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# Climate Change is Human Induced?

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## Abstract

Climate is the most vital element of our planet and its live ability is key concern for every habitat.From Silent Spring till present debate is on about humankind's impact on nature. Since its establishment in 1988, the Intergovernmental Panel on Climate Change (IPCC) has been playing pivotal role in raising public concerns on human-induced climate change through its various assessment reports. These reports follow exhaustive review process, and are widely accepted.In 2007, IPCC's 4 th assessment report-'Climate Change 2007 -Impacts, Adaptation and Vulnerability' came in question on Himalayan glacier melt. The Climate gate in 2009 further strengthened the confusion on credibility of IPCC's projections. Present study analyses district level temperature and rainfall patterns of Uttarakhand-a Himalayan state, and examines the validity of IPCC's projection.Uttarakhand is a tourism oriented economy. State is best known for its religious places and natural sites. Rapid urbanisation in mountainous regions is disturbing regional eco-balance, but increasing vehicular pollution in climatesensitive areas seems to have greater impact on temperature and precipitation patterns. Result shows a noticeable shift in the variability of temperature and rainfall, and a significant warming especially in mountainous districts, However human activities does not correlate very well with these changes.

***Index terms***— climate-sensitive sectors, monsoon, climatic variability, polar caps, vehicular pollution.

## 1 Introduction

ndia is considered highly vulnerable to climate change, not only because of high physical exposure to climate-related disaster, 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). More than 40 million hectares of India (12 per cent of land) is prone to floods and river erosion; of the 7,516 km long coastline, close to 5,700 km is prone to cyclones and tsunamis; 68 per cent of the cultivable area is vulnerable to drought and hilly areas are at risk from landslides and avalanches **??**NDMA, 2007). The country 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 Himalayas influence the climate of the Indian subcontinent by sheltering it from the cold air mass of Central Asia. The range also exerts a major influence on monsoon and rainfall patterns. They prevent frigid and dry arctic winds from blowing south into the subcontinent keeping South Asia much warmer when compared to regions located between corresponding latitudes throughout the globe.

Himalayan glaciers cover about three million hectares or 17 per cent of the mountain area. They form the largest body of ice outside the polar caps and are the source of water for the innumerable rivers that flow across the Indo-Gangetic plains. About 15,000 Himalayan glaciers form a unique reservoir which supports perennial rivers such as the Indus, Ganga and Brahmaputra which, in turn, are the lifeline of millions of people in South Asian countries (Pakistan, Nepal, Bhutan, India and Bangladesh). The Gangetic basin alone is home to 500 million people, about 10 per cent of the total human population in the region.

The Himalayan ecosystem is highly vulnerable to the stress caused by increased pressure of population, exploitation of natural resources and other related challenges. Climate change may adversely impact the

Himalayan ecosystem through increased temperature, altered precipitation patterns, and episodes of drought. According to IPCC‘s 4 th assessment report ”glaciers in the Himalaya are receding faster than in any other part of the world and, if the present rate continues, the likelihood of them disappearing by the year 2035 and perhaps sooner is very high if the Earth keeps warming at the current rate. Its total area will likely shrink from the present 500,000 to Syed Iqbal Hasnain, India’s well-known Glaciologist, observes that ”The Ganga system is about 60 to 70 per cent snow and ice. There are more than 800 glaciers in the Ganga basin. The Gangotri is the big one. It used to cover more than 250 square kilometers, but now it’s breaking up in many places. You will see blocks of dead ice that are no longer connected to the main ice body. I’m afraid that if the current trends continue, within 30 or 40 years most of the glaciers will melt out” (Black 2009).

Contrary to Hasnain‘s view, a white paper on the status of Himalayan glaciers and global warming by V.K. Raina, former Deputy Director General of the Geological Survey of India, suggests that ”in most cases glaciers have stopped retreating. While the Gangotri glacier stopped receding in the 2007-09 period, glaciers like Pindari in Kumaon continue to record a high annual retreat of almost 10 metres annually”. He further states that ”The glaciers are undergoing natural changes, witnessed periodically” (Raina, 2010: Survey of India, the Gangotri region has not shown any evidence of major retreat (Fig. 1). 100,000 km 2 by the year 2035” (Cruz et al, 2007). Present work is an attempt to identify anthropogenic influence over natural climatic variability of the Himalayan region by considering Uttarakhand as the case of study. The data has been collected from Census of India, India Meteorological Department, Survey of India and Geological Survey of India, and simple correlation and regression techniques have been used for analysis of temperature and rainfall patterns.

Uttarakhand is a part of the Indian Himalayan region (Fig. 2). Owing to its immense natural beauty, rich biological succession and India‘s great rivers feeding glaciers-Gangotri, Ponting, Milam, Pindari etc., the region is regarded as Devbhumi-abode of Gods, and Tapobhumi-land of asceticism in Indian scriptures.

Volume XIV Issue VIII Version I The climate of Uttarakhand is temperate, marked by seasonal variations in temperature but also affected by tropical monsoons. January is the coldest month, with daily high temperatures averaging below freezing in the north and near 21 °C in the southeast. In the north, July is the hottest month, with temperatures typically rising from 7 °C to about 21 °C daily. In the southeast, May is the warmest month, with daily temperatures normally reaching the high around 38 °C from a low around 27 °C. Most of the state’s roughly 1,500 mm of annual precipitation is brought by the southwest monsoon, which blows from July through September.

temperature at annual and monthly time scales for the periods of 1911-2012 to understand the climatic variability of the region.

Uttarakhand has two physiographic zonesmontane and non-montane. The mountainous regions have recorded more significant warming and declining rainfall trend, while Hardwar, which is almost plain, noticed positive rainfall trend (Table 1). It is evident that the temperature and rainfall departures from centennial average are significantly high in higher altitudes (Fig. 3). 2). These two districts have noticed less warming than others.

Contrary to other districts, Hardwar has recorded an increasing rainfall trend although this trend is insignificant. Evidently urbanisation holds no significant association with temperature and rainfall trends. Source: Census, 2011, GOI, and computed Heavy forest diversion for basic infrastructures is also being accused for deteriorating local climate‘s stability. But data suggests that green cover removal is not directly related with the warming. Dehradun and Hardwar which have recorded largest forest diversion are not the warmest districts of the region (Table 3). Forests attract rainfall, but here Hardwar having the noticeable forest diversion, has shown an increasing rainfall trend. Source: CSE, 2013

The three districts-Uttarkashi, Rudraprayag and Chamoli, where these religious centres are located, have recorded very significant warming during past decade. Increasing vehicular pollution seems fuelling temperature rise in these areas. Although growing industrialisation and vehicular density in Dehradun and Hardwar districts have no significant impression on temperature trend on the other hand. It can be said that vehicular pollution is more significantly correlated with temperature patterns in hilly areas while in the plain region, it has less impact on the atmospheric state. In other words neutralising capacity of plain ecosystem seems greater than mountainous ecosystem.

# 2 III.

# 3 Conclusion

Analysis shows noticeable departures in temperature and rainfall patterns. Months of March and May have recorded more rainfall and significant warming. Temperature of June, July, August and September are at cooler side. Result shows that surface temperatures have risen significantly during the last century, but this may be result of various cooling and warming phases. Besides having significant temperature-time correlations, R 2 values are very weak because of very noisy data. The ARIMA models predicted warming up to 0.3°C till 2035, being maximum for Chamoli district. Results show that this change is almost natural rather than anthropogenic. Warming is unequivocal with decreasing rainfall (except Hardwar), however, temperature and rainfall patterns do not fully support the hypothesis that urbanisation, industrialisation or green cover removal have great bearing on this warming or drying trend. Although increasing vehicular pollution in temperature-sensitive high altitude areas seems to have some impact on these trends. We can say while human interference has fuelled some variations

in patterns, natural factors are the major cause behind climatic variability and changes. IPCC's claim that due to human intervention in the Himalayan ecosystem, up to 2035 we are going to lose large volume of glaciers, thus, does not seem a real claim. [1]


Figure 1:

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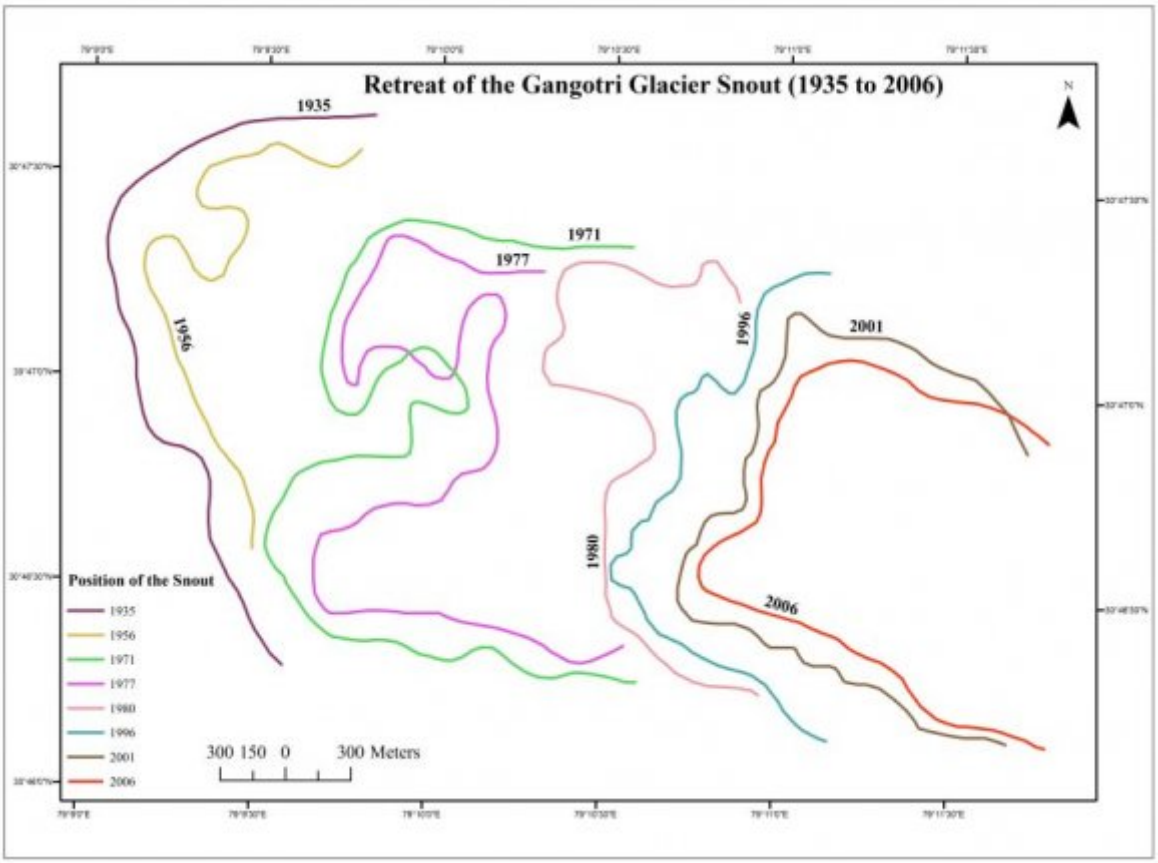
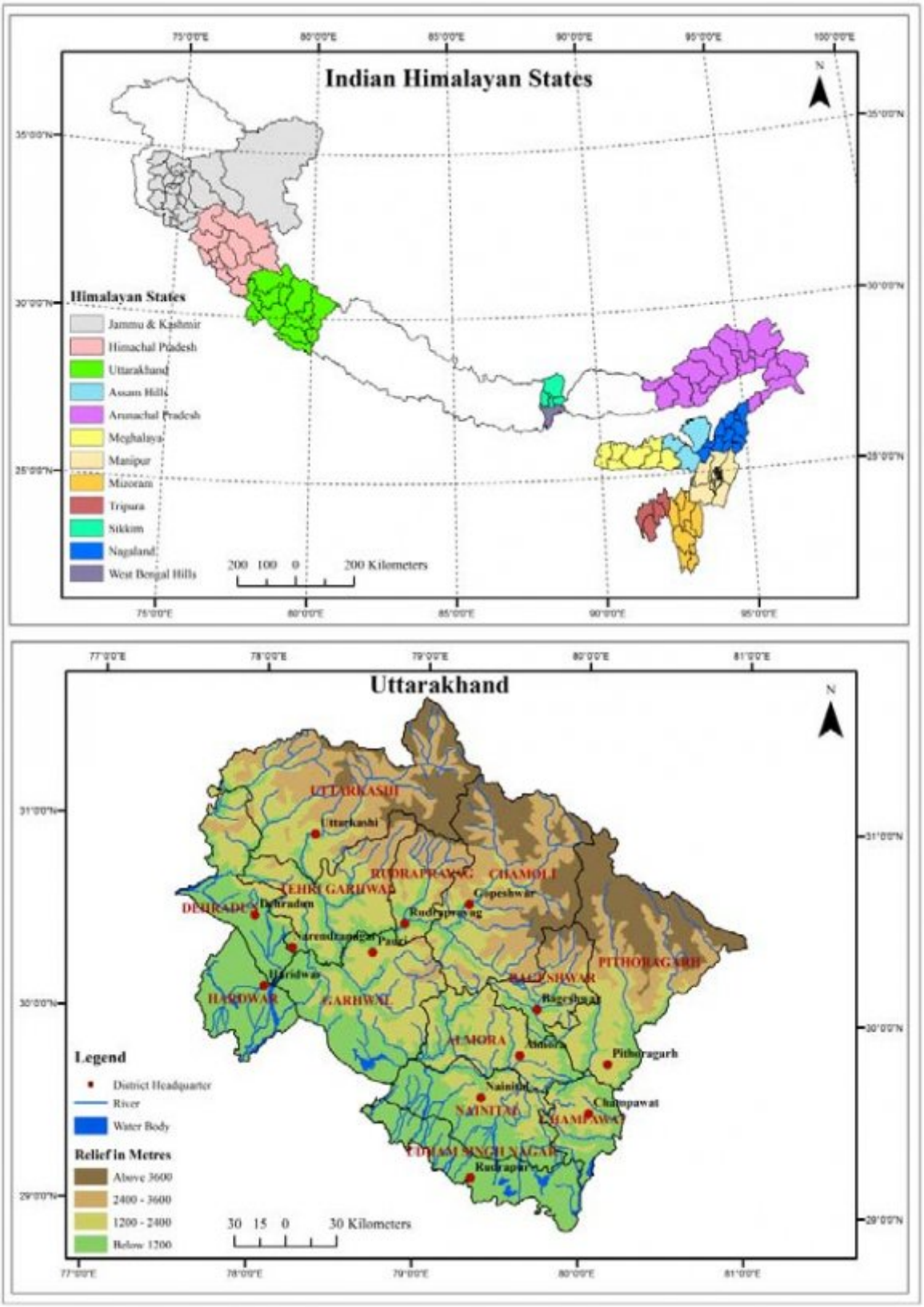



1

Figure 2: Figure 1 :




**2**

Figure 3: Figure 2 :

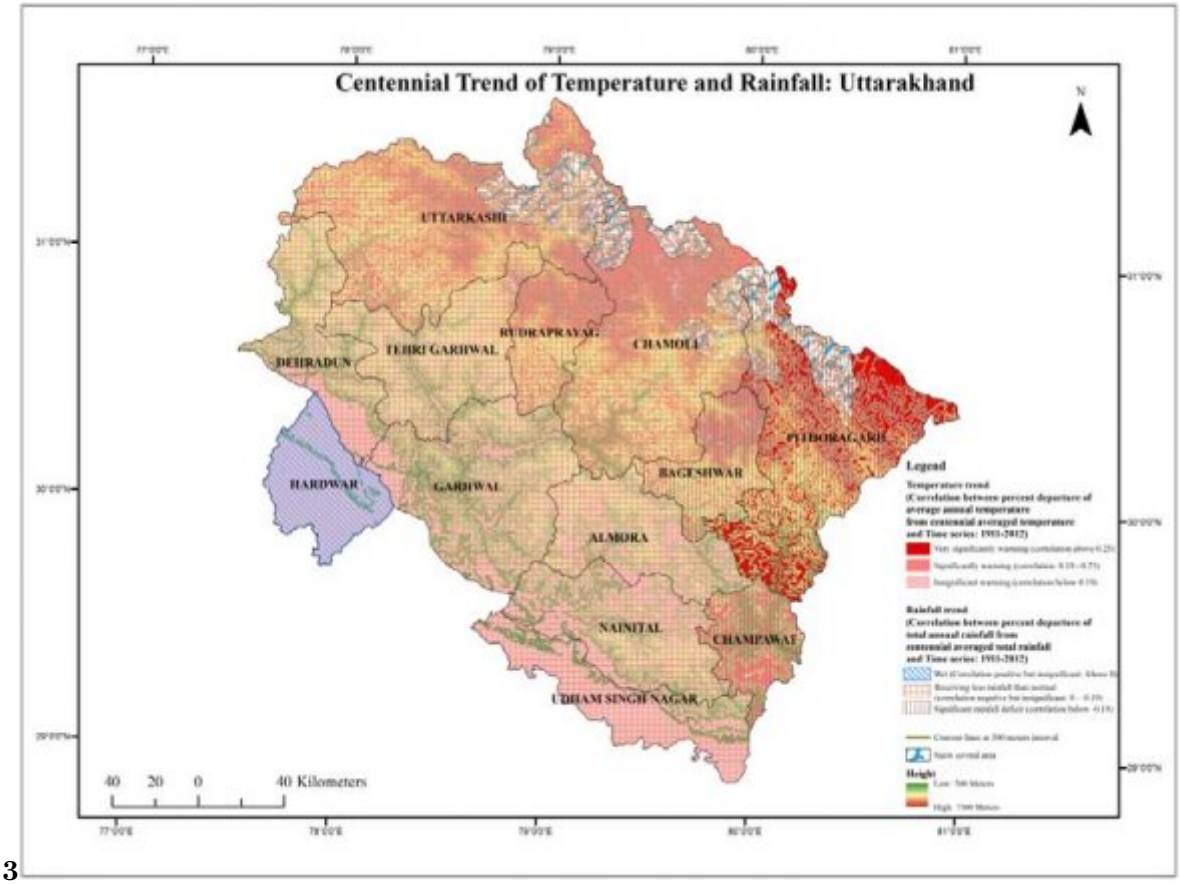



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Figure 4: Figure 3 :

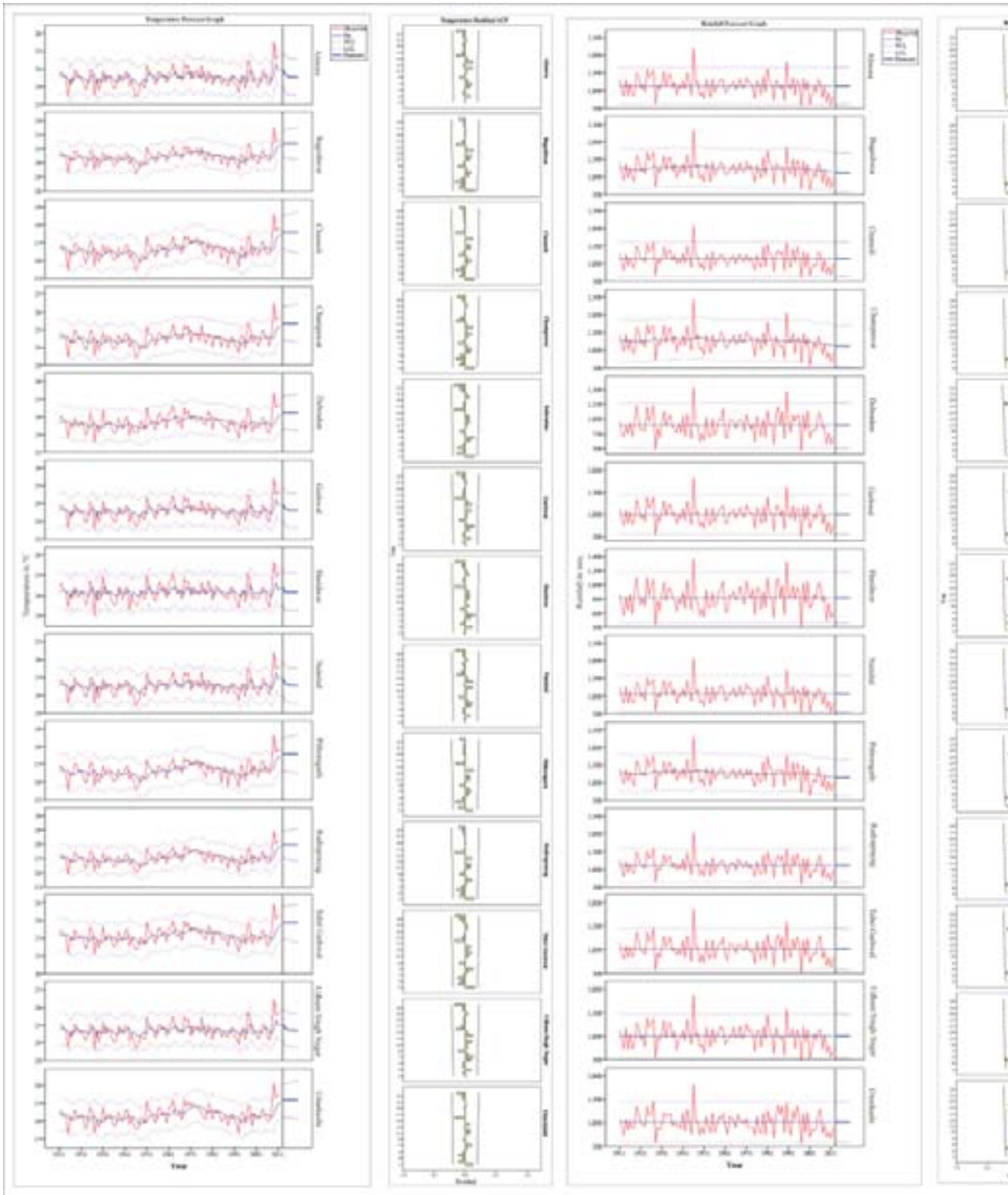

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Figure 5: Figure 4 :

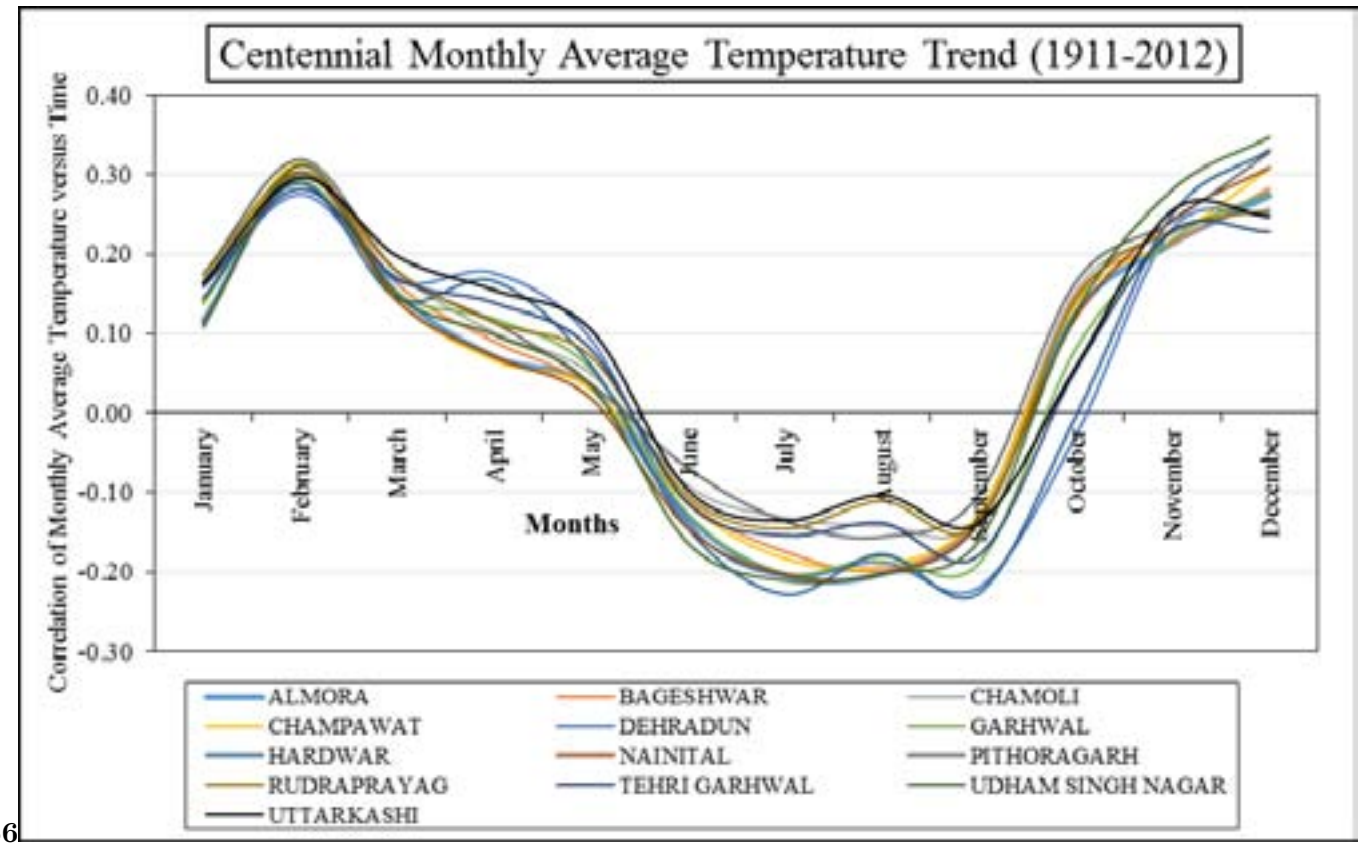


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Figure 6: Figure 5 :Figure 6 :

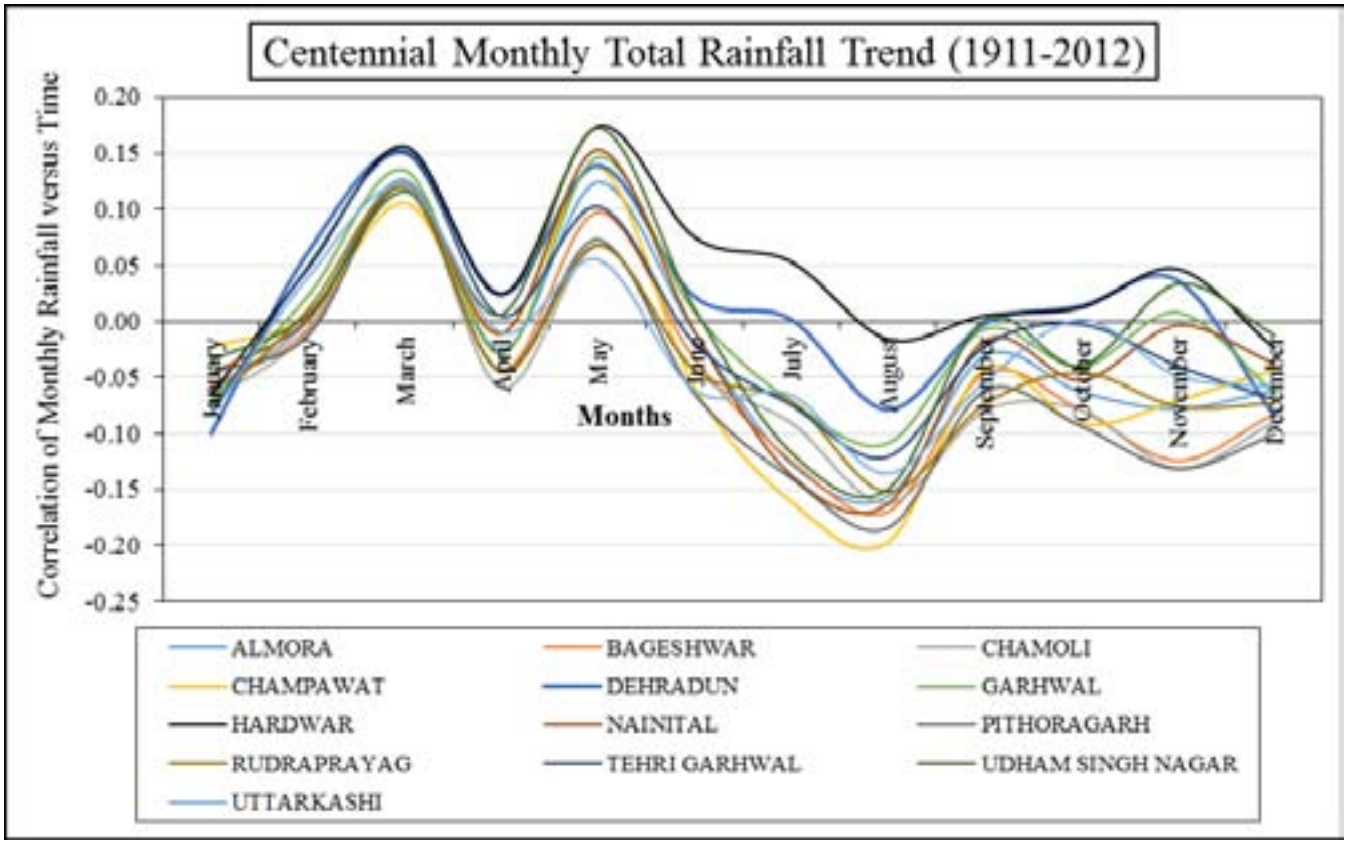


Figure 7:

**1**

| S. No. | District | Correlation between temperature and time series (r) | Regression result for temperature series | | Correlation between rainfall and time series (r) | Regression result for rainfall series | |
|---|---|---|---|---|---|---|---|
| | | | R 2 | F | | R 2 | F |
| 1 | Almora | 0.266 | 0.071 | 7.598** | -0.209 | 0.044 | 4.579* |
| 2 | Bageshwar | 0.299 | 0.089 | 9.826** | -0.221 | 0.049 | 5.125* |
| 3 | Chamoli | 0.315 | 0.099 | 10.984** | -0.184 | 0.034 | 3.515 |
| 4 | Champawat | 0.291 | 0.085 | 9.246** | -0.242 | 0.058 | 6.211* |
| 5 | Dehradun | 0.232 | 0.054 | 5.694* | -0.035 | 0.001 | 0.125 |
| 6 | Garhwal | 0.247 | 0.061 | 6.515* | -0.122 | 0.015 | 1.503 |
| 7 | Haridwar | 0.221 | 0.049 | 5.124* | 0.023 | 0.001 | 0.051 |
| 8 | Nainital | 0.260 | 0.068 | 7.254** | -0.201 | 0.041 | 4.229* |
| 9 | Pithoragarh | 0.342 | 0.117 | 13.250** | -0.236 | 0.056 | 5.919* |
| 10 | Rudraprayag | 0.308 | 0.095 | 10.514** | -0.153 | 0.023 | 2.404 |
| 11 | Tehri Garhwal | 0.263 | 0.069 | 7.435** | -0.114 | 0.013 | 1.311 |
| 12 | UdhamSingh Nagar | 0.260 | 0.068 | 7.275** | -0.164 | 0.027 | 2.769 |
| 13 | Uttarkashi | 0.308 | 0.095 | 10.455** | -0.103 | 0.011 | 1.075 |

*[Note: * *: p<0.01, *: p<0.05]*

Figure 8: Table 1 :

**2**

| S. No. | District | Total Population | Percent Urbanisation | Statutory Towns | Census Towns | Village |
|---|---|---|---|---|---|---|
| 1 | Almora | 621927 | 10.02 | 4 | 1 | 2289 |
| 2 | Bageshwar | 259840 | 3.5 | 1 | 0 | 947 |
| 3 | Chamoli | 391114 | 15.11 | 6 | 0 | 1246 |
| 4 | Champawat | 259315 | 14.79 | 3 | 1 | 717 |
| 5 | Dehradun | 1698560 | 55.9 | 11 | 11 | 748 |
| 6 | Garhwal | 686527 | 16.41 | 6 | 3 | 3473 |
| 7 | Hardwar | 1927029 | 37.77 | 8 | 16 | 612 |
| 8 | Nainital | 955128 | 38.94 | 8 | 3 | 1141 |
| 9 | Pithoragarh | 485993 | 14.31 | 3 | 0 | 1675 |
| 10 | Rudraprayag | 236857 | 4.19 | 2 | 0 | 688 |
| 11 | Tehri Garhwal | 616409 | 11.37 | 6 | 1 | 1862 |
| 12 | Udham Singh Nagar | 1648367 | 35.58 | 14 | 5 | 688 |
| 13 | Uttarkashi | 329686 | 7.35 | 3 | 0 | 707 |

Figure 9: Table 2 :

**3**

| District | Total forest diverted area in hectare | Percent of the total forest diverted area for different purposes | | | | | |
|---|---|---|---|---|---|---|---|
| | | Road construction | Managing drinking Water | Irrigation | Electricity transmission Lines | Hydroelectric power plants | Mining | Oth uses |
| Almora | 816.29 | 88.36 | 1.7 | 0.61 | 2.94 | 0.01 | 0 | 6.39 |
| Bageshwar | 559.05 | 67.73 | 1.57 | 0.52 | 0.99 | 2.88 | 20.01 | 6.3 |
| Chamoli | 2097.74 | 44.85 | 0.46 | 0.05 | 37.45 | 11.54 | 0.05 | 5.59 |
| Champawat | 738.57 | 37.76 | 0.8 | 0.28 | 0.49 | 0 | 52.09 | 8.58 |
| Dehradun | 19496.09 | 2.05 | 0.05 | 0.01 | 0.13 | 0 | 8.22 | 89.5 |
| Garhwal | 677.4 | 43.97 | 2.95 | 0.18 | 24.69 | 0.43 | 21.48 | 6.3 |
| Haridwar | 5197.71 | 1.16 | 0 | 0.31 | 0.16 | 0 | 55.79 | 42.5 |
| Nainital | 3165.71 | 13.71 | 2.24 | 0.32 | 0.61 | 0 | 77.14 | 5.98 |
| Pithoragarh | 1667.66 | 66.42 | 0.58 | 0.1 | 29.6 | 0.75 | 0.25 | 2.3 |
| Rudraprayag | 389.56 | 66.19 | 1.76 | 2.36 | 3.99 | 16.16 | 0 | 9.55 |
| Tehri Garhwal | 1591.74 | 30.35 | 1.16 | 0.08 | 9.88 | 44.46 | 0.41 | 13.6 |
| Udham Singh Nagar | 156.23 | 9.15 | 0 | 2.3 | 3.16 | 0 | 0 | 85.3 |
| Uttarkashi | 830.95 | 52.71 | 1.1 | 0.95 | 13.22 | 27.59 | 0 | 4.44 |

Source: Uttarakhand forest statistics, Forest Department, Government of Uttarakhand, p. 44.

*[Note: Uttarakhand]*

Figure 10: Table 3 :

**4**

| Place | District | Percent increase in tourist Inflow (2001-2012) |
|---|---|---|
| Yamunotri | Uttarkashi | 240 |
| Gangotri | Uttarkashi | 250 |
| Kedarnath | Rudraprayag | 378 |
| Badrinath | Chamoli | 136 |

Figure 11: Table 4 :

[Black ()] George Black . *India Enlightened. onearth*, 2009. p. . (Summer edition)

[Cruz et al. (ed.) ()] R V Cruz , H Harasawa , M Lal , S Wu , Y Anokhin , B Punsalmaa , Y Honda , M Jafari , C Li , N N Huu . *Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M L Parry, O F Canziani, J P Palutikof, P J Linden, V D Hanson, CE (ed.) (Cambridge, UK) 2007. Cambridge University Press. p. .

[Raina ()] *Himalayan Glaciers: A State-of-Art Review of Glacial Studies, Glacial Retreat and Climate Change. MOEF Discussion Paper, Ministry of Environment & Forests, Government of India*, V K Raina . 2010. p. 7.

[National Disaster Management Guideline, National Disaster Management Authority, Government of India NDMA ()] 'National Disaster Management Guideline, National Disaster Management Authority, Government of India'. *NDMA* 2007. p. 1.