The Andhra Agric. J 57(4):432-434, 2010

Assured Rainfall Estimation Through Percentiles

Key words : Assured rainfall, Dependable rainfall

Clasification was done based on the average rainfall. (White and Perry 1989, Driggs and Lemin Jr 1992 and Kulkarni and Reddy 1994). Rainfall recorded over a period of time generally exhibits considerable year to-year variation and is therefore inconsistent. Hence the choice of average rainfall would be appropriate only for summarizing the characteristics, but in appropriate for agricultural planning. The most suitable approach would be to obtain a classification based on "assured" availability of rainfall. Here, an attempt has been made to obtain a classification of the mandals of Khammam district, Andhra Pradesh, which accounts for the "assured" availability of rainfall.

Suppose there are 'm' mandals for which "n" years of monthly data are available. Let X(i) be the observation vector corresponding to the i-th mandal(i = 1,2..m).Let X(i) represents the estimates of assured rainfall of 'k' months of the seasons. Now, based on X(i),the 'm' regions are to be classified into homogeneous groups, as described below:

Estimates of Assured Rainfall- The assured rainfall which is also referred as 'dependable Precipitation' (DP) in the context of measuring the Moisture Availability Index (MAI),is the largest possible rainfall that can occur in a period (week/ month/season) at a given probability. The assured rainfall X(p) at p-th level of probability can be expressed with a probabilistic expression:

$$P[X \geq X(p)] = \int\int f(x)\,dx = p$$

Or, alternatively

$$P[X \leq X(p)] = 1-p[[X \geq X(p)] = (1-p) = q$$

i.e., X(p) is the $(1-p)^{th}$ percentile of the frequency distribution f(x) of the rainfall variable X.

It is thus obvious that as the level of q increases, the magnitude of X(p) also increase. However, the values at the higher percentiles are less frequent and therefore not "likely" to represent the assured rainfall. Hence, the choice of X(p) is corresponding to the lower percentiles. In this context, Viramani(1975) and Hargreves (1975) advocated p = 0.75 as the acceptable level for estimating the rainfall on monthly basis; where as Biswas and Sarker(1978) and Sarker,et al.,(1982) considered 50 percent probabilistic rainfall as the dependable as the precipitation for rainfall measured on weekly basis. Since the present study involves monthly rainfall data, the dependable rainfall X(p) was estimated at p = 0.75

The estimate of assured rainfall X(p) can be conveniently obtained from the percentile of the distribution f(x). X(p) is the (1-p)th percentiles of f(x).The percentiles of the rainfall distribution are generally obtained by fitting statistical distribution to the yearly rainfall data. These distributions are either Gamma or Normal distribution (Hills and Morgan 1981). A less restrictive approach, which do not assume any statistical distribution, was proposed by Davy, et al.,(1976). The approach involves empirically determining the percentiles from the array of rainfall data as follows: The 'n' years of rainfall data (corresponding to month) can be arranged in an ascending order of magnitude. Now, if q = (1-p) is any chosen level of proportion, the (100 x q)th percentile which is the estimate X(p),is represented by the (n x q)th value of the array.

Classification of mandals: The mandal wise rainfall data on the observation vector X (i) (i= 1,2,..m) which represents the vector of assured rainfall(of the rainfall month)obtained at p = 0.75 can be subjected to Cluster Analysis. Among the various methods of clustering, those based on Hierarchical approach and in particular, the Ward's Minimum Variance method can be applied due to its several advantages over the other approaches (Everitt 1974).

The approach outlined above was applied for obtaining the rainfall-based classification of three mandals of Khammam district. Classification was obtained by using 20 years of monthly rainfall data for the three mandals were considered.

The three mandals were considered as a cluster and taking the 5 rainfall variables in the observation vector. These variables were the monthly rainfall of June to October. Classification was done on the basis of two criterions: i.e mean rainfall and the estimates of assured rainfall. Statistical data was collected at Mandal Revenue Office's of each mandal.

Table 1. Characteristic of three mandals rainfall (mm) during 1990-2009

Mandal	June	July	August	September	October
Sathupally					
Average	145.23	270.67	296.03	180.65	130.14
C.V(%)	51.21	41.96	41.95	76.05	52.52
Estimate	73.8	191.4	214.6	90	77.6
Vemsoor					
Average	122.04	242.10	235.09	133.44	125.79
C.V(%)	51.03	34.16	45.45	56.31	59.81
Estimate	66.4	195.2	167.5	72.4	65.6
Aswaraopet					
Average	121.41	221.56	204.34	160.73	111.86
C.V(%)	61.25	47.03	49.00	60.70	62.72
Estimate	59.5	116.2	127.8	112.4	38

Table 2. Rainfall based classification of three mandals

Cluster	Mandal	Jun	Jul	Aug	Sep	Oct	Mandal	Jun	Jul	Aug	Sep	Oct
		Classification with Mean rainfall						Classification with Dependable rainfall estimate				
	Sathupally	121	222	204	133	112	Sathupally	60	116	128	72	38
	Vemsoor and Aswaraopet	145	271	296	181	130	Vemsoor and Aswaraopet	74	195	215	112	78

The rainfall characteristics of the mandals are presented in Table 1. In general, it can be observed that July and August are “peak” as well as the consistent rainfall months. The inconsistent nature of rainfall for agricultural planning. The most suitable choice would be the estimates of dependable, i.e., assured rainfall which is generally obtained at 0.75 level of probability.

The estimates of assured rainfall are obviously less than the corresponding mean values. If the distribution of the rainfall variable were symmetric, the mean values would represent the median or the 50^{th} percentile of the data; while the estimate of assured rainfall (or, the dependable rainfall) would represent the 25 percentile of the data. However, the frequency of occurrence of rainfall less than this estimate is sufficiently greater than with the mean values.i.e., at least a “minimum” possible rainfall represented by the estimate is “assured” with a probability of 0.75.

In light of these limitations of the mean values, and the results of cluster analysis, which are represented in table 2. Classification is done based on the estimates of assured rainfall among the three mandals. The dependable rain fall in the month of July and August is very high comparing to the June, September and October.

The mean values of the rainfall variables are always at higher level and also inconsistent. Hence, it is obvious that for agricultural planning, the classification based on the mean values would be misleading and may lead to heavy crop losses. With this effort the agriculturist effectively utilizing the assured rainfall data and accordingly plan his crop and prevent the heavy crop losses.

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(Received on 27.12.2010 and revised on 28.12.2010)