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Smoothing of 70-Year Daily Rainfall Data Based on Moving Average and Weighted average Technique

K. Sasireka , S.Surianarayanan

Abstract: ***An extreme value analysis of rainfall for Thanjavur town in Tamil Nadu was carried out using 70 years of daily rainfall data. Moving average method is a simple method to understand rainfall trend of the selected station. The analysis has been carried out for monthly, seasonal and annual rainfalls. No other graphical methods such as Ordinate graph, Bar diagram, Chronological chart will describe about the trend or cyclic pattern. By smoothening out the extreme variations and indicating the trend or cyclic pattern is known as moving average curve. Through this moving average curve, it is possible to understand the trend which can be used in the future years. From the results of annual wise rainfall analysis, based on 3-year, 5-year, 10-year moving average, it is found that there is no persistent regular cycle is visible and where as in 30-year, 40-year, 50-year moving average a horizontal linear trend has been observed. In Winter season, Summer season, North-East monsoon, South- West monsoon wise rainfall analysis, for 3-year, 5-year, 10-year moving average denote no apparent trend or cyclicity where as in 30-year, 40-year, 50- year moving average a horizontal linear cycle has been noticed. It is clear from the study that there is no large variation of rainfall that had been occurred in the Thanjavur city based on selected years of analysis.***

Key words: ***Analysis, Comparison, Moving Average, Weighted Average, Rainfall.***

I. INTRODUCTION

An important aspect in hydrology is to interpret the future probabilities of occurrence from past records of hydrological events. The standard procedure for estimating the frequency of hydrological event is frequency analysis and moving average technique. The use of moving average technique is to find out the peak obtained through the smoothening curves. The objective of frequency analysis of hydrologic data is to relate the magnitude of extreme events to their frequency of occurrence using probability distributions.

Many applications in water resource engineering require proper evaluation of rainfall potential and its return period from available historic data. Examples include flood estimation in water sheds, water balance studies, rain water harvesting, water management studies, irrigation planning etc. Planning and development of water resources at local or regional level requires comprehensive and reliable information of hydrological data of the area under investigation. Assessing water availability of a region needs proper database; the absence of which can lead to erroneous planning and design. Long period data can provide reliable water resources assessment. The degree of uncertainty tends to be more if the data length is short. The magnitude of rainfall with various recurrence interval is important from irrigation scheduling point of view. Rainfall at a particular place is also known to be influenced by the results of its local/regional atmospheric and geomorphologic environments. Precipitation is the important parameter of Hydrological cycle. So, consumptive use of rainfall is to be considered. The present study aims to compare the results obtained from both simple moving average and weighted moving average and also the change in variations as per seasonal wise.

II. LITERATURE VIEW

Punithavathi et al. [1] carried out rainfall analysis, in order to identify the flood zone especially agriculture damages, hutment damages, transport damages due to flood in Thanjavur district. Annual 2 to 5 days consecutive were computed using the method described by Umarfarooque MominPrasad et al. [2], by summing up rainfall of corresponding previous days. Rainfall for 1 day and consecutive day's maximum rainfall for different return periods were determined by extreme value distribution called Gumbel's method. Rainfall over central Oman is due to the influence of the Oman convergence zone [3]. From 30-year period of rainfall analysis of the semi-arid southeast Spain observed neither trends nor abrupt changes, but they observed summer drought that indicated strong annual cycles. Trends and changes in rainfall intensities in arid and semi-arid environments are not easy to estimate and the same has been reported by several researchers. Using modern technique like Genetic Algorithm with Fuzzy System and ANN showed better accuracy in rainfall analysis [4]. Several studies have engaged in assessing the trend and a variability of rainfall data [5], [6] and [7].

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III. METHODOLOGY

A. *Simple moving average technique:*

In probability and statistics, mean and expected value are used synonymously to refer to one measure of the central tendency either of a probability distribution or of the random variable characterized by that distribution.

$$T_t = \frac{1}{k}\sum_{j=-m}^{m} Y_{t+j} \qquad (1)$$

where

T_t Moving average result value with Y=year/record data

B. *Weighted moving average technique:*

$$T_t = \sum_{j=-m}^{m} a_j Y_{t+j} \qquad (2)$$

where

m =(k-1)/2 and

a_j = weights for j-index,

Commonly used weight like Spencer's WMA and Henderson's WMA could be used in determining weight. Weight function like on above equation could also be used

$$a_j = \frac{Q(j,m)}{\sum_{-m}^{m} q(j,m)} \qquad (3)$$

$$Q(j,m) = \left(1 - \left(\frac{j}{m}\right)^2\right)^2$$

where Q (j, m)=Weight function.

III. STUDY AREA

Thanjavur, formerly Tanjore, is a city in the south Indian state, Tamil Nadu and it is an important centre of south Indian religion, art and architecture. Thanjavur district is more benefited by northeast monsoons because of its heavy rainfall and this district lies at the Cauvery delta region which is most fertile region in the state. The district is the main rice producing region in the state. Hence, it is known as "Rice Bowl of Tamil Nadu". The district is located at 10.08° N 79.16° E. The daily rainfall data is collected from meteorological station from the year 1906 to 1975.

IV. RESULTS AND DISCUSSION

From the 70 years daily rainfall data, by calculating Simple Moving Average (S.M.A) and Weighted Moving Average (W.M.A) the future trend of the rainfall is predicted. The analysis for annual wise rainfall as well as seasonal wise rainfall for 3-year, 5-year, 10-year, 20-year, 30-year, 40-year, 50-year, 60-year has been made.

A. *Annual wise rainfall analysis*

From Figure 1, the graph of 3 Year-wise Analysis, till 1919 the trend is going normal positive slope strength and after that it has been changed to abnormal (gradual rise) positive trend from 1919 to 1921, and then again it followed downward trend till 1924, and after that it follows up and down trend pattern and again in between 1931 to 1932 it has followed abnormal positive trend and then 1932 to 1936 abnormal downward trend. After that there is no much variation just followed downward trend from 1941 to 1953 and then it has been followed up and down ward trend simultaneously till the end of 1975. The above discussions show that the 3-year wise analysis, the rainfall trend is not normal. Similar rainfall analysis for 5-year, 10-year, 20-year also shows that there is no proper trend whereas for 30-year wise analysis which is shown in Figure 2, the horizontal linear trend has been observed. The same linear trend is observed for 40-year, 50-year, 60-year wise annual rainfall analysis.

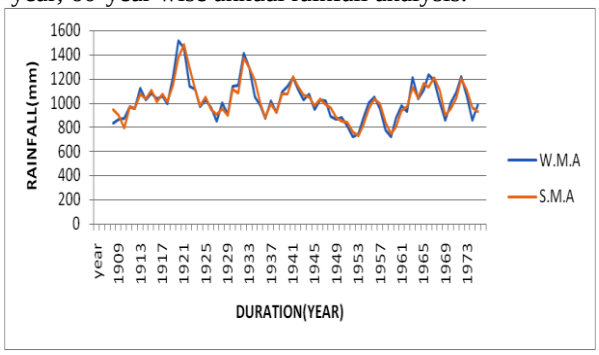

Fig. 1 3-year wise Annual Analysis

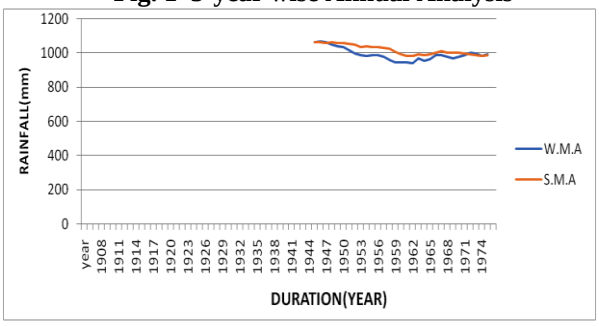

Fig. 2 30-year wise Annual Analysis

B. *Seasonal wise rainfall analysis*

Winter season

This season prolongs during January, February. During these months, there will be less rainfall when compared to monsoonal rainfall. Graph of 3 year-wise Analysis –winter season is shown in Fig. 3. The 3-year wise analysis for winter season, till 1923 it was an upward trend and then it attained downward trend till 1927 and after that it has attained an upward trend till 1931 and it has got downward trend till 1939 and then again it got upward trend from 1939 to1944, downward trend from 1944 to 1949, upward trend from 1949 to 1957, downward trend from 1958 to 1962. So, Overall trend is abnormal. . In the same way analysis has been made for all other year wise analysis in which for 5-year, 10-year, 20-year the trend is not normal whereas for 30-yearwise graph analysis also plotted which is shown in Fig. 4, 40-year, 50-year, 60-year wise annual rainfall analysis the horizontal linear trend has been identified.

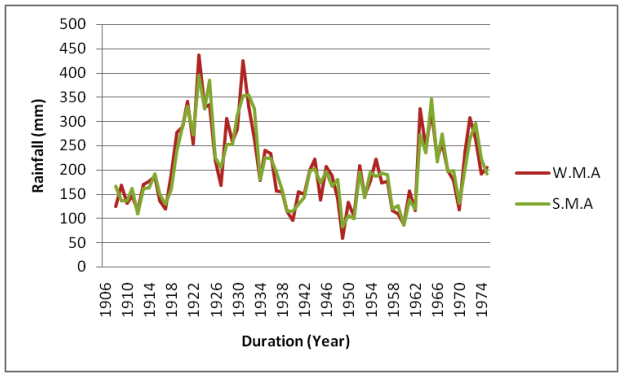

Fig. 3 3-year wise Winter season Analysis

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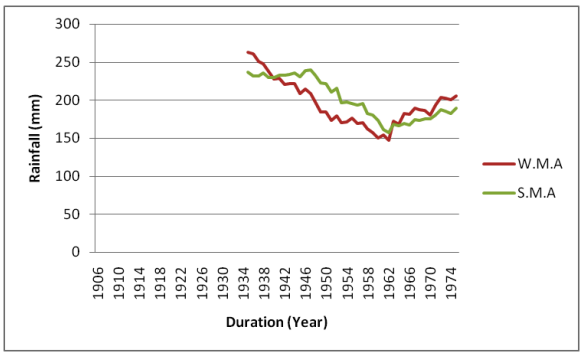

Fig. 4 30-year wise Winter season Analysis

Summer season

This season prolongs during March, April, May. Almost least rainfall will be recorded in this season. 3-year wise analysis for summer season is shown in Fig. 5, it was an upward trend till 1914 after that it has followed a downward trend till 1918 and then it was an upward trend till 1921 and then it is downward trend. Here there is no proper trend has been followed, it follows upward trend followed by downward trend. The overall peak is obtained at 1940 in upward trend where as in downward trend it is at 1952. Overall trend in this analysis is abnormal. In the same way analysis has been made for all other year wise analysis in which for 5-year, 10-year, 20-year there is no proper trend whereas for 30-year wise graph analysis also plotted is shown in Fig. 6. 40-year, 50-year, 60-year wise annual rainfall analysis the horizontal linear trend has been observed. The same trend can be predicted for the future years.

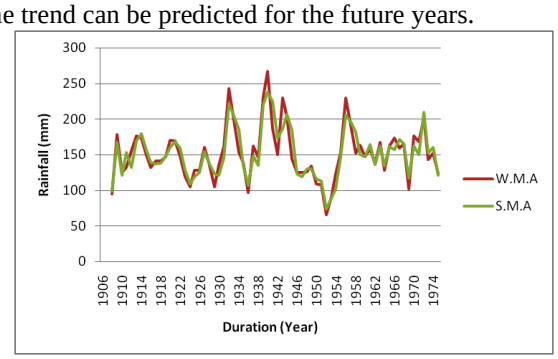

Fig. 5 3-year wise Summer season Analysis

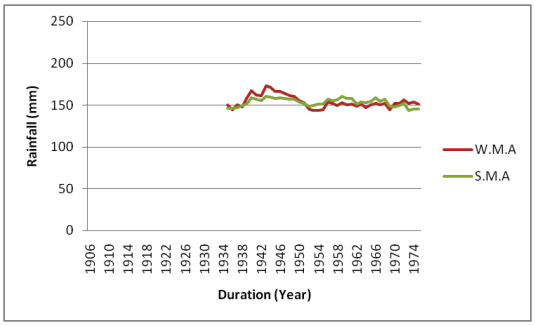

Fig. 6 30-year wise Summer season Analysis

C. *South-west monsoon*

This season prolongs during June, July, August, September. Moderate rainfall will be received in this monsoon. 3-year wise analysis for south-west monsoon is shown in Fig. 7, from 1908 to 1910 it was an upward trend and then to 1914 it was a downward trend and the it was an upward trend up to 1917. From 1922 to 1926 there is no much variation. The peak has been obtained at 1942 and after that it has followed a downward trend till 1959 and then it followed and upward trend till 1966 and then downward trend till 1969 and now it is following upward trend till the end of 1975. The overal trend in this analysis is not normal. The above adopted analysis has been made for 5-year, 10-year, 20-year wise analysis there is no cyclic trend for these years where as for 30-year wise analysis graph also plotted which is shown in Fig. 8, 40-year, 50-year, 60-year wise analysis the horizontal linear trend has been observed which can be adopted for the future years also.

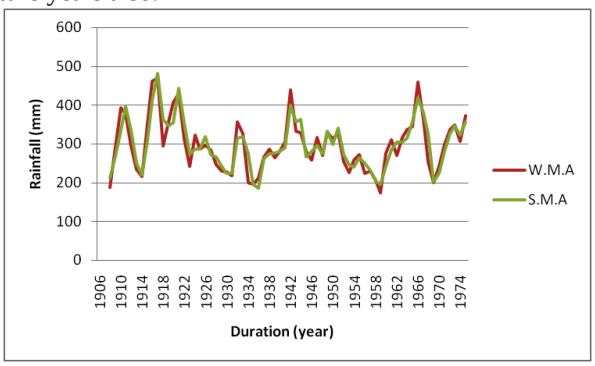

Fig. 7 3-year wise Southwest season Analysis

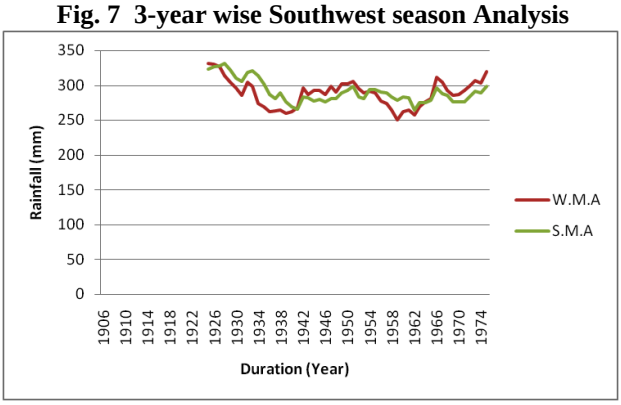

Fig. 8 30-year wise South-west seasonl Analysis

D. *North-east monsoon*

This season prolongs during October and November months. Highest rainfall will be recorded during these monsoons. Thanjavur will be more benefited by north-east monsoons. Figure 9 represents the 3-year wise analysis for north-east monsoon, the trend is abnormal and there is no specific trend observed in this analysis, starting from 1908 it was downward trend till 1910 and after that it was an upward trend till 1913 and then again it was downward up to 1917 and upward trend till 1920 and the again downward trend till 1924 and after that it has attained upward trend till 1934 and then downward till 1936 and again upward till 1941. At the end, it has followed a downward trend from 1970 to 1974 and then it is picking upward trend in 1975. So, the overall trend is not normal. In the same way analysis has been made for all other year wise analysis in which for 5-year, 10-year, 20-year there is no proper trend whereas for 30-year wise analysis graph also plottedis shown in Fig. 10, 40-year, 50-year, 60-year wise annual rainfall analysis the horizontal linear trend has been observed. We can predict this for future coming years also.

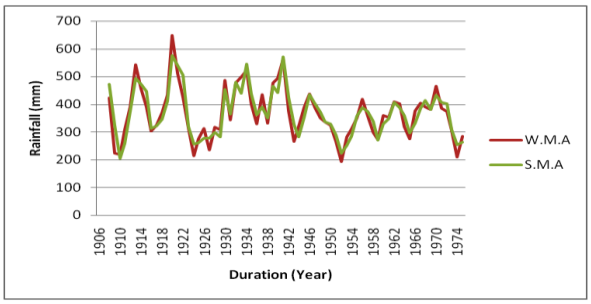

Fig. 9 3-year wise North-east season Analysis

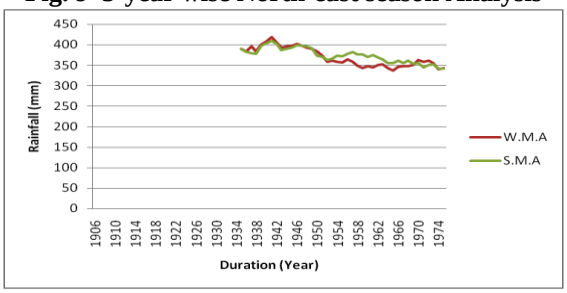

Fig. 10 30-year wise North-east season Analysis

V.CONCLUSION

The prime scope of this paper is to analyze the historical rainfall data and predict the management of water recourses for various purposes. The results obtained are very much statistical and of great use for future predictions and utilizations. From the results of annual wise rainfall analysis, based on 3-year, 5-year, 10-year, 20-year moving average, it is found that there is no persistent regular cycle is visible and where as in 30-year, 40-year, 50-year moving average a horizontal linear trend has been observed. In Winter season, Summer season, North-East monsoon, South- West monsoon wise rainfall analysis, for 3-year, 5-year, 10-year, 20-year moving average denote no apparent trend or cyclic where as in 30-year, 40-year, 50- year moving average a horizontal linear cycle has been noticed. It is clear from the study that there is no large variation of rainfall that had been occurred in the Thanjavur city based on selected years of analysis.

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