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THE STUDY OF TEMPERATURE AND RAINFALL OVER BIHAR REGION

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ABSTRACT

In the present study, the temperature and rainfall events during south west monsoon season (June to September) have been analyzed over Bihar region using 30 years (1985-2014) daily surface data of temperature and rainfall of four stations of Bihar region. The rainfall has been classified in six groups based on the India Meteorological Department (IMD) criteria. It is seen that the frequency of moderate and heavy rainy days decreases which is compensated by the increasing trend of rather heavy and very heavy rainy days. The overall seasonal rainy days shows decreasing trend except Gaya and Bhagalpur. The temperature events have been analyzed in four categories (>30 °C, >35 °C, >40 °C and >45 °C) for all the stations. An increasing trend of temperature in >35 °C category is noticed for all the stations except Gaya. However, the frequency of extreme temperature events (>45 °C) increases for Patna and Gaya and Bhagalpur.

Keywords: Temperature, Rainfall, Trend Analysis and Decadal

INTRODUCTION

There are number of ways in which temperature and rainfall daily affects the lives of the people. The surface temperature and rainfall is influenced by the geographical features of the region. The long term trend in monsoon season for 1951 -2005 conducted by Pattanaik and Rajeevan, 2010 has shown that the increasing trend of contribution from extreme rainfall events is balanced by a decreasing trend in low rainfall events. Consequently, extreme weather and climate events have received increased attention in the last few years (Karl and Easterling, 1999).

Dash *et al.*, (2009) examined possible changes in the frequency of rain events in India in terms of their duration and intensity per day using daily gridded $(1^{\circ} \times 1^{\circ})$ rainfall data for the period 1951–2004. They found that the frequencies of moderate and low rain days considered over the entire country have significantly decreased in the last half century. Studies in the past by Dash *et al.*, (2007), Lal, (2003) and Goswami *et al.*, (2006) shows that, in general the frequency of more intense rainfall events in many parts of Asia has increased whereas the number of rainy days and total annual precipitation decreased. Mason *et al.*, 1999 suggested that climate change projection is understood better using change in extreme events rather than climatic means. It is seen that most of the temperature trend studies in India focus on the analysis of annual and seasonal temperature data for a single station or group of stations. Recently similar type of study has been done by Bhatla and Tripathi, 2014, for Varanasi shows that the frequency of extreme rainfall shows overall decreasing trend. But in the current scenario, the identification of the temperature and precipitation trends and their projections is the main theme of the studies. Goswami *et al.*, (2006) showed that there were significant rising trends in the frequency and magnitude of extreme rain events over central India during the monsoon season.

MATERIALS AND METHODS

Data and Methodology

In the present study, the temperature and rainfall data used is taken from meteorological centre Patna. The data has been analyzed for four stations of Bihar, Patna, Gaya, Bhagalpur and Purnea departmental observatories of last 30 years monsoon season (June to September). The frequency of rainfall was

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calculated based on the India Meteorological Department (IMD) criteria: 0.1mm -7.5 mm (light rain), 7.6 mm -35.5 mm (moderate rain), 35.6mm -64.4mm (rather heavy rain), 64.5mm - 124.4 mm (heavy rain), 124.5 mm - 244.5mm (very heavy rain) and > 244.5 mm (exceptionally heavy rain). The frequency of temperature events were calculated for the criteria >30 $\degree C$, >35 $\degree C$, >40 $\degree C$ and >45 $\degree C$. Further, the linear trend analyses have been carried out and tested its statistical significance using Mann-Kendall Rank Statistics (WMO, 1966) at 95% significant level.

RESULTS AND DISCUSSION

The rain events of rainfall > 0.0 mm are considered rainy days. No of rainy days in six different categories are represented in figures 2(a) to 2 (v). The cumulative rainy days over the monsoon season of all the four stations are given in figures 3 (a) to 3 (d). It is noticed that Gaya and Bhagalpur show negative trend in cumulative rainfall, figures 3 (b) and 3 (c) except Patna and Purnea, Figures 3(a) and 3(d). It is also observed that inter annual variability is more in 35.6 -64.4 mm category followed by 7.6 to 35.5mm and 64.5 to 244.5 mm. It is also seen that the year 1999 to 2002 none of heavy rainfall event is observed for Gaya followed by Patna Bhagalpur region.

Temperature events of four categories $(>30 \degree C, >35 \degree C, >40 \degree C$ and $>45 \degree C$) over Bihar region (Patna, Gaya, Bhagalpur, Purnea) along with the linear trend during monsoon season have shown in figure 1 (a) to figure 1 (o). Increasing trend is noticed for all the stations in >35 $\degree C$ number of temperature events except Bhagalpur in last 30 years.

Figure 1 (c) and 1 (0) in >40 $\degree C$ temperature category of Patna and Purnea show slight increasing trend except Gaya and Bhagalpur, figures 1 (g) and 1(k). Inter annual variability also observed in between the

selected temperature categories. No event has been observed for Purnea in the temperature range >45 $\degree C$, however Patna and Gaya shows slightly increasing tendency. Bhagalpur shows negative trend in >45 $\degree C$

however Patna and Gaya shows slightly increasing tendency. Bhagalpur shows negative trend in >45 C temperature range.

Table 1 (a) shows the frequency of rainy days for three decades namely 1985-1994, 1995-2004, 2005-20104 using different criteria i.e the rain in mm 0.1-7.5, 7.6-35.5, 35.6-64.4, 964.5-124.4, 124.5-244.5 and >244.5 mm over Bihar region (Patna, Gaya, Bhagalpur, Purnea) during monsoon season as a whole. The frequency of the rainy days in 7.6-35.5 mm (moderate) category decreases for all the three decades. The frequency of the rainy days in 0.1-7.5 mm (light) category increases for Patna and Purnea and than decreases for Bhagalpur & Gaya during all the three decades. The frequency of the rainy days in 35.6-64.4 mm (rather heavy)category decreases during last two decades, 1995-2004, 2005-20104for all the four stations of Bihar.

The rainy days frequency in 64.5-124.5 mm (heavy rain) category increases for Gaya and Purnea however, decreases for Patna and Bhagalpur during last two decades, 1995-2004, 2005-20104. Rainy days frequency of 124.5 -244.5 mms (very heavy) category increases in last two decades of Patna, Gaya and Bhagalpur, except Purnea. No change has been noticed for the frequency of rainy days in > 244.5 (exceptionally heavy rain) category.

Table 1 (b) shows the frequency of temperature events for three decades namely 1985-1994, 1995-2004, 2005-20104 using different criteria i.e the temperature >30 $^{\circ}C$, >35 $^{\circ}C$, >40 $^{\circ}C$ and >45 $^{\circ}C$ over Bihar region (Patna, Gaya, Bhagalpur, Purnea) during monsoon season as a whole. It shows that frequency for criteria more than 35 $^{\circ}C$ is increases for Patna and Gaya and decreases for Bhagalpur and Purnea. Temperature events for the criteria >40 $^{\circ}C$ increases for Patna and Purnea and decreases for Bhagalpur except Gaya in which >40 $^{\circ}C$ events are decreases during the 1995-2004 decades and increases thereafter in 2004-2014. For the criteria >30 $^{\circ}C$ the frequency decreases for Gaya and Purnea and increases for Bhagalpur except Patna for which the frequency of such events decreases during last two decades namely 1995-2004 and 2005-2014. However, for the criteria >45 $^{\circ}C$ the frequency is higher during all the decades 1985-1994, 1995-2004, 2005-20104 for all the four stations.

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Figure 1: Variation of frequency of maximum temperature of Patna for the criteria (a)>30 $^{\circ}C$, (b)>35 $^{\circ}C$, (c)>40 $^{\circ}C$, (d)>45 $^{0}C^{\circ}C$ for the monsoon season, same for Gaya (e to h), same for Bhagalpur (i to l) and same for Purnea (m to o) respectively

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Figure 2: Variation of frequency of rainfall for Patna (a)>0.1-7.5mm, (b)7.6-35.5mm(c)35.6-64.4mm, (d)64.5-124.4 mm (e) 124.5-244.5mm (f to j) same as before for Gaya (k to 0) same as before for Bhagalpur and (p to t) same as before but for Purnea (u and v) > 244.5 mm for Purnea and Gaya respectively



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Figure 3: (a) Cumulative rainfall of monsoon season. For Patna (b) same for Gaya (c) Same for Bhagalpur (d) Same for Purnea

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7.6-35.5 35.6-64.5-124.5->244.5 **Decades** 0.1-7.5mm 64.4mm 124.4mm 244.5mm Station mm mm 1985-Patna 1995-2004-1985-Gaya 1995-2004-1985-Bhagal pur 1995-2004-1985-Purnea 1995-2004-

Table 1 ((a)• Decadal	frequency	of rainfall	events	over Riha	r region
	(a). Decaual	nequency	VI I amian	CVCIILS	UVEL DILLA	I I Cgiun

Table 1	(b): Deca	dal frequenc	v of temperatu	ire events over	r Bihar region
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Station	Decades	>30 (deg C)	>35 (deg C)	>40 (deg C)	>45 (deg C)
	1985-1994	840	109	33	1
Patna	1995-2004	875	156	35	1
	2004-2014	850	194	55	2
	1985-1994	800	270	72	3
Gaya	1995-2004	788	270	48	5
•	2004-2014	750	350	64	6
	1985-1994	505	265	85	2
Bhagalpur	1995-2004	593	238	30	0
	2004-2014	604	198	15	2
	1985-1994	771	152	1	0
Purnea	1995-2004	677	177	3	0
	2004-2014	646	169	6	0

Conclusions

The frequency of rainfall events is classified in six classes (light, moderate, rather heavy, heavy, very heavy and exceptionally heavy). The number of moderate rainfall days (7.6 mm -14.4 mm) of all the four stations decreases while light rainfall days increases except Gaya. Similarly, the rainy days for heavy rainfall criteria (64.5 -124.4 mm) decreases for three stations except Gaya. The number of rainy days for rather heavy rain criteria (35.6 -64.4 mm) increases all the stations except Bhagalpur and very heavy rain

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fall criteria rainy days increases of all the three stations except Purnea. No case has been reported for exceptionally heavy rain criteria (> 244.5 mm) of all the stations of about two decades.

The frequency of extreme temperature events shows increasing trend for the criteria >35 C for all the stations except Bhagalpur. The frequency at >40 C criteria shows increasing trend except Gaya. The frequency of >30 C show increasing trend of all the stations except Gaya and Bhagalpur. The region might be the correct exposure of the weather instruments at the site. The results obtained at micro level will help to understand the behavior at global and regional scale.

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REFERENCES

Bhatla R and Tripathi A (2014). The Study of Rainfall and Temperature Variability over Varanasi. *International Journal of Earth and Atmospheric Science* **1**(2) 90-94.

Das SK, Jenamani RK, Kalsi SR and Panda SK (2007). Some evidence of climate change in the twentieth –century India. *Climate Change* 85 299-321.

Dash SK, Kulkarni MA, Mohanty UC and Prasad K (2009). Changes in the characteristics of rain events in India. *Journal of Geophysical Research* **114**(D10109) 1-12.

Goswami BN, Venugopal V, Sengupta D, Madhusodanam MS and Xavier PK (2006). Increasing trends of extreme rain events over India in a warming environment. *Science* **314** 1442-1445.

Karl TR and Easterling DR (1999). Climate extremes: Selected review and future research directions. *Climatic Change* 42 309-325.

Lal M (2003). Global climate change: India's monsoon and its variability. *Journal of Environmental Study Policy* **6** 1-34.

Mason SJ, Waylen PR, Mimmack GM, Rajaratnam B and Harrison JM (1999). Changes in Extreme Rainfall Events in South Africa Events. *Climatic Change* **41** 249- 257.

Pattanaik DR and Rajeevan M (2010). Variability of extreme rainfall events over India during southwest monsoon season. *Meteorological Applications* 17 88-104.

WMO (1966). WMO Technical N>30 $^{\circ}C$, >35 $^{\circ}C$, >40 $^{\circ}C$ and >45 $^{\circ}C$ over Bihar region (Patna, Gaya, Bhagalpur, Purnea)ote No.79, WMO No. 195-TP100, WMO, Geneva 79.