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A statistical modeling between rainfall and temperature for the district of Bankura located on Lower Ganges Basin.

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Abstract: Water is the prime natural resources for all life. Water scarcity is the most challenges at present day of hydrologists. In this paper we established a statistical model on Simple Linear Regression Analysis. This analysis is evaluating the relative impact of a predictor (independent) variable as temperature on a particular outcome (dependent variable) as rainfall. We also workout the Pearson Correlation Coefficient 'r' to measure and interpret the strength of linear relationship between two variables. The Correlation Coefficient value (-) 0.40 indicates the direction and strength which is moderately negative. For this analysis, we have collected the data of annual rainfall and temperature (average) of 100 years (1901- 2000) from India Meteorological Department, Pune. In this analysis we focused on the direction and strength of correlation between two climatic elements rainfall and temperature for the district of Bankura located on Lower Ganges Basin.

Key words: Simple Linear Regression analysis, Pearson Correlation Coefficient, Rainfall and Temperature.

I. INTRODUCTION

Climate is weather averaged over an extended period of time (30 years intervals are typically used in climatology). Climate change is a change in the statistical distribution of weather pattern for a long-term average condition, whether due to natural variability or as a result of human activity. Due to increase of concentration of Green House Gases (GHG) particularly CO_2 in atmosphere the following factors responsible for prominent climate changes (i) the increase of temperature of atmosphere and earth surface. (ii) Change in precipitation pattern and (iii) Rise in sea level. An analysis done by NIH Roorkee of temperature data of 125 stations distributed all over India shows that the changes in temperature in India and Indian subcontinent over last century as global trend of increase in temperature.

The district Bunkura 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 district classified as water scarce area. In this district 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.

Temperature drives the hydrological cycle which influence the hydrological processes in a direct or indirect way. 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 boost 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.

In this study, analysis has been made the direction and strength of correlation between two climatic elements rainfall and temperature for the district of Bankura located on Lower Ganges Basin. In the research work we have collected 100 years (1901- 2000) data from India Meteorological Department, Pune. From this investigation we observed and summarized that the Correlation Coefficient value 'r' (-) 0.40 indicates the direction and strength which is moderately negative.

From literature review, several researchers have analysed 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 of W.B, India. So, this analysis will give the fruitful suggestion and information about Climate Change on water resources.

Study area: Bankura district is situated between $22^0 38^/$ and $23^0 38^/$ north latitude and $86^0 36^/$ and $87^0 46^/$ east longitude. It has an area of 6882 square kilometres. 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 eastern slope Chhotanagpur Plateau. The major portion of the district falls under Drought Prone Area Programme (DPAP)

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2008, Govt. of India. To west the surface gradually rises given way to undulating country, interspersed with rocky hillocks.

II. MATERIALS AND METHOD

Data collection and data range:

The annual rainfall and temperature (average) data for the period 1901-2000 collected from India Meteorological Department, Pune have been employed in this study. All calculation we have done by M.S Excel.

Simple Linear Regression Analysis:

The purpose of Simple linear Regression Analysis is to determine the relative impact of a predictor variable on a particular result. This is different from a correlation analysis, where the purpose is to examine the strength and direction of the relationship between random variables. A Simple Linear Regression model contains only one independent (explanatory) variable, X_i for i=1,2,…n subject, and linear with respect to both the regression parameters and the dependent variables. The corresponding dependent (out comes) variable is labelled.

The model expressed as $Y = a + bX_i + e_i$, where the regression parameter 'a' is the intercept (on Y axis) and the regression parameter 'b' is the slope of the regression line. The random error term e_i is assumed to be uncorrelated with a mean of '0' (zero) and constant variance. Long-term mean Temperature and mean rainfall is denoted by $\bar{X}$ and $\bar{y}$ respectively. The estimate of intercept 'a' and regression coefficient 'b' by the least square method.

i.e $a = \bar{y} - b\,\bar{X}$ .....(1)

$$b = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sum (X_i - \bar{X})^2} \quad \text{.....(2)}$$

Correlation Coefficient:

Correlation Coefficient find out the strength of linear relationship between two variables. It always takes a value -1 and +1 with 1 or -1 indicating the perfect Correlation (all points would be along a straight line). A Correlation Coefficient equal to zero indicates no relationship between the variables. A positive Correlation Coefficient indicates a positive (upward) relationship and a negative Correlation Coefficient indicates a negative (downward) relationship between the varibles. Given the values of X_i denotes the temperature (X_1, X_2,……..X_n) and Y_i denotes the as rainfall (Y_1, Y_2, ……Y_n).

Correlation Coefficient given by $r = \dfrac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2 \sum_{i=1}^{n}(Y_i - \bar{Y})^2}}$ .....(3)

III. RESULT AND DISCUSSION

Simple Linear Regression model $Y = a + bX_i + e_i$

Table - 1

$\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})$	$\sum_{i=1}^{n}(X_i - \bar{X})^2$	$a = (\bar{Y} - b\bar{X})$	'b'	Simple Linear Regression Model
-239.720	11.490	-20.863	661.255	$Y = 661.255 - 20.863X_i$

Correlation Coefficient $r = \dfrac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2 \sum_{i=1}^{n}(Y_i - \bar{Y})^2}}$

Table - 2

$\sum_{i=1}^{n}(X_i - \bar{X})^2$	$\sum_{i=1}^{n}(Y_i - \bar{Y})^2$	$\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})$	Correlation Coefficient 'r'	Direction and Strength
11.490	30,906.469	- 239.720	- 0.40	Moderately negative

This analysis is evaluating the relative impact of a predictor (independent) variable as temperature on a particular outcome (dependent variable) as rainfall. We also workout the Pearson Correlation Coefficient 'r' to measure and interpret the strength of linear relationship between two variables. The Correlation Coefficient value (-) 0.40 indicates the direction and strength which is moderately negative.

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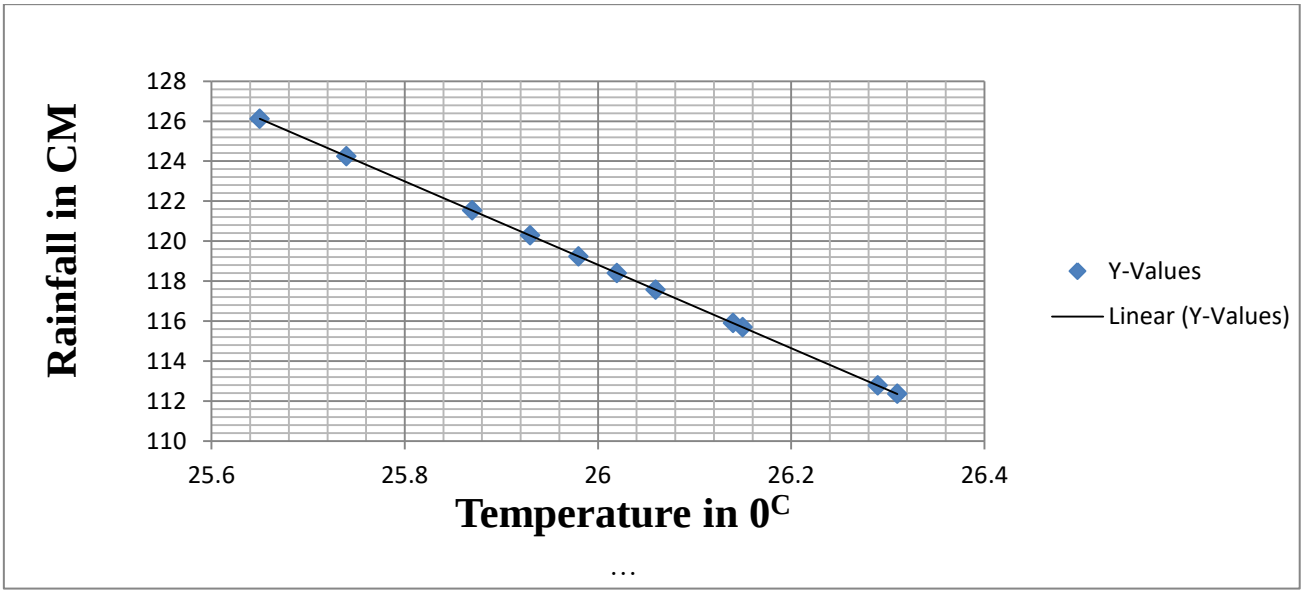

Graphical representation of Simple Linear Regression Model.

IV. CONCLUSION

i) From the equation of the linear regression model we concluded that temperature and rainfall are strongly interdependent with each other.

ii) Correlation Coefficient - 0.40 indicates the moderately negative (downward) relationship between the temperature and rainfall.

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