# SPATIO TEMPORAL OCCURRENCES OF CLOUD BURST IN THE HIMACHAL HIMALAYA

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**Abstract**

*The cloud bursts are a common feature in the hills and mountains of the Himalayan region. The exact mechanism of the cloud bursts is yet to be understood. Cloud bursts leads to flash floods, landslides, uprooting of trees, house collapse, dislocation of traffic and bridges. Himachal Himalaya experienced devastating flash floods, from a spate of cloudburst events which killed hundreds of people. The Himachal Himalaya has experienced a number of incidences of Cloudburst since its inception in 1971. Typical terrain of this Himalayan state provides a conducive environment for the cloudburst phenomena. These disastrous events have brought heavy* toll *to the state as the loss was estimated in several thousand millions of rupees and also killed several hundreds of people besides large number of cattle heads.The study focuses on the Himachal Himalaya where cloud bursts are increasing in both their frequency and magnitude. Keeping this problems in view, this paper comprises three objectives. They are: They are: a) to record the temporal incidences of cloud burst in Himachal Himalaya, b) to analyse the spatial pattern of cloud bursts in the Himachal Himalaya, and c) to analyze the mechanism and causes underlying cloudbursts and their impact. The study is based on secondary data which is collected from disastrous weather events published by Indian meteorological Department. The methodology adopted includes simple tabulations and mapping to reflect the trends and spatial patterns simulated by using GIS technology. The incidence and intensity of cloud bursts in different areas have been divided into three different intensity zones, such as, less, moderate and high. Based on the intensity of cloud bursts in different zones, appropriate measures to reduce the adverse impacts of cloud bursts can be adopted.*

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## Introduction

Cloudburst and associated flash floods are one of the most potent disasters occurring in the Himalayan region. Flash floods occur as a result of rapid accumulation of runoff waters from rainstorms in mountainous or hilly areas. The floodwaters usually collect in relatively confined areas (example gullies, wadis or arroyos) then cascade until they reach other streams or wider, less restrictive areas where the waters spread out and slow down. The speed of the floods and the debris they carry are what make flash floods dangerous. Historically, people have avoided living in constricted areas although some economic activities (such as sand or gravel extraction) are carried out there. With rapid, unchecked urbanization this has changed. Since many poor people are forced to live in these areas, the threat to human life is growing annually.The flood can be of various origins, but in a hilly area like Himachal they are the result of some typical reasons. They include cloudburst in the catchment's region, intense and prolonged rainfall, the downstream blocking of river channels by landslides or avalanches or the sudden breach or burst of artificial /natural lakes. In Himachal Pradesh, the flash-floods are mostly the result of cloudbursts or blockage of river channel due to landslides. Typical terrain of this Himalayan state provides a conducive environment for the cloudburst phenomena. The cloudbursts are the result of combination of different factors like deep valleys, steep gradient, vegetation cover and geology of area. Early prediction and warning of such severe local weather systems is crucial to mitigate societal impact arising from the accompanying flash floods.

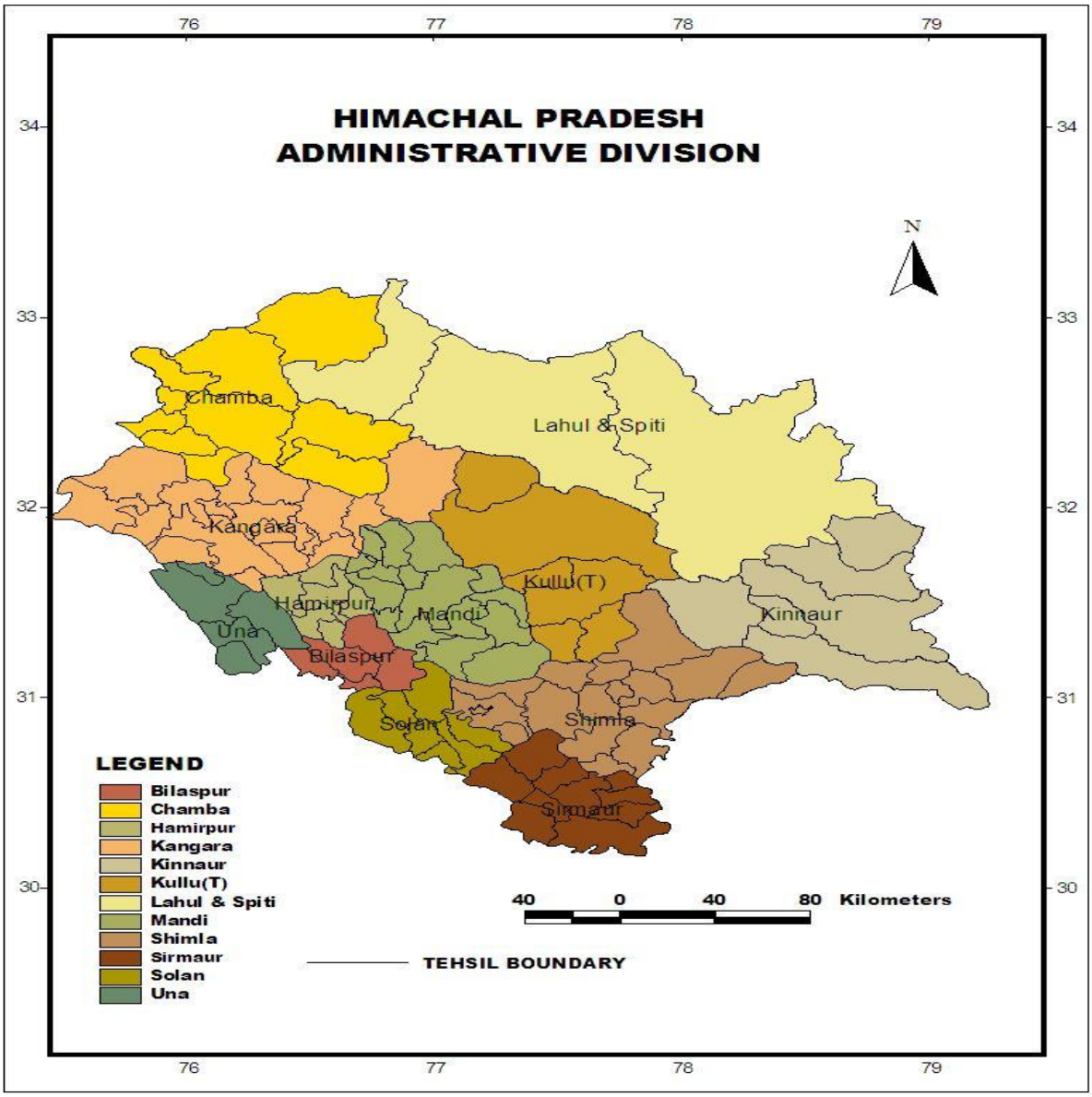
## Literature Review

From the literature survey, it is found that the studies on "cloud bursts" are scanty dealing with different problems. Therefore, an attempt is made to systematize the studies on the proposed research problem. The studies dealing with cloud burst floods from different parts of India are few. Bhan indicates that there is need for protective structures against falling debris in case of cloud bursts and other remedial measures. Mazari and Sah give geomorphologic account of the Pulia Nal cloud burst of July 16, 2003, in Kullu. Joshi and Bhagwan describes that on heavy rainfall, cloud bursts and floods in the river Beas and Gambhar affect the NH 21 and NH 22 causing different forms of damage every year. Das, Ashrit and Moncrieff examine a cloudburst event in the Himalayan region at Shillagarh village in the early hours of 16 July 2003. They

tested the fidelity of MM5 configured with multiple-nested domains (81, 27, 9 and 3 km grid resolution) for predicting a cloudburst event with attention to horizontal resolution and the cloud microphysics parameterization. Ambalagan ( 2004) discusses the disastrous events triggered by cloud burst in July 1983 in Karmi village of Almora along with its consequences. The consequences of large scale erosion due to cloudburst in small catchment are twofold. The study by Thayyen., et.al describes that how the insight developed on the cloudburst phenomena by the atmospheric and the hydrological modeling is hugely constrained by the spatial and temporal scales of data used for the analysis. Apart from this, study also highlighted the regular occurrence of cloudburst events around Leh in the recent past. Most of such events go unreported due to lack of monitoring mechanisms in the region and weaken our ability to understand these events in complete perspective.

**Study Area**

The Himachal Pradesh is situated in the northern part of India. It extends between 30˚ 22′ North latitude to 33˚ 40′ North latitude and 75˚ 55′ East longitude to 79˚ 22′ East longitude and covers an area of 55,673 square kilometers (Fig. 1). There are 12 districts in the Himachal Pradesh comprising 116 tehsils, 59 towns and 20,118 villages. It is a hilly state with altitude ranging from 350 m to 6816 m above mean sea level. The important ranges in the state include the Shiwaliks, Dhauladhar, Pirpanjal, Great Himalaya and Zanskar. There is a general increase in elevation from East to West and South to North. Geologically the Himachal Pradesh consists of a complex sequence of massive Palaeozoic and Mesozoic rocks. The study region consists of mainly massive quartz intruded by basalts and other crystalline rocks of unfossilferous sediments. The region is drained by major river systems i.e. Chenab, Ravi, Beas, Satluj. Few tributaries of the Yamuna also drain extreme eastern part of the study region. The study region is moderately forested part of the state and vegetation pattern varies from dry scrub at lower altitudes to alpine meadows at higher altitudes. There is a considerable variation in the distribution of rainfall and temperature due to varying aspects and altitudes. The Himachal Pradesh is the home of about 68,64,602 persons with an average density of about 123 persons per square kilometer.




## Result and Discussion

**Temporal Occurrences of Cloud Bursts:** The occurrences of cloudburst in the Himachal Himalaya are complex. It means that a flash flood is caused due to cloud burst and heavy rainfall leads to flash floods. High monsoon rains in the area cause extensive floods during rainy season. In the upper reaches of the Beas and Satluj valley the main problem was flash floods and bank erosion because of steep slopes of rivers and high river flows due to heavy rains. Often flash floods caused due cloud burst, glacial lake outburst and temporary blockade of the river channels. The occurrences of cloud burst reveals that they are mostly taking place between June

to mid September months. Based on the reports conducted by Indian Meteorological Department has revealed that a total of 60 cloudbursts took place in Himachal from 1987-2009. There are about 3 per year with a maximum of seven in year 2000. The cloud burst has its maximum occurrences and days in the month of August followed by July. The year wise occurrences of cloudburst in the Himachal Himalaya reflects that the first incidence of cloudburst was reported in the year as early as possible in 1987 that too in the Shimla district. It is seen from data that there is neither increase nor decrease on continuous basis in the occurrences of cloud burst in the Himachal Himalaya but the occurrences are continuous from 1999 onwards. The maximum cloud burst are recorded in the year 2007 followed by 2008, 2004 and 2001 though the figures are high in 2006, 2000 and 1994 as well as shown in the Table 1.0.

Table: 1.0 Temporal Incidence of Cloud Bursts in the Himachal Himalaya

| Year | Incidences of Cloud Burst |
|---|---|
| 1987 | 01 |
| 1994 | 06 |
| 1999 | 01 |
| 2000 | 06 |
| 2001 | 07 |
| 2002 | 01 |
| 2004 | 07 |
| 2005 | 02 |
| 2006 | 06 |
| 2007 | 14 |
| 2008 | 08 |
| 2009 | 01 |
| Total | 60 |

Source: Compiled by the Author based on Disastrous Weather Events ( Indian Meterological Department)

**Spatial Occurrences of Cloud Bursts:** The district wise occurrences of cloud bursts in the Himachal Himalaya reveal that the maximum events has been recorded from the district of Kullu followed by Shimla. There was 18 cloudburst recorded only from Kullu out of the total 60 occurrences. The cloudbursts has been reported almost every year from this part. In case of Shimla the first incident was in 1987 and second was reported in 2000 and so on. In the district of Kinnaur the first incident was recorded in 2000 and second in 2004 followed by 2006 and 2007. The district of Chamba faced cloud bursts in 2002, 2004, 2006 and 2008. The district of Solan and Kangra recorded equal number of cloud bursts but solan witnessed first incident in 2000 while Kangra in 2001. The Hamirpur and Sirmaur district faced low incidences of the Cloudburst phenomenon though the Una and Bilaspur has not recorded the event as yet as shown in Table 1.1.

Table: 1.1 Spatial Incidence of Cloud Bursts in the Himachal Himalaya

| Districts | Incidences of Cloud Burst |
|---|---|
| **Bilaspur** | **00** |
| **Chamba** | **06** |
| **Hamirpur** | **03** |
| **Kangra** | **05** |
| **Kinnaur** | **07** |
| **Kullu** | **18** |
| **Lahaul and Spiti** | **02** |
| **Mandi** | **04** |
| **Shimla** | **08** |

| | |
|---|---|
| **Sirmaur** | **02** |
| **Solan** | **05** |
| **Una** | **00** |
| **Total** | **60** |

Source: Compiled by the Author based on Disastrous Weather Events ( Indian Meterological Department)

Out of the 60 cloudbursts, 18 were reported in Kullu, 8 in Shimla, 7 in Kinnaur, 6 in the Chamba, 5 each in Kangra and Solan, 4 in Mandi, 3 in the Hamirpur and 2 each in Sirmour, and Lahaul & Spiti. This indicates that Kullu, Shimla, Kinnaur , Chamba, Kangra and Solan districts are more prone to cloudbursts than any other area. There are no satisfactory techniques for anticipating the occurrence of a cloudburst because of their small scale.

**Causes and Impact of Cloud Burst**

Cloudburst is a devastating weather phenomenon representing highly concentrated rainfall over a small area lasting a short term. In meteorological terms, the rain from a cloud burst has a fall rate equal to or greater than 100 MM (4.94 inches) per hour and usually last for over an hour. Though the exact mechanism is not yet perfectly understood, research suggests that they are a manifestation of intense vortices on a small scale. These vortices generate strong convective currents which lift the moisture laden air rapidly to form cumulonimbus clouds, which shed the water loads with ferocity. In other words, a cloudburst is a freak phenomenon caused by an up rush of air currents holding up a large amount of weather, rising as a plume of air slightly warmer than its surroundings. The sudden cooling and consequent cessation of currents, causing the entire mass of water descend on a small area with catastrophic force due to rapid condensation of clouds. Cloud burst usually occurs as a result of combination factors. In deep valleys of Himalayas, sometimes temperature increases suddenly, which creates air uplifting resulting into low pressure in valley areas. To fill up this pressure gap the air from all sides move towards the valley creating eddy conditions. In this situation two fronts of clod and warm air move toward each other and the cold air from high mountain comes in conflict with moist air of

valley. Cold front is associated with strong atmospheric disturbances. The warm air then lifted, opens breaking out in violent thunderstorm. Here again cold air renders in contact with the ground warm air and is forced to rise as if ascending a long ramp. In such conditions the warm air becomes unstable and develops convection cells resulting into heavy shower and thunderstorms. Though the exact mechanism of these systems is not yet perfectly understood but research bibliography suggests that they are manifestations of intense vortices on small scale. These vortices generate strong convective currents which lift the moisture laden air with sufficient rapidity to form cumulonimbus clouds which shed their water load with great strength and ferocity. Orographic configuration adds to the vertical lifting necessary for the formation of cumulonimbus clouds. From this stand point the geomorphological set up of the Himalayas presents most conducive situation for frequent occurrences of cloud burst because of numerous sites of narrow valleys surrounded by steep valley sides and high reliefs, ablated and active cirques, passes and wind gaps, transverse position of ridges etc.

The impact of cloud bursts varies and leads to flash floods, landslides, uprooting of trees, house collapse, dislocation of traffic and bridges. A cloud burst comes with a speed of thunder and may not last for a few minutes to few hours. The impact is all the more ravaging if the area involved is a small catchment characterized by steep hill slopes and high riverbed gradient. The Himachal Himalaya has experienced a number of incidences of Cloudburst since its inception in 1971. There were several incidences of the same during 1987-2009 which were really serious in nature. These disastrous events have brought heavy toll to the state as the loss was estimated in several thousand millions of rupees and also killed several hundreds of people besides large number of cattle heads. The estimates are about 149 lives has been lost with 100 injured while another 100 trapped.

**Conclusion**

A cloudburst, also known as a rain gush or rain gust is a sudden heavy downpour over a small region, is among the least well-known and understood type of mesoscale system. It represents cumulonimbus convection in conditions of marked moist thermodynamic instability and deep, rapid dynamic lifting by steep orography. Cloudburst events over remote and unpopulated hilly areas often go unreported but lead to total devastation in areas where population lives. The Himachal Himalaya is one of the most affected due to the steep topography. Most of the damage

to property, communication systems and human causalities result from the flash floods that accompany cloud bursts. The cloud burst is one of the major natural hazards in the Himachal Himalaya occurring amid of extreme hydro meteorological conditions. It strikes at random and at a lightning speed, generally lasts for a limited time and leaves behind a trail of devastation. The highly rugged Himalayan terrain often faces extreme hydro-meterological conditions of the type leading to flashfloods and their consequent devastation. The temporal and the spatial variation in such extreme rainfall constitutes the chief determinant factors of the floods. Prediction of cloudbursts is challenging and requires high-resolution numerical models and mesoscale observations, high-performance computers and Doppler weather radar. Societal impact could be markedly reduced if high-resolution measurement of atmospheric parameters and vertical profiles are provided through observations such as Automatic Weather Station, Radiosonde/Rawinsonde, and Doppler weather radar. Also, education and training of local administrators to give short-notice warnings would greatly help disaster mitigation. Monitoring and conducting research on cloudburst in the Himalayan region is a challenge as it generally occurs around remote and rugged mountain slopes.

**Biliography**

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