

Flood Disaster and its Management in Terai Region with Special Reference to Udham Singh Nagar District of Uttarakhand, India

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ABSTRACT

District Udham Singh Nagar is a plains district in the Uttarakhand state, situated at the foothills of mountain ranges. Earthquake and flood are among the potential disasters in the district. Flood is a recurring natural disaster in Uttarakhand, affecting various parts of the state almost every year. The state, with a population of 10.1 million inhabitants, faces significant natural hazards caused by water, such as floods, flash floods, heavy precipitation, avalanches, landslides, and glacier lake outburst flows. The recent calamity on June 16-17, 2013, resulting from heavy downpour and subsequent devastating floods in various rivers, led to substantial loss of life and property. District Udham Singh Nagar is located in the low-lying Terai region, making it susceptible to several devastating floods that have caused loss of life, significant damage to infrastructure, and the loss of cropland livelihood. The purpose of this study is to discuss the nature of flood disasters in the district, considering the potential impact on areas along the banks of rivers such as Fika, Kosi, Jagbuda, etc., during the rainy season. In 2021, a severe flood in the Gaula River, attributed to a natural disaster, resulted in the complete destruction of several gates of the Kichha barrage built in the Gaula River. This destruction occurred due to water discharge exceeding 15,000 cusecs, surpassing the design capacity of the Kichha barrage. Since the kichha Barrage is under the control of the Uttar Pradesh Irrigation Department, the reconstruction work of the gate will be undertaken by the same department. Following heavy rainfall in the year 2022, waterlogging was observed at various locations in the district. In the Udham Singh Nagar district, 11 management teams have been established, each equipped with a 24-hour standby ambulance. Additionally, two control rooms have been set up in the district, along with flood posts in every tehsil. However, there remains a pressing need for permanent security measures at sensitive locations. This study aims to spotlight the flood-affected areas in Udham Singh Nagar

district. The primary objective of the study is to scrutinize the flood disaster mitigation measures implemented by the district administration in Udham Singh Nagar.

Keywords: Disaster, Hazard, Causes, Damages, Waterlogging, Disaster Management

INTRODUCTION

In the state of Uttarakhand, home to a population of 10.1 million, residents contend with severe natural hazards primarily triggered by water, including floods, flash floods, heavy precipitation, avalanches, landslides, and glacier lake outburst flows. A poignant exile of the devastating impact of these hazards occurred on June 16-17, 2013, when torrential downpours resulted in catastrophic floods across various rivers, causing significant loss of life and property. The year 2013 witnessed extreme weather conditions, particularly heavy rainfall in parts of Uttarakhand, such as the Kedarnath surroundings, leading to flash floods and debris flow on June 17, 2013 (Das 2013; Rana *et al.*, 2013).

On February 7, 2021, in Chamoli District, another colossal flash flood swept through the valleys of the Rishi Ganga, Dhauliganga, and Alaknanda rivers. The aftermath confirmed over 70 casualties, with an additional 134 individuals reported missing. Uttarakhand has witnessed a series of flood events over the years, including incidents in Malpa and Okhimath (1998), Fata (2001), Gona (2001), Khet Gaon (2002), Budhakedar (2002), Uttarkashi (2003), Arav (2004), Govindghat (2005), and more (source: Mongabay.com).

In the years 1993 and 2000, severe flooding in the Gaula River resulted in water-flooding issues in the city of Kichha, and the railway line passing through it was also damaged. In 2021, another severe flood in the Gaula River, caused by a natural disaster, led to the complete destruction of several gates of the Kichha barrage. This was due to the water discharge exceeding 15000 cusecs, surpassing the design capacity of the Kichha barrage.

Floods, a natural disaster triggered by excessive rainfall, result in an increase in the amount of silt in river water. Heavy rains can also lead to a rise in the normal water level of rivers, causing breaches in dams and embankments and submerging the surrounding land. When extensive loss of public money occurs, this event is termed a flood disaster. The state of Uttarakhand is highly susceptible to floods and flash floods, experiencing significant incidents over the past 40 years. Residents of Uttarakhand have been consistently affected by flood disasters, with numerous lives lost and billions of properties damaged annually.

The Wadia Institute of Himalayan Geology reported that since 2010, the incidence of cloudbursts in the Uttarakhand Himalayas has increased by more than 50 percent. Over a six-year period, the intensity of the monsoon in Uttarakhand has risen by 60-70 percent (source: Valdiya 2013; Environmental Geology).

Flood is a recurring natural disaster in Uttarakhand that impacts various parts of the state almost every year. Due to its low-lying location called Terai, U.S. Nagar district (Udham Singh Nagar) has witnessed several devastating floods, resulting in loss of life, significant damage to infrastructure, and the loss of cropland livelihood. According to the National Disaster Management Authority (NDMA), over 40 million hectares of land in India are prone to flooding (www.ndma.gov.in). Flood is a major disaster occurring in the Terai region.

In addition to this, the area falls under low-lying areas or plains where the speed of rivers descending from the mountains usually slows down. During the monsoon period, these rivers take on a harsher form later on. Following floods, it is common to experience diseases such as dengue and malaria in the area. After rains in the hilly areas of the nearest district, Nainital, water flows into the plain areas with the help of slopes. Consequently, plain areas of the district, such as Jaspur, Kashipur, Rudrapur, Sitarganj, Khatima, and Kichha, get affected due to waterlogging. Waterlogging is the saturation of soil with water. Flash floods represent another form of flood disaster. It is also observed in the district, particularly during heavy rainfall that occurs in a short period of time. This overwhelms the capacity of the drainage system, causing water to rapidly accumulate in low-lying areas. Flash floods can be particularly dangerous as they can occur with little or no warning.

This practice now serves as the foundation required by planners and decision-makers to establish portfolios of cost-effective measures. These measures are designed not only to prevent flooding but also to minimize the impact of floods on the economy and population (Dasgupta, 2011).

STUDY AREA

The study is conducted in the U.S. Nagar (Udham Singh Nagar) district of Uttarakhand. It is located between 28 degrees North to 58 degrees North latitude and 78 degrees East to 81 degrees East longitude. District U.S. Nagar is adjacent to the border of Parvatanchal and is situated in the foothills of mountain ranges. District U.S. Nagar was created as a separate district on 29.09.1995 by separating from Nainital district. The total area of the district is 3055 sq.km, extending from Thana Khatima to Thana Jaspur. The northern boundary of this district is defined by Nainital, Chawat, and the Nepal border; in the east, it is bordered by Pilibhit Bahedi (Bareilly), in the south by Bilaspur, Rur, and Moradabad, and in the west by Bijnor (U.P. border).

The primary rivers entering the district include Fika, Dhela, Kosi, Gaula, etc. These rivers collect water from the mountains and flow into the district. Although the construction of dams on major rivers has reduced their destructive impact, the tributaries, drains, and upstream areas of the dams still experience flooding during the rainy season. This phenomenon adversely affects tehsils such as Kashipur, Khatima, Bajpur, etc.

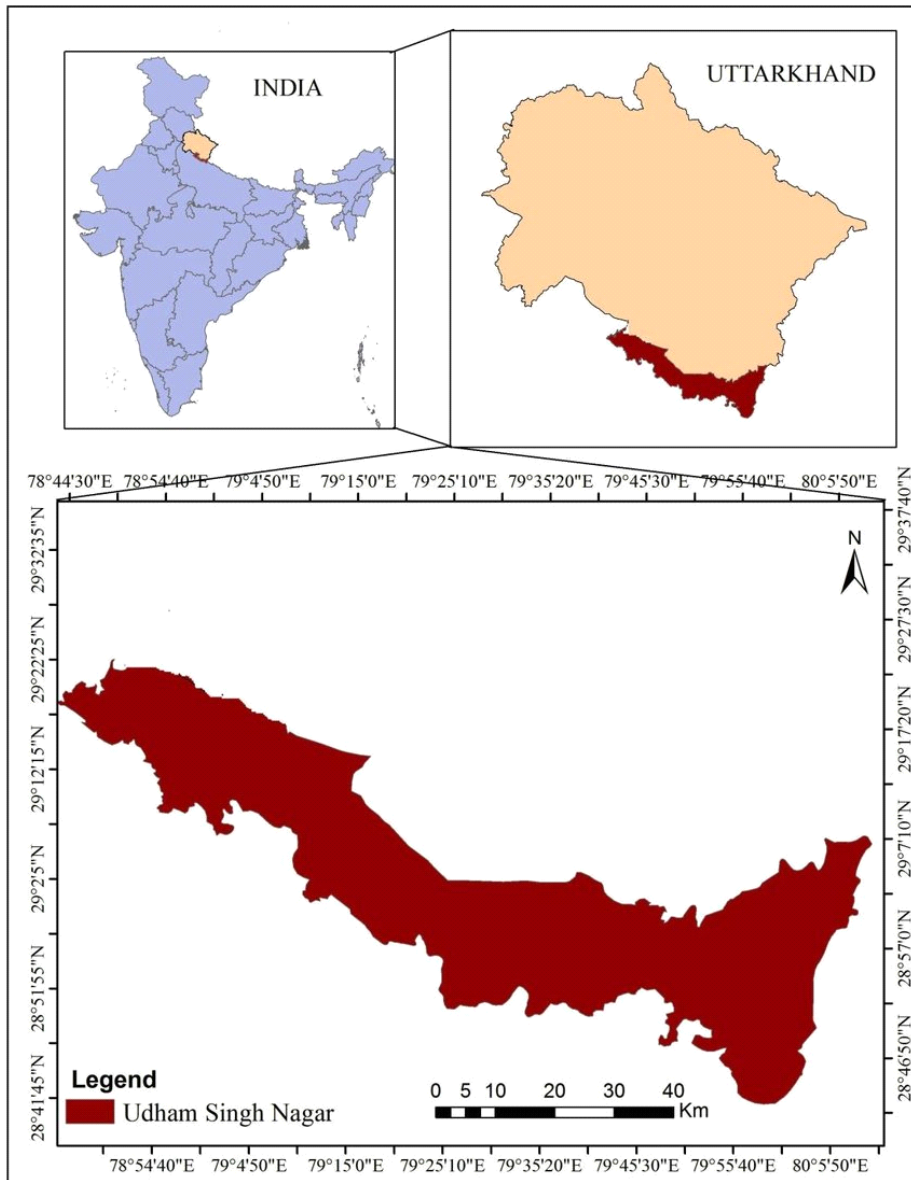


Figure 1: Location map of Udham Singh Nagar, Uttarakhand, India

Source: ResearchGate

Potential disasters in the district include earthquakes and floods. The district is particularly sensitive due to its location in earthquake Zone-4. Excessive water in the rivers during the rainy season could potentially impact areas along the riverbanks (Table 1 and 2).

OBJECTIVES

- The study aims to identify flood-affected areas in Udham Singh Nagar District.
- The objective of the study is to assess the flood disaster mitigation measures implemented by the district administration in Udham Singh Nagar.

DATA SOURCES AND METHODOLOGY

The present study relies on secondary sources obtained from various departments, articles, websites, previous works, and government officials. Hydrological descriptions of rivers, flood-affected areas in the district, and data related to flood management, such as the total available equipment and names of flood posts, were collected from the District Disaster Management Authority, Rudrapur, and the District Disaster Management Action Plan (DDMP). Information regarding the total number of families affected by the flood disaster and the population of affected villages was sourced from the Census of India 2011. It is important to note that this study exclusively focuses on examining the efforts made by the District Disaster Management Authority in Udham Singh Nagar district for the prevention of flood disasters.

RESULT AND DISCUSSION

Flood-Affected Area in U.S. Nagar, Uttarakhand

District U.S. Nagar is susceptible to floods due to its geography, heavy rainfall during the monsoon, changing weather patterns with rising temperatures, resulting in more frequent and intense rainfall events, river overflows, dam or levee failures, as well as flash flooding and landslides. Land-use/

Table 1:

Tehsil name	River name	Maximum recorded disposal; year 2020-21 (cusecs)	Average length of river (m)	Average width of river (m)	Slop of river (m)
Kichha	Gaula	17000	125	1.50	0.008
Sitarganj	Sukhi	45000	60	2.80	0.85
Sitarganj	Begul	45000	60	2.80	0.85
Sitarganj	Kailash	79000	110	3.00	1.00
Sitarganj	Devha	56500	80	2.75	0.50
Sitarganj	Nihai	12000	60	3.30	0.65
Jaspur	Fika	1190	240	03	1.69
Jaspur	Dhela	2295	260	03	1.13
Bajpur	Kosi	4600	-	-	-

Source: District Disaster Management Action Plan (DDMP), Udham Singh Nagar

land-cover changes, such as deforestation, rapid urbanization, poor drainage, and inadequate agricultural practices, might have contributed to the severity of flooding. The government has formulated a national or state-level disaster management plan to address floods and other natural disasters. The flood-affected area in U.S. Nagar district is approximately 433 hectares (source: Flood-Affected Area Atlas of India).\ Hydrological description of rivers in U.S. Nagar.

Table 2: List of sensitive villages situated on the banks of rivers/ streams from the point of view of floods in U.S. Nagar

River name	Name of Villages/affected area	Population of villages (approximate)	No. of kachhe & pance bhawan (approximate)
Gaula	Shantipuri, Kichha, Bandiya, Kotkharra, Bhagwanpur, Satiyya	8500	962
Sukhi/ begul	Paragano, Shaktinagar, Thakurnagar, Rudpur, Nirmal Nagar, Rajnagar, Surendranagar, Kotafarm, Jhari No. 9 Bamanpuri, Sitarganj city	30,000	5000
Kailash	Ukrauli, Santfarm, Sadhunagar, Nkuliya, Dohri, Kailashpuri, Anjaniya, Turkatisaur, Pathariya farm, Dohra, Rosoiyapur, Khairana, Salamti, Jhukha, Kadhaashraf, Kaudharatan, Bichpuri, Kanpura Matiya	13000	1600
Devha	Bichua, Boorjala, Agli Patti, Tukdi, Mohammadpur, Bhooriya, Sunpahar, Majgami, Mohammadganj	3000	700
Nihai	Bihi, Aichta, Chetuakhera, Gyanpur, Gauri, Devipura	700	230
Fika	Pooranpur, Rajpur, Gularbhoji, Veerpuri, Hajro, Nadehi (sugar mill)	10,171	1790
Dhela	Maldhanchaur, Chandranagar, Gautam Nagar, Devipura, Gopalnagar, Anandnagar, Gandhinagar, Kilavali, Durganagar, Baitwala, Bailjudi, Sarverkhera, Hempurdaya, Manpur, Kachnalgazi, Dhakiya Gulabo, Kashipur city (Aanshik)	55324	6469
Levda	Khambhari, Chanakpur, Bhaisiyana, Namoon, Pharpur, Birah, Khamariya, Bhaunaislam Nagar, Ward No. 1 Bajpur city, Chakarpur	14890	2623
Kosi	Darakhera, Nastnagar	—	—

Source: District disaster management action plan (DDMP), Udham Singh Bagar

Table 1 presents details such as length, width, and maximum recorded disposal of the major rivers located in the district. Floods cause inconvenience in the movement of residents in villages situated along the riverbanks (Table 2). In this flatland district, the arrival of water from the nearest mountainous region intensifies, taking on an intense and fierce form. Consequently, issues (Asthana and Asthana, 2014) such as soil erosion and waterlogging in populated areas escalate into destructive problems (Sharma, 2014).

Three rivers, Begul, Devha, and Kailash, fall under the Sitarganj tehsil of the district. Villages like Surendranagar, Arvindnagar, Nirmalnagar, Rura, Sisouna, etc., situated along these rivers are categorized as flood-sensitive. In the Kashipur tehsil, villages including Beljudi, Laximpur Patti, Sarverkheda, Jagannathpur, Guldiya, Ehtmali, etc., and other urban areas are generally prone to flooding. Flood impacts extend to the bridges on the Kosi and Dhela rivers, as well as National Highway 74. Additionally, NH-121 Moradabad-Tehri road, Kashipur-Aliganj road, and Kashipur-Dadial road are partially affected during the monsoon season due to heavy rains. Dhela river affects villages Nawalpur, Kilawali, etc., while Fika river impacts villages Durgapur, Kishanpur, and the Kashipur main road.

Responsible Factors of Flood Disaster in U.S. Nagar

Forest destruction and Widespread heavy rains: The Terai region runs parallel to the Shivalik hills in the south, with the Bhabar region to the north. The re-emergence of river water occurs in the Terai, which is the richest region in Uttarakhand in terms of population and agricultural productivity. In the catchment areas of rivers, the increasing destruction of forests intensifies the likelihood of floods. Fast-flowing rivers carry significant amounts of soil and debris, such as the Kailash, Devha, Dhela, Kosi, etc., causing flood situations during the monsoon. **Widespread Heavy Rains:** Despite significant advances in flood forecasting and early warning systems, flash floods remain a challenge due to intense short bursts of rainfall. Measuring the intensity and duration of high-intensity rainfall is extremely difficult. Flash floods predominantly occur during the rainy season, with heavy rainfall and cloudburst being the main contributors to floods in the U.S. Nagar district (Lone and Subramani, 2016).

Tourism and other human activities: Large-scale tourism exerts tremendous pressure on infrastructure and has led to unchecked development of houses, hotels, and shops in floodplains and ecologically fragile areas (source: Floodlist). In Rudrapur, settlements have emerged in areas adjacent to the drainage routes of the Kalyani River, resulting in numerous new settlements grappling with flood and waterlogging issues. **Overloaded Sewage System:** In urban areas, the built environment and pavement can prevent rainwater from being absorbed into the ground, causing accumulation in low-lying areas known as urban floods. These floods can be triggered by a blocked drainage system, overloaded sewage system, or other forms of infrastructure failure Rautela et al. (2019).

Table 3:

Tehsil name	Name of the river likely to be affected	Flood posts
Jaspur	Fika river	Govt. Primary School Rajpur
	Dhela river	G.H.S. School Kilavali
Kashipur	Dhela river	Primary School Missarwala, Laxmipur Patti, located at Primary School Ojhana, Primary School Manpur, Primary School Dhakiya Gulabo
	Kosi river	Primary School Dhabora Mustaqam (Ajeetpur)
	Arjun Nala	Primary School Dhakiya Kalan, Primary School Gandhinagar
Bajpur	Kosi river	Police Station Sultanpur, Govt. Primary School Ratanpura
	Bor river & Gadri river	Govt. Primary Health Center Jogipura Police Station Kelakhera
Gadarpur	Nihal river, Bor river	Tehsil Office Gadarpur
	Bhakhra river, Barsati nala	Nagar Panchayat Dineshpura
	Haripura reservoir	Nagar Panchayat Gularbhoj
Kichha	Gaula river	Sirauli Khurd Primary School Khamiya No. 4 Tehsil Kichha Flood Control Room
	Kalyani	Tehsil Rudrapur Govt. Primary School Baghwala
	Begul river	GIC Shaktifarm
Sitarganj	Kailash & begul river	Panchayat Bhawan Sisona, Mandi Samiti Sitarganj
	Devha / Kaman/ Kailash river	Panchayat Bhawan Rudrapur Primary School Khairana Primary School Saroja Balkhera
	Jagbuda river	Primary School Bhawan Sisayya
Khatima	Nanak Sagar Dam	Primary School Bhawan Majhola Primary School Bhawan Sunpahar
	Devha, Kaman river	Primary School Bhawan Gangi
	Parveen river	Primary School Janglje Gether

Source: District disaster management action plan (DDMP), Udham Singh Nagar

Landslides and erosion: The role of landslides might have played in making the flooding so much worse specially in hilly region of Uttarakhand but the effect of landslide in Terai region is quite less, so the erosion here plays its role in making the flood situation more dire. For example in the year 2000, due to the severe floods of Kosi river, there was a lot of erosion near Sultanpur Patti, due to which two poles of the High Tension Line of the Electricity Department were damaged. In the year 2010 and 2011, excessive erosion took place near Sutaiyya Dakbunglow and NH-34, efforts were made to stop it immediately with temporary arrangements. But these alternative flood protection measures did not prove to be very useful, as a result of which 4-5 residential houses got washed away due to erosion (Source- DDMP, Udham Singh Nagar).

Prone areas: These factors are sometimes considered to exacerbate floods due to their impact on the river's course, water levels and poor management practices, further worsening the situation (source: Mongabay). For instance, in Khatima, the water reaching the top of the dam resulted in a catastrophic flood (Source- DDMP, Udham Singh Nagar). In the year 2010, due to water flowing over the dam in Shaktifarm area by Sukhi and Baigul river of Sitarganj block, there was heavy devastation and waterlogging in this area was done (Source- DDMP, Udham Singh Nagar).

Functions to be Performed in Different Phases of Flood Management in Udham Singh Nagar District

Over the past decade, diverse methods encompassing both structural and non-structural approaches have been implemented in Uttarakhand for flood protection. The choice of method is contingent upon the specific nature of the problem and local conditions. It is noteworthy that our focus in this study is exclusively on the flood disaster management initiatives spearheaded by the District Disaster Management Action Plan (DDMP). The following delineates the three pivotal phases of flood disaster management:

Pre-preparatory action phase: This initial phase involves identifying vulnerable and sensitive areas within the district (Table 2) and establishing a disaster management team. It is crucial to nominate at least one Nodal Officer to oversee this phase

During flood disaster (Response) phase: In this active phase, the entire team collaborates with various allied departments to execute response activities. After the Disaster Phase: Marking the culmination of flood disaster management, this phase involves several essential tasks (Khanduri, 2017). The department is tasked with ensuring the repair of damaged assets, facilitating the clearing of debris obstructing roads due to natural waterflow, and conducting recovery and rehabilitation activities for affected individuals to help them regain a sense of normalcy. These recovery and rehabilitation activities are carried out in collaboration with flood posts situated throughout the district (Table 3).

In Udham Singh Nagar district, 11 management teams have been formed, each equipped with one ambulance available 24/7. Additionally, two control rooms have been established in the district, and flood posts have been set up in every tehsil.

CONCLUSION

The present study reveals that several causative factors contribute to flooding in the district. Inadequate river capacity to contain high flows from the upper catchment area, intensified by heavy rainfall, leads to flooding. Areas with poor drainage characteristics experience flooding due to the accumulation of water caused by the high intensity of rainfall. Sudden heavy rains or cloudbursts during the rainy season affect the plains of the district, resulting in flood, soil erosion, and waterlogging.

With the assistance of the above study, it can be concluded that flood disasters significantly impact people, and their effects cannot be entirely prevented. However, measures can be implemented to mitigate these impacts and ensure that individuals are adequately prepared to handle the consequences of flood hazards. This necessitates a multi-stakeholder approach involving government organizations, civil society, and individuals, with coordination and planning facilitated by disaster management support organizations. Despite these efforts, additional measures must be taken by district administrations for the mitigation and prevention of flood disasters.

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