

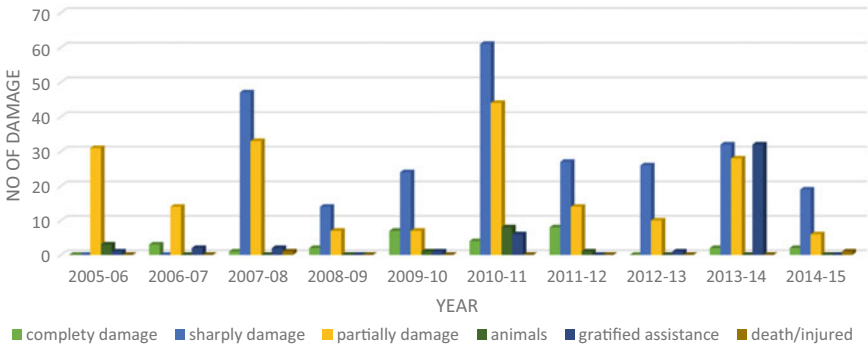
From the Table 1 and Fig. 2, it is considered that due to extreme weather events in the last years, 31 houses were partially damaged in Kanda tehsil in the year 2005–06, 3 animals have been lost, and 1 family has been provided with gratified assistance. In the year 2006–07, complete damage to 3 houses and partial damage to 14 houses were observed and gratified assistance have been provided to 2 family. In 2007–08, 1 house was completely damaged, 47 houses were sharply damaged, and 33 houses were partially damaged; 2 families have been given ex-gratia assistance along with one loss of life. In 2009–10, 7 houses were completely damaged, 24 houses were sharply damaged, and 7 houses were partially damaged along with 1 animal loss; 2 families have been given ex-gratia assistance. In the year 2010–11, 4 houses were completely damaged, 61 houses were sharply damaged, and 44 houses were partially damaged along with 8 animal losses; 6 families have been given ex-gratia assistance. In the year 2011–12, 8 houses were completely damaged, 27 houses were

**Table 1** Damage due to weather events during 2005–2015

Year	Damage house			Animal	Gratified assistance	Death/Injured
	Complete	Sharp	Partial			
2005–06	–	–	31	03	01	–
2006–07	03	–	14	–	02	–
2007–08	01	47	33	–	02	01
2008–09	02	14	07	–	01	–
2009–10	07	24	07	01	02	–
2010–11	04	61	44	08	06	–
2011–12	08	27	14	01	–	–
2012–13	–	26	10	–	01	–
2013–14	02	32	28	–	32	–
2014–15	02	19	06	–	–	01 (Inj.)



**Fig. 1** Location map of Kanda Tehsil



**Fig. 2** Damage due to weather events during 2005–2015

sharply damaged, and 14 houses were partially damaged along with the loss of 1 animal. In the year 2012–13, 26 houses were severely damaged and 10 houses were partially damaged; 1 family has been given ex-gratia assistance, 2 houses completely, 32 houses severely and 28 houses were partially damaged and 32 families have been given ex-gratia assistance in the year 2013–14. In the year 2014–15, 2 houses were

completely damaged, 19 houses were sharply damaged, and 6 houses were partially damaged with one person being injured.

## ***4.2 Affected villages of Kanda tehsil***

In the past, many villages of Kanda Tehsil have been affected due to extreme weather events, due to these incidents, there has been a lot of damage in many villages, on this study, a mapping of the villages of Kanda tehsil has been done, which has been affected by most extreme weather events from the year 2005 to 2015.

## ***4.3 Villages Affected by Extreme Weather Events During 2005–2015***

From 2005 to 2015, many villages of Kanda Tehsil have been affected due to extreme weather events and there have been a lot of loss of lives and properties in these villages. The number of affected villages of Kanda Tehsil during 10 years is presented in Table 2 and bar diagram as well.

From the analysis of the Table 2 and Fig. 3, it is known that the extreme weather events in the Kanda Tehsil from 2005 to 2015 have been very high. Twenty-two villages in the years 2005–2006, 16 villages in 2006–2007, 40 villages in 2007–2008, 17 villages in 2008–2009, 25 villages in 2009–2010, 47 villages in 2010–2011, 21 villages in 2011–2012, 22 villages in 2012–2013, 32 villages in 2013–2014, and 2 villages in 2014–2015 were the most affected by these extreme weather events. In the last 10 years, 47 villages from 2010 to 2011, 40 villages from 2007 to 2008, and 32 villages from 2013 to 2014 have been most affected by the disaster. The analysis of the above table shows that Kanda Tehsil has been affected by extreme weather events

**Table 2** Number of most affected villages during 2005–2015

Year	Number of most affected villages
2005–06	22
2006–07	16
2007–08	40
2008–09	17
2009–10	25
2010–11	47
2011–12	21
2012–13	22
2013–14	32
2014–15	20

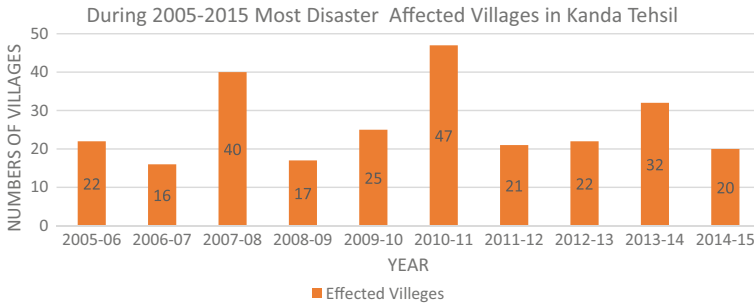


Fig. 3 Disaster Affected villages of Kanda Tehsil (2005–2015)

in the last 10 years, some villages here were the most affected by these incidents, among which Simkuna, Simgari Wajina, Jhaker, Naghar Manjila, Kandy Kanyal, Bhadura, Bhandola, Banigaon, Mahruri, Ratdhar, Siyakot, Patal, Seri, Thala, Dhapli, Malsuna, Chhana, Thanga, etc., are prominent. The most affected villages of Kanda tehsil in the last 10 years has been displayed on the map (Fig. 4).

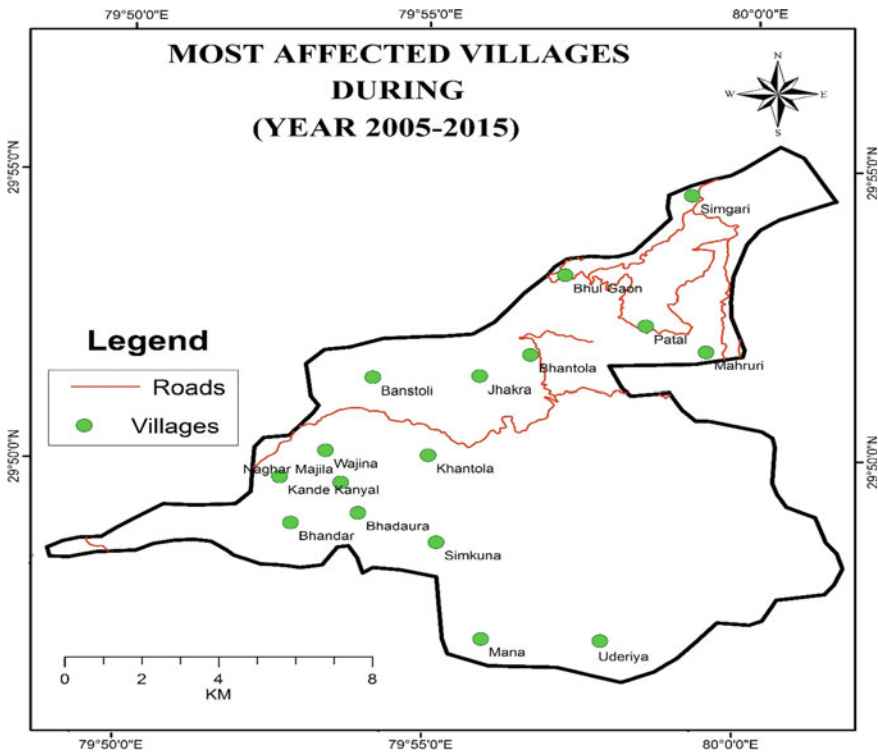


Fig. 4 Spatial representation of disaster affected villages in Kanda tehsil (2005–2015)

## 5 Conclusion

In the present research paper, the disasters caused by extreme weather events in the last 10 years of Kanda Tehsil have been studied and the damage caused by these incidents in the Tehsil has been assessed, and the most affected villages have been mapped, which provides assistance in disaster management in Tehsil Kanda. Due to these incidents, cloudbursts, landslides, and flash floods were quite common in this study area causing a lot of damage to many villages here. The disaster affected villages which are identified in the study could be given disaster awareness programmes, rehabilitation and mitigation strategies.

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