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Recurring Cloudbursts: A Frightening Reality of Indian Hills

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Cloudbursts over India's hilly regions and the ensuing flash floods which cause property damage and fatalities, have frequently made headlines in the media. Many people living in the Himalayan region's steep and landslide-prone areas face a constant, life-threatening fear of cloudbursts. Recent large-scale destructive cloudburst incidents in Uttarakhand and Himachal Pradesh, such as the Dharali, Uttarkashi, 2025 incidence, and the Kedarnath, 2013 disaster, have worsened the situation. A geo-hydrological hazard, cloudbursts can be particularly frightening at times due to their aggressive nature and potential for massive destruction. These events typically occur in India between June and September, during the South-West Monsoon season. They are difficult to predict accurately because they happen suddenly, with a catastrophic force, over a very small area, and in a short period of time. To a certain extent, recent technological developments such as Doppler Radar and government assistance from organizations like the NDMA and other disaster relief NGOs and agencies can be helpful, however the ultimate solution lies in citizens taking proactive measures by adhering to government guidelines on preparedness, mitigation, and prevention of such natural disasters.

Keywords: Cloudburst, Disaster, Flash flood, Hills, NDMA.

Introduction

A cloudburst is a localized, abrupt, and unusually heavy rainfall event. India Meteorological Department (IMD) defines a "cloudburst" as rainfall that exceeds the intensity of 100 mm/hour over a narrow area of 20 to 30 km². It usually happens in high altitudes, between 1000 and 2500 meters above sea level and is caused by Cumulonimbus clouds. These are convective clouds, which produce thunder, lightning, and hail in addition to a heavy rainfall. High-altitude places, such as hills and mountains, experience this geo-hydro-meteorological phenomenon because of development of low-pressure areas and accumulation of clouds forcefully on top of mountains, causing orographic precipitation. In some cloudbursts, raindrops up to 5 cm in size can also develop. In India, this catastrophic occurrence frequently occurs during the monsoon season, particularly in areas like Jammu and Kashmir, Uttarakhand, and Himachal Pradesh. Cloudburst occurrences cause torrential downpours with hail and thunder, resulting in devastating flash floods and enormous landslides with frightening intensity. As a result, nearby hillslopes and valleys suffer severe damage, and both human lives and property are at risk of loss of life. In addition to landslides and flash floods, such prolonged and intense rainfall episodes can result in mudslides, debris flows, mass movements, drownings, road closures, and occasionally dangerous accidents. In addition to harming people and property, cloudbursts cause irreparable harm to the environment and economy, particularly those that rely heavily on tourism. The Himalayan

regions have had some of the most destructive cloudbursts with the highest shattering losses over the last 15 years (**Table 1**).

Table 1: Latest records of cloudburst in Himalayan region

S.No.	Month, Year	Location	State	Major loss
1	September, 2025	Dehradun and Chamoli	Uttarakhand	More than a dozen people were killed in Dehradun. At least 7 people were reported missing and 20 injured in Chamoli.
2	August, 2025	Dharali village, Uttarkashi	Uttarakhand	Destroyed more than 50 hotels and bridges and around 40–50 houses were washed, as many as 70 people were reported missing.
3	June, 2025	Near the Indira Priyadarshini Hydel Project	Himachal Pradesh	Due to associated flash floods at least two people lost their lives, and 15–20 other workers were feared missing.
4	August, 2024	Kullu's Nirmand, Sainj and Malana; Mandi's Padhar and Shimla's Rampur sub-division	Himachal Pradesh	Significant damage and loss of life. Nearly 9 people were reported dead and about 45 missing.
5	July, 2022	Amarnath Shrine	Jammu and Kashmir	At least 16 individuals lost their lives, and 40 plus were missing and at least 25 people were severely injured.
6	July, 2021	Chasoti village in Kishtwar district	Jammu and Kashmir	Widespread damage occurred. Claiming at least 65 lives and 32 people reported missing.
7	May and July, 2021	Binsar and Chamoli	Uttarakhand	flash floods and debris flows caused by heavy monsoon rainfall destroyed homes, roads, and public infrastructure.
8	July 2017	Thathri town of Doda district	Jammu & Kashmir	Cloudburst and flash floods led to a loss of at least 6 people, injuries to 11people, and caused extensive damage to infrastructure.
9	July 2017	Haridwar	Uttarakhand	In an hour, 102 mm of rainfall was recorded at some local stations. Surprisingly, no significant damage was reported.
10	July, 2016	Bastari, Pithoragarh and Chamoli districts	Uttarakhand	Cloudbursts and torrential rains caused severe flash floods and landslides, destroying houses in several villages and, as per reports loss at least 30 lives.
11	June, 2013	Kedarnath	Uttarakhand	Devastating cloudburst claimed more than 6,000 lives, destroyed significant property at Kedarnath except for the temple, and thousands of pilgrims became stranded.
12	August, 2012	Bhatwari and Sangam Chatti villages, Uttarkashi	Uttarakhand	Flash flood led to 35 deaths, 436 livestock fatalities and significant damage to buildings and national highway.
13	August, 2010	Leh region	Ladakh	Resulted in at least 234 deaths, injured hundreds, and destroyed thousands of homes, property and other infrastructure.

Cloudbursts are exceedingly hard to predict since they happen quickly and over a relatively small area. However, the likelihood of cloudbursts may be predicted roughly six hours, and occasionally twelve or fourteen hours, ahead of time using Doppler weather radars. Techniques for forecasting cloudbursts are limited and necessitate a radar network, which is too costly and scarce in the nation. Furthermore, this technique simply identifies

regions with possibility of severe rainfall; it cannot determine the quantity, intensity, or degree of damage.

Causes of recurring cloudbursts

1. **Geography and atmospheric condition:** A common cause of cloudbursts is atmospheric instability, which is occasionally brought on by the collision of cooler, high-altitude Himalayan air with moist air from the Arabian Sea and the Bay of Bengal. Intense surface heating of narrow valleys during the Indian summer monsoon traps and pushes warm, humid air masses upward quickly, creating powerful convective currents. This orographic lifting causes the air mass over the mountain to cool. The vaporized moisture begins to condense rapidly, forming cumulonimbus clouds and resulting in a quick, heavy rainstorm with lightening and thundering **(Figure 1)**.
2. **Climate change:** The warming of the atmosphere is also on the rise as a result of rising GHG levels. For every degree Celsius of warming above normal, the atmosphere's capacity to hold moisture increases by about 7%. This extra moisture drives more intense and irregular rainfall events, resulting in longer dry spells followed by shorter, but much more intense, wet episodes. The melting of glaciers and glacial lakes is exacerbated by rising global temperatures, which increases water volume and raises sea levels. In the Himalayan region, this melting can occasionally cause a Glacial Lake Outburst, which can exacerbate the catastrophe.
3. **Human led developments:** In the name of hill region development, there has been a major increase in forest cutting, hydropower dam construction, and the widespread and unregulated construction of roads and structures over unstable mountainous slopes and riverbeds. When natural vegetation is removed, landslides and soil erosion occur. In such geographically sensitive locations, all of these human activities contribute to the destabilization of the terrain, the obstruction of natural water flow, and the disruption of drainage patterns, resulting in landslides and flooding.

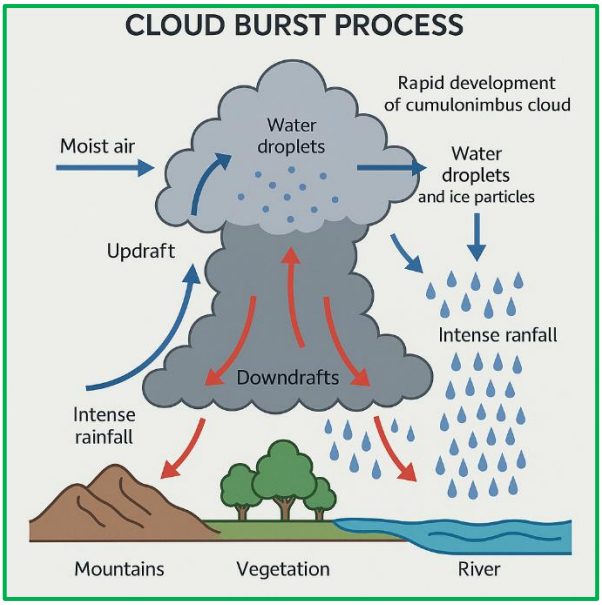

Figure 1: Schematic Representation of the Cloudburst Process

Management strategies against Cloudburst

Every cloudburst incident has high lightened the fragility of Himalayan states and taught us how important it is to spend time and resources on approaches to prevention, precaution, preparedness, and mitigation. It is crucial that citizens and local authorities are informed of these management measures and diligently adhere to them in order to reduce the extent of damage and safeguarding the life.

1. Local authorities should have a landslide-prone area map for the entire region, as well as a vulnerability inventory of critical properties such as highways, schools, bridges, and hospitals in cloudburst-prone areas.
2. In order to improve forecasting, the government must establish and strengthen a network of automatic weather stations and high-resolution Doppler weather radars.
3. In order to promptly broadcast weather forecasts and early warnings to citizens in hazardous locations, local authorities should have a well-established communication infrastructure that includes sirens, radios, proactive local messengers and mobile phones.

4. Communities and local authorities in the area should actively participate in government-organized disaster management training programs, particularly those that focus on flood, landslide, and cloudburst.
5. Education and training on emergency response and evacuation protocols must be provided to local kids, students, and communities.
6. In vulnerable hilly states, the government must establish more stringent regulations governing the use of subpar building materials, hydropower projects, and the construction of multistory buildings.
7. Inter-agency collaboration is essential for the efficient handling of any disaster, particularly between emergency response teams, health services, NGOs in the region and meteorological organizations.
8. Governments should prioritize watershed improvement and reforestation with the assistance of local communities. This helps to improve water retention, prevent soil erosion, and stabilize slopes, so reducing the effects of cloudburst.
9. The goal of rehabilitation must be to establish resilient communities that can adjust to shifting environmental conditions, not only to replace infrastructure.

Government initiative

The National Disaster Management Authority (NDMA), which is led by the prime minister, is the highest authority in the nation for handling all types of catastrophic events. Established on September 27, 2006, NDMA was founded on the National Disaster Management Act of 2005. In addition to developing the policies, strategies, and guidelines for the management of both natural and man-made disasters in the nation, this government agency is in charge of the mitigation, prevention, preparedness, and response to national catastrophes. The NDMA has recently launched a "multilingual disaster awareness e content" service on their website, https://www.ndrf.gov.in/en/disaster-awareness-e-content , in 13 different languages to help the public better comprehend the hazards connected with disasters and increase their level of preparedness. In order to provide LIVE location-specific (user's current location) disaster alerts and precise weather updates nationwide, it has also launched the National Disaster Alert Portal (सचेत) https://sachet.ndma.gov.in/. This technology can simultaneously deliver geotargeted alerts in many languages for all man-made and natural disasters across all media platforms. Citizens need to pay attention when they receive disaster related notifications by SMS with the header XX-NDMAEW, from NDMA. Additionally, the citizens can download a mobile application for the same (सचेत) from the Play Store or App Store, as per their convenience.

Conclusion

Due to a terrible combination of unsustainable human activity, climate change, and topographical weaknesses, cloudbursts have become a terrifying reality for both locals and visitors in India's mountainous regions. The recent disaster episodes have revealed the weaknesses in early warning systems, even though the India Meteorological Department issues weather alerts and NDMA sends location-specific disaster notifications directly to mobile devices. The difficulty is not only anticipating events, but also ensuring that weather warnings are translated into community-wide responses. This indicates that in order to increase resilience and safeguard the delicate Himalayan ecology and its inhabitants, immediate action is required on all fronts, from infrastructure and technology to policy and community involvement. All of these terrible cloudburst incidents serve as a reminder of the associated risk to life and property in the surrounding urban areas as well as the steep Himalayan regions. With improved planning, technology, and community involvement, the emphasis must now be on preventing and mitigating the effects of disasters rather than just responding to them.