

The Study of Patterns, Risks, and Trend of Climatic Data/Projection on Uttarakhand Himalayas: With Special Reference to Almora District

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Abstract:

Climate change and erratic weather patterns are increasingly common worldwide, leading to glacial melt, cloud bursts, landslides, floods, heat waves, and more frequent seismic activities. India faces such disasters annually, exacerbated by a growing population and pressure on natural ecosystems. The concept of Earth Overshoot Day highlights the urgent issue of humanity's resource consumption exceeding the Earth's capacity to regenerate. As global populations may reach 9 billion by 2050 and 10.8 billion by 2100, providing food, safety, and health support will become increasingly challenging. Local policies are essential, as central government solutions may not address specific regional issues. This research emphasizes the need to study district-level policies and integrate climate change adaptation (CCA) and disaster risk reduction (DRR) measures to optimize resource use. Community insights into traditional coping mechanisms and resilience strategies are vital, as they are first responders to disasters. Capacity building and awareness generation among local government officials and communities are crucial for effective disaster management. Understanding sustainability and integrating it into developmental planning can enhance resource allocation, restore ecosystems, and strengthen social capital, fostering a resilient society. This research specifically examines climatic risks and adaptation strategies in Almora, Uttarakhand.

Keywords: Himalaya, Climate change, Disaster, Risk, Sustainability, Strategies.

Introduction:

1.1 Global Scenario

The world faces an increasing frequency and intensity of natural and man-made disasters, significantly impacting economies and communities. Disasters know no boundaries and affect regions differently based on socio-economic, geographical vulnerabilities, and local coping capacities. Asia experiences more disasters than any other continent, with India disproportionately affected among Asian nations. The 3rd UN World Conference in 2015 in Sendai, Japan, introduced the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030, to which India is a signatory. This framework emphasizes the need for a comprehensive understanding of disaster risk, focusing on exposure, vulnerability, and hazard characteristics. Strengthening disaster risk governance is essential. Actions must address the underlying causes of disaster risks, including poverty and inequality, unpredictable climate change, unsustainable urban development, and inadequate implementation of land use and building regulations. Additional challenges include the lack of risk insurance coverage and the degradation of ecosystems, which affects their ability to provide essential services. By tackling these issues, countries can enhance their resilience to disasters and minimize their impacts on vulnerable populations.

Glaciers in mountain ecosystems are rapidly disappearing due to the adverse impacts of climate change. Notably, the Pizol glacier in eastern Switzerland has vanished, prompting the country to hold a ritual funeral to mourn its loss (BBC, 2019). Similarly, Iceland's Okojokul glacier, formed over 700 years ago and spanning 38 square kilometers, faced the same fate, also receiving a funeral ceremony.

The World Meteorological Organization (WMO) reported that 2019 was the second warmest year on record, following 2016. This assessment is based on the analysis of five global data sets, revealing that the average global temperature in 2019 was 1.1°C higher than that of the late 19th century. The last decade has witnessed significant environmental changes, including retreating ice, rising sea levels, warmer ocean surfaces, acidification, and an increase in extreme

weather events. In response to the growing climate crisis, the European Union has introduced the "Fit for 55" scheme, aiming to reduce greenhouse gas emissions by 55% by 2030 compared to 1990 levels. This initiative underscores the urgent need for collective action to address climate change and its impacts on our planet.

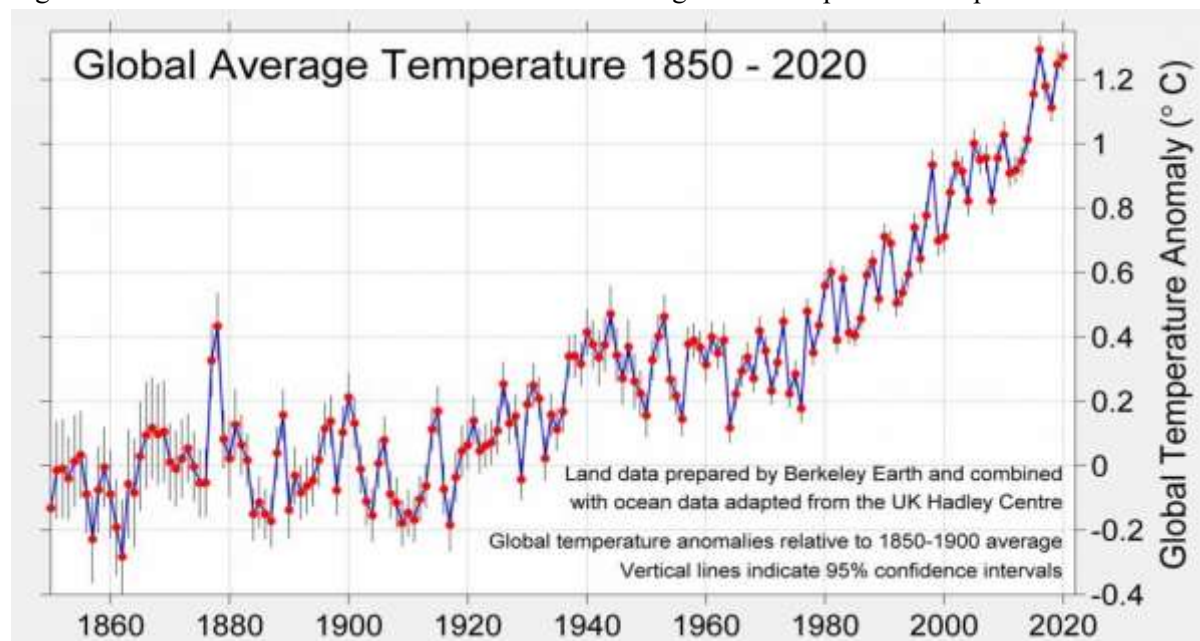


Fig 1.1 Variation in Global Average Mean Temperature (Source: Global Temperature Report, 2020)

As per the Global Temperature Report 2020, the Global Mean Temperature and GHG emissions are raising faster with time with respect to its 1850-1900 average (**Fig 1.1 and 1.2**). Further, the Global Project Study, 2020 indicates that Methane gas has taken a quantum jump across the continents and nations, globally. India's contribution, however, is 6%, far below the contribution of world leaders. Even two decades from now, India's per capita GHG emission, would be well below the global average, 25 years earlier. India's total GHG emissions will remain under 6 billion tonnes of CO₂e [1 tonnes of carbon is equivalent to 3.67 tonnes of CO₂e].

Change in Total Methane Emissions — 2017 compared to 2000-2006 (Tg CH₄ per year)

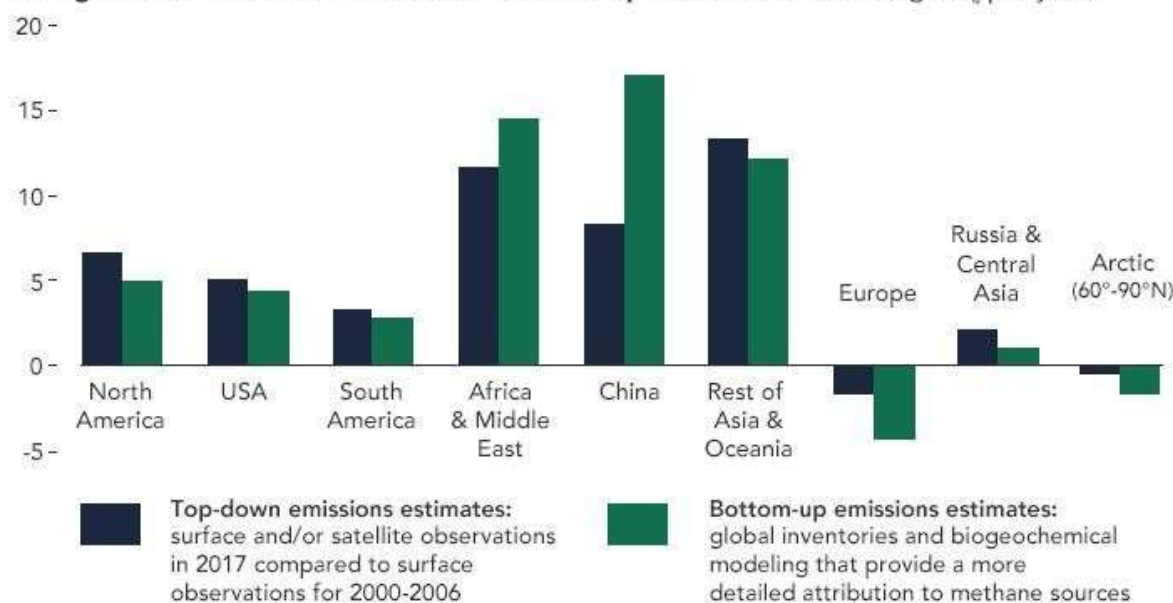


Fig 1.2 Change in Total Methane Emissions (Source: Global Carbon Project Study, 2020)

1.2 Indian Context

The increasing frequency of disasters, coupled with inadequate climate-sensitive development policies, poses a significant concern for developing nations like India, particularly in the vulnerable Himalayan regions. India's diverse terrains, from the Himalayan ranges to extensive coastlines and arid deserts, make it susceptible to a range of disasters including cyclones, floods, droughts, landslides, and more.

Climate change is expected to exacerbate these issues, with projections indicating that India is currently unprepared for its effects. Erratic rainfall, rising sea levels, and extreme weather events are likely to become more common, as human activities have already raised global temperatures by approximately 1°C compared to pre-industrial times. Without significant global action to limit greenhouse gas emissions, achieving the Paris Agreement goal of keeping the temperature rise below 2°C will be a daunting challenge.

The socio-economic disparities within India complicate disaster management. A significant portion of the population lives below the poverty line, lacking equal resources and opportunities to cope with disasters. Past events, such as the 2005 flash floods in Mumbai and the Uttarakhand cloud burst in 2013, have underscored the urgent need for improved preparedness and response strategies.

Mumbai experienced its heaviest rainfall in 14 years in July 2019, highlighting the uneven distribution of rainfall and the growing unpredictability of monsoon patterns. Despite these challenges, studies suggest that India's per capita CO₂ emissions may remain below the global average by 2030, indicating a potential for continued progress in reducing emissions.

India is shifting its disaster management approach from a relief-centric model to a more holistic framework that emphasizes prevention, mitigation, and preparedness. The National Disaster Management Plan (NDMP) aligns with global initiatives like the Sendai Framework for Disaster Risk Reduction, aiming to significantly reduce disaster risk and safeguard livelihoods, health, and the socio-economic fabric of communities. This integrated approach is essential for enhancing resilience and addressing the multifaceted challenges posed by climate change.

Further, in 2019, the NDMP went through a major review process (NDMP,2019), where 3 additional chapters were added:-

- **Climate Change Risk Management** is now a new management theme for Disaster Risk Management Responsibility [Others: Understanding Risk, Inter Agency Cooperation, Making Investment in Structural and Non Structural Measures for DRR and Capacity Building].
- **Social Inclusion** covering aspects of vulnerabilities based on gender, poor conditions of the Scheduled Caste and Tribes, disadvantaged sections like elderly people, children and differently-abled persons in our society.
- **Synchronization of NDMP** with the post-2015 international agreements: 2022, 2027 and 2030 have been envisaged as the ending year for short, medium and long term programmes in this regard.

1.3 Indian Himalayan Region:

The Indian Himalayan Region (IHR) has experienced a dramatic rise in climatic extremes, leading to increased mortality and morbidity. The devastating Kedarnath flash floods in 2013 highlighted the region's vulnerability, with recovery efforts still ongoing. In 2021, the Chamoli district faced glacial lake outburst floods (GLOFs), marking a troubling trend of repeated glacial disasters in the Himalayas. Additionally, cloud bursts have become more frequent, causing flash floods and landslides that threaten the safety and stability of local communities. Himalayan glaciers, often referred to as the "Water Towers of Asia," are at risk due to climate change, which can lead to the formation of glacial lakes, such as Lake Imja near Mount Everest. According to the World Wildlife Fund (WWF, 2021), triggers like accelerated glacial melt, extreme weather, or natural disasters could breach these lakes, resulting in catastrophic GLOFs that endanger downstream communities, particularly the Sherpa people. The region's subsistence agriculture, largely rain-fed, is highly susceptible to climatic variability, leading many residents to migrate in search of better livelihood options. Extreme weather events also damage critical infrastructure, disrupting connectivity and essential services like health care, water supply, and drainage systems, further exacerbating the challenges faced by mountain communities.

1.4 Uttarkhand

Uttarakhand, located between 78°E to 81°E longitude and 29°N to 31°N latitude, is highly vulnerable to climate-mediated risks. As one of the key Himalayan states, it is home to over 15 major rivers and numerous glaciers, making it a critical freshwater reserve. The state's forests support many forest-based industries, but climate change is impacting its natural resources. Rising temperatures are pushing the snowline higher, causing shifts in the monsoon and winter rainfall patterns, leading to frequent cloudbursts, flash floods, and drying perennial streams. Agriculture is also affected, with changes in crop seasons, shifts in cultivation areas, such as for apples, and altered plant phenology.

Established on November 9, 2000, as the 27th state, Uttarakhand was carved from Uttar Pradesh and features an elevation ranging from 200 to 8,000 meters above mean sea level. It is divided into 13 districts (Fig.1.3), with the southeast known as Kumaon (6 districts) and the northwest as Garhwal (7 districts). The state's literacy rate, around 80%, surpasses the national average. Uttarakhand's major river basins include the Yamuna, Kali, Pindar, Mandakini, Bhagirathi, and Alaknanda. Climate change poses significant challenges, threatening ecosystems, water resources, and the livelihoods of the people in this region.



Fig.1.3 Uttarakhand Political Map (Source: SAPCC, 2014)

2.1 Study Area: Almora

Almora falls in the Kumaun region of Uttarakhand and has been divided into 11 Tehsils/Blocks for administrative purpose. District Headquarter falls in Almora Tehsil/Block (Fig. 2.1). As per demographic census (2011), Almora is spread in an area of approximately 3,144 Sq Kms. 1,577 Sq Kms area is forest cover. With 1,27,627 occupied households, there is a total population of approximately 6,22,506 people in the District (Male: 291081& Female: 331425). Only 12% population resides in urban areas and the rest are rural population. Literacy rate is nearly 58.66% in the District. Female Literacy is an area of concern with only 39.6%. Compared to State level and national level figures, population density (155 persons/Sq. Km) and urbanization (6.4%) is very less here. Nearly half of the population is of worker class (47%) and out of that nearly 79% work in agriculture sector (www.almora.nic.in).



Fig.2.1 Almora District Tehsil Map (Source: www.almora.nic.in)

3. OBJECTIVES OF STUDY

A. To study the climatic data/projections and patterns over time for Almora district area, and risk of climatic disasters and extreme events.

B. To show and analysis the trend of Climatic data of selected location in Almora district.

4. Methodology Adopted:

The Study of climatic scenario, weather pattern and events over time with specific reference to the Almora District and the risk of climate related stresses and extremes have been undertaken through the blend of secondary and primary data collection.

Secondary Data:For secondary data, a number of means have been utilized which include Government Offices, Institutions, Organizations, Published Reports, Studies, Journals, Papers, Newspaper Articles and Internet etc..

Primary Data: Questionnaire was developed for the Panchayati Raj Institutions Representatives viz the Gram Pradhans, for collecting their set of knowledge about the change of climate and issues in various blocks and villages of Almora.

Interviews and Interactions were done with Experts as well as Sr. Govt. Officers of the domain subject.

5. Climatic Scenario, weather pattern and events over time with specific reference to the Almora District and the risk of climate related stresses and extremes

Almora, situated in the Himalayan mountain range, has a land use pattern (Fig.5.1) dominated by agriculture, riverbeds, and forests, with a sparse urban population. Once rich in water bodies, the district now faces water scarcity, particularly in urban areas. Population migration, especially among youth, has led to a decline in agriculture as a preferred livelihood, while the increasing human-wildlife conflict and expanding barren lands further compound the challenges. These shifts are transforming Almora's landscape, threatening its traditional agricultural base and natural resources.

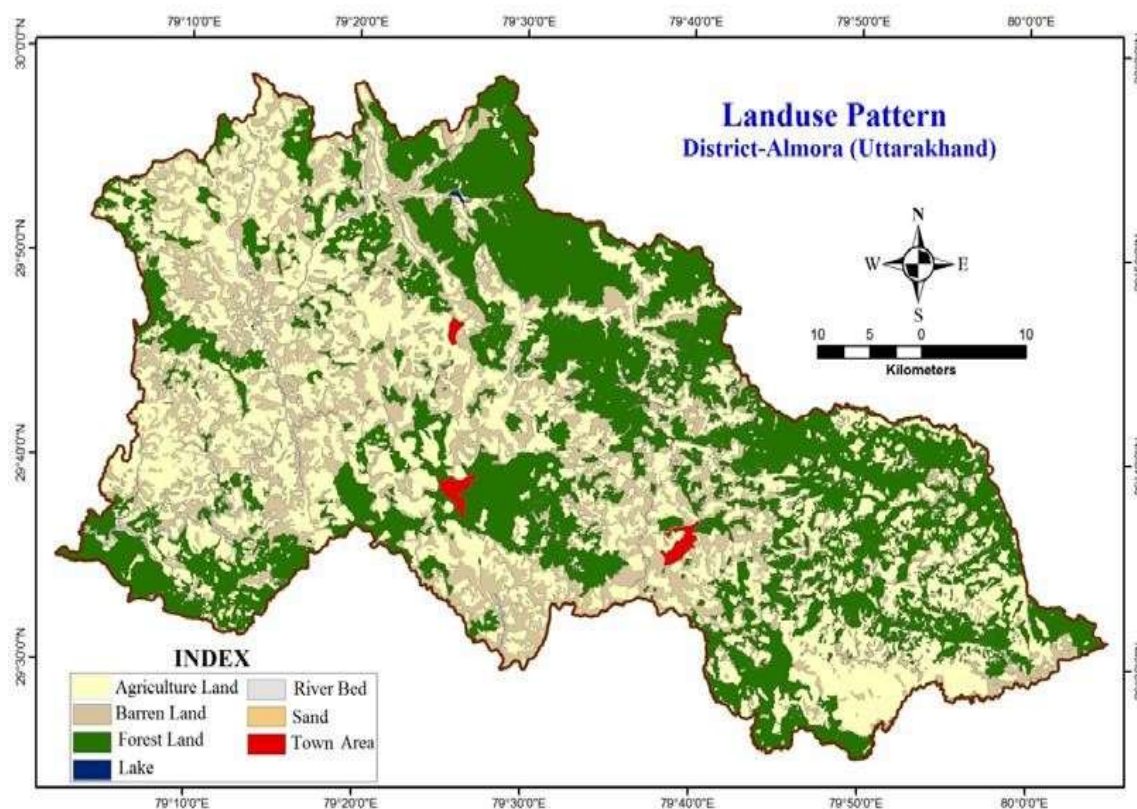


FIG. 5.1 Land Use Pattern of Almora District in Uttarakhand (Source: DDMP Almora: 2018-19)

Forests cover approximately 50% of Almora's land, followed by agricultural and residential areas. To optimize land use, science and technological innovations should be integrated, considering the unique mountain terrain. Sustainable practices can enhance resource management and improve livelihoods while preserving the district's ecological balance.

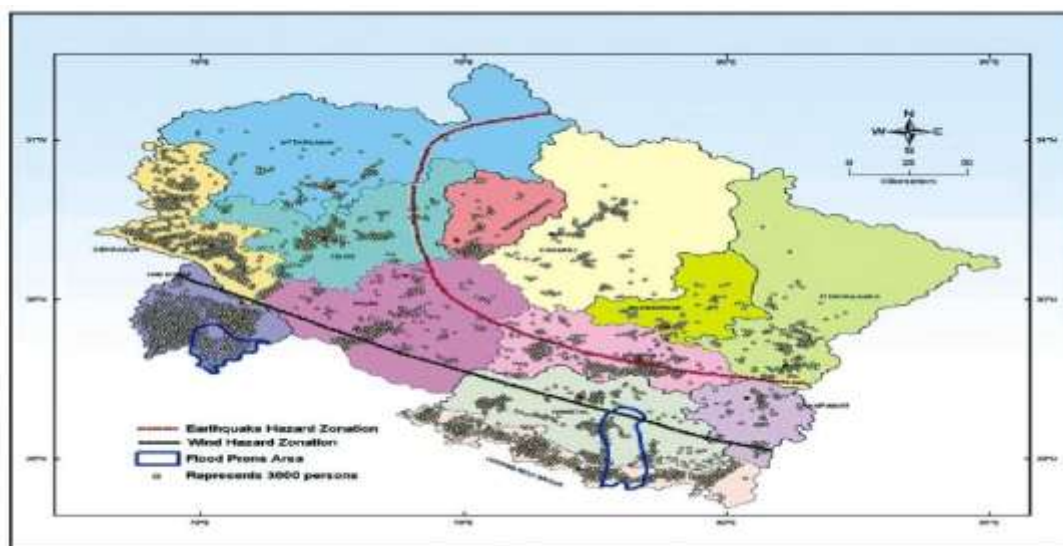


FIG. 5.2 Hazard Zonation of Almora (Source: DDMP ALMORA: 2018-19)

Almora, with its unique geographical and climatic features, is highly prone to natural hazards such as earthquakes, landslides, cloudbursts, forest fires, cold waves, road accidents, epidemics, and man-animal conflicts. The district's proximity to rivers like Kosi, Gagas, Ramganga, and Sarayu heightens the risk of floods and soil erosion for nearby populations. Located in Earthquake Zones IV and V, Almora is particularly sensitive to seismic activity, with several bridges built over earthquake fault lines. The district's rich natural resources have led to increased construction, raising concerns among policymakers and scientists about its vulnerability to climate-induced disasters and unplanned urbanization. Mitigating these risks requires urgent attention to sustainable development and disaster preparedness.

As per known records, in **1994**, there was a flashflood incidence in the Chaukhutia Block of Almora with 4 fatalities. Later in **2004**, a cloudburst had taken place in Ranikhet, Almora with 1 casualty. However, **2010** onwards the incidences of extreme events have grown in number and intensities.

(Table 5.1) shows that the Sult, Bhanauli, and Almora blocks were the most severely affected by recent major climatic disasters. The 2014 hailstorm, 2013 landslides and cold waves, and the 2010 cloudburst caused significant damage in this region. It is also observed that, for livestock, the months of January and February, due to cold, and July to September, due to heavy rains, are particularly challenging.

TABLE 5.1 Details of Major Climatic Disaster Loss and Damage in Almora District (2010, 2013 & 2014)

Tehsil/Block	Cloudburst, Flash flood and Landslides (2010)			Landslides and Heavy Rainfall (2013)			Landslides and Heavy Snowfall (2014)		
	Human fatality	Livestock fatality	Damage to House (full or partial)	Human fatality	Livestock fatality	Housing damage (full/partial)	Human fatality	Livestock fatality	Housing damage (full/partial)
Almora	30	19	959	7	11	122	5	2	87
Bhanoli	3	1	197	1	15	143	2	10	115
Jayanti	3	3	902	0	3	26	0	0	23
Someshwar	0	10	241	1	3	115	0	4	76
Ranikhet	1	12	342	1	3	70	0	0	45
Dwarhat	2	6	289	1	0	42	0	1	24
Chaukhutia	0	5	75	1	25	9	0	0	13
Bhikiasen	4	11	430	0	1	99	0	0	56
Sult	3	3	423	1	9	43	2	45	13
Total	46	70	3858	13	70	669	9	62	452

(Source:- District Administration, Almora District)

There has also been an increasing trend in drought occurrences in recent years. Rainfall records from Hawalbagh, Almora, reveal that from 1964 to 2000, there were 16 droughts in total, 5 of which were severe. However, from 2001 to 2009, out of 7 droughts, 3 were severe.

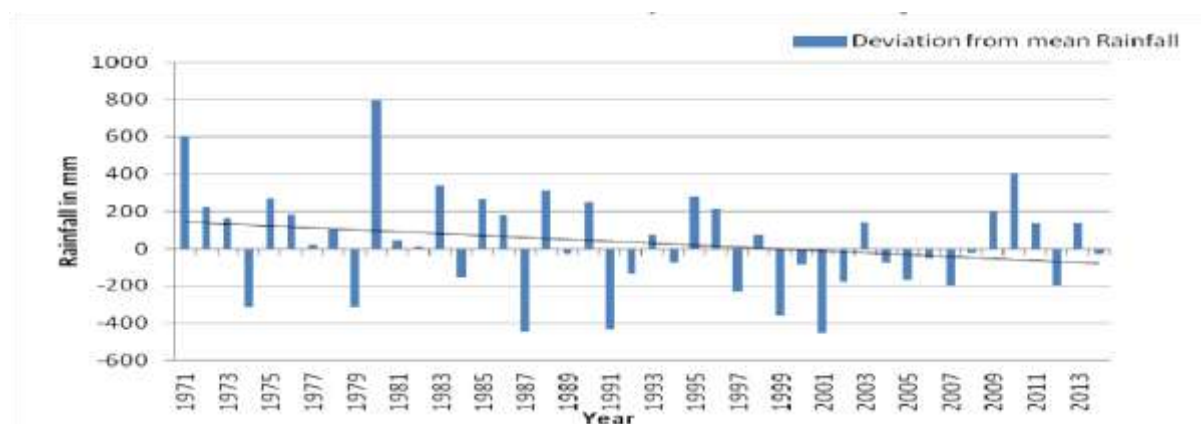


FIG. 5.3 Deviation from Annual Mean Rainfall in Almora(1971-2014)(SOURCE:- DISTRICT ADMINISTRATION, ALMORA DISTRICT)

(Fig. 5.3) shows that the **Annual and seasonal Monsoon Rainfall** in Almora (June, July and September) have declined and average rainfall of August has increased over time. Land use, livestock, water scarcity, forest area will be hugely affected due to this change in rainfall.

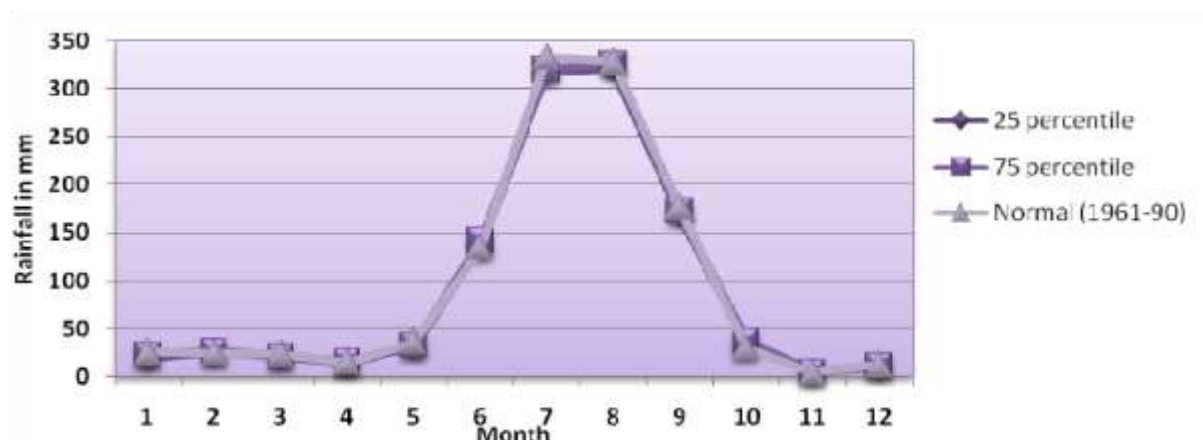


FIG. 5.4 Projected Rainfall Almora for Year 2040 (SOURCE: GEAG, 2016)

(Fig. 5.4) shows the projected rainfall for the region in the year 2040. It is estimated that while monsoon rainfall may decrease, there could be a 3-7% increase in total annual rainfall.

TABLE 5.2 Monthly Occurrence Probability of Disasters in Almora

Disasters/MOP	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
Flash Flood												
Earthquake												
Fire												
Cyclone												
Cold Wave												
Hail Storm												
Landslide												

(SOURCE: DISTRICT ADMINISTRATION ALMORA, UTTARAKHAND)

Almora frequently experiences various disasters (Table 5.2). Earthquakes can occur at any time throughout the year. During the monsoon months, landslides and flash floods affect the region. Cold waves are observed from December to January, while fires are common from March to June during the summer.

5.2 TREND OF CLIMATIC DATA OF ALMORA DISTRICT:

To understand the climatological trends in Almora district, precipitation, and maximum and minimum temperature data for 116 years (from 1901 to 2016) have been taken from the Climate Research Unit (CRU) database. The graphical representation of variations in Tmax, Tmin, and precipitation during this period, observed at eight different points in and around Almora, is shown in Fig. 5.5 and Table 5.2.



FIG. 5.5 Weather Stations, 8 locations in and around Almora (SOURCE: Self Plot) ANALYSIS OF PRECIPITATION DATA

Part – A Analysis of complete precipitation data (1901 – 2016)

Table 5.3 Almora CRU Precipitation Data (1901-2016) - Descriptive

	Minimum	Maximum	Mean	Std. Deviation	Variance
29.50° N, 79.25° E	543.2808	2013.5280	1190.500438	244.0558374	59563.252
29.50° N, 79.50° E	557.0256	2127.7200	1230.189207	256.4352899	65759.058
29.50° N, 79.75° E	570.7704	2241.9240	1269.877945	270.0244130	72913.184
29.50° N, 80.00° E	597.2160	2285.0040	1296.994407	273.9544236	75051.026
29.75° N, 79.25° E	546.0000	1999.0800	1198.885883	241.1158885	58136.872
29.75° N, 79.75° E	552.1476	2121.7200	1232.616279	258.1666940	66650.042
30.00° N, 79.25° E	538.8552	1854.5160	1150.197134	223.1227249	49783.750
30.00° N, 79.50° E	502.6104	1788.2640	1091.249297	215.0441443	46243.984

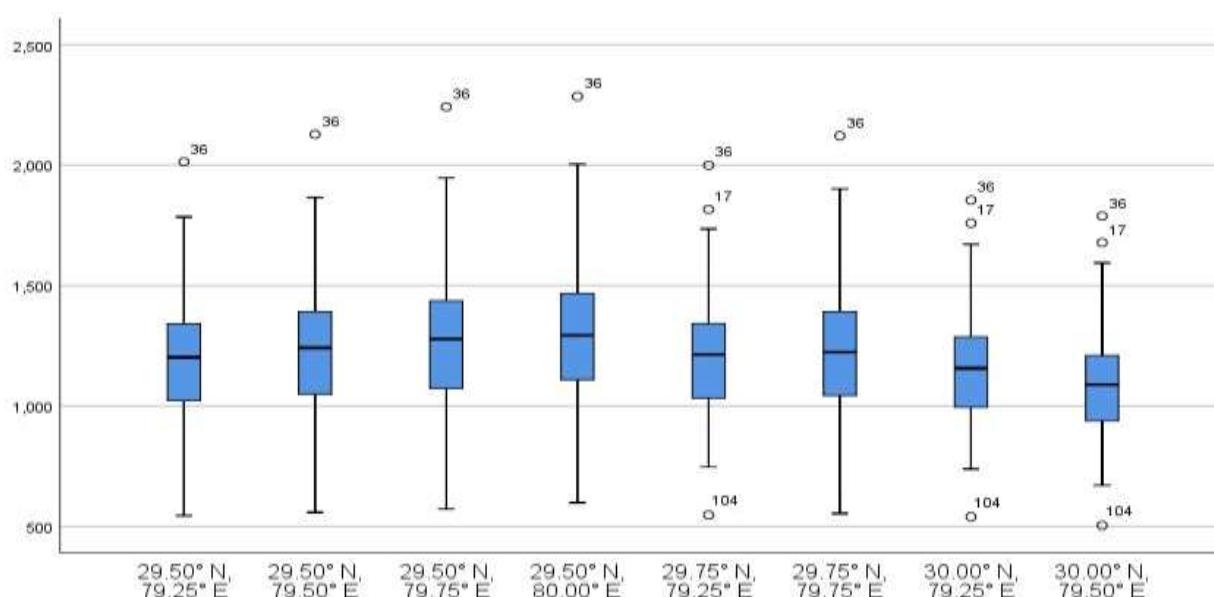


Fig. 5.6 Box plot of all 8 locations precipitation data.

It can be observed from Fig. 5.6 and Fig. 5.7 that all eight locations show a decrease in precipitation over the years. The period from 2001 to 2009 was marked by drought. The years 1917, 1936, and 2004 stand out as outliers, with 1917 and

1936 being years of heavy precipitation and 2004 experiencing very low precipitation, deviating from the overall precipitation trend over the 116 years in Almora. Since 2001, precipitation has generally been lower than the mean precipitation for the past 116 years. Fig. 5.8 illustrates the anomaly in precipitation, indicating the shift from the average over the years, which supports the points mentioned above. Furthermore, an analysis of the precipitation trend over the last 16 years shows a slight increase following the drought years of 2001-2009, but it subsequently returns to a decreasing trend (Fig. 5.9).

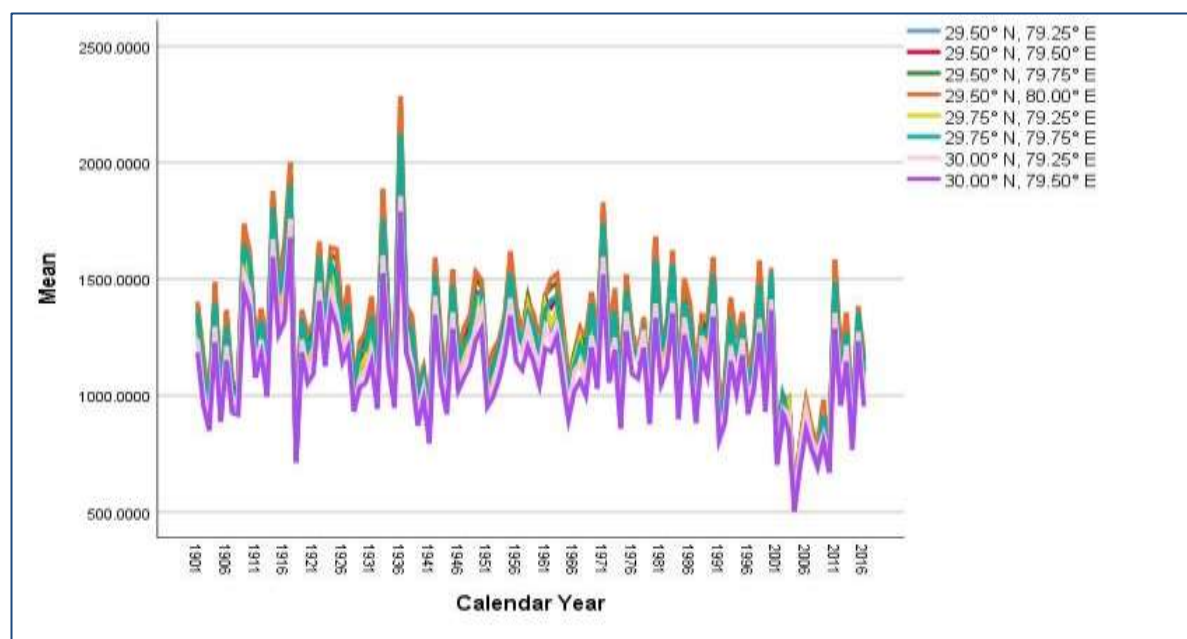


FIG. 5.7 Line Graph Of All 8 locations Precipitation Data.

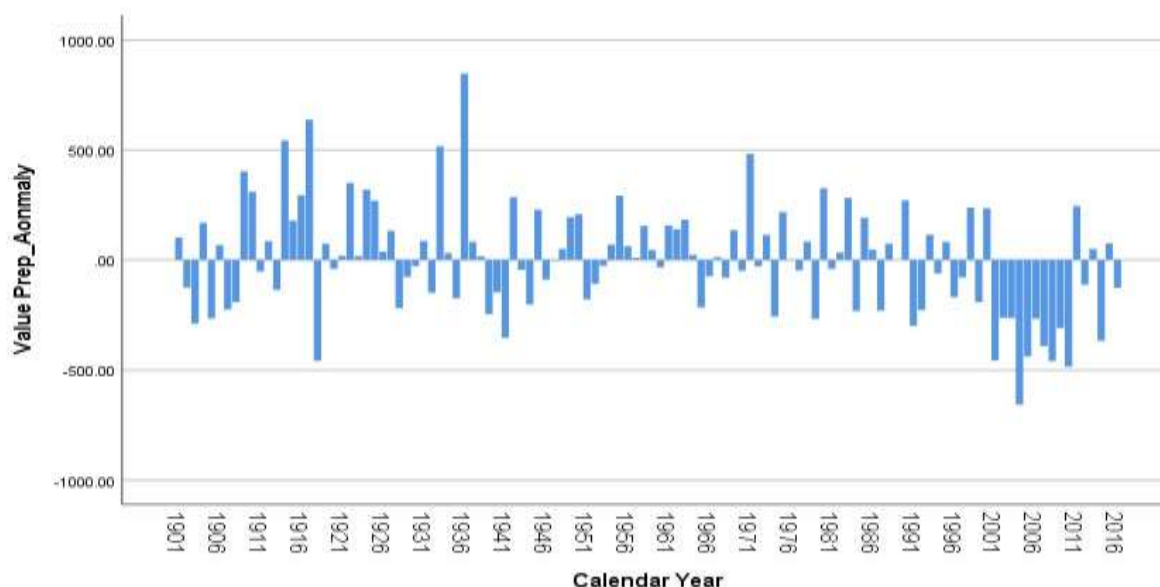


FIG. 5.8 Anomaly in Precipitation for all 8 Locations.

Part – B Analysis of last 16 years precipitation data (2001 – 2016)

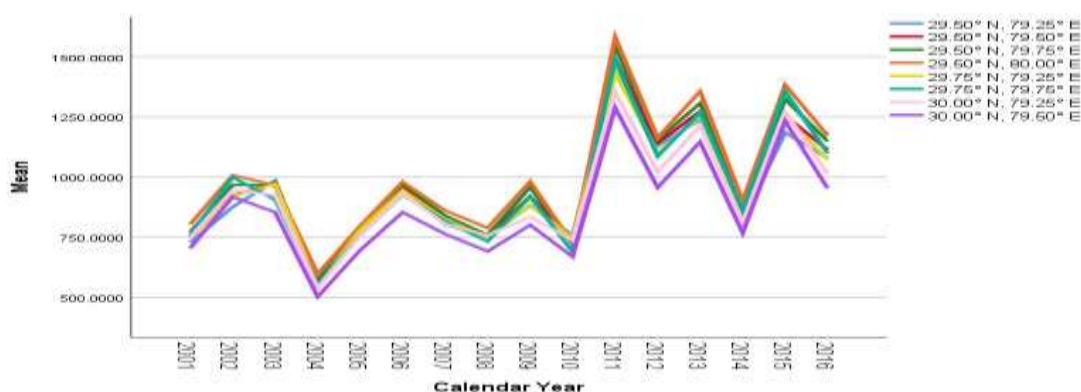


FIG. 5.9 Precipitation Line Graph All 8 Location 2001-2016

ANALYSIS OF T-MAX DATA

Part – A Analysis of complete Tmax data (1901 – 2016)

Table 5.4 Almora CRU Maximum Temperature Data (1901-2016) - Descriptive

	Minimum	Maximum	Mean	Std. Deviation	Variance
29.50° N, 79.25° E	24.7893	27.4122	26.214766	.4787344	.229
29.50° N, 79.50° E	23.5937	26.2296	25.020212	.4752024	.226
29.50° N, 79.75° E	22.3981	25.0470	23.825662	.4734927	.224
29.50° N, 80.00° E	22.4151	25.0469	23.800172	.4717206	.223
29.75° N, 79.25° E	21.9479	24.5924	23.356323	.4814734	.232
29.75° N, 79.75° E	20.2825	23.0109	21.709266	.4805803	.231
30.00° N, 79.25° E	19.7079	22.3687	21.107609	.4806336	.231
30.00° N, 79.50° E	17.3097	20.0018	18.708920	.4801091	.231

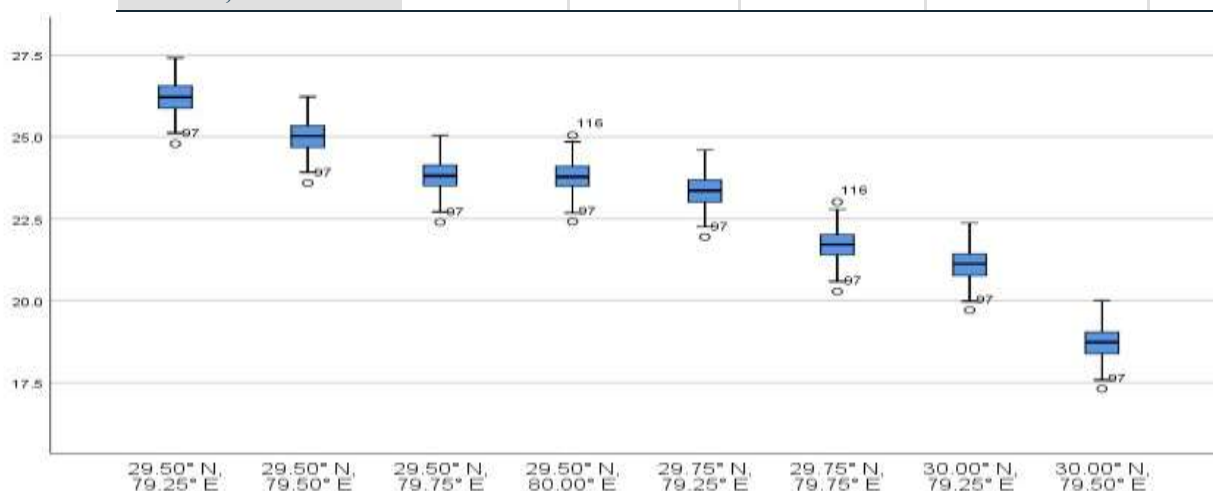


FIG. 5.10 Box Plot All Location T Max

All eight locations have different ranges of maximum temperature due to the effect of altitude above mean sea level (MSL) (Fig. 5.10). The years 1997 and 2016 are outliers in the box plot diagram, with 1997 showing the lowest Tmax and 2016 showing the highest Tmax, both outside the entire range of Tmax over the 116 years. An analysis of the 116-year trend shows an increase in maximum temperature across all eight studied locations (Fig. 5.11 and Fig. 5.13). Fig. 5.12 displays the anomaly of Tmax compared to the average Tmax, further supporting the observed trends in Tmax over the years in Almora. The 16-year trend analysis also shows a marginal increase in maximum temperature across all eight locations (Fig. 5.14).

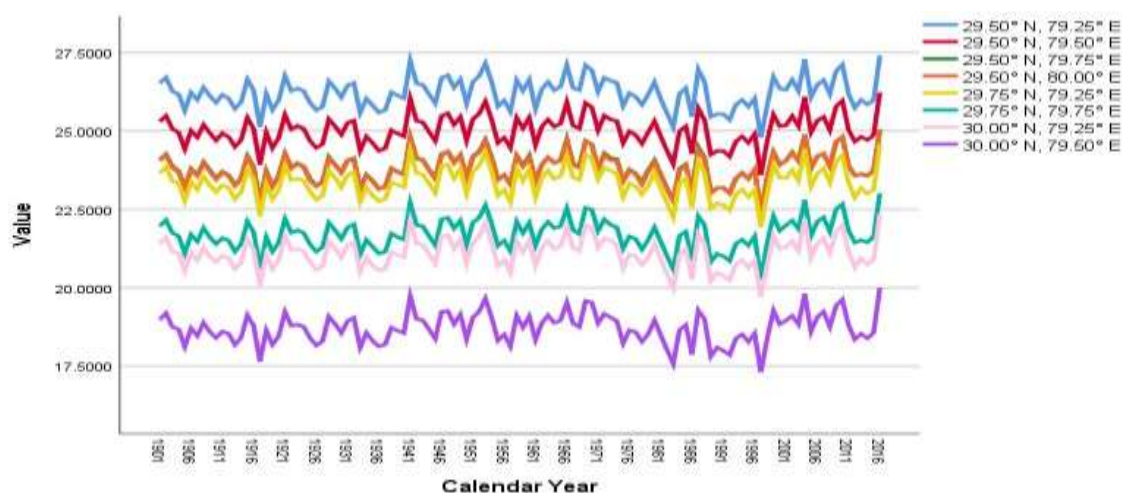


FIG. 5.11 T Max Line Graph All 8 Location

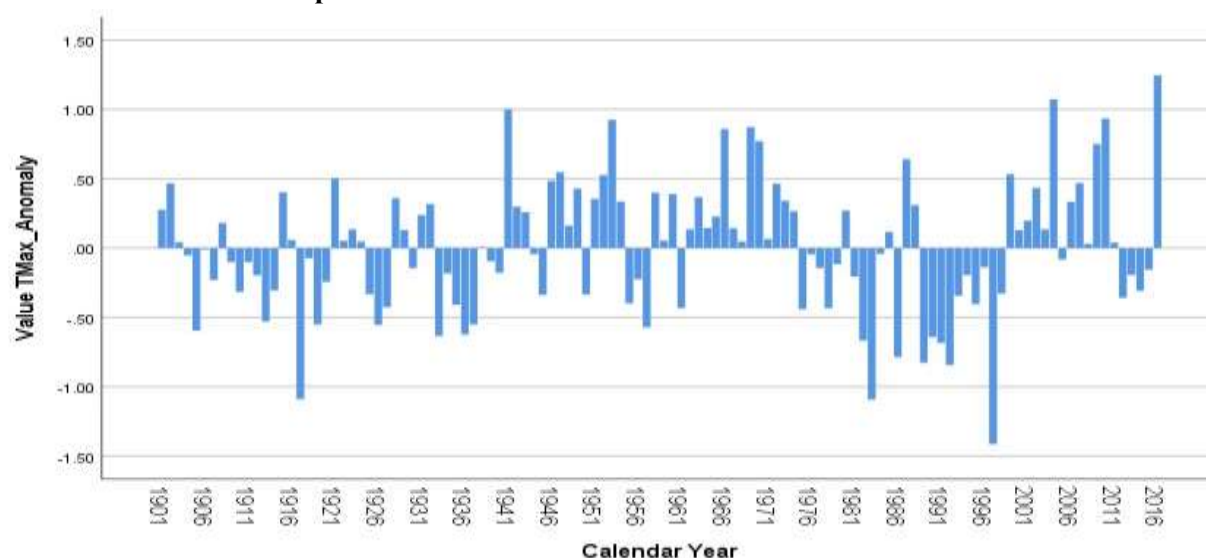


FIG. 5.12 T Max Anomaly Plot All 8 Location T Max

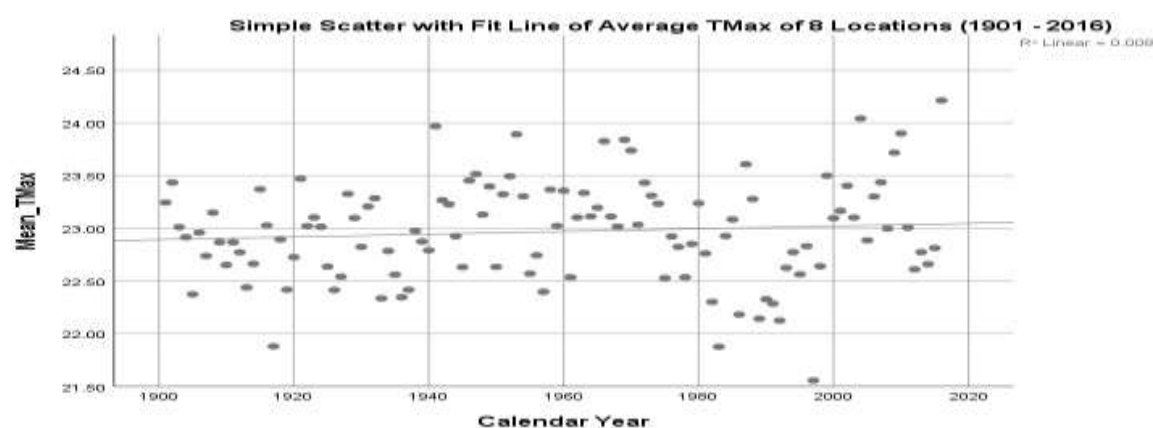


FIG. 5.13 T Max Trend Analysis All 8 Locations

Part – B Analysis of last 16 years T Max data (2001 – 2016)

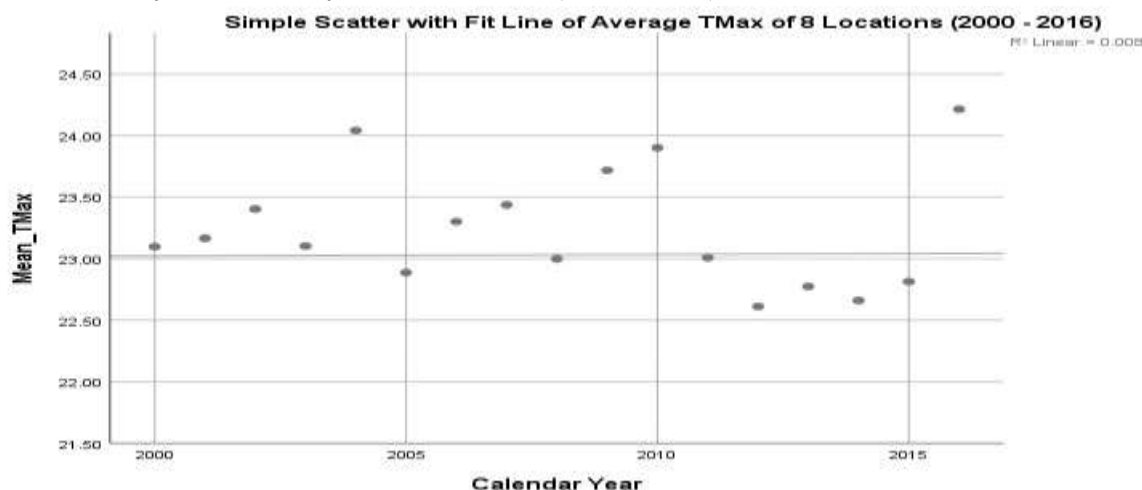


FIG. 5.14 Last 16 Yrs Trend Analysis T Max All 8 Locations

ANALYSIS OF T-MIN DATA

Part – A Analysis of complete data (1901 – 2016)

Table 5.5 Almora CRU Minimum Temperature Data (1901-2016) - Descriptive

	Minimum	Maximum	Mean	Std. Deviation	Variance
29.50° N, 79.25° E	13.4715	16.7266	14.822176	.6037060	.364
29.50° N, 79.50° E	12.4785	15.7585	13.830823	.6022774	.363
29.50° N, 79.75° E	11.4855	14.7904	12.839472	.6014034	.362
29.50° N, 80.00° E	11.3151	14.6531	12.674346	.6041136	.365
29.75° N, 79.25° E	11.4077	14.6893	12.749967	.6098167	.372
29.75° N, 79.75° E	9.8595	13.2243	11.197502	.6120344	.375
30.00° N, 79.25° E	9.5914	12.8775	10.914809	.6132219	.376
30.00° N, 79.50° E	6.8846	10.2162	8.209086	.6145968	.378

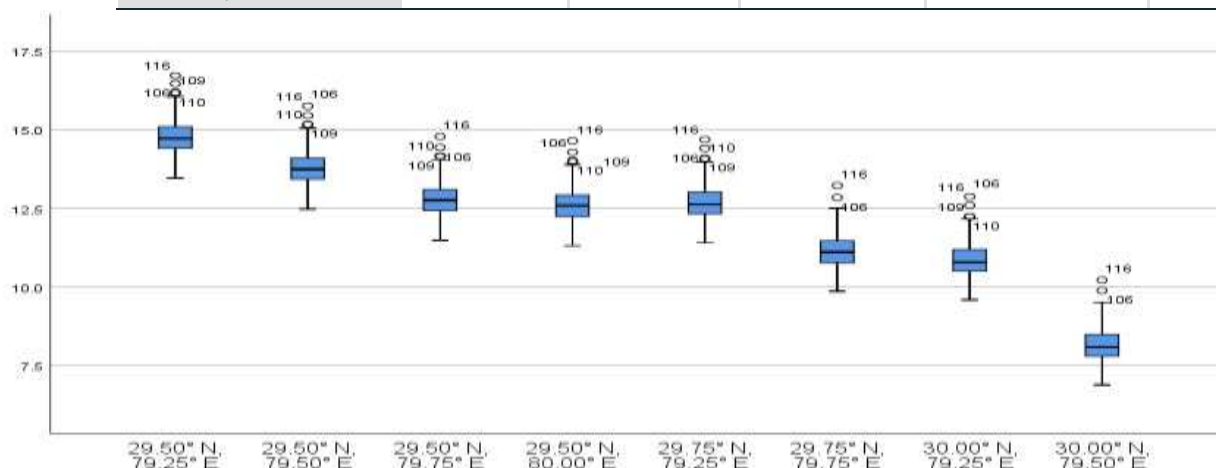


FIG. 5.15 Box Plot T Min All 8 Locations

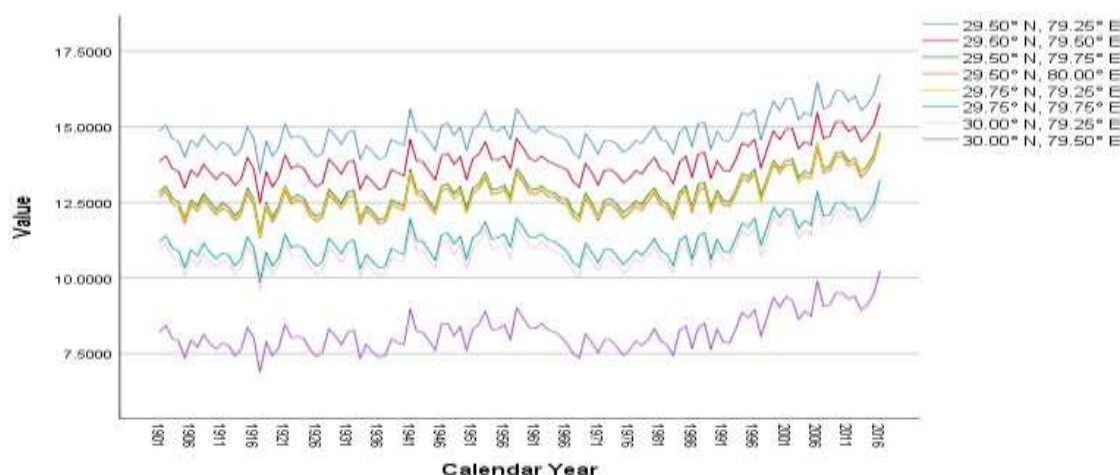


FIG. 5.16 Line Graph T Min All 8locations

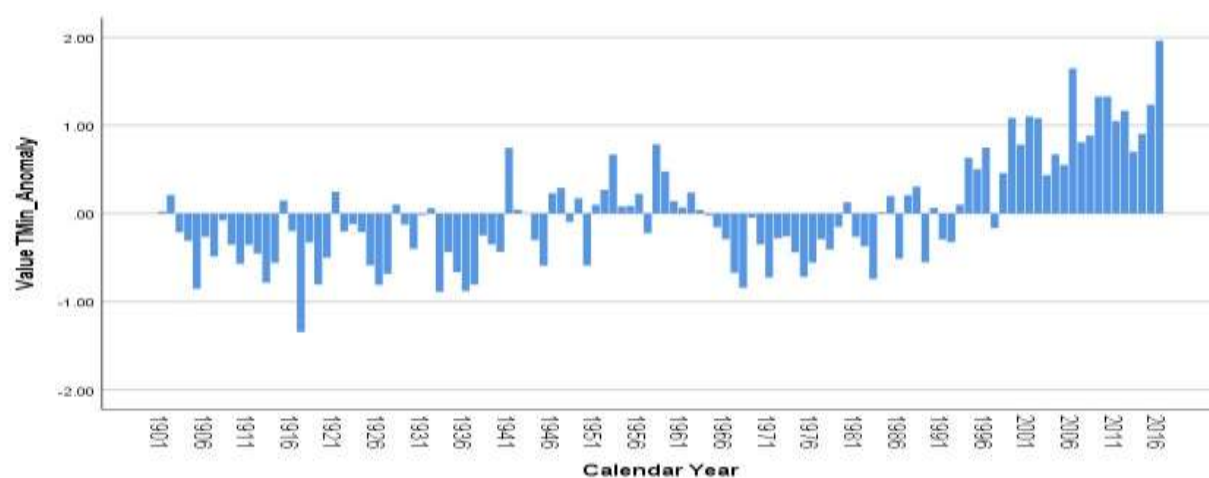


FIG. 5.17 Anomaly Plot T Min All 8 Locations

Trend Analysis

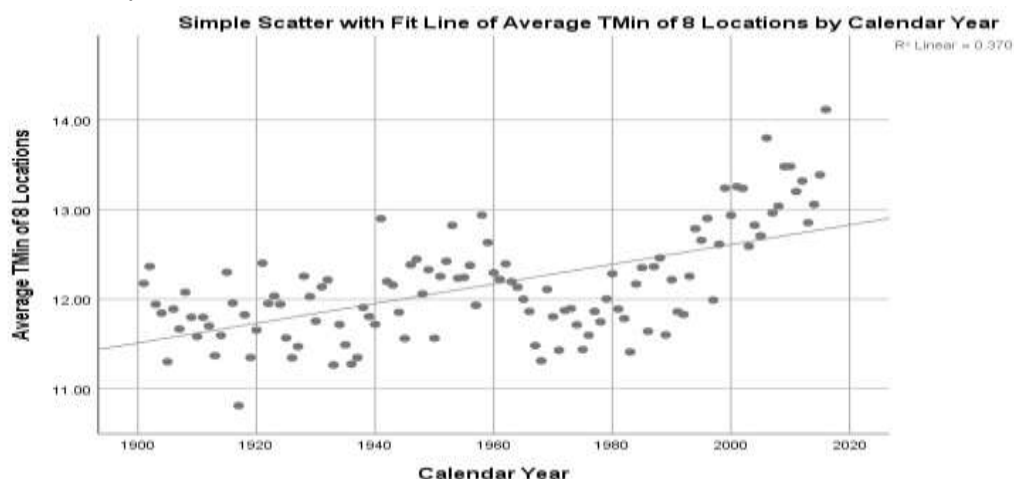


FIG. 5.18 Trend Analysis T Min All 8 Locations

There has been an increasing trend in minimum temperature values over the past three decades. An analysis of the 116-year trend shows an increase in minimum temperature across all eight studied locations (Fig. 5.16 and Fig. 5.18). The years 2006, 2009, 2010, and 2016 stand out as outliers in the box and plot diagram, with Tmin rising significantly beyond the normal range of variation during those years (Fig. 5.15). The 116-year trend, as well as the analysis of the last 16 years, consistently shows an increase in minimum temperature across all locations (Fig. 5.19). The anomaly plot (Fig. 5.17) further corroborates these findings about T Min.

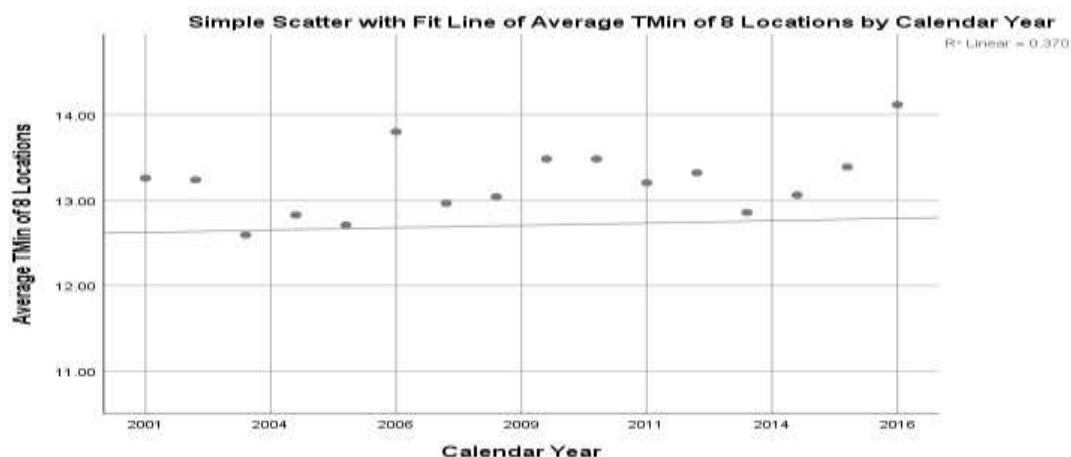


FIG. 5.19 Trend Analysis T Min All 8 Locations

6. Conclusion & Findings:

Objective I: To study the climatic data/projections and patterns over time for Almora district area, and risk of climatic disasters and extreme events.

- The Himalayan state of Uttarakhand is highly sensitive to climate and disasters. Its geographical, social, and economic vulnerabilities make it increasingly susceptible to climatic hazards. Development activities and their exposure to climate change and hazards are evident throughout the terrain.
- Field visits highlighted the significant vulnerability of the local community due to the lack of infrastructure such as hospitals, schools/colleges, disaster-resilient safe houses, and road networks. Issues such as last-mile connectivity, limited participation in decision-making processes, and widespread migration were observed across the entire region.
- Extreme events are on the rise. Erratic rainfall patterns and temperature trends have been recorded, with future projections placing Uttarakhand in a grim situation for sustainable development. The state is frequently revisited by a plethora of disasters, making life very challenging for the local community.
- According to local government officials, cloudbursts, landslides, and flash floods are the highest-ranked climatic disasters that frequently affect Uttarakhand. Officials have identified the districts of Rudrapur, Uttarkashi, Pithoragarh, and Chamoli as the most vulnerable to climatic extremes.
- Officials have cited faulty land use, poor building design, lack of communication systems, inadequate safety and environmental planning, poor implementation of laws, insufficient future investments, lack of public participation in planning, substandard building materials, improper construction activities, lack of awareness, and a lack of political will as major factors that turn hazards into disasters.
- In terms of key action points for building a climate-resilient Uttarakhand, top priorities include afforestation/banning deforestation, proper urban planning, community awareness and capacity building, effective water management systems, and timely pollution control measures.
- Block Development Officers emphasize the hazard vulnerability of their departments and assets, stressing the importance of coordination and inter-departmental synergy during disasters. They advocate for remedial actions such as environmental measures, implementing government policies at the ground level, human resource and skill development training for local government officials, and increasing awareness and capacity building within the local community.

6.2 Objective II : To show and analysis the trend of Climatic data of selected location in Almora district.

I. District Almora is highly sensitive and vulnerable to climate change, which affects various aspects of life, livelihood, critical facilities, and the safety and growth concerns of the local community. Due to a lack of facilities and bleak future prospects, people are migrating from remote villages to areas with better opportunities.

II. A 116-year climatic data analysis (1900–2016) from 8 locations in and around Almora reveals:

- **Precipitation:** A decrease in precipitation across all 8 locations over the years. The period from 2001 to 2009 was marked by drought. The years 1917 and 1936 experienced heavy precipitation, while 2004 saw very low rainfall. Since 2001, precipitation has generally been lower than the 116-year average.
- **Maximum Temperature:** An increase in maximum temperature has been observed at all 8 locations over the years. The year 1997 recorded the lowest Tmax, while 2016 showed the highest Tmax.
- **Minimum Temperature:** An increase in minimum temperature has been noted across all 8 locations. The years 2006, 2009, 2010, and 2016 showed significant rises in Tmin.

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