e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.11, Nov. 2022

THE ANNAUL RAINFALL VARIATION OF THE SABARMATI BASIN USING NON PARAMATRIC MANN-KENDALL TEST

Kasar Snehal N

K.V.N. Naik Arts, Commerce And Science College Canada Corner, Nashik-422 002.
Email- markadsnehal@gmail.com

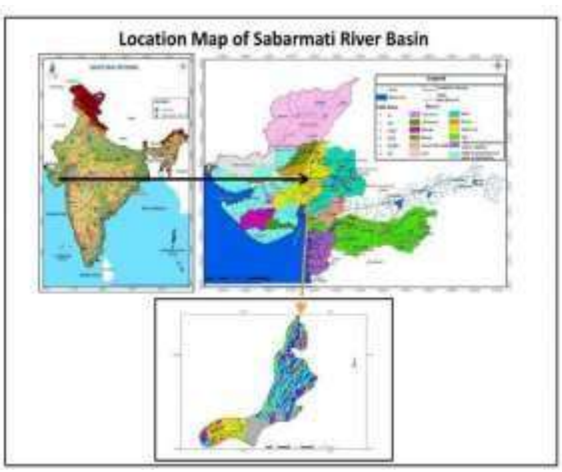
ABSTRACT:

The rainfall studies in India is whether the monsoon rainfall has changed over the last few decades and whether a change is probably to occur in future. Nonetheless, it is difficult to identify the probable future trend of rainfall, it is possible to detect the nature of changes that have occurred in the past. The Non-parame trie Mann- Kendall test has been used to evaluate the long-term changes/trends in the annual rainfall records of the Sabarmati Basin. The data analyzed for present work consists of long-term annual rainfall series entailable for 4 rain gauge stations located in the basin. The Mann-Kendall's Tau (z) for the Sabarmati Basin is 0.067. The positive value suggests that the rainfall trend for the given period is increasing. However, although the value is positive, the application of this non- parametric test to the annual rainfall data of the basin designates no significant trend at 0.01 and 0.05 level.

Introduction

The rainfall studies in India is whether the monsoon rainfall has changed over the last few decades and whether a change is probably to occur in future. Though it is difficult to identify the probable future trend of rainfall, it is possible to detect the nature of changes that have occurred in the past. According to Kale (1999) determining the trends or changes in the rainfall are extremely essentialsince studies of hydro-meteorological conditions triggered them is useful to detect climatic changes.

Most of the studies in the last few decades have shown worldly distinctions in the Indian monsoon rainfall (Mooley and Parthasarathy, 1984; Gregory, 1989, Parthasarathy et al., 1991; Kripalani and Kulkarni, 1997). Nevertheless, the studies of rainfall to determine continuing changes on river basin scale are inadequate (Gunjal, 2016).Therefore, in the present work, an attempt has been made to investigate the annual rainfall data of the Sabarmati Basin and to evaluate the long-term changes/trends in the annual rainfall records of the basin. The Non-parametric Mann-Kendall test can be used to evaluate the long-term changes/trends in the annual rainfall records of a basin (Hollander and Wolfe, 1973). In accordance with Subramanian et al. (1992), the Mann-Kendall test is a powerful statistical technique for randomness against trend. Numerous workers have reported the use of the Mann-Kendall test in trend analysis of meteorological parameters, particularly of rainfall. Krishnakumar et al. (2009) established the long-term changes in seasonal and annual rainfall over Kerala by the Mann-Kendall trend test. Several workers have also applied this non-parametric method for quantifying the direction and magnitude of trends in the stream flow and rainfall records (Probst and Tardy, 1987; Chiew and McMahon, 1993; Marengo, 1995; Kale, 1999; Hire, 2000; Hire and Gunjal, 2006;Gunjal, 2008; Gunjal, 2016). Moreover, some other workers namely Saliu (2004), Seetharam (2003), Lai et al. (1993) and Suresh et al. (1998) used this test for detection of the nature of changes in the rainfall of the small regions or stations.



Source : CWC Fig. 1.1

e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.11, Nov. 2022

Geomorphological and hydrological aspects of the Sabarmati Basin

The river Sabarmati originating from the Aravalli hills of Rajasthan flows across the alluvial plains before meeting the central part of the Cambay Graben. This river has a total length of 416 km, almost two third of which lies within the state of Gujarat. It has a ENE-WSW course. Interestingly it shows an entrenched channel from Ahmedabad northwards up to the edge of the plains. South of Ahmedabad and its channel tend to gradually flatten out before meeting the Gulf of Cambay. The last few kilometres of the river traverse the saline marshland of the 'Bhal' area. A peculiar feature of this river is that it has practically no tributaries to its west and in contrast along its left bank numerous tributaries meet the Sabarmati. The major tributaries are Hathmati, Vatrak Meshwo, Khari, Shedhi, Rameshwar Nadi and Debhol Nadi; all these rivers provide a network of channels that are more or less parallel to the trunk stream. They follow more or less identical courses.

River Hathmati originates in the Dungarpur hills and flowing across Himmatnagar meets Sabarmati SW of Himmatnagar. The rivers Meshwo and Vatrak also flow down the hilly slopes of Dungarpur. The Meshwo meets Vatrak at Samadha, which in turn joins the Sabarmati at Wautha. The river Khari originates at the fringe of the alluvial plains south of Himmatnagar and joins Meshwo before it meets Vatrak. The river Shedhi forms the chief drainage of the alluvial plains between Sabarmati and Mahi. It is interesting to observe that it originates in the Panchmahals at Sathamba and flows quite close by to the Mahi. But instead of meeting it, it takes a westerly trend near Dakor and flows for almost 50 km to meet the Vatrak. Except Shedhi most of the tributaries in their upper courses show very well defined entrenchment and cliffy banks. The entire drainage network of Sabarmati and its tributaries typically reveal very prominent tectonic lineaments that control their charnel trends and entrenchment The Khari and Meshwo flowing almost parallel to each other for 67 km meet near Vaneh before finally meeting Vatrak.

The average rainfall in the basin has been reported as 750mm, falling during the monsoon season (June to September). The majority rainfall occurs during July (47%), August (33%) and rest 20% during June and September months. The southwest monsoon sets in by middle of June and withdraws by the first week of October. Monsoon contributes nearly 9194% of annual precipitation. The spatial variation in rainfall is moderate. Major part of the basin area receives rainfall from 600-800 mm.

Regime of rainfall may be defined as the variations in its widest sense and involves all occurrences. This is portrayed by a graph, based on continues observations of rainfall (Beckinsale, 1969). To recognize the variations in the total amount of rainfall at different stations and to understand the overall pattern of the rainfall, study of rainfall regime is important. The Sabarmati Basin is situated in an environment typical of monsoonal tropics, with periodic high-magnitude rainfall (Kale et al., 1994). The monsoon rainfall is variable, both spatially as well as temporally. The spatial variation in the monsoon rainfall illustrates interplay of meteorology and topography characteristics. In addition to this, the geographical location and the east-west orientation of the Sabarmati Basin has also determined the distribution of rainfall in the basin (Abbi and Jain, 1971). Due to orographic effect of the Aravalli hills (the source areas of Sabarmati, Sai, and Wakal Rivers) and Kulali hills and Southwest foot hills and Panchera hills (source of the Harnav, Hatmati and Watrak Rivers) 1000 mm rainfall is received. The amount of rainfall exceeds 1000 mm in the lower part of the basin. Seasonal pattern of rainfall is almost similar to its annual distribution, since more than 90 percent of the annual rainfall is recorded during the monsoon season (Abbi and Jain, 1971). Most of the basin receives about 700 to 800 mm rainfall with average annual rainfall of 799 mm.

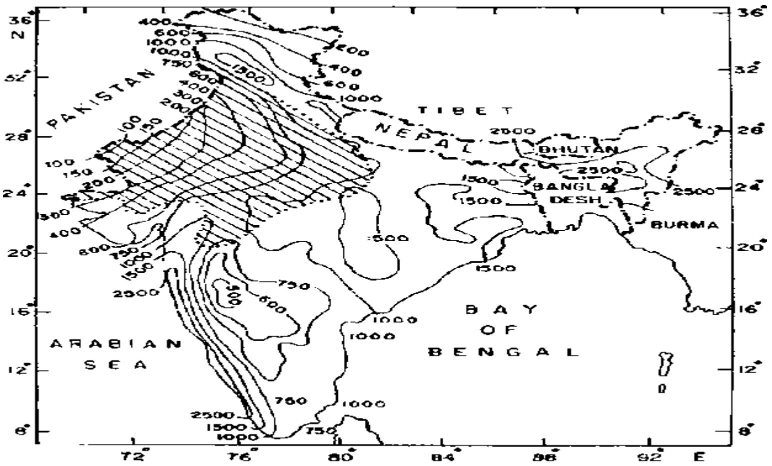


Fig. 1.12

Data and Method of Analysis

The data were procured from India Meteorological Department (IMD), Pune. It is important to understand the areal distribution of rainfall. Generally, average depths of rainfall for representative portions of the watershed are calculated and used for this purpose (Viessman and Lewis, 2003). One of the basic methods is to consider the arithmetic average of rainfall. This procedure, however, is suitable for uniformly distributed rain gauge stations and flat topography. Nevertheless, neither the rain gauge stations of the Sabarmati Basin are uniformly distributed nor the topography is flat. Therefore, commonly applied methods such as the Thiessen method is used understand the areal distribution of rainfall. The Non-parametric Mann-Kendall test has been used to evaluate the long-term changes/trends in the arealy distributedannual rainfall records of the Sabarmati Basin.

The Mann-Kendall's Tau (t) has been obtained by following equation;

$$t = \frac{\text{Actual total of scores (ATS)}}{\text{Maximum possible total}} \qquad \text{Equation 1}$$

Where, actual total of scores (ATS) is the total of all sum(s) as calculated by the method adopted by Gunjal, (2016).The maximum possible total has been acquired with following equation;

Maximum possible total = $A^r (N-l) / 2$ Equation 2

Where, N - Number of observations. The Mann-Kendall's x is obtained by putting values in Equation 1.

The computed trend by applying the Mann-Kendall testis practically significant or not is to be tested as under;

The method delineated for testing the significance of x becomes extremely burdensome for the large *N*. Nevertheless, Kendall (1955) has revealed that when *N* is greater than 8, the theoretical distribution of all probable values ofx approaches the normal distribution. The x may be transformed into a normal standard deviate as follows;

$$Z = \frac{T}{J2(2N+5) / 9N(N-1)} \qquad \text{Equation 3}$$

The value of the z can be obtained while substituting the calculated value of x. 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.

Results, Discussions and Conclusions

In this section and attempt has been made to evaluate the long term changes/trends in the annual rainfall records by using the test of Mann- Kendall (Hollander and Wolfe, 1973). This non parametric method has been used by several workers to quantify the direction and magnitude of trends in the stream flow and rainfall records (Probst and Tardy, 1987; Chiew and Mcmohan, 1993; Marengo, 1995; Kale 1998; Hire, 2000; Hire and Gunjal, 2006).

It apparently appears that the frequency and magnitude of large floods has increased in recent decades. To see whether this trend is reflected in the annual rainfall, the Mann-Kendall test was applied to the annual rainfall data of four sites. The non-parametric test indicates that there is no statistically significant increasing or decreasing trend for any of the sites (Table 4.3). The recent study of the long-period trends in the 24-hr heavy rainfall over India, including Sabarmati Basin, for the period 1961-2012 by Sinha Ray and Srivastava (1998) show that there is no trend and thus this study also lends support to the results given in Table 4.3. Applied Mann Kendall test for trend of these five sites to test

H0: No trend V/S. H1: there is Monotonic trend conclusion: for all the sites, p-value is > 0.05 therefore we conclude that there has no trend occurred.

Table 1.1 Nature of changes/trends in annual rainfall records based on Mann-Kendall test.

Site	Time-span	*N*	Tau (τ)	p-value	Remark
Ahmedabad	1961 - 2012	52	-0.014	0.89329	No trend
Dakor	1974 - 2012	39	-0.217	0.052894	No trend
Kheda	1967 - 2012	46	0.044	0.70058	No trend
Nadiad	1965 - 2012	48	-0.013	0.9137	No trend
Vijapur	1967 - 2012	46	0.068	0.524	No trend

See Fig. 1.1 for location of sites; *N* = Number of observations

References

1. Gregory, S., 1989. Macro-regional definition and characteristics of Indian summer monsoon rainfall, 1871-1985. International Journal of Climatology, v. 9, pp. 465-483.
2. Gunjal, R.P., 2016. Rainfall characteristics of the Tapi basin. Ph.D. Thesis, Tilak Maharashtra Vidyapeeth, Pune.
3. Hollander, M. and Wolfe, D.A., 1973.Nonparamentrie Statistical Methods. John Wiley and Sons, New York. pp. 192.
4. Kale, V.S., Ely, L.L., Enzel, Y. and Baker, V.R., 1994. Geomorphic and hydrologic aspects of monsoon floods on the Narmada and Tapi Rivers in central India. Geomorphology, v. 10, pp. 157-168.
5. Kale, V.S., 1999. Long-period fluctuations in Monsoon floods in the Deccan Peninsula, India. Journal of Geological Society of India, v. 53, pp. 5-15.
6. Kendall, M.G., 1955. Rank Correlation Methods.Hafner, New York. pp. 54.
7. Kripalani, R.H. and Kulkarni, A., 1997. Climatic impact of El Niho/La Nina on the Indian monsoon: A new perspective. Weather, v. 52, pp. 39-46.
8. Krishnakumar K.N, Prasada Rao G.S.L.H.V. and Gopakumar C.S. 2009. Rainfall trends in twentieth century over Kerala, India. Atmospheric environment v. 43, pp. 1940-1944.
9. Lai, B., Lakshmanaswamy, B. and Meena, L.R., 1993. Trends and periodicities of winter, monsoon and annual rainfall of districts of hills of west Uttar Pradesh.VayuMandal, No. 1, pp. 28-34.
10. Marengo, J.A., 1995. Variations and change in South American streamflow. Climate Change, v. 31, pp. 99-117.
11. Mooley, D.A., Parthasarthy, B., 1984. Fluctuation of all-India summer monsoon rainfall during 1871-1978. Climatic Change, v. 6, pp. 287-301.
12. Parthasarathy, B., Rupa Kumar, K. and Munot, A.A., 1991. Evidence of secular variations in Indian monsoon rainfall- circulation relationship. Journal of Climatology, v. 4, pp. 927-938.
13. Probst, J.I. and Tardy, Y., 1987. Long range stream flow and world continental runoff fluctuations since the beginning of this century. Journal of Hydrology, v. 94, pp. 289-311.
14. Srivastava, H.N., Sinha Ray., Dikshit, S.K. and Mukhopadhyay., 1998. Trends in rainfall and radiation over India.VayuMandal, v.28, No.2, pp.41-45.
15. Seetharam, K., 2003. Inter annual and intra decadal behavior of monsoon rainfall over Jalpaiguri. Mausam, v. 54, No. 2, pp. 539-560.
16. Subramanian S.K., Palande S.V., Dewan B.N., Dikshit S.K. and Joseph, L., 1992.Trends and periodicities in sub- divisional rainfall.Mausam, v. 43, No. 1, pp. 77-86.
17. Suresh, R., Mistry, R.D. and Bhan, S.C., 1998. Variability of rainfall between Colaba and Santacruz.Vayumandal, v. 28, No. 1, pp. 18-24.