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National Academy of Agricultural Science (NAAS) Rating : 3. 03

Trend Analysis for Temporal Variation in Rainfallat Parbhani and Aurangabad Stations of Marathwada Region, Maharashtra

Deepika Mavale[1], Dipika Bhamare[2] and Rajanee Salunkhe[3]

ABSTRACT: *Rainfall is the most important component of hydrologic cycle and has a dominant influence of hydrologic phenomena. Crop planning is solely dependent on the distribution pattern and amount of rainfall. The rainfall distribution in India is most uneven and varies considerably from region to region and year to year. Changes in extreme climatic events are of great consequence owing to the high vulnerability of the region to these changes. The future rainfall trend will have its impact globally and will be felt severely in developing countries. In respect with this to study the variation in precipitation at Aurangabad and Parbhani stations over Marathwada region Trend analysis were followed. Analysis also helpful for crop plannings for both Kharif and Rabi seasons. The Mann-Kendall test applied to weekly rainfall data of Parbhani and Aurangabad. The Z statistic for each week computed and considering the criteria the trends in the weekly rainfall were decided. The increasing trends in weekly rainfall at Parbhani observed for 47th weeks. Whereas there is no trend observed during remaining crop growth period and thus we can expect normal rainfall during most of monsoon season. In case of Aurangabad decreasing trend for 8th, 28th, 29th and 33rd week.*

Keyword: *Rainfall, Trend Analysis, Temporal Variation.*

INTRODUCTION

The rainfall distribution in India is most uneven and varies considerably from region to region and year to year. About 60-90% of the annual rainfall over India is received from the southwest monsoon season (June to September), which is vital for the economy of the country. Inter-annual variation of seasonal and annual rainfall is a subject for more serious research work also the growth of flourishing civilization, existence of highly developed irrigation systems and operation of important industrial complexes are directly or indirectly dependent on rainfall.Our climate management strategy must be based on the promise that the frequency of drought, unseasonal rain temperature will rise.

The 2009 drought in India is a wakeup call about the shifting trends of monsoon behavior in the emerging era of climate change. It brought home the point that weather prediction will be increasingly difficult. Our climate management strategy must be based on the promise that the frequency of drought, unseasonal rain temperature will rise. Assam, which normally only faces floods was amongst the first states to declare drought, at the same time there was a crop failure in west-coast regions due to high rain in 2009. Global warming will make the Indian monsoon more variable and less predictable with respect to regions

MATERIALS AND METHODS

Trends in data can be identified by using either parametric or non-parametric method. The nonparametric test are more suitable for non-normally distributed, censored data, including missing values, which are frequently encountered in hydrological time series (Hirsch and Slack,1984). In the present study The MK test used,(suggested by U.S. Army Corps of Engineers2005), is based on the test statistic. The MK test is based on the test statistic, *S*, defined as follows :

[1] Ph.D. Scholar, Deptt. of SWCE, MPKV, Rahuri. *E-mail* : *dpmavale@gmail.com*
[2] Ph.D. Scholar, Deptt. of IDE, Dr. PDKV, Akola. *E-mail* : *salunkhe7988@gmail.com*
[3] Ph.D. Scholar, Deptt. of SWCE, MPKV, Rahuri

Table 1
Trends in weekly rainfall along with calculated Z statistic for Parbhani

Week No.	*Z (calculated)*	*Trend*	*Week*	*Z (calculated)*	*Trend*
1.	1.5651	No trend	No. 27	–0.6276	No trend
2.	1.3780	No trend	28	0.2264	No trend
3.	0.7407	No trend	29	–0.9118	No trend
4.	–0.3215	No trend	30	0.5775	No trend
5.	1.8312	No trend	31	–0.1004	No trend
6.	1.1446	No trend	32	0.97.5	No trend
7.	–0.1250	No trend	33	–1.5090	No trend
8.	–1.0800	No trend	34	0.1422	No trend
9.	0.6454	No trend	35	–0.5441	No trend
10.	–0.3421	No trend	36	–0.2259	No trend
11.	–0.7794	No trend	37	0.1767	No trend
12.	–0.3365	No trend	38	0.1090	No trend
13.	–1.5200	No trend	39	0.4053	No trend
14.	0.8180	No trend	40	0.5107	No trend
15.	0.6370	No trend	41	0.3889	No trend
16.	–0.5640	No trend	42	0.3771	No trend
17.	–1.2900	No trend	43	–0.5194	No trend
18.	–0.8052	No trend	44	0.7291	No trend
19.	–0.5939	No trend	45	1.3600	No trend
20.	–0.0098	No trend	46	1.2040	No trend
21.	0.5398	No trend	47	2.1660	Increasing
22.	–0.7957	No trend	48	–0.2381	No trend
23.	–0.1297	No trend	49	–1.3230	No trend
24.	1.7567	No trend	50	–0.1339	No trend
25.	–0.0586	No trend	51	–0.6682	No trend
26.	–0.4374	No trend	52	0.5486	No trend

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} sign(x_j - x_k) \quad (1)$$

Where,

$$\text{sign } (x_j - x_k) = 1 \text{ if } (x_j - x_k) > 0$$
$$= 0 \text{ if } (x_j - x_k) = 0$$
$$= -1 \text{ if } (x_j - x_k) < 0$$

When n ³ 10, the statistic S is approximately normally distributed with the mean and the variance as follows:

$$VAR = \frac{1}{18}\left[n(n-1)(2n-1) - \sum_{p=1}^{g} t_p(t_p - 1(2t_p + 5) \right] \quad (2)$$

Where n is the number of data points, g is the number of tied groups (*a* tied group is a set of sample data having the same value), t_p is the number data points in the p^{th} group.

Standard Normal Variance Z is Computed by

$$Z = \left\{ \frac{S-1}{\left[VAR(S)^{1/2} \right]} \right\} \quad \text{for } S > 0$$

$$Z = 0 \quad \text{for } S = 0$$

$$Z = \left\{ \frac{S+1}{\left[VAR(S)^{1/2} \right]} \right\} \quad \text{for S} < 0$$

The values of test statistic, Z, are computed and if the value lies within the limits –1.96 and 1.96, the null hypothesis of having no trend in the series cannot be rejected at the 5% level of significance using a two–tailed test.

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} sign(x_j - x_k)$$

Where,

$$\text{sign } (x_j - x_k) = 1 \text{ if } (x_j - x_k) > 0$$
$$= 0 \text{ if } (x_j - x_k) = 0$$
$$= -1 \text{ if } (x_j - x_k) < 0$$

When $n \geq 10$, the statistic S is approximately normally distributed with the mean and the variance as follows:

$$VAR = \frac{1}{18}\left[n(n-1)(2n-1) \sum_{p=1}^{g} t_p(t_p - 1)(2t_p + 5) \right]$$

Where n is the number of data points, g is the number of tied groups (a tied group is a set of sample

Table 2
Trends in weekly rainfall along with calculated Z statistic for Aurangabad

Week No.	*Z (calculated)*	*Trend*	*Week*	*Z (calculated)*	*Trend*
1.	0	No trend	No. 27	0.3034	No trend
2.	–0.7243	No trend	28	–2.249	Decreasing
3.	–1.617	No trend	29	–2.249	Decreasing
4.	0	No trend	30	0.1784	No trend
5.	–1.081	No trend	31	0.411	No trend
6.	0.6553	No trend	32	–1.303	No trend
7.	0.0178	No trend	33	–2.573	Decreasing
8.	–2.173	Decreasing	34	–0.1963	No trend
9.	1.155	No trend	35	1.198	No trend
10.	0.719	No trend	36	1.25	No trend
11.	–0.636	No trend	37	0.1253	No trend
12.	–1.00	No trend	38	0.0178	No trend
13.	0.693	No trend	39	–0.84	No trend
14.	–1.138	No trend	40	–0.2354	No trend
15.	–1.124	No trend	41	–1.019	No trend
16.	0.172	No trend	42	0.4652	No trend
17.	–1.094	No trend	43	–1.267	No trend
18.	–0.373	No trend	44	–1.224	No trend
19.	0.668	No trend	45	0.5341	No trend
20.	0.3872	No trend	46	0.9759	No trend
21.	–1.099	No trend	47	0.5908	No trend
22.	–0.68	No trend	48	0.1035	No trend
23.	0.0543	No trend	49	–0.3104	No trend
24.	–1.142	No trend	50	–1.163	No trend
25.	–0.089	No trend	51	–1.08	No trend
26.	–0.393	No trend	52	–0.034	No trend

data having the same value), t_p is the number data points in the p^{th} group.

Standard Normal Variance Z is Computed by

$$Z = \left\{ \frac{S-1}{\left[VAR(S)^{1/2} \right]} \right\} \quad \text{for } S > 0$$

$$Z = 0 \quad \text{for } S = 0$$

$$Z = \left\{ \frac{S+1}{\left[VAR(S)^{1/2} \right]} \right\} \quad \text{for } S < 0$$

The values of test statistic, Z, are computed and if the value lies within the limits –1.96 and 1.96, the null hypothesis of having no trend in the series cannot be rejected at the 5% level of significance using a two –tailed test.

In present study daily rainfall dataof 50 years for Parbhani station wascollected from 1961 to 2010 and 30 years for Aurangabad from 1981 to 2010 from Meteorological Observatory, Department of Agricultural Meteorology, MKV, Parbhani.Parbhani lies at 76°47′ E longitude are 19°16′ N latitude and 409 m above mean sea level. Climatically the area falls under tropical zone with annual rainfall is in range 700 to 900 mm. Aurangabad is located in Godavari basin. The latitude and longitude are 19°532 N and 75°232 E, respectively. Climatically the area falls under dry, rain scarcity and rain shaded zone. The Annual rainfall is in range 500 to 700 mm. The Mann-Kendall test was applied to weekly rainfall data using the methodology. The Z statistic for each week was computed and considering the criteria the trends in the weekly rainfall were decided. The results of trends in weekly rainfall at Parbhani station and Aurangabad station are tabulated in table 1 and 2 respectively.

RESULTS AND DISCUSSION

Trend analysis of weekly rainfall for Parbhani station indicate that during the monsoon period slightly increasing and decreasing trends was observed while for Aurangabad station it indicates that slightly decreasing trend in the occurrence of rainfall was observed. The Mann-Kendall test applied to weekly rainfall data of Parbhani and Aurangabad.The Z statistic for each week computed and considering the criteria the trends in the weekly rainfall were decided. The increasing trends in weekly rainfall at Parbhani observed for 47th week. While for Aurangabad station decreasing trend for 8th, 28th, 29th and 33rd week were observed.The increasing trends in weekly rainfall at Parbhani observed for 47th weeks. Whereas there is no trend observed during remaining crop growth period and thus we can expect normal rainfall during most of monsoon season. While in case of Aurangabad station decreasing trend for 8th, 28th, 29th and 33rd week, for remaining weeks no trends were observed.

Trend analysis for Parbhani station indicate that during the monsoon period slightly increasing trend was observed during 24th meteorological week i.e. onset of effective monsoon and later on during 38th, 39th and 40th meteorological week. During withdrawal of effective monsoon, again slightly increasing trend was observed from 44th to 46th meteorological week.

During the 47th meteorological week significantly increasing trend in the occurrence of monsoon was observed. Occurrence of rainfall at the stage will be beneficial for the rabi season. A slightly decreasing trend in monsoon during 26th, 27th and 29th meteorological week which may affect the early crop growth stage. Similarly slightly decreasing trend during 33th to 36th meteorological week indicate the occurrence of dry spell and required attention for adoption of in-situ rainwater conservation techniques for maintaining soil water holding capacity and avoid water stress during crop drop period.

Trend analysis for Aurangabad station indicate that slightly decreasing trend in the occurrence of rainfall was observed during 24th to 26th meteorological week which may affect the sowing time of various crops during kharif season. Significantly decreasing trend of rainfall was observed during 28th, 29th and 33rd meteorological week which shows that the occurrence of early dry spell. This situation indicates that adoption of moisture conservation techniques and provision of supplement irrigation are highly essential for assured crop yield. During 45th to 47th slightly increasing trend in the occurrence of rainfall was observed indicating the availability of moisture for rabi crops.

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