Meterological Drought Assessment of Rayalaseema Region

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ABSTRACT *Rayalaseema region comprising the four districts of Ananthapur, Chittoor, Kadapa and Kurnool is located in the southern part of Andhra Pradesh. Frequent drought occurrence from the 19th century onwards is the prime cause of backwardness of Rayalaseema region, depressing its economy to stagnation and poverty. Chronically drought prone Rayalaseema region has become a foster child of the state Andhra Pradesh. The climate in Rayalaseema region is mostly dry with very low annual rainfall. The subject field of assessment of drought in Rayalaseema therefore becomes very significant to plan effective management of the limited water resources available.. Drought indices play a substantial role in drought assessment. In the present survey, district wise drought probabilities over Rayalaseema districts of Andhra Pradesh, which are severely prone to droughts, has been established using meteorological drought indices. The meteorological drought indices are: Deciles,Standard Precipitation index(SPI),Reclamation Drought Index (RDI). Such type of information would be a beneficial instrument for planning roles and for input in modelling.*

INTRODUCTION

Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. Definitions of meteorological drought must be considered as region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region. Meteorological Drought is a temporary, recurring natural disaster, which originates from the lack of precipitation and brings significant economic losses. It produces an air of doom and despair.Drought is a slow poison, no one knows when it sneaks in, it can last any number of days and its severity cannot be anticipated. It is not possible to avoid droughts. But drought preparedness can be developed and drought impacts can be managed. The success of both depends, amongst the others, on how well the droughts are defined and drought characteristics quantified. Drought indices are one of the most important elements of an effective drought monitoring and early warning system. They serve to characterize drought and guide appropriate responses to reduce drought impacts. Drought indicators are more useful than raw data in the decision-making process, even though each index has a specific use and limited by its strengths and weaknesses. In this study Deciles,Standardized precipitation index and the Reconnaissance drought index were used for meteorological drought assessment.

Deciles:

The distribution of the time series of the cumulated precipitation for a given period is divided into intervals each corresponding to 10% of the total distribution (decile). Gibbs and Maher (1967) proposed to group the deciles into classes of events as listed in the Table 1:

Table 1: Decile values

Class	Percent	Period
Decile 1-2	20% lower	Much below normal
Decile 3-4	20% following	Below normal
Decile 5-6	20% medium	Near normal
Decile 7-8	20% following	Above normal
Decile 8-9	20% higher	Much above normal

Standardized Precipitation Index:

The Standardized Precipitation Index (SPI) was developed by McKee et al (1993). The SPI is based only on precipitation. The SPI assigns a single numeric value to the precipitation, which can be compared across regions and time scales with markedly different climates. Jain et al. (2010) reported that there are a number of indices to quantify drought using meteorological data; however, the SPI is most widely used index. SPI can be computed at different time scales and hence can quantify water deficit so different duration.SPI was designed to demonstrate that it is possible to simultaneously go through wet conditions on one or more time scales and dry conditions at another time scale.The calculation of the index needs only precipitation record. It is calculated by considering the precipitation anomaly with regard to the average value for a given time scale, separated by its standard deviation. The precipitation is not a normal distribution, at least for time-scales less than one year. Therefore, the variable is adjusted so that the SPI is a Gaussian distribution with zero mean and unit variance.Adjusted index allows comparing values related to different areas. Moreover, because the SPI is normalized, wet and dry climates can be monitored in the same way. The index computation is founded on the following aspects:

$$SPI = \frac{X_I - X}{\sigma} \ldots\ldots\ldots\ldots\ldots 1$$

Where, X: the mean annual rainfall, X_i: the annual rainfall at any year and σ : the standard variation.

Table 2: SPI values and its indication of drought

SPI VALUES	
2.0+	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severly dry
-2 to less	Extremely dry

Reconnaissance Drought Index (RDI):

A new reconnaissance drought identification and assessment index was first presented by Tsakiris, 2004 while a more comprehensive description was presented in Tsakiris et al. (2006). The index, which is mentioned to as the Reconnaissance Drought Index, RDI, is being worked out by the following equations.

$$\alpha_0 = \frac{\sum_{j=1}^{12} P_{ij}}{\sum_{j=1}^{12} PET_{ij}} \quad i= 1 \text{ to } N \text{ and } j= 1 \text{ to } 12 \ldots\ldots 2$$

In which P_j and PET_j are the precipitation and potential evapotranspiration of the month j of the year i.

$$RDI_{ST}^i = \frac{y_i - \overline{y}}{\hat{a}_y} \ldots\ldots\ldots 3$$

In which y$^{(i)}$ is the $\ln(\alpha_0)$ $\overline{y}$ is its arithmetic mean and $\hat{a}_y$ is its standard deviation.

Table 3: RDI Values and its indication on drought

RDI VALUES	
2.00 or more	Extremely wet
1.5 to 1.99	Severly wet
1.00 to 1.49	Moderately wet
0 to 0.99	Normal conditions-wet
0 to -0.99	Normal conditions -dry
-1 to -1.49	Moderate drought
-1.5 to -1.99	Severe drought
-2 or less	Extreme drought

STUDY AREA AND DATA COLLECTION

Rayalaseerna is one of the three major geographical regions of Andhra Pradesh. The other two regions are Coastal Andhra and Telangana. The Rayalaseema region of Andhra Pradesh comprises of four southern districts of Kurnool, Anantapur, Cuddapah and Chittoor. It has an area of about 73,495 sq.kms, and forms 24.46 percent of total area of Andhra Pradesh.The region lies in between the north latitudes 12° 57′ - 16° 00′:and and east longitude 76° 37′ - 80°00.Half of the region of Rayalaseema region were identified as hard-core drought prone areas

Climate

The Rayalaseema region belongs to the arid and semi arid, temperate region of India with an average rainfall ranging from 350 to 650 millimeter. Of the entire annual rain, about 90% is obtained during the south-west monsoon season (June–September) and the remainder of the year remains nearly dry. The climate is of extreme type, with May being the hottest month with mean daily maximum and minimum temperature of 42 °C and 31 °C respectively.

Figure 1: study area-Rayalaseema Districts

The blue region of the map shows study area(Rayalaseema region).

Data Collection

Monthly rainfall, potential evapo-transpiration, and other related data for 112 years from all the rain gauge stations were collected from Indian Meteorological Departement. The actual drought year data from Department of Agriculture, Andhra Pradesh

Methodology
Deciles

Using Table 1, the deciles were estimated for 112 years of monthly rainfall data. It is seen that all the years are coming under the class of deciles 1-2 (20%lower), which is considered much below the normal and are drought affected years. Figure:2 shows the class deciles from the years 1901 to 2012. It has been observed that the drought is affecting Ananthapur district the most and Chittoor district the least.
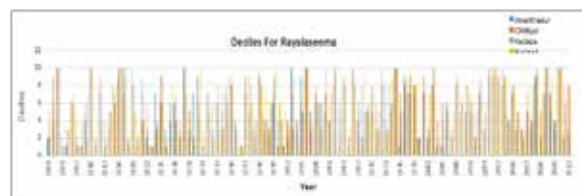

Figure 2: Deciles For Rayalaseema Districts

Standardized Precipitation Index (SPI):

The SPI has been applied in the study area to quantify annual precipitation deficits anomalies on an annual scale for the period during 1901 to 2012.The estimate of SPI values for the time scale of 12 months has been estimated. The estimated value of SPI demarcates precipitation events over a specified time period into surplus (heavy Precipitation), medium/normal, low/deficits precipitation. The analysis revealed that the extreme drought events with SPI values less than -2 are hardly seen. In the year 1923 Ananthapur and Chittoor, Kadapa in the year 1904 had this extreme sort of post. Otherwise, they all fall in the range of moderate to severe dry situation more frequently. SPI plot of Rayalaseema district is shown in Figure:3
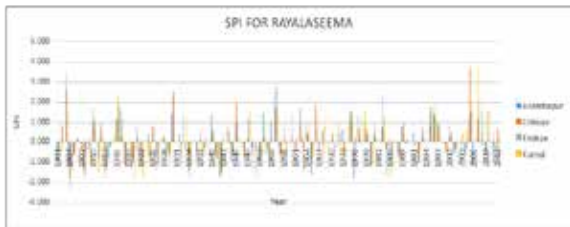
Figure 3: SPI For Rayalaseema Districts

Reconnaissance Drought Index (RDI)

The computation for RDI was carried out for drought assessment in Rayalaseema regions. Its range is similar to that of SPI. Its value -1 or less indicates a dry condition. -1 to -1.49 moderately dry, -1.5 to -1.99 severely dry, -2 or less extremely dry. This study has been done for a period of 1901 to 2002. Figure 4 indicates the RDI values for all the districts of Rayalaseema. From the figure 4 it is seen that in the year 1923 almost all districts are drought affected in the range of moderate to severe dry.
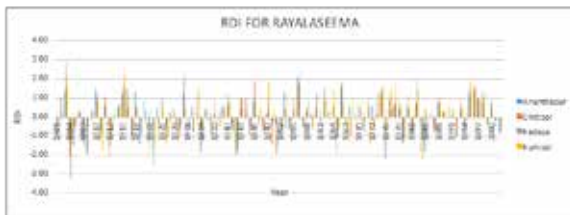

Figure 4 RDI For Rayalaseema Districts

Results:

Comparison of Results Obtained From Drought Analysis by Different Indices with Actual Data:

Actual data is used from "Status of Agriculture in Andhra Pradesh", Directorate of Agriculture,Andhra Pradesh which indicate 1986,1987,1992,1994,1999,2002 and 2011 were drought years with ranging from Mild to moderate drought whereas 1980,1984 and 2009 was a severe drought years. From the Table 4 it is summarized that when we look for only severe drought according to the actual data SPI ,Deciles and RDI gives better result .

Table 4: Drought Affected Years Resulted From Meteorological Drought Analysis;

District	Deciles	SPI	RDI	ACTUAL
Ananthapur	1980,1984,1985, 2006,2011,2013	1980,1984,1985, 2006,2011,2013,	1980,1984,1985	1980(SD),1982(MD),1984(SD),1986 (MD),1987(MD)1 992(MD)1994(MD)1999(MD)2002 (MD)2009(SD)20 11(MD)
Chittoor	1980,1982,1987, 1992	1980,1992	1980,1992	1980(SD),1982(MD),1984(SD),1986 (MD),1987(MD)1 992(MD)1994(MD)1999(MD)2002 (MD)2009(SD)20 11(MD
Kadapa	1980,1984,1992, 2006,2012	1980,1984,2006	1980,1984	1980(SD),1982(MD),1984(SD),1986 (MD),1987(MD)1 992(MD)1994(MD)1999(MD)2002 (MD)2009(SD)20 11(MD)
Kurnool	1980,1984,1985, 2002	1980,1984,1985	1980,1984,1985	1980(SD),1982(MD),1984(SD),1986 (MD),1987(MD)1 992(MD)1994(MD)1999(MD)2002 (MD)2009(SD)20 11(MD)

Conclusion

An assessment of meteorological droughts in the Rayalseema region of Andhra Pradesh was conducted based on monthly precipitation data in the period 1901to 2012. Indices applied in this study include Deciles, standardized precipitation index and reconnaissance drought index at time scales of 12 months. The results showed that SPI and RDI demonstrate the severe drought pattern successfully for raylaseema region. Deciles indicate the values of threshold which include severe droughts too. The method can provide valuable information for water resources planners and policy makers in developing appropriate management to cope with drought consequences. . It has been observed that Ananthapur district is severely affected by the drought most of the time.However, Chittoor, Kadapa and Kurnool are also in the line of Ananthapur.

REFERENCE Heim.R.R(n.d.).AReviewof twentiethcenturyDrought Indices used in the united states Bulletin of the American Meteorological Society. Bullet inof the American Meteorological Society. | DIA A, D. (2010.). Drought under global warming: A review. WIRES CLIM CHANG.2: -65.DOI"10.1002/WCC.81 | M, Allaby..Statement on meteorological | drought (Vols. 771-733). American Meteorological society (AMS). | D. Tigkas. (2013). Drought characterization and Monitoring in regions of Greece. European water in Regions of Greece. | RasoulMirabbasi, E. N. (n.d.). Analysis of meteorological drought in the northwest Iran uses the Joint Defect Index. Journal of Hydrology. | Mishra, A. (2010). A Review of Drought concepts. Jornal of Hydrology. | World meteorological organization, (1997). Climate, Drought and Desertification. | Danpanah, H. y. (2003). Regional assessment of Meteorological drought in Azarbaijan province using the SPI model and GIS. Map India. | catherine, M. (2013). An assessment of meteorological drought occurrence and severity in Uganda.Makarereuniversity. | G, Appa Rao (1981). Atmospheric Energies Over india during drought and normal monsoon.mausam. |