RESEARCH PAPER | International Journal of Agricultural Engineering | Volume 10 | Issue 2 | October, 2017 | 550-555
e ISSN–0976–7223 ■ Visit us : *www.researchjournal.co.in* ■ **DOI: 10.15740/HAS/IJAE/10.2/550-555**

Probability analysis of seasonal rainfall pattern for Ananthapuramu district of Andhra Pradesh

■ **B. LAXMAN, A. ANIL KUMAR, CH. RAMULU AND G. PRASANNA**

Received : 25.07.2017; **Revised :** 28.08.2017; **Accepted :** 14.09.2017

See end of the Paper for authors' affiliation

Correspondence to :

B. LAXMAN
College of Agricultural Engineering (A.N.G.R.A.U.), MADAKASIRA (A.P.) INDIA

■ **ABSTRACT :** Rainfall is the major controlling factor in planning of agricultural programmes, design and management of any water resource scheme. India is predominantly an agricultural country with about 60 per cent of the cultivated area under rainfed conditions. The present study was carried for Ananthapuram district which is one among the rainfed areas in the country.The design rainfall is calculated from the probability analysis. It is assigned some probability level of occurrence or exceedance. The daily or monthly rainfall analysis for a wide range of applications extending from real time monitoring and prediction of flood events to initialization and validation of numerical weather prediction (NWP), climate analysis and climate diagnostic study. The study showed there is a large variation in the rainfall received yearly as well as *Kharif* and *Rabi* seasons. Similarly the co-efficient of variation is 39.15 per cent for yearly rainfall, 57.35 per cent for *Kharif* and 65.18 per cent for *Rabi* seasons this indicates the annual rainfall data are less variable and is more stable or more uniform. The probability analyses were conducted for the year 2001-2012. Probability of getting 2012 year wise as well as season wise the yearly rainfall is 731mm only five per cent and probability of getting 413mm is 94.9 per cent. It indicates that the last 12 years trend shows the yearly rainfall will not cross 400-500 mm which is the bench mark for designing the crops that are to be grown in Ananthapuramu district. Similar trends were noticed in the probability analysis in season wise. When analyzed statistically there was a negative correlation between water requirement and yield and similarly positive correlation between rainfall and yield, the results are reflected. The trend values are shown linearly dependent. There is a perfect linear dependency on the trend values. The actual crop water requirements are progressively decreasing from 2012 to 2020.

■ **KEY WORDS :** Rainfall, Probability analysis

■ **HOW TO CITE THIS PAPER :** Laxman, B., Kumar, A. Anil, Ramulu, Ch. and Prasanna, G. (2017). Probability analysis of seasonal rainfall pattern for Ananthapuramu district of Andhra Pradesh. *Internat. J. Agric. Engg.*, **10**(2) : 550-555, **DOI: 10.15740/HAS/IJAE/10.2/550-555.**

India is predominantly an agricultural country with about 60% of the cultivated area under rainfed conditions. Rainfall variability has major implications on country's economic prosperity. In addition to irrigation and crop planning, rainfall information is also useful for introduction of new crops in an agro-ecological region, identifying moisture availability periods, developing drought characterization index, designing of drainage structure and devising water harvesting polices.

Ananthapuramu is the southern-most district of the Rayalseema region of Andhra Pradesh. The district has a total geographical area of 19.13 lakh hectare. Agriculture remains the predominant activity in the villages, with 80 % of total workers engaged in

agriculture, either as cultivators or agricultural labourers. It is located in the rain-shadow region of Andhra Pradesh, the district is drought-prone.

The geographical location of Ananthapuram district is such that it does not get the full benefit of either of the monsoons. The south-west monsoon gets cut off by the western ghats, while the full benefit of the north-east monsoon is not derived, as the district lies far from the eastern coastline. The normal rainfall in this district is 553 mm. On an average once in every five years, the district experiences drought conditions. The rainfall zones are classified as 341-400 mm, 401-500 mm, 501-600 mm and 601-700 mm.

Rainfall is the major controlling factor in planning of agricultural programmes, design and management of any water resource scheme. In case of rainfed areas, it are still more significant in planning of farming operations. The occurrence or non-occurrence of rainfall at decisive times can resolute the accomplishment or miscarriage of a venture in agricultural production, germination of seeds, drying of crops, application of irrigation, fertilizers, insecticides and herbicides.

Rainfall is a stochastic variable and a large number of annual rainfall data are needed for its depth and duration frequency analysis. High rainfall less often occurs. Higher the recurrence of large rainfall there is a need for soil conservation and water harvesting yields structures, *viz.*, contour trenches, contour bunds, spillways, water harvesting structures, check dams etc.

Antonia *et al.* (2009), studied rainfall time series over a wide time interval and area, detecting potential trends. Statistical analysis indicates that the trend appears predominantly negative, both at the annual and seasonal scale, except for the summer. Hyun-Han *et al.* (2008), proposed a dynamical hierarchical Bayesian analysis to govern the summer rainfall. This shows that the probability of occurrence of extreme events is projected at 90% rate. Christian and Ebenebeizuchkwu (2009), examined the variations in rainfall distributions during the "little dry season". This reported that the temporal variations in rainfall for the months under consideration were not significant. Changa *et al.* (2010), investigated on indigenous knowledge in seasonal rainfall prediction in Tanzania. It has been found that plant phenology is widely used by local communities in both districts in seasonal rainfall forecasting. Ishappa and Aruchamy (2010) studied the rainfall characteristics of the Coimbatore. This study analyzes the long term average of monthly and annual rainfall, the annual rainfall is 1242 mm, of which the winter, summer, southwest and northeast monsoon record 2.07, 14.97, 46.13 and 36.83 mm, respectively. Sharad and Kumar (2012), conducted a study on basin-wise trend analysis. It showed 15 basins had decreasing trend in annual rainfall and only one basin showed significant decreasing trend.

METHODOLOGY

Analysis rainfall pattern in Ananthapuram :

Rainfall is one of the most important and at the same time one of the most difficult meteorological /hydrological parameter on which the economy of India depends. There has been increasing operational demands for daily or monthly rainfall analysis for a wide range of applications extending from real time monitoring and prediction of flood events to initialization and validation of numerical weather prediction (NWP), climate analysis and climate diagnostic study.

A detailed knowledge of the rainfall regime at a place is an important prerequisite for agricultural planning and management. More so far rainfed agriculture rainfall is the single most important agro-meteorological variable influencing crop production. In the absence of reliable physically based seasonal forecasts, crop management decisions and planning have to rely on statistical assessment based on the analysis of historical rainfall records.

Design rainfall :

It is defined as the total amount of rain during the cropping season at or above which the catchment area will provide sufficient runoff to satisfy the crop water requirements. If the actual rainfall in the cropping season is below the design rainfall, there will be moisture stress for crop. If the actual rainfall exceeds the design rainfall, there will be surplus runoff which may cause damage to the structures. The design rainfall is calculated from the probability analysis. It is assigned some probability level of occurrence or exceedance. Suppose the probability of 67 per cent is given to rainfall, it indicates that the seasonal rain fall may occur or exceed 2 years out of 3 and therefore, the crop water requirements would also be met two years out of three in a crop season. More the probability of the rainfall, it is more reliable for getting assured runoff into the farm ponds.

The design rainfall has to be calculated as suggested in section rainfall analysis. A conservative design would be based on a higher probability in order to make the system more reliable and thus to meet the crop water requirement more frequently.

Statistical parameters of rainfall :

- Mean(Average of rainfall)
- Standard deviation (SD)
- Co-efficient of variation (Cv)

Mean :

The sample mean is the average and is computed as the sum of all the observed outcomes from the sample divided by the total number of events. Here indicated as the symbol for the sample mean.

$$\bar{X} = \frac{\Sigma X}{n} \quad (1)$$

where n is the sample size and the x correspond to the observed valued.

Standard deviation of the sample :

In statistics and probability theory, standard deviation ( ) shows how much variation or "dispersion" exits from the average (mean, or expected value). A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data points are spread out over a large range of values. An estimator for sigma sometimes used is the standard deviation of the sample, denoted by SN and define as follows. Standard deviation (σ).

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2} \quad (2)$$

where (x_1, x_2,------,x_n) are the observed values of the sample items and is the mean value of these observations, while the denominator N stands for the size of the sample.

Co-efficient of variation :

Co-efficient of variation is the percentage variation between mean, standard deviation being considered as the total variation from the mean. High CV indicates that the group is more variable and less stable.

$$CV = \frac{\sigma}{m} \times 100 \quad (3)$$

In other words co-efficient of variation is defined as ratio of the standard deviation to the mean.

Probability analysis :

A simple graphical method can be used for probability analysis and frequency of occurrence of annual or seasonal rainfall for the design of ponds. There are several analytical methods by selecting a suitable probability distribution function. Weibulls distribution is commonly used for its simplicity and easy to adaptation for such field situations. The occurrence of probability for each of the ranked observation can be calculated from the below equation (Critchley *et al.*, 1991) for the period N=10 to 100.

$$P = \frac{m - 0.375}{N + 0.25} \times 100 \quad (4)$$

where,

P = Probability in % of the observation of the rank m

m = Rank of the observation

N = Total number of observations used.

Percentage deviation from normal :

The percentage deviation formula is very useful to determining accurate values in the rain fall data.

Percentage deviation = ((Yearly annual rainfall - Average annual rainfall) ÷average annual rainfall) ×100

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Rainfall analysis :

The rainfall data were obtained for the period 2001-2012 from Agricultural Research Station, ACRIP on Agro-meteorology, Ananthapuramu. Rainfall analysis was carried out using various statistical methods. The average yearly rainfall in Ananthapuramu district is 573.54 mm. The average rainfall of *Kharif* and *Rabi* season is 355.5mm and 86.48mm, respectively. The standard deviation for yearly rainfall is 224.52 mm, for *Kharif* 203.95 mm and *Rabi* 56.36 mm (Table 1). This shows there is a large variation in the rainfall received yearly as well as *Kharif* and *Rabi* seasons. Similarly the co-efficient of variation is 39.15 per cent for yearly rainfall, 57.37 per cent for *Kharif* rainfall and 65.18 per

Table 1 : Yearly rainfall data of *Kharif* and *Rabi* during 2001-2012

Year	Total rainfall (mm)	*Kharif* rainfall (mm)	*Rabi* rainfall (mm)
2001	731.20	477.2	88.6
2002	389.40	127.8	37.5
2003	256.20	148	13.6
2004	495.60	251.80	122.60
2005	685.00	462.00	70.40
2006	450.60	224.80	3.50
2007	1073.89	857.40	21.70
2008	619.00	386.40	109.80
2009	417.00	214.20	127.00
2010	885.80	595.60	200.00
2011	466.00	231.40	132.40
2012	412.80	289.40	110.60
Mean	573.54	355.50	86.48
Standard deviation	224.52	203.95	56.36
CV	39.15	57.37	65.18

Table 2 : *Kharif* rainfall in % deviation

Year	*Kharif* actual rainfall (mm)	Normal rainfall (mm)	% Deviation
2001	477.2	351.03	35.94
2002	127.8	351.03	-63.59
2003	148	351.03	-57.84
2004	251.8	351.03	-28.27
2005	462	351.03	31.61
2006	224.8	351.03	-35.96
2007	857.4	351.03	144.25
2008	386.4	351.03	10.08
2009	214.2	351.03	-38.98
2010	595.6	351.03	69.67
2011	231.4	351.03	-34.08
2012	235.8	351.03	-32.83

Table 3 : *Rabi* rainfall in % deviation

Year	*Rabi* actual rainfall (mm)	Normal rainfall (mm)	% Deviation
2001	88.6	86.48	2.45
2002	37.5	86.48	-56.64
2003	13.6	86.48	-84.27
2004	122.6	86.48	41.77
2005	70.4	86.48	-18.59
2006	3.5	86.48	-95.95
2007	21.7	86.48	-74.91
2008	109.8	86.48	26.97
2009	127	86.48	46.85
2010	200	86.48	131.27
2011	132.4	86.48	53.10
2012	110.6	86.48	27.89

Table 4 : Yearly rainfall in % deviation

Year	Yearly rainfall (mm)	Normal rainfall (mm)	% Deviation
2001	731.2	573.44	27.49
2002	389.4	573.44	-32.11
2003	256.2	573.44	-55.33
2004	495.60	573.44	-13.59
2005	685.00	573.44	19.43
2006	450.60	573.44	-21.44
2007	1073.89	573.44	87.24
2008	619.00	573.44	7.93
2009	417.00	573.44	-27.29
2010	885.80	573.44	54.44
2011	466.00	573.44	-18.75
2012	412.80	573.44	-28.03

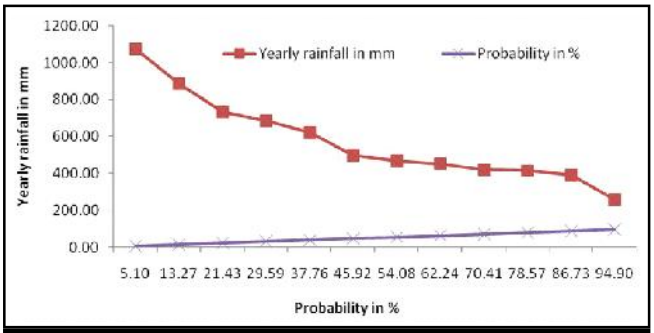

Fig. 1 : Yearly rainfall and probability graph from 2001-2012

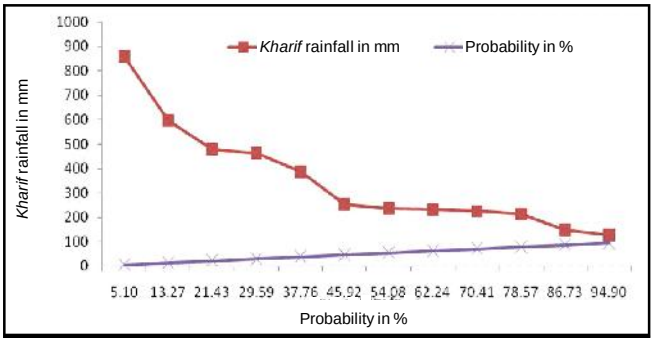

Fig. 2 : *Kharif* rainfall and probability graph from 2001-2012

cent for *Rabi*. This indicates that the yearly rainfall data is less variable and is more stable.

For the year 2001-2012 the percentage deviation was calculated with respect to yearly rainfall as well as seasonal rainfall. There is a negative trend over the years starting from 2001-2012 except during the year 2005, 2007 and 2010. The rain fall received in the year 2007 is 87.24 per cent which is above the average rain fall. Similarly in the year 2012 is 131 per cent and 144 per

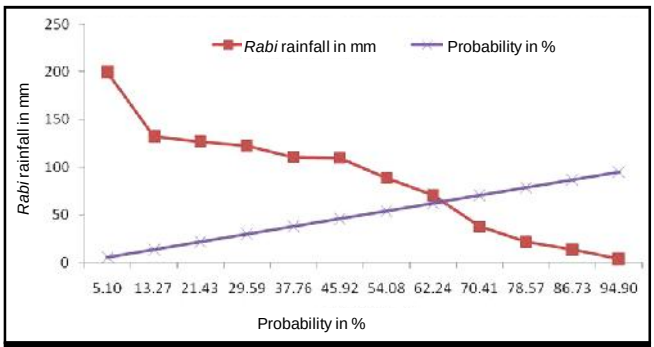

Fig. 3 : *Rabi* rainfall and probability graph from 2001-2012

cent in 2007 (Table 2-4).

Probability analysis :

The probability analyses were conducted for the year 2001-2012. Probability of getting 2012 year wise as well as season wise the yearly rainfall is 731mm only five per cent and probability of getting 413mm is 94.9 per cent. It indicates that the last 12 years trend shows the yearly rainfall will not cross 400-500 mm which is the bench mark for designing the crops that are to be grown in Ananthapuramu district. Similar trends were noticed in the probability analysis in season wise. Probability of getting 127.8mm in *Kharif* season is more than the probability of getting 857.4mm. During the *Rabi* season the probability of getting 3.5 mm is more than probability of getting 200 mm (Fig. 1 -3).

Conclusion :

– When analyzed statistically there was a negative correlation between water requirement and yield, and

similarly positive correlation between rainfall and yield, the results are reflected. The trend values are shown linearly dependent. The actual crop water requirements are progressively decreasing from 2012 to 2020.

– The average yearly rainfall in Ananthapuramu district is 573.54mm. During the *Kharif* period the average rainfall is 355.5mm and 86.48mm in *Rabi*, respectively. The standard deviation for yearly rainfall is 224.52 and for *Kharif* 203.95 and *Rabi* 56.36. The co-efficient of variation is 39.15per cent for Yearly rainfall, 57.31per cent for *Kharif* and 65.18per cent for *Rabi* rainfall. Hence the annual rainfall data is more stable.

– The average yearly rainfall in Ananthapuramu district is 573.54 mm. The average rainfall of *Kharif* and *Rabi* season is 355.5mm and 86.48mm, respectively. The standard deviation for yearly rainfall is 224.52 mm, for *Kharif* 203.95 mm and *Rabi* 56.36 mm. This co-efficient of variation is 39.15 per cent for yearly rainfall, 57.35 per cent for *Kharif* rainfall and 65.18 per cent for *Rabi*. Hence, the annual rainfall data is less variable and is more stable

– The probability analyses were conducted for the year 2001-2012. Probability of getting 2012 year wise as well as season wise the yearly rainfall is 731mm only five per cent and probability of getting 413mm is 94.9 per cent. It indicates that the last 12 years trend shows the yearly rainfall will not cross 400-500 mm which is the bench mark for designing the crops that are to be grown in Ananthapuramu district. Similar trends were noticed in the probability analysis in season wise.

Authors' affiliations:
A. ANIL KUMAR, CH. RAMULU AND G. PRASANNA, College of Agricultural Engineering (A.N.G.R.A.U.), MADAKASIRA (A.P.) INDIA

■ REFERENCES

Antonia, Longobardi and Paolo, Villani (2012). Trend analysis of annual and seasonal rainfall time series in the Mediterranean area. *International Journal Climatolology published online in Wiley Inter Science*. DOI: 10.1002/joc.2001.

Changa, L.B., Yanda, P.Z. and James, Nagana (2010). Published a Research paper on Indigenous knowledge in seasonal rainfall prediction in Tanzania. *J. Geography & Regional Planning*, **3**(4): 66-72

Christian, E.I. and EbenebeIzuchkwu (2009). Analysis of rainfall distribution over Enugu during the little dry season (1990-2005). *J. Geography & Regional Planning*, **2**(7) : 182-189.

Critchley, W., Siegert, K. and Chapman, C. (1991). Water Harvesting, A Manual Guide for the Design and Construction of Water Harvesting Schemes for Plant Production. FAO, Rome.

Hyun-Han, K., Abedalrazq, F., Khalil and Siedfried (2008). Analysis of extreme summer rainfall using Climate Teleconnections and Typhon Characteristics in South Korea. *J. American Water Resour. Association*, **44** (2): 436-448.

Ishappa, M.R. and Aruchamy, S. (2010). Spatial analysis of rainfall variation in Coimbatore DistrctTamilnadu using GIS. *Internat. J. Geometries & Geosci*., **1** (2) : 106-118.

Sharad, K.J. and Kumar, Vijay (2012). Trend analysis of rainfall and temperature data for India. *Curr. Sci.*, **102** (1) : 37-49.