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A Study on Rainfall Pattern through Multivariate Approach

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ABSTRACT

An effort is made to study the rainfall pattern by using the Multivariate approach. This approach is based on the cluster analysis, this analysis would provide pattern of rainfall at different levels. The rainfall recorded in different periods of the season is generally inter-related, the approaches available for estimation of rainfall involve fitting of suitable statistical distribution on the period wise rainfall recorded over a period of time. However, in this approach the estimation is carried out independently corresponding to each period ignoring the possible inter relation between the rainfall of the other period. Hence, a multivariate approach is proposed which consider the inter-relation between the rainfall recorded in the different periods of the season. This approach was applied to study the rainfall pattern of the three mandals i.e, Sathupally, Vemsoor and Aswaraopet of Khammam district. The rainfall analysis was based on 20 years of monthly rainfall data from 1990 to 2009. The application of this approach identified rainfall pattern in the mandals.

Key words : Rainfall, Multivariate

There are several approaches available for carrying out cluster analysis. In the context of rainfall, it was found that the hierarchical approach of clustering was relatively more suitable than Canonical Approach. The hierarchical approach involves the classification on the basis of distances between the objects(i.e., year in the present situation);where as in Canonical Approach, the objects are classified on the basis of canonical scores. The Canonical Approach has a tendency to classify "distant objects more faithfully than the closer ones" (Rohlf,1970).Due to this tendency, the approach leads to more number of clusters as the closer objects are not given due weightage. On the contrary, the Hierarchical Approach and in particular, the Average linkage method gives more weightage to the closer objects, which leads to identify less number of clusters. Further, in the context of rainfall, the choice of distance between the years instead of the canonical scores is more appropriate for classification.

The cluster analysis would provide patterns of rainfall at different levels. Among these, pattern would represent the "assured" availability of rainfall. This can be identified from the cluster, which is relatively more frequent. The monthly average rainfall corresponding to the relatively more frequent cluster can be regarded as the "Multivariate Estimate" of rainfall. Since, a vector of variable is considered instead of single variable in the estimation process, the multivariate estimate thus duly considers the inter-relation between the variables of the vector.

MATERIAL AND METHODS

Let X be a random vector consisting of m variables. Let these variables represent the rainfall record of the period i.e., week/month of the season. Suppose that time series data for n years are available on the observation vector X.

The n years of rainfall data on the random vector X can be subjected to cluster analysis. The classification would provide clusters consisting of years of "similar" rainfall. Corresponding to each cluster, the average of the rainfall variable based on the number of years of similar rainfall can be computed. These cluster Averages indicate the pattern of rainfall in the season. The number of observations i.e., years in each cluster represents relative frequency of the occurrences of these patterns. It is obvious that these patterns would be at different levels,as the clusters are distinct.

The studies of Kulkarni and Reddy(1994) and Baldwin and Lakshmivarahan(2001) revealed that the hierarchical approach of clustering is relatively more suitable in analyzing the rainfall patterns. The approach classifies the objects, i.e., years in the present situation, on the basis of distance between them. The ward's minimum variance method of clustering, based on the hierarchical approach, can be applied for classification due to its several advantages over the other procedures (Seber,1984)

The hierarchical approach was applied to study the rainfall pattern of the three mandals of Khammam district in Andhra Pradesh. These mandals are Sathupally, Vemsoor and Aswaraopet.

Table 1.Pattern of rainfall-Sathupally mandal

(1990 – 2009)
Average rainfall (mm)

Clusters	No.of years	June	July	August	September	October
1	15	138.87	249.59	252.77	154.62	138.27
2	3	206.23	378.60	509.60	114.67	90.33
3	1 (2005)	129	418.80	171.80	676	224.60
4	1 (2006)	73.80	115	428.40	273.60	33.20
Average	20	145.23	270.67	296.03	180.65	130.14
SD		74.38	113.57	124.17	137.37	68.35
CV%		51.21	41.96	41.95	76.05	52.52

Table 2. Pattern of rainfall-Vemsoor mandal

(1990 – 2009)
Average rainfall (mm)

Clusters	No.of years	June	July	August	September	October
1	13	113.12	223.60	211.22	98.55	108.12
2	4	147.40	323.70	173.33	222.00	238.95
3	2	116.90	258.70	453.90	115.30	47.40
4	1(2006)	146.80	123	354.80	269	59.60
Average	20	122.04	242.10	235.09	133.44	125.79
SD		62.27	82.70	106.85	75.13	75.23
CV%		51.03	34.16	45.45	56.31	59.81

About 70 percent of the total rainfall is recorded during the SouthWest monsoon season. July is generally the rainiest month in Sathupally and Aswaraopet but in Vemsoor the maximum rainfall is spread in different way. Considering these characteristics of the mandals, the observation vector was defined with five rainfall variables. These variables represented the rainfall of five months from June to October. Rainfall patterns were obtained for all the three mandals on the basis of 20 years of rainfall data covering the years 1990 to 2009,by applying the Ward's method of clustering. The rainfall data were analysed by using the statistical software SYSTAT,version 10.0

RESULTS AND DISCUSSION

The cropping system of these three mandals namely Sathupally, Vemsoor and Aswaraopet of Khammam district are mainly depend on rainfall pattern. This leads to a considerable year to year variability in the rainfall recorded over the years. Considering this variability in the rainfall, the classification obtained in four clusters. This classification was done with years of similar rainfall as the variable. The results are presented mandal-wise in table 1 to 3.

The variability in the occurrence of rainfall over the years was found, in Sathupally mandal. It ranged from 42 percent in July and August months to about 76 percent in September. August was the rainiest month with an average rainfall of 296.03mm (Table.1).

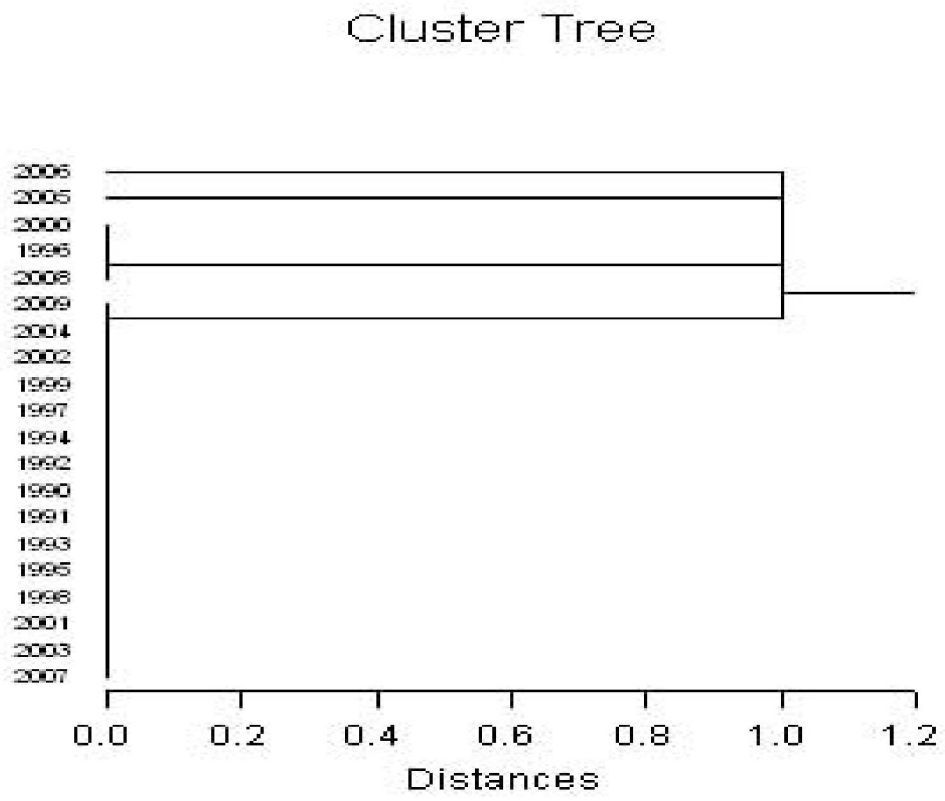
The highly inconsistent pattern in the rainfall was analysed through the cluster analysis in the form of four clusters. It was observed that a majority of the years i.e., 15 out of 20 years data exhibited a similar pattern in the rainfall. These years formed the first cluster and data is exhibited relatively most frequent pattern. In this cluster, rainfall ranged from

Table 3.Pattern of rainfall-Aswaraopet mandal

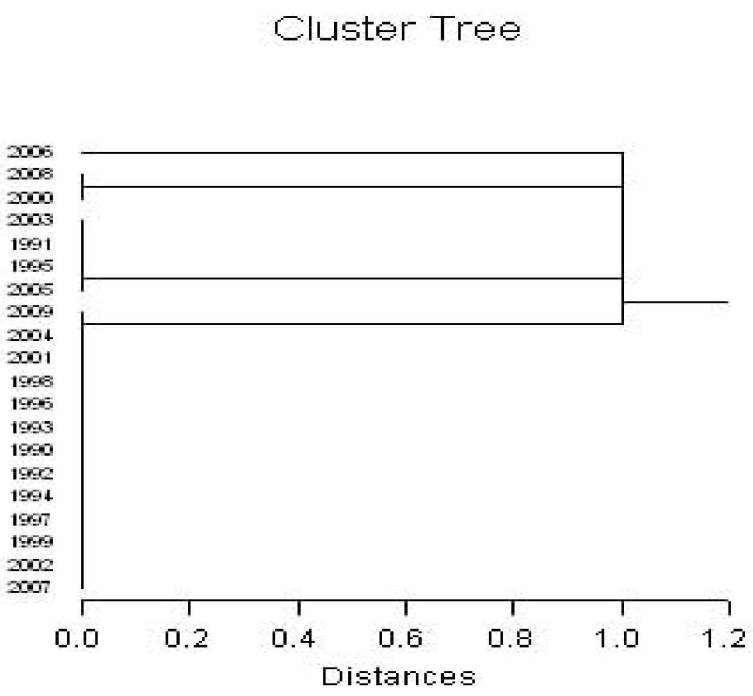
(1990 – 2009)
Average rainfall (mm)

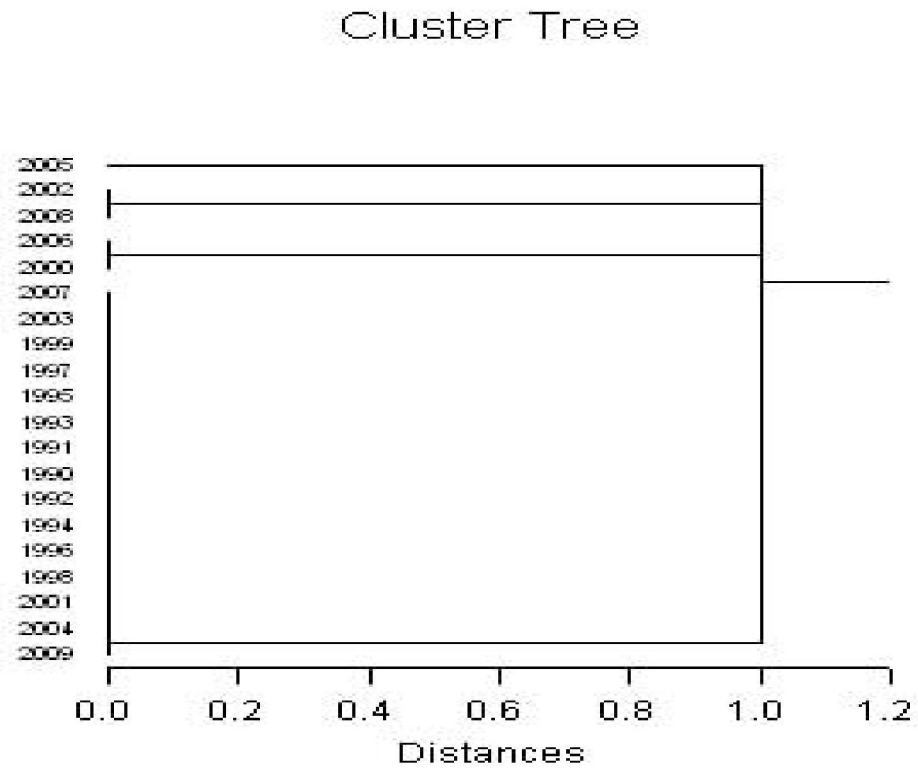
Clusters	No.of years	June	July	August	September	October
1	15	126.48	240.67	166.39	150.02	106.89
2	2	40.15	70.60	372.40	182.05	35.35
3	2	131.80	183.65	359.10	54.50	211.70
4	1 (2005)	187.00	312.50	127.80	491.20	139.60
Average	20	121.41	221.56	204.34	160.73	111.86
SD		74.36	104.19	100.11	97.56	70.16
CV%		61.25	47.03	49.00	60.70	62.72

Sathupally taluk



Vemsoor taluk





Aswaraopet taluk

138.27 mm in October to 242.77 mm in August. There were two single observation clusters. The years classified in these two single observations clusters were respectively 2005 and 2006.The characteristic of these two clusters was unusual rainfall in September month (676 mm; Year: 2005) and October month (33.2 mm; 2006).

The variability in the occurrence of rainfall over the years was found, in Vemsoor mandal. It ranged from 34 percent in July to about 60 percent in October. July was the rainiest month with an average rainfall of 242.10mm (Table.2).

The highly inconsistent pattern in the rainfall was observed through the cluster analysis in the form of four clusters. It was observed that a majority of the years i.e., 13 out of 20 years data exhibited a similar pattern in the rainfall. These years formed the first cluster and data is exhibited relatively most frequent pattern. In this cluster average rainfall over months ranged from 98.55 mm in September to 223.60 mm in July. The year 2006 was the single observation cluster and August (354.8 mm) was unusual rainfall

It was identified through the cluster analysis of rainfall data out of 20, 15 years is more similar pattern of rainfall ranges form 106.89 mm in October to 240.67 mm in July month. Only one year i.e., 2005 year was recorded more unusual rainfall i.e., 491.20mm in September month. The variation ranges from 47.03 percent in July month to 62.72 percent in October month and July month was rainest month with an average rainfall of 221.56 mm (Table.3)

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