International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 11, Issue 24, 2019, pp.-9368-9369.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

TEST FOR HOMOGENEITY OF RAINFALL IN YADGIR DISTRICT OF KARNATAKA

K. PAVAN KUMAR* AND M. GOPINATH RAO
Department of Agricultural Statistics, University of Agriculture Science, GKVK, Bengaluru, 560065, Karnataka, India
*Corresponding Author: Email - pavan134134@gmail.com

Received: December 07, 2019; Revised: December 26, 2019; Accepted: December 28, 2019; Published: December 30, 2019

Abstract: Climatological records assume a paramount role in the studies of variation of the atmospheric conditions. They provide vital information about climate variability, trends and cycles. To identify such in the current study using non-parametric test such as Van Neumann ratio test, Pettitt test, standard normal homogeneity test and Buishand range test. Study concludes that there is a break in annual rainfall data of Yadgir district from SNHT and it was found to 1983 *i.e.*, maximum annual rainfall received year.

Keywords: *Van Neumann ratio, Pettitt test, Standard normal homogeneity test*

Citation: K. Pavan Kumar and M. Gopinath Rao (2019) Test for Homogeneity of Rainfall in Yadgir District of Karnataka. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 11, Issue 24, pp.- 9368-9369.

Academic Editor / Reviewer: Swapnil Pandey, Dr Harshada Shah, Dr H. V. Pandya, Er P. K. Dhara

Introduction

Long instrumental climatological records assume a paramount role in the studies of variation of the atmospheric conditions. They provide vital information about climate variability, trends and cycles. Unfortunately, long-term series often contain inhomogeneities caused by a number of non-climatic factors that could provide unrealistic trends, shifts and jumps These inhomogeneities are originated by changes in instruments of station, and locations surrounding environment. Methods of preliminary data treatment such inhomogeneities have severe affect on the information of instruments was noticed many researches earlier in the study of homogenization of Portuguese long-term temperature data series detected and corrected the data series to be used in any kind of further analysis [1]. The simplest way to detect the shift-like inhomogeneities is a visual analysis, preferably by an experienced meteorologist, It is clear that this method is very subjective and could be used as an initial part of the analysis, providing information about doubtful periods that have to be studied thoroughly with other objective. The methods developed to detect a break in the time series data are belong to one of three likelihood-based methods, linear-regression based methods, and non-parametric methods. In climatic studies the most commonly used methods are the standard normal homogeneity test and its variations, the Buishand cumulative deviation test, the non-parametric rank Pettitt test. These methods were used to estimate not only the level of inhomogeneity in the series, but also detect the highly probable homogeneity break points. The other tests, like the von Neumann ratio test do not give any information about the date of the break, but estimate the overall level of inhomogeneity in the data.

Material and Methods

To detect homogeneity in the rainfall data here we have used the four test methods were selected to test the departure of homogeneity in the time series are The standard normal homogeneity test (SNHT), Buishand range test (Buishand, 1982), Pettitt test and Von Neumann ratio test. All four tests define the null hypothesis that the annual values Yi of the testing variable Y are independent and identically distributed. (there is no break in the data). These three tests are capable of locating the year where a break is likely to be present in the series. Where in case of Von Neumann ratio test assesses the randomness of the series, but does not give information about the year of the break.

Van Neumann ratio

The Van Neumann ratio N is defined as the mean square successive (year to year) difference, When the sample is homogeneous the expected value is N=2. If the sample contains a break, then the value of N tends to be lower than this expected value. If the sample has rapid variations in the mean, then values of N may rise above two. This test gives no information about the location of the shift.

$$N = \frac{\sum_{i=1}^{n-1}(Y_i - Y_{i+1})^2}{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}$$

Pettitt's test

Pettitt during (1979) describes the test can be used for detection of change point. The test is conducted by giving ranks to the data series.
The test is also more sensitive to the breaks in the middle of the series.
The ranks *r1……..r n.* of the *Y1…….. Yn* are used to calculate
the statistics. The null and alternative hypotheses in this test are the same as in the Buishand test.

Null hypothesis: The variables Y follow the same distribution/ No change of point in the data series.

Alternative hypothesis: At a time, t there is a change of distribution/change of point in the data series

$$X_k = 2\sum_{i=1}^{k} r_i - k(n+1)$$

If a break occurs in year K, then the statistic is maximal or minimal near the year k= K.

$X_k = \max_{1 \le k \le n} |X_k|$

The statistical significance (for probability level) is given as

$$X_{ck} = |-\ln \alpha\,(n^3 + n^2)/\ 6|^{1/2}$$

Reject the null hypothesis if value of X_k is greater than the X_{ck} at specified level of α.

The standard normal homogeneity test

The standard normal homogeneity test (SNHT) was developed by Alexandersson during 1986. SNHT is one of the most popular homogeneity tests in climate studies used to detect a point of change in series of rainfall data. SNHT is more sensitive to the breaks near the beginning and the end of the series.

Statistic $T_{(k)}$ to compare the mean of the first k years of the record with that of the last (n-k) years

$$T_{(k)} = KZ_1^2 + (n-k)Z_2^2$$

Where

$$Z_a = \frac{1}{k}\sum_{i=1}^{n}\frac{(Y_i - \bar{Y})}{s}$$

$$Z_2 = \frac{1}{n-k}\sum_{i=k+1}^{n}\frac{(Y_i - \bar{Y})^2}{s}$$

$$s^2 = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \bar{Y})^2$$

If a break is located at the year K, then $T_{(k)}$ reaches a maximum at year k = K. The test statistic T_0 is defined as

$T_0 = Max\ T_{(k)}$

$1 \le k \le n$

H_0: The T variables X_i follow same distribution/No change of point /no break

H_a: The variables X_i does not follow same distribution/there is change of point/there is a break

Buishand rang test

The Buishand range test is also a non-parametric test checking presence of a change-point in the given data, a change of the location parameter (average values) distribution.

The null hypothesis H_0 implies data homogeneity in terms of the location parameter *i.e.*, absence of a change regarding the said parameter over time.

The alternative hypothesis H_1 implies presence of a change-point involving an increase or decrease of the average value of the observed feature.

In this test, the adjusted partial sums are defined as

$S_0 = 0$

$$s * k = \sum_{i=1}^{k}(Y_i - \bar{Y})$$

k=1,2,.....K

When a series is homogenous the values of s*k will be fluctuated around zero, because no systematic deviations of the Yi values with respect to their mean will appear. If a break is present in year, then S_k^* reaches a maximum (negative shift) or minimum (positive shift) near the year k=K.

The significance of the shift can be tested with the rescaled adjusted rang R, which is the difference between the maximum and minimum of the S_k^* values scaled by the sample standard deviation but it is more sensitive to breaks in the middle of a time series

$Q = \max |s^*|$

$R = (\max S_k^* - \min {}_kS^*) / s$

Buishand gives critical values for $R/\sqrt{n}$

Conclusion

From above observation of [Table-1] we can conclude by Van Neumann ratio test statistic value is less than 2 *i.e.*, there exists a break in the data, but in this illustration we noticed that SNHT test was found to be significant with a break in the year 1983 and other test are non-significant. Based on illustration we can conclude that test for homogeneity of rainfall can be taken by the standard normal homogeneity test (SNHT), The Buishand range test, Pettitt test, Von Neumann ratio test. Von Neumann ratio test can clearly define whether there exists a break in the data are not and from both illustrations can be noticed that there exists a break in the data.

Form illustration a break was noticed in the year 1983 from the SNHT and this year as received the maximum rainfall. From non-parametric test (Pettitt test) break was noticed in the year 1990 for illustration. From SNHT was found to be significant in finding a break in the data *i.e.*, in the 1983.

Table-1 *Results of test for homogeneity of rainfall in Yadgir District*

Name of Test	Test Statistic	Critical value (α= 0.05 , n= 34)
Van Neumann ratio	1.98	--
Buishand rang test	0.62(1983)	1.54
Pettitt's test	102(1998)	142
SNHT test	8.52(1983)	7.93

Application of research: The time series analysis helps in forecasting the market price in future for farmers in order to take better decision to augment the profitability.

Research Category: Time series analysis

Acknowledgement / Funding: Authors are thankful to Department of Agricultural Statistics, University of Agriculture Science, GKVK, Bengaluru, 560065, Karnataka, India

***Research Guide or Chairperson of research: Prof Dr M. Gopinath Rao**

University: University of Agriculture Science, Bengaluru, 560065, Karnataka, India

Research project name or number: MSc Thesis

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Department of Agricultural Statistics, University of Agriculture Science, GKVK, Bengaluru, 560065, Karnataka, India

Cultivar / Variety / Breed name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

References

[1] Morozova A.L., and Valente M. A. (2012) *Earth Syst. Sci. Data*, 4,187-213.

[2] AL-Salihi A.M., AL-Timimi Y.K. and AL-Lami A.M. (2014) *Journal for Pure Science*, 10(2), 60-77.

[3] Heikki Tuomenvirta (2002) *Geophysica* ,38, 15-41.

[4] Ho Ming Kang and Fadhilah Yusof (2012) *International Journal of Contemporary Mathematical Sciences*, 7(1), 9-22.

[5] Jakub Langhammer and Jana Bernsteinova (2015) *Water*, 7,3320-3342.

[6] Khaliqa M.N. and Ouarda T.B.M.J. (2007) *International Journal of Climatology*, 27,681-687.

[7] Stephen Bunmi Ogungbenro and Tobi Eniolu Morakinyo (2014) *Weather and Climate Extremes,* 5,1-6.

[8] Wijngaard J.B., Klein Tank A.M.G. and Konnen G.P. (2003) *International Journal of Climatology*, 23, 679-692.