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RESEARCH ARTICLE

ANALYSIS OF LONG-PERIOD SEASONAL VARIATION OF TEMPERATURE FOR THE DISTRICT OF BANKURA AND PURULIA IN A TIME OF CLIMATE CHANGE

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ABSTRACT

The present study is carried out to find out the long-period variation of seasonal temperature of the districts Bankura and Purulia of West Bengal located on Lower Gangetic Basin. Temperature is a prime element which determines the Climate of the districts Bankura and Purulia. In this study, temperature has been analyzed statistically to determine the variability in magnitude over the period 1901-2000. The temperature data of the districts Bankura and Purulia have been collected from the India Meteorological Department (IMD), Pune. Trends are analyzed using Mann-Kendall test for the data period 1901-2000. From the trend analysis we observed that seasonal temperature variation of summer of the district Bankura is decreasing trend and the district Purulia is increasing trend. The fluctuation of Monsoonal and post Monsoonal temperature of both districts are decreasing trend but variation of winter temperature of both districts are increasing trend. For all cases the value of Mann-Kendall Z are greater than 1.64 at 0.05level. So, all results are statistically significant.

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INTRODUCTION

The hydrological cycle is influenced by the temperature. The warmer climates lead to higher rates of evapotranspiration and increase of precipitation. The processes in association with shifting pattern of precipitation, runoff, soil moisture, humidity, surface and ground water resources etc. and may increase the frequency of drought and floods. It has been found that in India 12% and 16% of total geographical area are flood prone and drought prone area respectively. The district Bunkura and Purulia located in Lower Ganges Basin and eastern slope of Chhotanagpur Plateau fall under Drought Prone Area Programme (DPAP) 2008.They have clearly mentioned 7 blocks in Bunkura and 20 Blocks in Purulia district classified as water scarce area. In these two districts the distribution of rainfall is highly non-uniform both in terms of time and space. As a result water is required to be stored and utilized for meeting the increasing demands of that area. When the temperature increases, process of evaporation is also increases. For every 1^0C increase of global temperatures, moisture holding capacity is increased by 07% in atmosphere (NASA Official-2008).

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From literature review, several researchers have analyzed and studied different aspects of this area over last century but they have not given prominent signals. For this reason we have started to investigate on the district of Bankura and Purulia of W.B, India. So, this analysis will give the fruitful suggestion and information about Climate Change on water resources of that area for further research.

Study area

Bankura district is situated between $22^038^/$ and $23^038^/$ north latitude and $86^036^/$ and $87^046^/$ east longitude. It has an area of 6882 square kilometers'. North and north-east of the district is bounded by Bardhaman district from which it is separated mostly by the Damodar River. On the south-east it is bounded by Hooghly district, on the south by Paschim Midnapur district and on the west by Purulia district. Bankura district has been described as the "connecting link between the plains of Bengal on the east and Chhotanagpur Plateau on the west. The major portion of the district falls under Drought Prone Area Programme (DPAP) as on February 2008, Govt. of India. To the west the surface gradually rises given way to undulating country, interspersed with rocky hillocks. Geographically the district Purulia is located in between $22042^/35^{//}$ and $23042^/00^{//}$ N latitude and $85049^/25^{//}$ and $86054^/37^{//}$ E longitude. The district boundary follows the Damodar in the north and

Subarnarekha in the West. Purulia has a long history of water scarcity. Purulia is one of the most backward districts in West Bengal in terms of agriculture, economy and human development. The district is very poor in ground water resources because of hard crystalline basement (Halder and Saha, 2015). Ground water is available in localized areas covered by cracks and crevices in the hard rock and also from the upper weathered zone of the bed rock. The discharge from the well is generally satisfactory. A majority of shallow wells go dry or retain scanty water during the summer. There are more or less no function of ground water in agriculture development, about 1% area is irrigated from ground water (Ghosh, 2015).

MATERIALS AND METHOD

Materials used

The temperature data of the districts Bankura and Purulia have been collected from the India Meteorological Department (IMD), Pune website for the time period of 1901-2000. After that, statistical analysis and trend detection has been done using Microsoft Office Excel 2010.

Methodology followed

Entire temperature data are categorized in five temporal scenarios like Annual average for the entire year, Summer for March to May, Monsoon for June to September, Post-monsoon for October-November and winter for December to February. Then, trend analysis is done based on these classified temperature data. The temperature trend analysis of West Bengal has been done here using Mann-Kendall trend statistics, which is a non- parametric statistical method for time series analysis (Mann, 1945, Kendall, 1975, Yu *et al*. 1993, Lettenmaier *et al*. 1994, Douglas *et al*. 2000, U.S. Army Corps of Engineers 2004, Burn *et al*. 2004, Mandal *et al*. 2013).

The Mann-Kendall trend statistics is calculated by them as-

$$S=\sum_{k=1}^{n-1}\sum_{j=k+n}^{n}\operatorname{sgn}(X_j - X_k)$$

Where, S = Mann-Kendall Trend Statistics, n = Number of Data Points, X_j, X_k = Data Values at the time period of j & k respectively, Sgn (X_j-X_k) = sign function and is equal to 1, 0 or -1 whether (X_j-X_k) is positive, zero or negative respectively. Mann-Kendall τ (tau) =ATS / MPT, where ATS = Actual Total Scores and MPT = Maximum Possible Total, where MPT = n(n-1) / 2, n = number of observation. Kendall's tau(τ) has been also calculated to show the nature of trend using the software. The positive and negative τ (tau) value indicates the increasing and decreasing trends respectively (Mann 1945, Kendall 1975, Lettenmaier *et al*. 1994).

$$Z = \frac{\tau}{\sqrt{2(2n+5)/9n(n+1)}}$$

The statistic *Z* is a Normal distribution and n is the no of observation. Here 'Z' value is generated which will identify the significance of the trend. It is done at the 95% level of significance. For large number of observations ($N > 30$), z value has to be greater than 2.32 at 0.01 level and 1.64 at 0.05 level for the sample to be statistically significant. A positive (negative) value of *Z* indicates an upward (downward) trend.

RESULT AND DISCUSSIONS

The Mann-Kendall trend statistics are performed for the districts of Bankura and Purulia, West Bengal located in Lower Gangetic Basin varying seasonal conditions for the last century (1901-2000). The outcome of such operations are shown in the following Tables

Table 1. Summer temperature

District	Minimum ^{0}C	Maximum ^{0}C	Mean ^{0}C	S.D	Mann- Kendall Statistic (S)	Kendall's tau τ	Z Value	Trend (At 95% level of Signifi-cance)	Remarks
Bankura	24.778	35.313	29.973	2.512	-1390	-0.280	-4.139	Decreasing	Statistically significant
Purulia	23.696	35.101	29.508	3.324	914	0.184	2.722	Increasing	Statistically significant

Table 2. Monsoonal temperature

District	Minimum ^{0}C	Maximum ^{0}C	Mean ^{0}C	S.D	MannKendall Statistic (S)	Kendall's tau τ	Z Value	Trend (At 95% level of Significance)	Remarks
Bankura	26.777	35.313	28.841	1.371	-3880	-0.783	-11.555	Decreasing	Statistically Significant
Purulia	26.006	33.625	28.291	1.667	-3880	-0.783	-11.555	Decreasing	Statistically Significant

Table 3. Post- Monsoonal temperature

District	Minimum ^{0}C	Maximum ^{0}C	Mean ^{0}C	S.D	Mann- Kendall Statistic (S)	Ken- dall's tau τ	Z Value	Trend (At 95%level of Significanc)	Remarks
Bankura	20.218	27.945	24.167	3.065	-974	-0.196	-2.900	Decreasing	Statistically significant
Purulia	19.218	27.273	23.273	3.165	-1114	-0.225	-3.317	Decreasing	Statistically significant

Table 4. Winter temperature

District	Minimum ^{0}C	Maximum ^{0}C	Mean ^{0}C	S.D	Mann-Kendall Statistic (S)	Ken- dall's tau τ	Z Value	Trend (At 95% Level of Signifi-cance)	Remakrs
Bankura	16.348	23.395	19.638	1.671	3926	0.793	11.692	Increasing	Statistically Significant
Purulia	15.463	22.441	18.839	1.560	4024	0.812	11.984	Increasing	Statistically Significant

Temperature Distribution Pattern

From the above calculations shown in the Tables 1, 2, 3 & 4. It is evident that temperature varied considerably between the two districts. Seasonal variability in temperature is also very much obvious. In case of Summer, Bankura district has found Mean temperature (29.973 ± 2.512) ^{0}Cand Purulia district has received Mean temperature (29.508 ± 3.324) ^{0}C during the last century. During the Monsoon period, the amount of temperature has received the district Bankura (28.841 ± 1.371)^{0}C and the district Purulia (28.291 ± 1.667)^{0}C. During the post Monsoon period, temperature has seen in the Bankura (24.167 ± 3.065)^{0}C and the Purulia district (23.273 ± 3.165.)^{0}C. In the winter season, the district Bankura (19.638 ±1.671)^{0}C and the district Purulia has received temperature (18.839 ± 1.560)^{0}C during the last century. Therefore, from this long-term temperature distribution pattern analysis in the district Purulia is a more drought prone district than Bankura.

Temperature trend pattern

If we look at the seasonal trend of temperature, then we can see that during pre-monsoon, temperature is decreasing trend in the district Bankura and increasing in the Purulia (see Table-1).In case Monsoonal temperature (see Table-2) the both districts are decreasing trend. During Post- Monsoon period (see Table-3) the both districts are decreasing trend. In case of winter temperature (see Table-4) the both districts are increasing trend. The normal standard deviate value (z) for all cases have calculated and obtained greater than 1.64 at 0.05 level which is statistically significant. So, significant trend (decreasing or increasing) of temperature is observed on the basin scale during the last century.

Conclusion

For long-period fluctuation of temperature analysis, the seasonal variation, the both Monsoonal and Post-Monsoon temperature are decreasing trend for the both districts Purulia and Bankura. We have seen in Pre-Monsoon rainfall, the district Bankura is decreasing trend and the district Purulia is increasing trend.

When we look at the winter temperature, the both districts are increasing trend. Hence, the normal standard deviate value (z) has calculated and obtained greater than 1.64 at 0.05 level which is statistically significant. So, significant trend (decreasing or increasing) of temperature is observed on the basin scale during the last century. Therefore, from this long-term temperature distribution pattern analysis in the district Purulia is a more warmer and drought prone district than Bankura.

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