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## Studies on extreme weather events of eastern plain zone of Uttar Pradesh

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### Abstract

The historical daily data of rainfall and temperature were collected for the period of last 30 years (1985-2015) for the various extreme weather events *viz.* Dry spell, Wet spell, Heat waves, Cold waves, and frost as to identify the impact of various extreme weather events. Based on the historical data results reveal that. In EPZ of U.P, the dry spell showed an increasing trend in recent years. The wet spell of 10mm for 7 days, 25mm for 3 days showed decreasing trend in recent years. S-W monsoon rainfall of EPZ of UP declined over the normal in recent years. Maximum days of heat waves were recorded in May (1.6 days) followed by June (1.5days). During the month of September there was no any heat waves, while during the month of March followed by August recorded lowest frequency of heat waves. Maximum days of cold waves (1.6 days) were recorded during the month of January followed by February and December month. The month of October and March have no cold wave in EPZ of U.P. The trend of extreme minimum temperature and extreme maximum temperature showed decreasing trend against the normal value of 3<sup>o</sup>C and 44<sup>o</sup>C respectively.

The number of frost events increased from 29 days to 57 days, against the normal of 44 days. The total increasing trend of frost occurrence over the decades in the area will force to make strategy on contingent plan for major crops and adoptive measures from frost protection as to harvest highest genetic potential yield. Probability % of maximum frost occurrence during the month of January showed the decreasing trend of variation from 69% (1986-1995), 85% (1996-2005) and 63% (2005-2015) over the normal value of 72 %. Frost occurrence in the month of Dec- Jan will coincides with active tuber bulking phase in potato its effect is to bring about yield losses, and frost, foggy weather in winter months and occasional rains favours the late blight disease of potato in this region. So the decreasing tendency of frost days in January month in recent decades have beneficial impact on the growth of rabi crops in the region.

**Keywords:** Extreme, dry spell, wet spell, heat wave, cold wave, contingent plan, frost, tendency

### Introduction

India being mainly an agricultural country, the economy and further its growth purely depends on the vagaries of the weather and in particular weather events. The weather and its variability are well known to the farming community. Possible impact of climate change on frequency and severity of weather extremes. They also referred that weather extremes can have a significant impact on agriculture and food security but their effect is often unclear, this may be due to interaction with other factors that affects yield and due to lack of precise definitions of relevant weather extreme. Extreme weather, in the most obvious sense, is weather that lies outside a locale's normal range of weather intensity. It is therefore by definition, infrequent or rare. Failures of rains and occurrence of natural disasters such as floods and droughts could lead to crop failures, food security, famine, loss of property and life, mass migration and negative national economic growth. Both the extremes of maximum and minimum temperatures cause stress to plant productivity (Ramakrishna, 2013) [2]. Extreme weather events like drought, flood, heat wave, cold wave, fog, thunder storm, dust storm, and hail storm causes considerable loss in crop productivity in the EPZ region. Use of improved climate and weather information and forecast along with efficient early warning systems contribute to the preparedness for extreme weather events to reduce loss of life and crop damage. For an instance, Providing forecasts and warnings of severe weather like extreme temperature, extreme cold, frost occurrence, and drought or flood in a timely manner contributes to preparedness. Better Agromet Advisories helps in minimizing the impact of extreme weather events in the region. Keeping above facts in view the present investigation was undertaken.

## Materials and Methods

The historical data of Temperature and Rainfall of last 30 years (1985-2015) of Eastern Plain Zone of U.P were collected from IMD and Agro-meteorological observatory, NDUAT Kumarganj, Faizabad. Criteria used for analysis of extreme weather events like, Trend analysis of monsoon (June–Sep) rainfall for different rainfall spell was undertaken using long term (1985-2015) Daily rainfall data of representative district of EPZ of UP. Customized extreme weather events analysis software was used to evaluate the trend of different rainfall spells. Criteria for analysis used as, Rainfall  $\leq 2.5$  mm for 10 Days duration for analysis of dry spell.  $\geq 10$ mm for 7 days in selected district.

Heat wave analysis was done for the month of March - September from the historical daily data of maximum temperature of representative district of EPZ of UP collected for the period of last 30 years (1985-2015). Criteria for analysis was used as actual maximum temperature for heat wave more than  $45^{\circ}\text{C}$ , for severe heat wave more than  $47^{\circ}\text{C}$ . Based on departure from normal temperature for Heat wave  $4.5^{\circ}\text{C}$  to  $6.5^{\circ}\text{C}$  (departure from normal), for severe heat wave more than  $6.5^{\circ}\text{C}$  (departure from normal). Cold wave analysis was done for the month of October-March from the historical daily data of minimum temperature of representative district of EPZ of UP collected for the period of last 30 years (1985-2015). Criteria for analysis was used as based on actual minimum temperature, for cold wave minimum temperature less than or equal to  $4^{\circ}\text{C}$ , for severe cold wave minimum temperature less than or equal to  $2^{\circ}\text{C}$ . When minimum temperature of station less than  $10^{\circ}\text{C}$ , for cold wave  $-4.5^{\circ}\text{C}$  to  $-6.4^{\circ}\text{C}$  (departure from normal), for severe cold wave less than or equal to  $-6.5^{\circ}\text{C}$  (departure from normal). For the study of frost occurrence, collected the historical daily data of minimum temperature (November-February) of representative district of EPZ of UP for the period of last 30 years (1986-2015).

## Result and Discussion

The trend of dry spell was slight below its normal value (87 days) upto the year of 2013, while the year 2013 onwards it was increased and the maximum days of dry spell recorded in year 2014(100 days), followed by 97 days during the year 2015 (Fig. 1). Wet spell categorized into 4 types. The trend of wet spell (rainfall  $\geq 10$ mm for 7 days) was above its normal value upto the year 1995, while year 1995 onwards, the wet spell was recorded below its normal value of 22 days (Fig. 2). S-W monsoon rainfall of EPZ of UP declined over the normal in recent years. (Tripathi *et al.*, 2007; Field, C. and Barros, V. 2012) [5, 1].

Heat waves frequency was analysed for the month of March to September reveal that five days of heat waves per annum

were recorded. Maximum days of heat waves were observed in May (1.6 days) followed by June (1.5 days), probably due to Westerly hot winds experienced from April month and continue up to mid June. During the month of September there was no any heat waves, while during the month of March followed by August recorded lowest frequency of heat wave, under present investigation. (Tripathi *et al.*, 1998; Ramakrishna, Y.S., 2013) [5, 2] also reported the similar results.

Cold waves frequency was analysed for the month of October to March (Period 1985-2015) reveal that 2.7 days of cold waves per annum were recorded. Maximum days of cold waves (1.6 days) were recorded during the month of January followed by February and December month. The month of both October and March have no cold wave in Eastern Plain Zone of UP. The trend of extreme minimum temperature was above the normal upto year 2000, while year 2000 onwards, the extreme minimum temperature was recorded below its normal value of  $3^{\circ}\text{C}$  (Fig. 3). The extreme maximum temperature ( $^{\circ}\text{C}$ ) recorded over the last 30 years (1986-2015) quite reveal that the trend of extreme maximum temperature in recent years was found below the normal value  $44^{\circ}\text{C}$ , indicating no effect of global warming at the regional level possibly due to having dense forest area (Fig. 4). Sharma, G.K. and Chaudhary, J.L. 2013 also reported the similar results.

The total number of frost occurrence during the decade 1986-2005 was 29 days. January month was reported to possess maximum 20 days of frost followed by December (8 days) and February have frost free month during the decade. In the decade 1996-2005, the total 48 days of frost occurrence was reported (Fig. 5). During the month of January, total 41 frost days was reported. November month was almost frost free month during the decade. During decade 2006-2015, the total 57 frost days was reported. In January month, total 36 days of occurrence of frost was reported in recent decade. November was frost free month in the decade. While in December month total 18 frost days were reported. February month was almost frost free month (only 2-3 days) during all the decades. The number of frost events increased from 29 days (1986-1995) to 57 days in 2006-2015, against the normal 44 days during 1986-2015. Probability % of maximum frost occurrence during the month of January showed the decreasing trend of variation from 69% (1986-1995), 85% (1996-2005) and 63% (2005-2015) over the normal value of 72 % (Fig. 6). This may be due to the fact that in the current decade (2005-2015) frost occurrence was shifted to December from January and recorded 32%. (Sinha, S.K. and Swaminathan, M.S., 1991). This decreasing tendency of frost days in January month in recent decades have beneficial impact on the growth of rabi crops in the region.

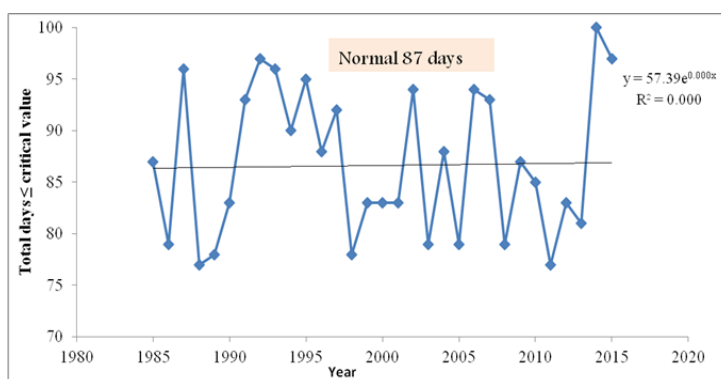


Fig 1: Rainfall  $\leq 2.5$  mm for 10 days during 1985-2015

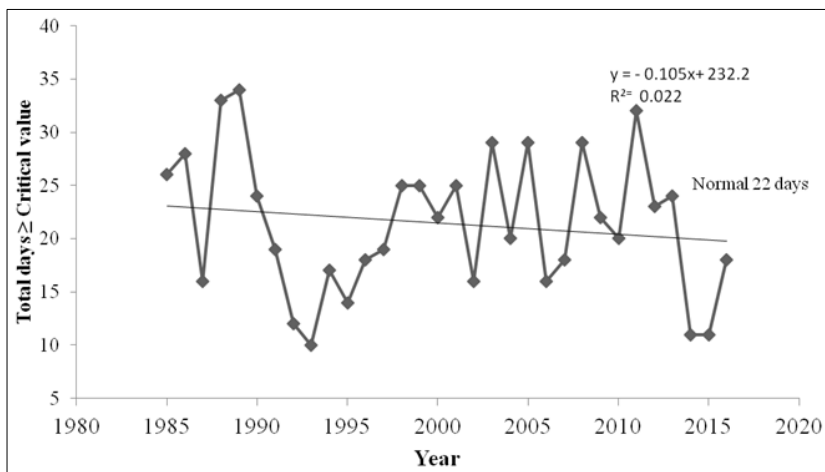


Fig 2: Rainfall  $\geq 10\text{mm}$  for 7 days during 1985-2015

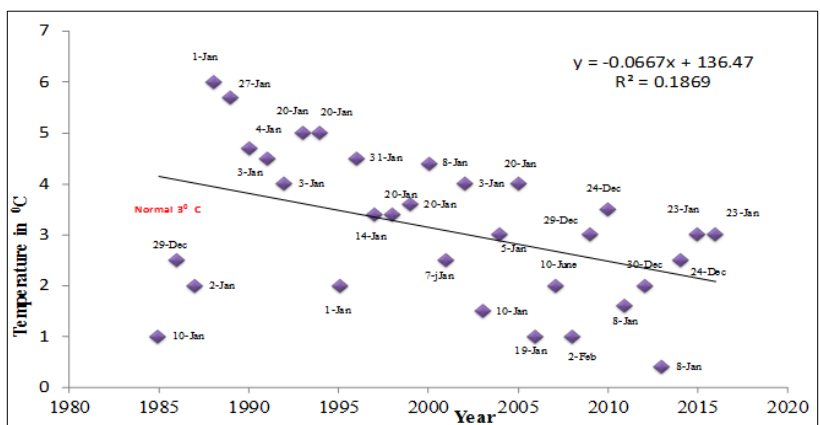


Fig 3: Trend of extreme minimum temperature

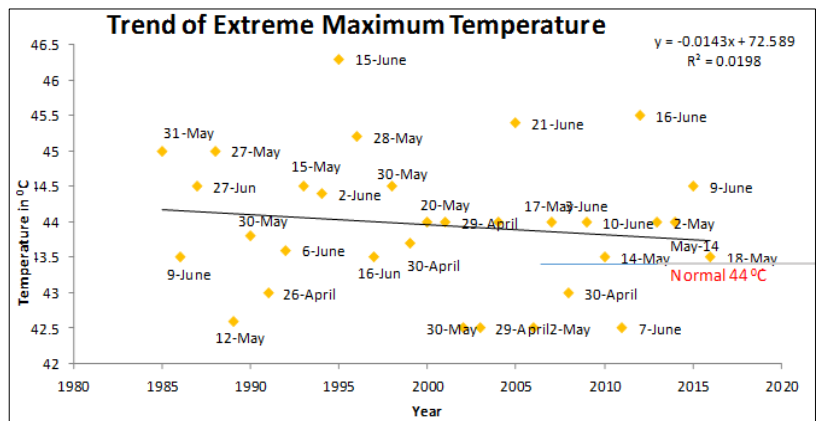


Fig 4: Trend of maximum temperature

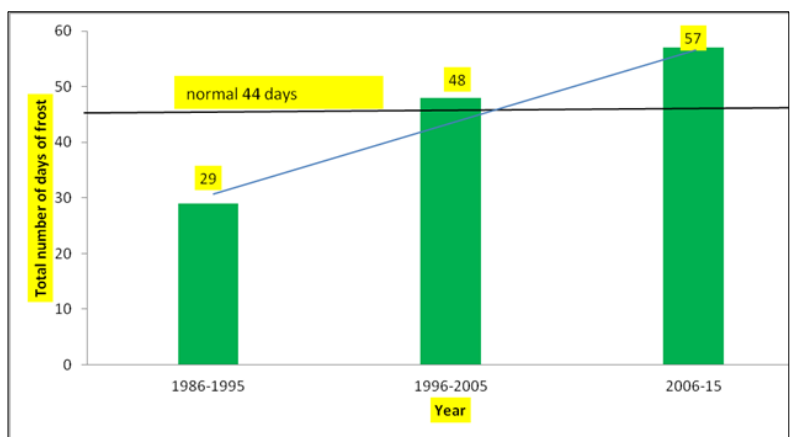
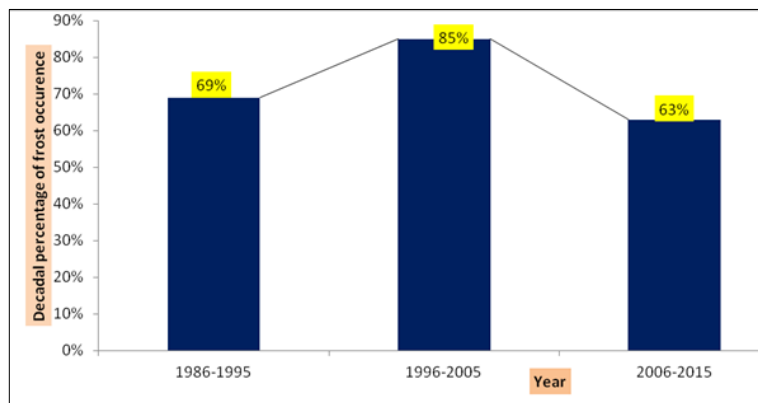


Fig 5: Decadal variation of total number of frost occurrence  
~ 2016 ~



**Fig 6:** Decadal % of maximum frost occurrence during January

### Conclusions

The trend of wet spell (rainfall  $\geq 10$ mm for 7 days) was above its normal value upto the year 1995, while year 1995 onwards, the wet spell was recorded below its normal value of 22 days. S-W monsoon rainfall of EPZ of UP declined over the normal in recent years. Maximum days of heat waves were observed in May (1.6 days) followed by June (1.5 days), probably due to Westerly hot winds experienced from April month and continue up to mid June. Maximum days of cold waves (1.6 days) were recorded during the month of January followed by February and December month. The trend of extreme minimum temperature was above the normal upto year 2000, while year 2000 onwards, the extreme minimum temperature was recorded below its normal value of  $3^{\circ}\text{C}$ . Trend of extreme maximum temperature in recent years was found below the normal value  $44^{\circ}\text{C}$ , indicating no effect of global warming at the regional level possibly due to having dense forest area. Probability % of maximum frost occurrence during the month of January showed the decreasing trend of variation from 69% (1986-1995), 85% (1996-2005) and 63% (2005-2015) over the normal value of 72 %.

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