

Causes of Climate Changes and Issues in Uttarakhand

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Abstract

Uttarakhand is experiencing a surge in average temperatures and a significant shift in precipitation regime, causing significant changes in the duration, amount, and form of atmospheric precipitation. The region's shorter snowfall season is believed to be responsible for decreased water supply, leading to water scarcity. The shift in plant blossoming and fruiting has also led to a shift in traditional life support activities, resulting in decreased agricultural productivity, increased pest infestations, and animal attacks. These changes are part of coping strategies for people experiencing climate-induced changes. The Himalayan region, particularly Uttarakhand, is vulnerable to frequent forest fires due to high summer temperatures, while infrastructure and croplands are severely affected by excessive rainfall. Unpredictable climatic variations in the mountains prompt residents to migrate towards the plains. This study analyzes extreme precipitation and temperature indices, focusing on landslides and forest fire incidents. The region has seen declining trends in soil water content, total precipitation, total run-off, and leaf area index (LAI). The rise in weather extremes over the last four decades poses challenges for both the community and government in adapting to these changes.

Keywords: Weather, Snow fall, Rain fall, Climate, Global, Temperature.

INTRODUCTION

Climate change is a major worldwide problem, primarily caused by human activities. The Intergovernmental Panel on Climate Change (IPCC) has confirmed that human activity is the primary cause of global warming, with over 95% certainty. While natural climate cycles can alter Earth's temperature, these changes are occurring at a scale and speed that natural cycles cannot explain. Longer-term changes, like Milankovitch cycles and solar irradiance, take thousands of years to occur. Human activity, including burning fossil fuels and altering land use, is the leading cause of climate change, with urbanization and increasing building construction being the main CO₂ emissions contributing to the issue. (Lundgren-Kownacki et al., 2018) [5]. Rapid urbanization in Uttarakhand is causing a surge in housing demand across various income groups. The residential sector, which is fragmented due to a lack of guidelines for climate-responsive design and low-carbon construction, requires strategic interventions in building design and construction. The frigid climate of Uttarakhand and the Himalayan region requires a comprehensive strategy for adapting to and reducing the effects

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of climate change. The design, construction, and operation of residential buildings in these regions must prevent heat loss and ensure heat gain to enhance indoor thermal comfort while optimizing energy use. By exploring climate-responsive and energy-efficient design and construction strategies, the growth of residential buildings in cold climates in India can be ensured, avoiding the long-term lock-in of inefficient, high-energy-consuming buildings and promoting a low carbon development pathway.

Aim

Uttarakhand is battling the effects of climate change and urbanization on its urban thermal environment. The region faces challenges in adapting to these changes, particularly in terms of climate change. The study focuses on the regional distribution and magnitude of these impacts as well as the particular drivers of these changes in order to identify gaps in the literature and opportunities for additional research.

NEED OF THE STUDY

Uttarakhand is experiencing a significant impact on its people due to decreasing rains and snowfall, as well as changing seasonal cycles. In December, the Himalayan state recorded up to 50% less rainfall, and snowfall is also decreasing. This has led to an increase in dry, cold weather, with snowfall occurring only in high-altitude areas above 3,000 meters (Figure 1). Farmers as well as the general public are the ones who will be most affected. Seasons are being impacted by global warming, which is making the atmosphere warmer and endangering seasonal cycles. This results in late summer, winter, and rainy seasons, causing a significant difference in the time cycle of seasons. Agriculture in the mountainous regions of Uttarakhand is heavily influenced by meteorological conditions, with more than 60% of farmers depending on it. The changing cycle of seasons is having the biggest impact on farming and adversely affecting human health.

CAUSES AND EFFECTS OF CLIMATE CHANGE

Climate change has become increasingly prominent in recent years. This issue arises as a consequence of the release of greenhouse gases, which have a detrimental impact on our ecosystem. Hence, it prompts inquiries as to whether the issue is attributable to human activity or simply a natural occurrence. The average global temperature has increased by approximately 1 degree Fahrenheit since

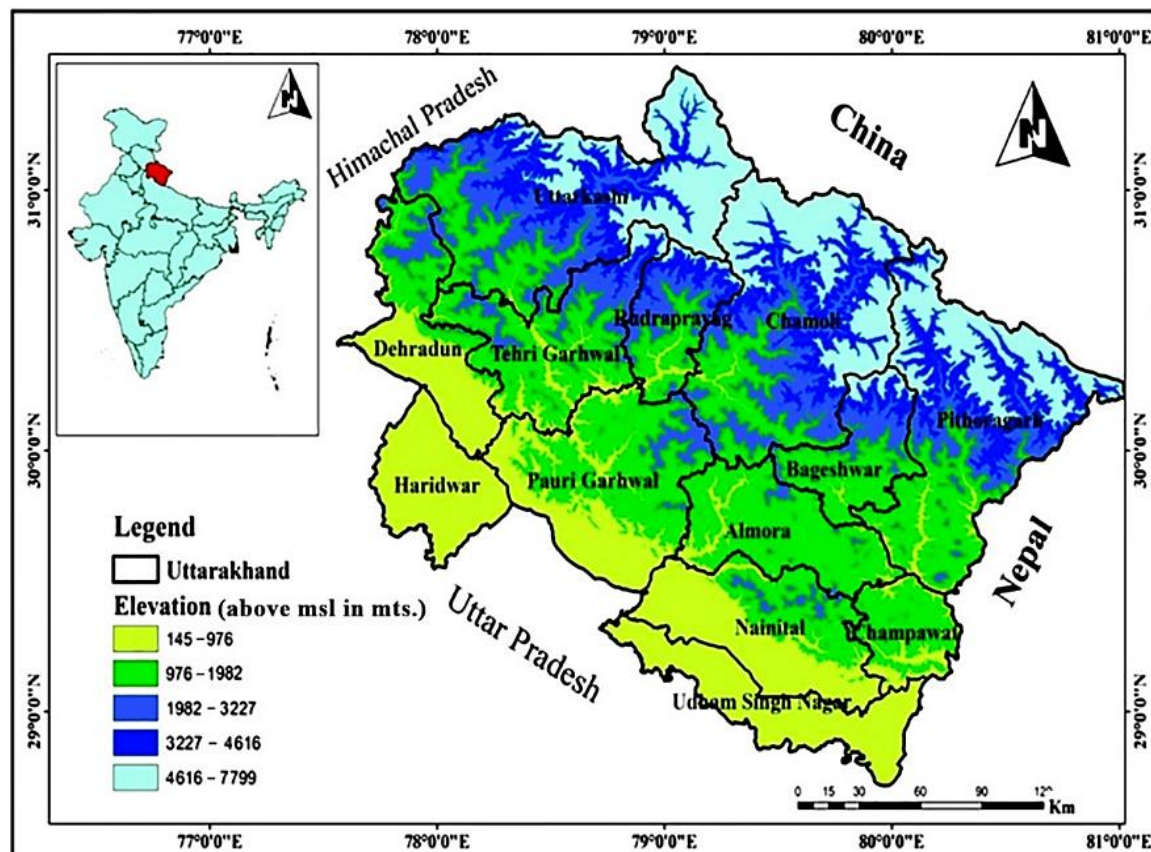


Figure 1. Climate changes projection.

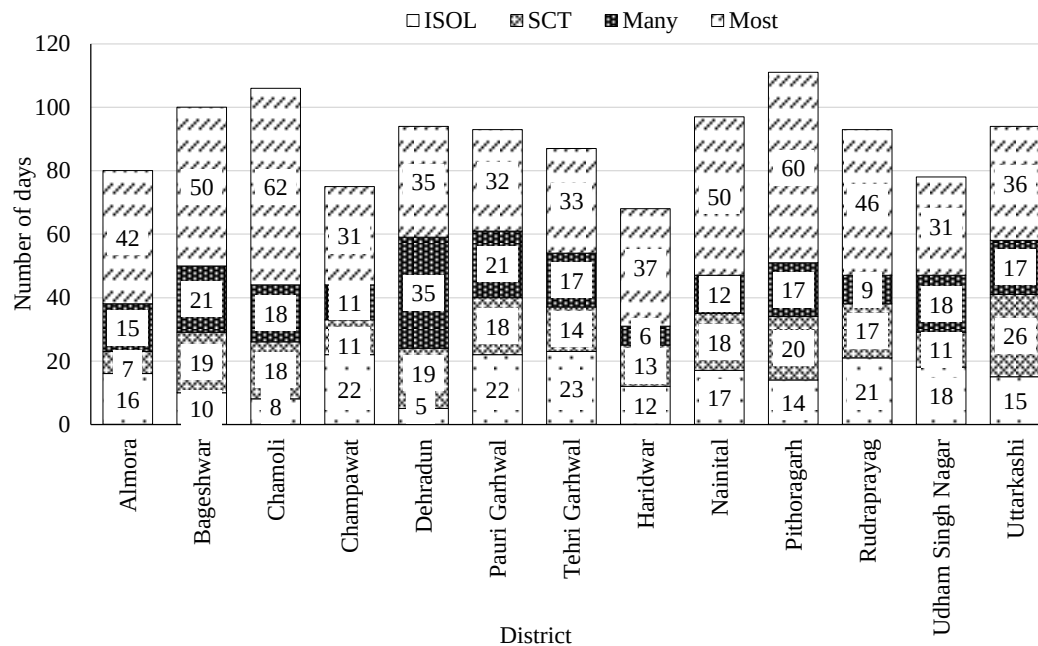


Figure 2. Mansoon 2023-spatial rainfall distribution Uttarakhand.

the turn of the 20th century, according to NASA. (Global Climate Change: Effects). Although it may initially appear insignificant, the impact of this alteration on our environment has demonstrated the contrary. The consequences of this slight alteration in temperature are manifold, ranging from extended periods of drought and intense heat waves to the heightened intensity of hurricanes (Global Climate Change: Effects). Moreover, the rise in the Earth's mean temperature has resulted in a multitude of issues that have had a long-lasting impact on our ecosystem (Global Climate Change: Effects).

Uttarakhand, a state in India, has been experiencing extreme weather events due to climate change. In August 2023, temperatures in portions of the state were at least five times more likely to be the result of anthropogenic climate change, according to an analysis by Climate Central. The state encountered temperatures that surpassed the mean from 1991 to 2020, with a considerable portion surpassing the average by two to three degrees for four time periods. From June 1st to August 31st, 2023, a total of 25 days were marked in Uttarakhand with a Climate Shift Index (CSI) equal to or exceeding 3. The presence of CSI 3 for a single day significantly increases the probability of temperatures in those regions by at least threefold. Two spans of days with elevated and sustained CSI were observed from August 7–12 and August 16–21. The CSI for the majority of Uttarakhand and the eastern half of India was 5, which signifies that temperatures in those areas were at least five times more probable between August 11 and 12. The sustained CSI levels from August 16–21 were exceptional, with the majority of the state remaining at 4 or 5, which signifies an extraordinary climate change event. Northeast India and southern India exhibited comparable CSI values, whereas central India witnessed a patch of negative CSI values from August 18–21 (Figure 2).

Some of the Climate Change Effects in Economy

The phenomenon of globalization has resulted in the swift advancement of industries, nations, and economies on a global scale. The increasing interdependence and reliance of countries on each other for commerce, production, and procurement has resulted in a situation where problems originating in one nation can have significant economic consequences for numerous other nations throughout the globe. Natural disasters can have enduring impacts on economies of all scales, frequently transpiring unexpectedly and sporadically. However, significant natural disasters have been few. Climate change is causing specific sorts of disasters to become more devastating and frequent, posing a threat to the

global economy (Vincent Diringer, 2020) [1].

Table 1. Season and Temperature of Uttarakhand

Seasons	Months	Temperature
Summers	March to June	20°C–35°C
Monsoon	July to Sep	15°C–25°C
Winter	Oct to Feb	3°C–15°C

Urbanization Thermal Environment

The urban thermal environment of Uttarakhand cities is experiencing significant changes as a result of the combined impacts of climate change and growing urbanization. (Table 1) Due to climate change, anthropogenic activities have a greater impact on the urban thermal environment, resulting in higher temperatures and more frequent extreme events. The evaporation and transpiration of heat from urban areas causes the expansion of impermeable surfaces and the reduction of natural areas in urban environments, which results in a decrease in atmospheric moisture. The dynamics and consequences of the thermal environment in urban areas can vary greatly due to intricate interactions among biophysical variables such as wind circulation, relative humidity, vapor pressure, and soil qualities. Moreover, urban environments alter the reflection of sunlight (albedo) and the release of heat throughout the night (nocturnal radiation), while urban traffic adds to the release of greenhouse gases that are expected to raise the temperature in the local area. Traditionally, the study of the urban thermal environment has relied on meteorological data. Long-term local monitoring records are crucial for capturing temporal climate variability (Wilk, 2018) [6]. Sensors and observational networks have been established to investigate the impacts of the constructed environment on the urban canopy layer in order to analyze small-scale fluctuations. Nevertheless, the process of setting up and maintaining a monitoring system of superior quality is frequently laborious and costly, resulting in a lack of data in certain areas, such as Uttarakhand. (Pörtner HO, Peck MA2010) [7] Improvements in thermal infrared and multispectral remote sensing have made temperature maps easier to obtain. (Hegerl GC, Brönnimann S2019) [8] These technologies offer surface temperature distributions of varying resolutions, allowing for the visualization of both hot and cold areas on the surface. Significant insights into the spatial dynamics of changes in the thermal environment can be gained from a variety of remote sensing data, particularly in places where monitoring networks are few and urbanization is happening quickly.

Risks to Urban Poor

Climate change is also exposing the urban poor to a variety of issues. This vulnerable group is at risk from heat waves, high levels of urban pollution, and climate-related catastrophes such as floods and mudslides. The number is 6. City administrations in developing countries are failing to deliver services of superior quality. (Kannan R, James DA2009) [9] Research comparing different countries has shown that the quality of governance is lower in nations with lower levels of wealth (La Porta, 1999) [2]. If local governments lack the necessary funds to provide essential services, such as clean water and sanitation, to an expanding urban population, the influx of "environmental refugees" caused by climate change can inadvertently contribute to local urban quality of life issues. (Barrios S, Bertinelli L, Strobl E. 2006) [3] The urban poor in these countries are particularly vulnerable to climate change-related occurrences, such as heat waves and flooding. In comparison to wealthier households, they possess limited access to medical services and household appliances that can mitigate the effects of climatic exposure, such as air conditioning and refrigerators. Dholakia, H. H., & Garg, A. (2018) [4]. In response to the variation in land prices, individuals with lower economic means opt to reside in the areas of the city that have the lowest quality and are least sought after, resulting in lower rental costs. The vulnerability of impoverished individuals to climate change is significant due to the limited capacity of local governments in developing nations to allocate financial resources towards the provision of public goods to safeguard the local populace. (Şekercioğlu ÇH,

Primack RB 2012) [10] Furthermore, because they are unlikely to cast ballots, these governments frequently show insensitivity to the interests of unofficial squatters.

Urban Thermal Environment Analysis at Different Scales

Scale models derived from many data sources have become essential for comprehending urban climate systems. By focusing on historical urban climate patterns and potential future climate scenarios, simulations from urban climate models can assist urban planners in devising cost-effective and scientifically grounded strategies for sustainable urban growth. Various models exist for estimating and explaining urban concerns across different spatial scales. (Dale VH 1997) [11] Regional-scale models have been employed to assess the impacts of climate and land use changes on urban climate across various time periods, including both short-term and long-term durations. These models also facilitate researchers in comprehending processes occurring at various spatial scales and the interactions among interconnected components (such as the atmosphere, land, aquatic bodies, and human-made emissions). (Robock A1978) [12] The primary objective of regional scale models is to parameterize urban processes in order to incorporate alterations in energy balance, which frequently fail to offer adequate information for specific urban development plans. City-scale models concentrate on the spatial extent of one or a limited number of cities, allowing for the simulation of atmospheric and surface processes to address specific requirements for urban planning and climate adaptation strategies. City-scale models can be utilized to identify and predict areas of climate risk in urban environments, thereby enhancing sustainability and resilience. These models can also aid in implementing strategies to mitigate the urban heat island effect, such as enhancing urban ventilation, managing blue-green infrastructure, and monitoring air pollution. In addition, important factors concerning the urban thermal environment and thermal comfort, such as the height and orientation of buildings, the materials used on surfaces, the presence of vegetation, and different scenarios for planting trees, as well as the speed and direction of wind at street level, are frequently simulated using models at the scale of buildings. Building-scale models are frequently employed alongside city-scale models for the purpose of studying urban thermal environments.

CONCLUSION

The Earth system is a complex system that is constantly evolving and changing. Humans and other species have been adaptable to these changes, with gradual changes being easier and less catastrophic. However, adapting to rapid changes is more challenging and entails greater disruption and risk. Abrupt transformations, particularly unforeseen climate surprises, pose significant threats to human societies, cultures, and ecosystems. Understanding historical climate variability offers insights into the inherent sensitivity and variability of the Earth system. Additionally, it enables the identification of potential hazards that may arise from modifying the system through the release of greenhouse gases and alterations in land cover at regional to global scales. The impacts of climate change on the environment, human health, and biodiversity are severe. If we continue to not take action to prevent these changes, our mother earth will become sicker and more vulnerable to deforestation. Moreover, psychological issues such as post-traumatic stress disorder, anxiety, and violence within communities may be exacerbated by climate change. To protect our environment and provide a better place for future generations, we must know how to prevent climate change, such as by stopping tree cutting, saving energy, increasing construction, and carpooling. By contributing to controlling climate change effects, we can help the world become cooler and safer. The paper also examines how city quality of life will be affected by climate change, highlighting the need for strategic interactions among individuals, cities, and national levels to prevent climate change.

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