Study on Rainfall Variability of North Gujarat Region by Statistical Test

Mr. Sunil Patel[1] Prof. (Dr.) R. B. Khasiya[2]
[1]M.E. Student [2]Professor
[1,2]Department of Water Resources Engineering
[1,2]L.D. College of Engineering, Ahmedabad – 380015, India

Abstract— This study is focused on the rainfall variability in the form of the rainfall pattern as homogeneity in rainfall data and trend of rainfall for "North Gujarat Region". Different types of statistical tests as Hartley test, Bartlett test, Tukey test, Link-Wallace test for testing Homogeneity of rainfall data of 50 years (1967 to 2016) recorded from 23 stations under taken. Similarly two tests such as Mann-Kendall test and Sperman Rank Order Correlation (SROC) test were also used for trend detection. The results for the statistical test show the homogeneity in the different time series of the rainfall such as One day maximum rainfall, annual rainfall. The station wise results of the statistical test indicated homogeneity in majority of the cases. Similarly in trend detection tests also the result indicated no trend of the rainfall data on for majority of the rainfall stations.
Key words: Rainfall Variability, Homogeneity, Trend

I. INTRODUCTION

Rainfall is an end product of a number of complex atmospheric processes, and it forms the input to all the hydrological studies. Rainfall patterns usually have temporal and spatial variability. This temporal and spatial variability of rainfall is due to seasonal atmospheric phenomenon and geographical (topographical) factors respectively. Rainfall Variability is an important feature of semi-arid climate and climate change is likely to increase that variability in many regions, an understanding of rainfall variability and trends in that variability is needed to help vulnerable dry lend agriculturists and policy maker address Current climate variation and future climate change. The degree to which rainfall amount vary across an area or through time is an important characteristics of climate of area. This subject area In metrological is called rainfall variability these are two types of rainfall variability areal and temporal. the study of latter is important in understanding climate change. The distribution of rainfall has major impacts in agriculture, affecting the soil, hydrology and plant health in agricultural systems daily rainfall records from the state water data center where used to analyze changes in rain variability and seasonal rainfall variability. Rainfall forms the input of all hydrological studies. Apart from the quantum of rainfall, its time distribution plays a critical role in the planning and management of water resources. Peak rainfall data are used in designing storm water management systems and in determining the flooding potential of various storm events. Daily or hourly data are required in continuous hydrologic simulation procedures. Monthly and seasonal data are used in determining supplementary irrigation water requirements, and in engineering studies related to storage analyses, water supply, and reservoir management. Variability of rainfall increases with decreasing mean annual rainfall. Variability in excess of 20 % implies great risk to farming (Williamson 1925) therefore, in the absence of irrigation or dry farming practices, agriculture is reduced to a gamble and consequent famines can be expected any time hence, in this situation, it is essential to provide additional water supplies for successful cropping.

II. OBJECTIVE OF STUDY

1) To study and analyze of historical data of rainfall occurrence in north Gujarat region.
2) To apply statistical techniques to historical data and characterize rainfall occurrence in north Gujarat region.
3) To carry out trend (change) analysis and homogeneity of historical rainfall time series.
4) To study variability of rainfall in north Gujarat region.

III. NEED OF STUDY

A torrential rains leading to flood wreaked havoc in north Gujarat, state revenue department has declared as 'disaster-affected areas'. The announcement was made by the department through a Gazette notification issued on which was made available.

- Last MONSOON 2017 during June to august that there is a heavy rainfall occur in north Gujarat and there is a high loss of human, cattle and other Property.
- For proper planning and management of water resources in a basin there is a need to constantly update the knowledge of temporal variability of rainfall in the basin.
- Monthly and seasonal data are used in determining supplementary irrigation water requirements, and in engineering studies related to storage analyses, water supply, and reservoir management.

IV. STUDY AREA

North Gujarat, the Northern part of Indian state of Gujarat includes the districts of Gandhinagar, Banaskantha, Sabarkantha, Aravalli, Mehsana, and Patan. Currently, the water table of the region is dropping 6 meters every year.

V. METHODOLOGY

A. General

The primary source of water for agriculture is rainfall. There for precise knowledge of the rainfall characteristics is essential for planning the full utilization of rainfall. The typical approach to gain better understanding of the spatial and temporal variability in precipitation starts with the acquisition of historical rainfall data. These historical data provide necessary information about accumulation amounts in both time and space for the region. Statically analyses of hydrological time series play a vital role in water resource studies .The homogeneity and trend stastical tests for detecting time series characteristics were evaluated by applying them to analyze 50 years of annual rainfall, of 1-day maximum rainfall .The performance of all tests were evaluated. The selected stastical tests were applied to know the rainfall variability in term of homogeneity and trend.

B. Statistical tests for Trend

The magnitudes (and sometimes the signs) of the trends in rainfall varied from season to season, and also from one station (or sub region) to another At a given station, trend from annual rainfall data tended to differ from those of the seasonal series. Some important factors to be considered in trend analyze is include data quality, data record length and selected time periods, etc To detect trends, nonparametric tests are more often used than the parametric ones due to their suitability for data with specific distribution properties (e.g. non Gaussian).Nonparametric trend detection can be carried out using the Spearman rank order correlation (SROC) the Mann–Kendall (MK) test. The statistical trend analysis was carried out for the one day maximum, annunal rainfall series. The results of the Mann-Kendall test, the SROC test at 5% significance level are presented. The critical values for Mann-Kendall test test were obtained from salas similarly critical values for SROC test were taken from shahin. The Mann-Kendall test non parametric test for exploring a tread in a time series without specifying the type of tread (linear or nonlinear).

C. Statistical tests for Homogeneity

The main characteristics of the hydrologic time series homogeneity and presence of trend was detected in one day maximum monthly and annual time series of rainfall for all rainfall stations. A multiple Statistical test approach suggested by machiwal and jha was applied for every time series characteristics. In climatic analysis, homogeneity is the most important characteristic of climatic time series. Homogeneity implies that the data in the series are similar and hence have no heterogeneous conditions. Homogeneity tests include a large number of tests for which the null hypothesis is that a time series is homogeneous between two times. Homogeneity of the rainfall time series was tested by applying four statistical tests, Bartlett test, Hartly test, Link-Wallace test, Tukey test. The major limitation with all the multiple comparison tests of homognifieneity is the requirement that the population should be normally distributed with equal variance which makes the tests parametric in nature. The homogeneity of the one day maximum rainfall, annual rainfall was carried out. The test results at 5% levels of significance are considered for the decisions in hydrological studies (Machiwal and Jha 2008). Hence, in the present study also stastical test results were interpreted at 5% significance level.

VI. DATA COLLECTION

This study required Daily rainfall data of different years for varying stations of north Gujarat region from State Water Data Center Government of Gujarat, Gandhinagar. Statistical analyses of hydrological time series play a vital role in water resources studies. The homogeneity and trend statistical tests for detecting time series characteristics were evaluated by applying them to analyze many years of annual rainfall. The performance of all tests was evaluated. The Selected statistical tests were applied to know the rainfall variability in terms of homogeneity, and trend.

VII. RESULT AND DISCUSSION

The station wise rainfall data of under the region was classified in different series to know spatial and temporal rainfall variation. The rainfall data of the 23 rain gauge station were considerd for analysis. The annual rainfall of different rain gauge station is presented in fig.1. The highest avg. Annual rainfall was Raipur weir, while lowest were obtained for Tharad. In anticipation of climate change increasing extreme events the series of one day maximum rainfall was including for variability assignment. The maximum rainfall recorded in year during the day at any station under the region was consider as the one day maximum rainfall (ODMR) of the year for the region. The lowest ODMR was recorded at tharad station, while highest ODMR was recorded at Raipur weir.
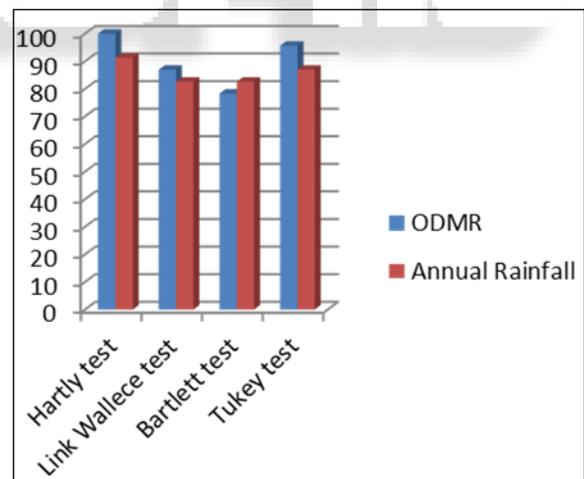
VIII. CONCLUSION

In Homogeneity analysis of rainfall, the rainfall series was leading among all, indicated Homogeneity in 88.04% station followed by one day and annual rainfall series with homogeneity in 90.21% and 85.86% cases respectively. The stastical test wise, the Hartley test and Tukey test were leading with highest output, indicated homogeneity in 95.65% and 91.30% station followed by Link Wallance test and Bartlett test in 84.78% and 80.43 cases respectively. The result suggested the homogeneity of rainfall. The trend

analysis indicated absence of trend among the rainfall series barring a few stations in some years.

REFERENCES

[1] Bihrat O, Mehmet_Cik Bayazit (2003) "The Power of Statistical Tests for Trend Detection", Turkish Journal Eng. Env. Sci. 27 (2003) ,pp. 247-251

[2] Donald H. Burn, Juraj M Cunderlik and Alain Pietroniro (2004),"Hydrological trends and variability in the Liard River basin" Journal of Hydrological Sciences Vol. 49, February 2004.

[3] Ihsan Cicek (2003),"The statistical analysis of precipitation in Ankara, Turkey", Journal of Social Science, Fırat University.

[4] Mohsen Sherif, Salem Akram and Amapr Shetty (2009),"Rainfall Analysis for the Northern Wadis of United Arab Emirates: A Case Study". Journal of Hydrologic Engineering, ASCE, Vol. 14, No.6.

[5] Elfatih A. And B. Eltahir (1992)," Drought frequency analysis of annual rainfall series in central and western Sudan" Journal of Hydrological Sciences, Vol.6.

[6] Turkes M. 1996. "Spatial and temporal analysis of annual rainfall variations in Turkey" International Journal of Climatology 16: 1056-1076.

[7] Mohsen Sherif, Salem Akram and Amapr Shetty (2009),"Rainfall Analysis for the Northern Wadis of United Arab Emirates: A Case Study". Journal of Hydrologic Engineering, ASCE, Vol. 14, No.6.

[8] Shahin, M., Van Oorschot, H. J. L. & De Lange, S. J. (1993) Statistical Analysis in Water Resources Engineering. A. A. Balkema, Rotterdam, The Netherlands

[9] Charles Onyutha,Patrick Willems (2016)Analyses of rainfall trends in the Nile River Basin Journal of Hydro-environment Research 2016.