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Decadal Trend Analysis of Monsoonal Rainfall for Udaipur District of Rajasthan

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***Abstract*: The climatic changeability for an area is alluded to the long haul change in precipitation, temperature, dampness, vanishing, wind speed and other meteorological parameters. Measurement of environmental change is essential with the end goal to identify the change that has just happened and this will be further useful to make expectation or figure for future. This will also lead to a better preparedness for natural disasters. To know the long term effect of rainfall trend analysis of rainfall is important to know either rainfall is decreasing or increasing in that area. This paper shows the decadal trend in monsoonal rainfall for Udaipur district of Rajasthan from 1901 to 2010. Generally the rainfall in Udaipur district is less than the average rainfall of India. In this study two methods has been used namely linear regression method and Mann Kendall test to detect decadal trend in rainfall. The result based on the both test has been suggested that the decadal monsoon rainfall trend in Udaipur district is decreasing.**

***Keywords*: Rainfall, Mann Kendall, Regression, Udaipur, Trend.**

1. Introduction

The effects of environmental change and atmosphere fluctuation on human life have driven established researchers to screen the conduct of climate and atmosphere factors. Rainfall as a standout amongst the most essential of these factors has an immediate and backhanded effect on the indigenous habitat and human life. It is additionally perceived that rainfall is one of the key climatic factors that influence both the spatial and transient examples on water accessibility. Quantitatively distribution of rainfall is very important for management of water resource, irrigation scheduling of crop, flood forecasting, ground water recharge, modeling of soil moisture etc. Quantity of rainfall also affects the design phenomena and parameter of hydraulic structure, canal design and culvert. The monsoon has two phases in India. The primary conveys dampness from the Arabian Sea up through the Indian subcontinent. It starts in June and covers the vast majority of India with rain until September. In late September, these winds achieve the Himalayas and make a sudden turn around. From late October to December, the storm coasts down over the subcontinent on its way to the Indian Ocean. For a developing country like India, rainfall is a crucial parameter as India has agricultural based economy. Rainfall also affects the demand of people. In a decent storm season, cultivate yield goes up, boosting interest for purchaser merchandise and also wage of country individuals. The majority of this prompts a more grounded financial standpoint that thusly helps lift values, particularly of organizations offering products in rustic regions. In any case, a poor storm season debilitates interest for FMCG items, tractors, rustic lodging. Additionally, it powers the legislature to spend on the import of nourishment and also take estimates like ranch advance waivers. Thus any changes in rainfall may affect the economy of country also. Hence it is important to know the rainfall trend weather it is increasing or decreasing. The Indian summer monsoon is the major component of the Asian summer monsoon. India receives about 80% of its total annual rainfall during the summer monsoon season, from June to September. (Sahani et al., 2003). One of the most significant consequences of global warming due to increase in greenhouse gases would be an uncertainty of the rainfall distribution and temperature variation both spatially and temporally. (Reshu Yadav et al., 2014). Simulation of GCMs, Forced with increasing atmospheric concentrations of greenhouse gases, indicates an increase in extreme daily rainfall events on a global (Meehl et al, 2000, Dubey et al. 2012). The rainfall from the monsoon winds is exceptionally factor and very unreliable. The monsoon winds may reach India much before its due date or may be considerably delayed. Attempts have been made to study trends in annul and seasonal rainfall over India since the beginning of the last century and it has been observed there is no similarity in rainfall in India. It is also noted that there is more variability in monsoonal rainfall in India so that some parts suffer from drought while some parts suffer from flood. The North West region of India (Western Rajasthan and Kutchchh Region of Gujarat) and part of Ladakh receives less than average rainfall. The average annual precipitation in these regions is less than 50 cm. Rajasthan is heavily depend upon rainfall as it is a major source of water in all arid and semi – arid state. If we not consider Chambal River all other rivers of Rajasthan are rain-fed. Hence in this study the monsoonal rainfall trend is detected for Udaipur district where the average rainfall is less than the total average rainfall of India.

2. Guidelines

Rajasthan is the biggest state with respect to the area and seventh largest with respect to the population situated at the north western part of India. Udaipur is the district of Rajsthan.

The district is the part of the Mewar region of Rajsthan. Udaipur district bounded with Rajsamand district on the north and on east Chittaurgarh district and Pratapgarh district located. Dungarpur district on the south end of Udaipur. The total area of the district is 13430 square km. It lies in the southern region of Rajsthan near the Gujarat border. The coordinate of the Udaipur district headquarter is 73056' N and 73056' E and the average elevation is 335 m above mean sea level. In this study rainfall data of Udaipur district between 1901 to 2010 has been used to analysis trend. Data for the study has been collected from India Water Portal from 1901 -2000. After 2000 the data is collected from Water Portal government of Rajsthan.

3. Methodology

In this study, the trend in rainfall is analysis by two methods namely Linear Regression method and Mann Kendall test. Linear Regression and Mann Kendall tests are commonly used test in case of hydrological data for checking spatial and temporal variation.

A. Mann Kendall test

Mann Kendal test is a non parametric test used to determine monotonic trends in series of environmental data, climate data or hydrological data to check the time series data follow any particular trend or not i.e. positive negative or no trend. The null hypothesis, H_0, is that the data come from a population with independent realizations and are identically distributed. The alternative hypothesis, H_1, is that the data follow a monotonic trend. A significance level α is also utilized for testing either an upward or downward monotone trend (a two-tailed test). If Z appears greater than $Z_{\alpha/2}$ where α depicts the significance level, then the trend is considered as significant.

The application of trend analysis is completed to a time series x_i that is ranked from i=1,2,…….n-1 and x_j which is ranked from j=i+1,2……n. Each of the data point x_i is taken as a reference point which is compared with the rest of the data points x_j.

The Mann-Kendall statistic S is given as

$$\sum_{i=1}^{n-1} . \sum_{j=i+1}^{n} sgn\,(xj - xi)$$

With

Sgn = +1 , > (x_j-x_i)
Sgn = 0, = (x_j-x_i)
Sgn = -1, < (x_j-x_i)

For n > 8, S follows approximately Normal distribution with mean i.e.
E(S) = 0,
The variance statistic V(S) is given by,

$$\frac{n(n-1)(2n-5) - \sum_{i=1}^{m} t(i)\,(i-1)(2i-5)}{18}$$

where, t_i is considered as the number of ties up to sample i. The test statistics Z (Mann-Kendall Co-efficient) is computed as

$Z = \frac{x-1}{\sqrt{var(S)}}$ if S > 0
Z = 0 if S =0
$Z = \frac{x+1}{\sqrt{var(S)}}$ if S < 0

The calculated Z here follows normal distribution. The positive value of Z shows positive trend in data and the negative value of Z shows negative trend in data.

B. Linear regression test

Linear regression is a basic and commonly used type of predictive analysis. If y = estimated dependent variable score, c = constant, b = regression coefficient, and x = score on the independent variable then the simplest form of the regression equation with one dependent and one independent variable is defined by the formula y = c + bx. This is a parametric test that assumes normally distributed data. It is used to test for linear trend by the linear relationship between time and the variable of interest. Regression analysis is utilized to discover conditions that fit information. When we have the relapse condition, we can utilize the model to make expectations. One kind of relapse investigation is straight examination. At the point when a correlation coefficient demonstrates that information is probably going to have the capacity to foresee future results and a disperse plot of the information seems to frame a straight line, we can utilize straight forward direct relapse to locate a prescient capacity. The correct application of this method requires the variables to be normally distributed and temporally and independent.

4. Result

In this study trend analysis for monsoonal rainfall has been carried out. Linear regression and Mann Kendal test is used to determine the trend in rainfall. The trend in rainfall is detected for every decade from 1901 to 2010.

A. Based on linear regression

Based on the linear regression it is clear that rainfall trend in every monsoonal month i.e. June, July, August and September in Udaipur is negative. The trend in rainfall sharply decreases in month of July, August, and September where the June shows gentle decrease in trend. The figures below show the trend in monsoonal rainfall in Udaipur.

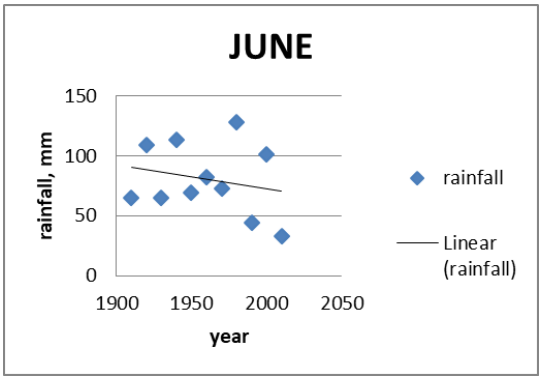

Fig. 1. Rainfall trend in month of June

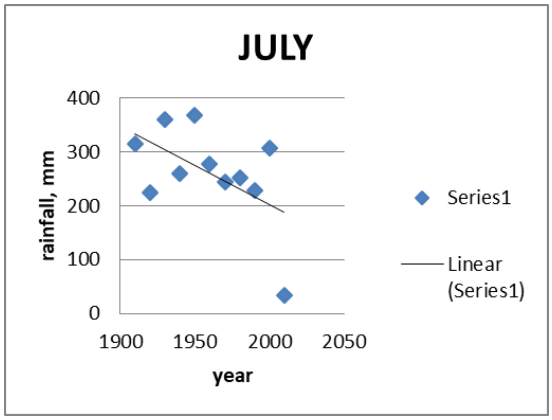

Fig. 2. Rainfall trend in month of July

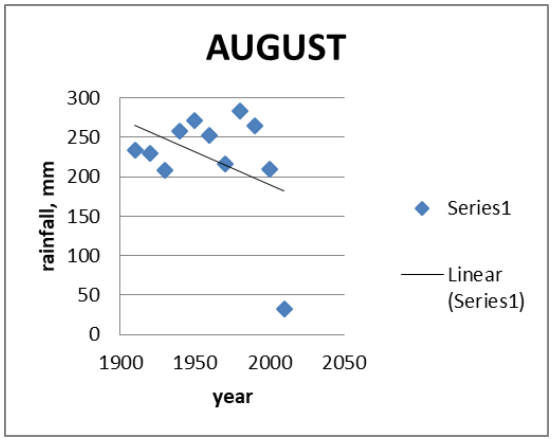

Fig. 3. Rainfall trend in month of August

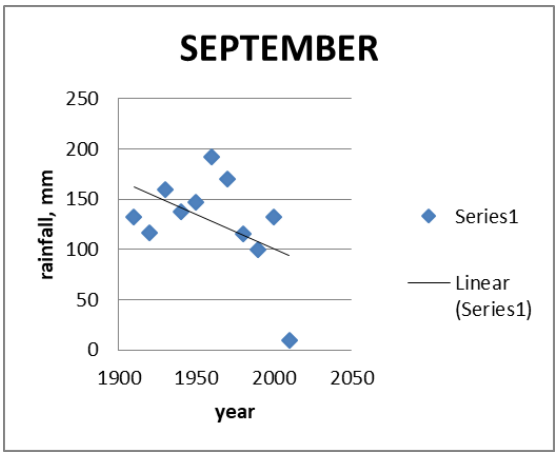

Fig. 4. Rainfall trend in month of September

B. Based on Mann Kendall test

The Mann-Kendall Statistic for different monsoonal months of a year is represented in the figure 4 below. The calculated Z values are -0.16, -1.25, - 0.31 and -0.93 for months June, July, August, September respectively.

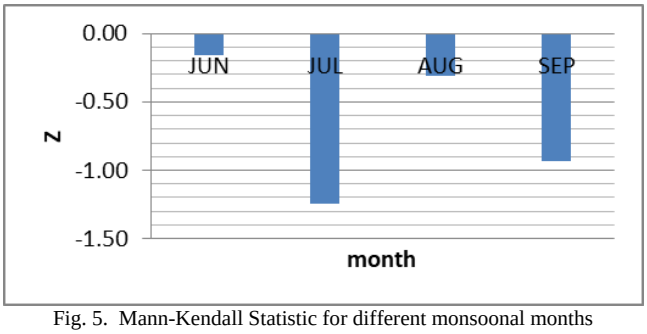

Fig. 5. Mann-Kendall Statistic for different monsoonal months

5. Conclusion

Quantity analysis of rainfall is very important to detect the changes. The changes may be positive or may be negative effects on environment. The trend analysis is made for Udaipur district of Rajasthan. The result shows negative monsoonal trend for all four India's monsoonal month. Since the all four monsoonal month shows negative trend. It is also conclude that the annual rainfall trend for Udaipur district is decreasing.

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