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Changing Climate of Uttarakhand, India

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Abstract

India has a unique climate system dominated by the monsoon, and the major physiographic features that drive this monsoon are its location in the globe, the Himalayas, the central plateau, the western and Eastern Ghats and the oceans surrounding the region. The country is considered highly vulnerable to climate change, not only because of high physical exposure to climate-related disasters, but also because of the dependency of its economy and majority of population on climate-sensitive sectors (e.g. agriculture, forests, tourism, animal husbandry and fisheries).

The Himalayan Region comprises of the highest mountain system of the world, the Himalayas and the North-Eastern hill states. Being the home of some very large and important glaciers (viz. Gangotri, Ponting, Milam, Pindari etc) the state of Uttarakhand has remained in centre of climate change discussions since over three decades. In addressing this debate and to eliminate confusions, the paper examines emerging climate trend scenarios in the region by measuring temperature and rainfall variabilities during the past century. The results indicate unanimous warming of the entire region but are more critical in mountainous parts. On the other hand the plain areas have received more rainfall, while it has declined in hilly districts.

Keywords: Climo-balance; Indian Himalayan Region; Ecological environment; Annual season cycle; Natural regime

Introduction

Human beings live in the realm of nature; they are constantly surrounded by it and interact with it. The most intimate part of nature in relation to man is the biosphere, the thin envelope embracing the earth, its soil cover, and everything else that is alive. Our environment, although outside us, has within us not only its image, as something both actually and imaginatively reflected, but also its material energy and information channels and processes. This presence of nature in an ideal, materialised, energy and information form in man's Self is so organic that when these external natural principles disappear, man himself disappears from life. If we lose nature's image, we lose our life.

Man is not only a dweller in nature, he also transforms it. From the very beginning of his existence, and with increasing intensity human society has adapted environing nature and made all kinds of incursions into it. Not only has man transferred various species of plants and animals to different climatic conditions; he has also changed the shape and climate of his habitation and transformed plants and animals.

Life, including human life, is not only metabolism; it is also a form of energy transformation and movement developed to degrees of subtlety that are as yet beyond our comprehension. Every cell, every organ and organism as a whole is a crucial arena of the struggle between entropic and anti-entropic processes, and the biosphere represents the constant victory of life, the triumph of the anti-entropic principle in the existence of the living [1-3].

So the biosphere is not a chaotic conglomeration of natural phenomena and formations. We are part of the ecological environment and it is a part of the universe. Those human actions which violate the laws of nature, the harmony of the biosphere, threaten to bring disaster and this disaster may turn out to be universal. Anthropogenic Climate change is a major global environmental and developmental problem and also an issue of great concern to all countries irrespective of their size or level of development.

Climate change is expected to manifest quite significantly in India. India is considered highly vulnerable to climate change, not only because of high physical exposure to climate-related disasters, but also because of the dependency of its economy and majority of population on climate-sensitive sectors (e.g. agriculture, forests, tourism, animal husbandry and fisheries).

The Indian Himalayan Region (IHR) - one of the most climate sensitive regions of the country- stretches across states in the western and eastern Himalayas and provides critical ecosystem services for communities in mountains and downstream plains. Uttarakhand, a vital segment of the Himalayan Regime, is most vulnerable to climate-mediated risks. The economy as a whole is characterized by low economic growth combined with high rates of population growth. The livelihoods are almost totally based on natural resources - water, forest, agriculture, etc. About three-fourth of state's population is rural and virtually all depend on agriculture. Tourism and Animal husbandry are other sources of income. With over 15 important rivers and over a dozen of major glaciers, Uttarakhand is a valuable freshwater reserve. A large portion of the state is under forests. Climate change may have severe impacts on livelihoods as most of the economic and livelihood sectors are vulnerable to the impacts of climate change. Several studies have documented a notable temperature rise over the region, especially in the mountainous areas, and attribute recent natural catastrophes and extreme weather events like receding glaciers and upwardly moving snowline, depleting natural resources, erratic rainfall, irregular winter rains, advancing cropping seasons, fluctuations in the flowering behaviour of plants, shifting of cultivation zones of apple and other crops, reduction in snow in winter, increasing intensity and frequency of flash floods, drying up of perennial streams, etc. to this warming [3-9]. On the other there are studies too, showing these predictions overestimated and misleading [10,11]. In view of these facts a fresh interpretation of climate pattern is needed to understand the real climate scenarios emerging in the state.

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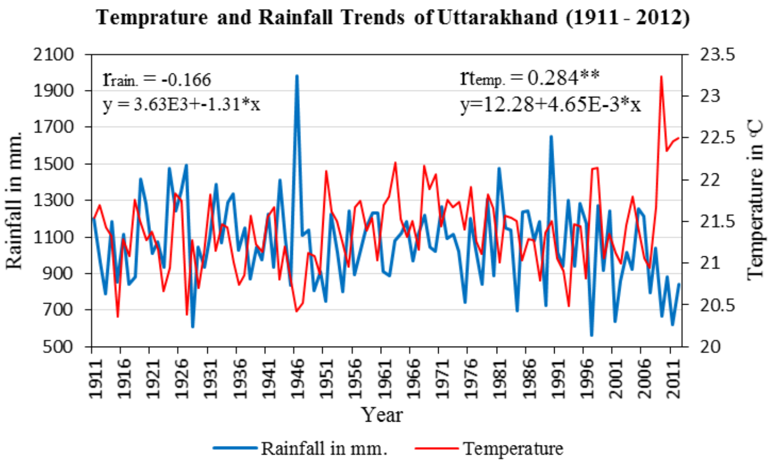
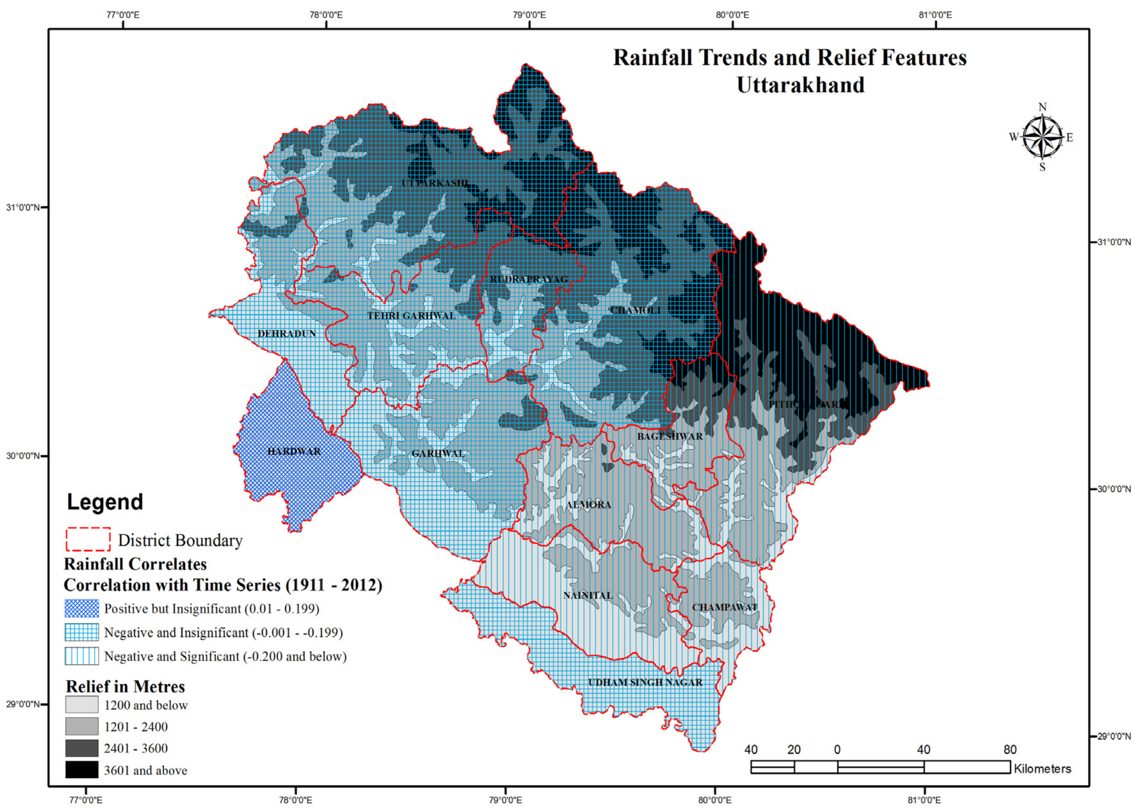


Source: Based on IMD Temperature Records

Figure 1: Analysis of 100 years temperature and rainfall data shows that the region has recorded a declining rainfall trend during the period and after 1970 onward, this trend has become steeper.



Source: Based on IMD Temperature Records

Figure 2: Rainfall declining trend is not the same all over the state.

Climate Trends of Uttarakhand

The climate of Himalayan region in general and of Uttarakhand in particular depends on the summer monsoon currents and associated cyclone system, westerly disturbances and local orographic and conventional thunderstorms that occur in the afternoon during pre and post monsoons. In Uttarakhand there exists a large variation of relief from 200 m. in south and more than 7,500 m. in the north. It has been observed that for every 1,000 m. ascend, there is a decrease in temperature by 6°C. The slope aspect also play an important role in determining the climate, as north facing slopes are much cooler and damp as compared to south facing slope due to insolation affect.

The annual season cycle of Uttarakhand can be classified into

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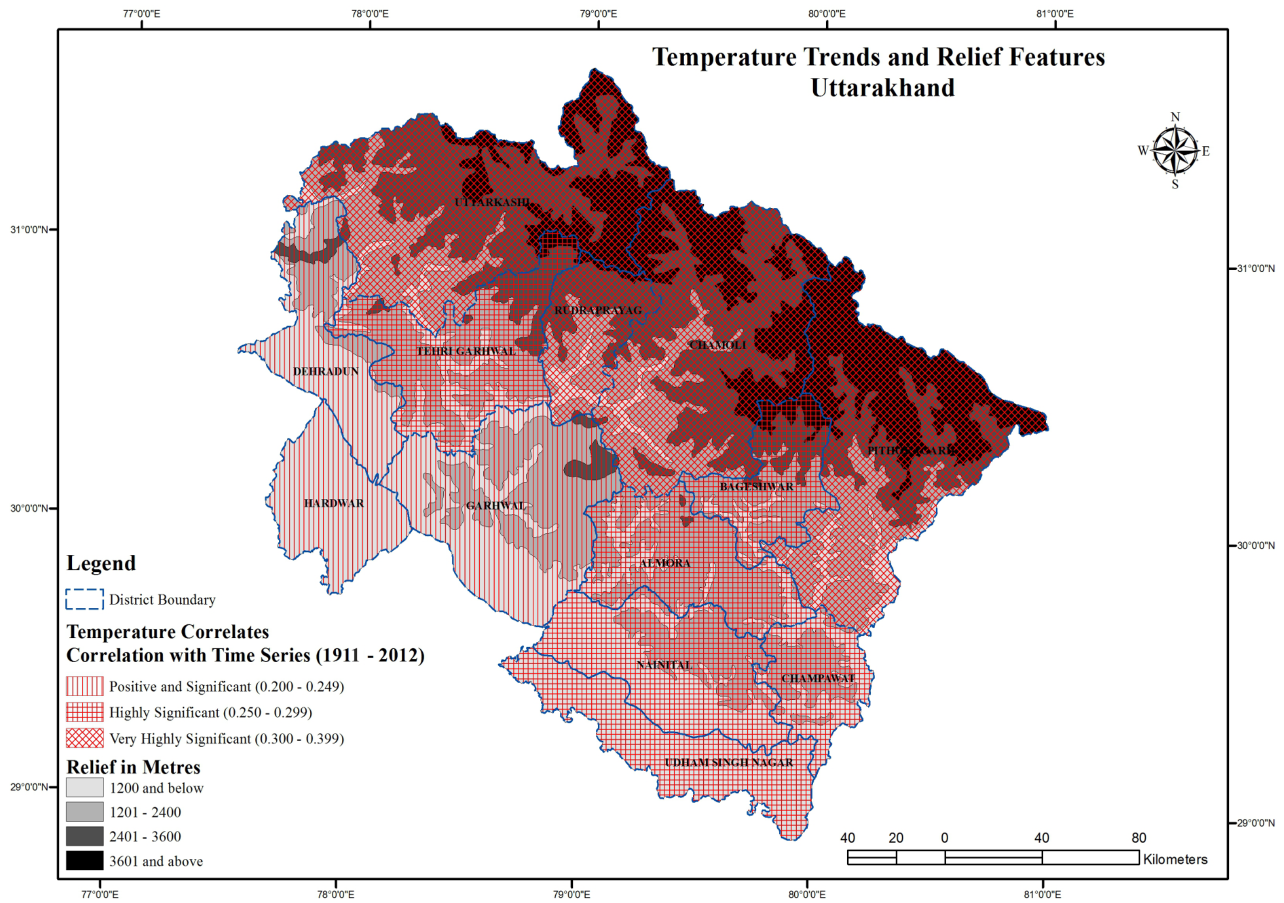
five distinct seasons and there duration depends on the relief and orographic conditions. The winter starts from mid November and lasts up to mid March, spring lies between mid March to April, May and June are summer months, and monsoon or rainy season lies between July to September and late September to mid November is autumn season. The season cycle is best observed in the Lesser Himalaya and adjoining parts of Higher Himalaya, which are most inhabited areas in Uttaranchal. In the Tarai, Bhabhar, Dun and adjoining plains winter is short and summer is hot while in the Higher Himalaya and particularly in the alpine zone winters are long and much severe. The temperature is governed by altitude and orographic parameters. In general, from south to north as altitude rises, the temperature decreases.

A analysis of 100 years temperature and rainfall data shows that the region has recorded a declining rainfall trend during the period and after 1970 onward, this trend has become steeper (Figure 1). Although the average reduction rate in annual total rainfall has been insignificant, yet it may put great stress on the water resources of the region. The rainfall declining trend is not the same all over the state (Figure 2). Haridwar, which is almost plain, has received more rainfall than normal. Rest all the districts have witnessed less precipitation. This rainfall shortage is more acute in Pithoragarh, Bageshwar, Almora, Champawat and Nainital Districts.

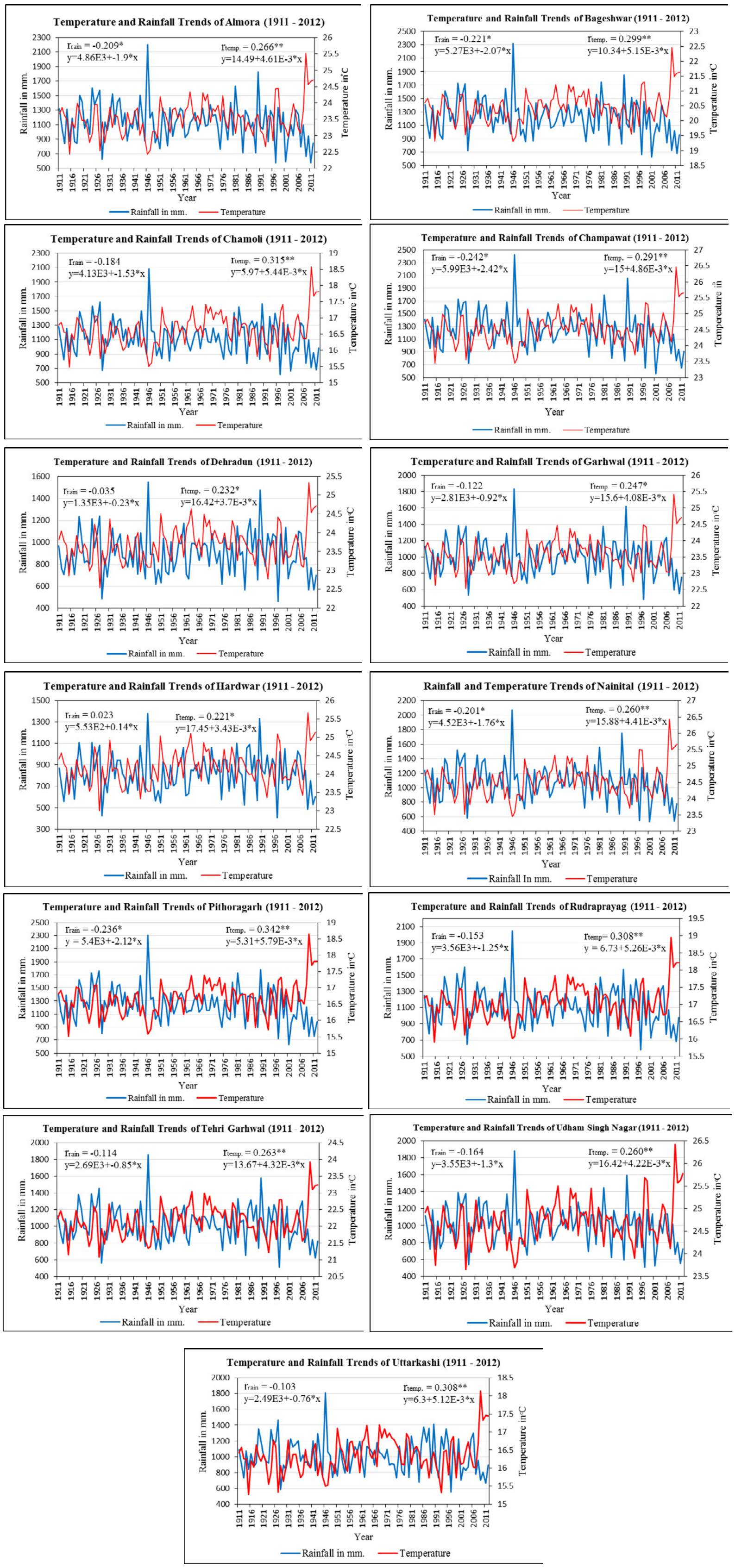
Temperature records of the region reveal a notable warming trend and this warming was more prominent during the last decade. While the entire region has shown a significant temperature increase, the mountainous districts- Uttarkashi, Chamoli, Rudraprayag and Pithoragarh- were the warmest areas (Figure 3). On the other hand, Hardwar, Dehradun and Garhwal districts, which are low in relief, witnessed less warming as compared to others. This pattern may calls for faster melt of glaciers and more active geomorphic processes. Due to enhanced energy levels, the atmospheric processes may bring rapid and catastrophic changes and the climatological disasters like cloudburst, landslides, floods etc., may visits the region more frequently and intensely.

District level Temperature and rainfall data shows almost the similar trends (Figure 4) and all the districts have noticed a significant decline in rainfall during past two decades. However, Almora, Bageshwar, Champawat, Nanital, Garhwal and Udham Singh Nagar districts were the most rainfall deficient; Uttarkashi district recorded no significant decline during the period. Between these deficiencies, there exists surplus too. In between 1950 to 1970, besides Uttarkashi, Rudraprayag, Garhwal and Pithoragarh, all the districts have noticed extended precipitation spells. It is worth mentioning here that frequency of precipitation curve has been higher before 1950, and afterwards it continuously reduced significantly. Thus the decade of 1950-60 seems a time divide in precipitation patterns of the state.



Source: Based on IMD Temperature Records

Figure 3: The entire region has shown a significant temperature increase, the mountainous districts- Uttarkashi, Chamoli, Rudraprayag and Pithoragarh- were the warmest areas.



Based on IMD Temperature and Rainfall Records

Figure 4: District level Temperature and rainfall data shows almost the similar trends.

Temperature trends follow the same pattern although moving upward. Last five years (2007-2012) were the warmest for all the districts, where Nainital, Champawat and Udham Singh Nagar districts witnessed the maximum rise. Temperature rising slope remained steeper during the last decade. These are three distinct spells of temperature patterns. From 1911 to 1950, temperature frequency curve shows a normal cycle of warming and cooling, during 1950-1980 it was warmer than earlier yet warming was not significant, and after 1980, the curve became steep.

Conclusions

Unanimous temperature rise over the region may disturb local eco-balance of this hilly state. The enhanced entropy of atmospheric system will result into stormier and unpredictable weather conditions. It seems that human interference in natural regime has a remarkable influence over climate of the region. Rapid urbanisation along hill regions after 1950`s have potentially contributed to temperature increase, and intensifying infrastructure development activities have disturbed the climo-balance of the state which is quite visible in form of more frequent climatological hazards hitting the state day by day. There is a need to adopt eco-friendly development strategy for this climate sensitive region and to monitor and regulate the urbanisation and settlement growth along fragile areas.

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