

Identification and categorisation of agricultural drought-prone zones of Andhra Pradesh

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Abstract

Drought-prone areas in Andhra Pradesh were identified using long-term weekly rainfall data. Seasonal variation in rainfall and percentage deviation from the mean, dry-spells during the crop growing season and the frequency of occurrence of drought were analysed. The length of growing period as an index for the period of soil moisture sufficiency was worked out using weekly rainfall, soil water storage, actual evaporation, potential evapotranspiration and moisture adequacy index. The drought-prone areas were further refined and categorized as mild, moderate, severe and chronic agricultural drought-prone zones based on the length of growing period, rainfall variability, frequency of recurrence of drought and number of dry spells. The study indicated that about 11.57 M ha (42%) covering 13 districts and spread over 64 taluks in the state are subjected to different degrees of agricultural drought either fully or partially. Mild drought-prone areas cover about 1.96 M ha, and the areas under moderate, severe and chronic are 4.73 M ha, 2.91 M ha and 1.93 M ha in the state, respectively. The regionwise distribution indicated that the largest drought-prone area is concentrated in Rayalaseema region (85%) followed by Telangana (33%) and the least in the coastal (21%) region.

Additional key words : Soil water balance, length of growing period

Droughts are of common occurrence in Andhra Pradesh. Drought is a natural hazard caused by insufficient rainfall resulting in the deficiency of soil moisture in the soil profile which adversely affects agriculture and agricultural productivity. The National Commission on Agriculture (1976) has classified drought into meteorological, hydrological and agricultural drought. Drought is a period of at least 15 consecutive days, none of which had rainfall of 0.25mm or more (Air Ministry, 1936). Ramdas (1960) defined drought as a situation when the actual seasonal rainfall is deficit by more than twice the mean deviation. Subramanyam (1964) defined drought in terms of moisture deficiency or aridity index which is the ratio of annual moisture deficiency to annual water need. Indian Meteorological Department considers a year with annual rainfall of 75% or less of the normal as drought year and 50% or less as severe drought year. Krishnan and Nagaraj (1991) used moisture adequacy index (MAI) of 50% for crop growing season and MAI-25 to 50% as moderate drought. It is the agricultural drought that is of common occurrence in semiarid and arid areas where rainfed agriculture is predominant (Virmani 1998). The frequency of occurrence of drought in arid regions of the state varies from 3 to 6 years in each decade (Srivastava *et al.* 1987). The occurrence of different kinds of drought during crop growing season were studied by Victor *et al.* (1991) and found that early, mid and

terminal droughts are more common in parts of Telangana (June to September), Rayalaseema (July to October) and Coastal (July to November) region. If these dry lands are to support increased crop yields, it is essential that these lands are to be used rationally as per their capability. Hence there is a need to identify the agricultural drought-prone areas of Andhra Pradesh, and to delineate and characterize different categories of droughts by using climatic and soil attributes which would help in mitigating the droughts by optimising land use.

Materials and methods

Long-term weekly rainfall data (1969-93) of 700 rain gauge stations of the state were used for drought analysis. The drought-prone areas of the state were identified and delineated based on the criteria that areas receiving less than 750 mm of average annual rainfall to separate from the other areas receiving high rainfall with better distribution. (Irrigation Commission 1972). Information on soil depth, soil texture and mineralogy for assessing soil available-water capacity (AWC) in the profile for major soils in the study area were extracted from the soil resource inventory of Andhra Pradesh (Reddy *et al.* 1996). The crop growing period (LGP) with nil or slight moisture stress for the areas receiving less than 750mm rainfall was worked out considering actual evaporation (AE) estimated by taking into account of both weekly rainfall and stored soil moisture that exceeds half of the potential evapotranspiration and moisture adequacy index. The characteristic features, geographic distribution and extent of different categories of agricultural drought-prone areas is given in table 1. The LGP, rainfall variability, number of dry spells (week with no rain or MAI < 10%) and frequency of occurrence of drought were integrated and further categorised as mild, moderate, severe and chronic agricultural drought-prone zones (Fig. 1). Areas that have an LGP of 150-180 days as mild, experiencing drought once in 8-10 years, LGP of 120-150 days as moderate with a frequency of drought once in 5-8 years, LGP of 90-120 days as severe with a frequency of drought once in 3-5 years and an LGP of 70-90 days as chronic with a frequency of drought once in 3 years. The rainfall variation in normal years versus drought years in different categories of drought-prone areas were worked out and are given in table 2. The possibility of getting 2 and 3 dry spells during crop growing season (June, July, August and September) were worked out and are given in figure 2. Soil water balance for three locations representing different kinds of drought-prone areas in Rayalaseema, Telangana and Coastal regions are presented in figure 3. The distribution and extent of agricultural drought-prone areas in different districts are given in table 3.

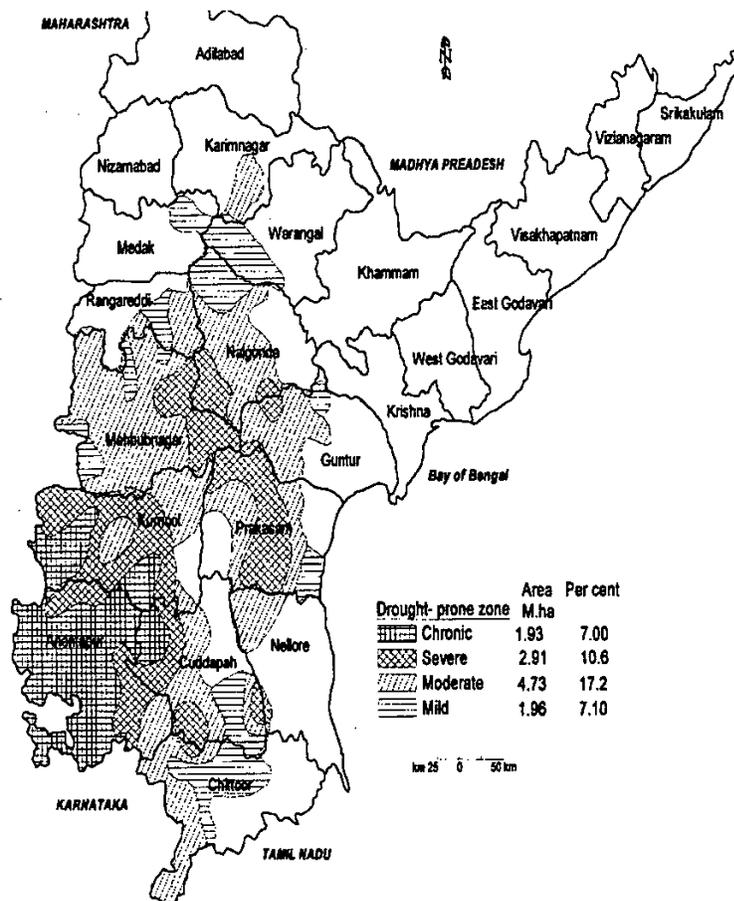


Fig.1 Drought-prone zones of Andhra Pradesh

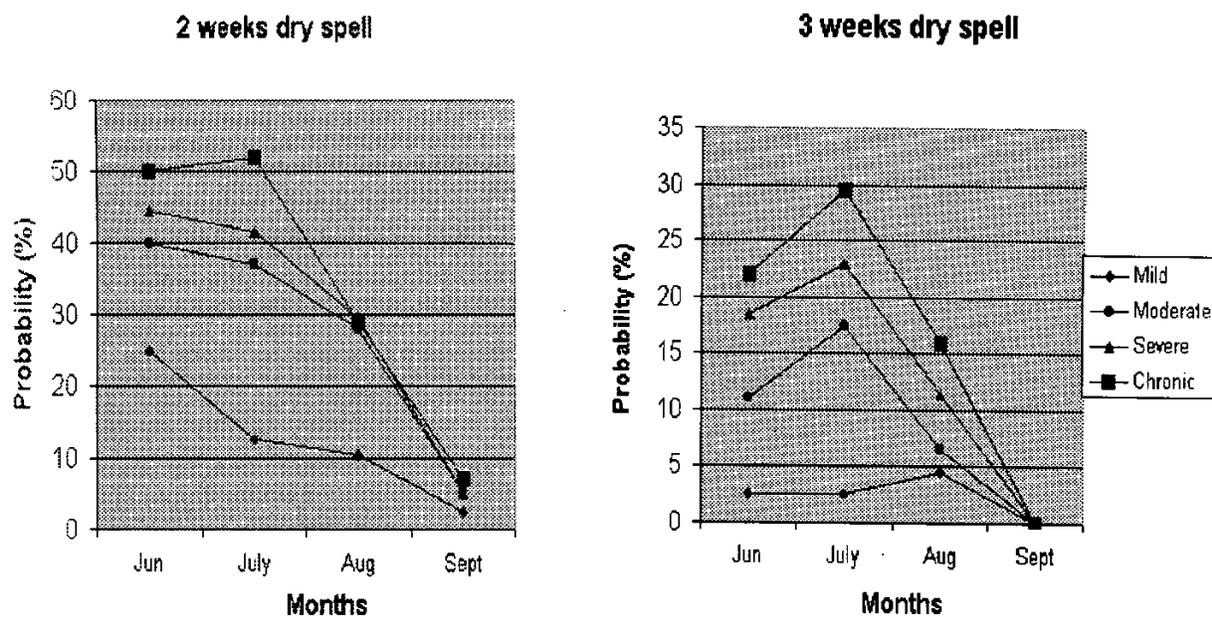


Fig. 2. Probability of getting 2 and 3 weeks dry spells during south-west monsoon period in different drought-prone zones

Results and discussion

The state has a total geographical area (TGA) of 27.5M ha with three administrative divisions namely, Rayalaseema, Telangana and Coastal regions. These regions have climate varying from arid to semi-arid in Rayalaseema, semiarid in Telangana and semi-arid to moist subhumid in coastal region (Subramanyam and Subramaniam 1962). The Irrigation Commission (1972) had identified 7 districts with 60 taluks covering about 9.7 M ha as drought-prone area in Andhra Pradesh. The drought analysis (Table 1) indicated that 11.57 M ha (41.9 %) of TGA of the state covering 13 districts and spread over 64 taluks either fully or partly are subjected to different types of agricultural drought (Fig. 1). The extent and geographic distribution of the four agricultural drought-prone zones are discussed below.

Mild agricultural drought-prone zone: These areas constitute about 1.96 M ha (7.1% of TGA) spread over (Table 1) 8 full or part of the taluks in Chittoor, Nalgonda, Medak, Warangal, Prakasam, Ranga Reddi and Guntur districts. This zone receives 700 to 750 mm rainfall with variability less than 25 per cent (Table 1). The soil water balance representing red soils of this zone indicates that the precipitation is deficit during the crop growing season. The length of growing period in this zone ranges from 150-180 days with probability of 50-60 per cent. This trend of getting LGP of 150-180days was observed to be 6 to 7 years out of 10 years. There is considerable reduction in total rainfall in drought years in these areas (Table 2). The possibility of getting 2-3 dry spells are likely in June, July and August months (Fig. 2). September month is found favourable with least or no dry spell during growing season. This is in confirmity with the findings of Victor *et al.* (1991). These areas are occurring in 1,3,4 and 5 NARP agro-climatic zones of Andhra Pradesh.

Moderate agricultural drought-prone zone: These areas account for 4.73 M. ha (17.2% of TGA) spread over (Table 1) 32 taluks either fully or partly in Anantapur, Kurnool, Cuddapah, Chittoor, Mahbubnagar, Nalgonda, Ranga Reddi, Karimnagar, Nellore, Prakasam and Guntur districts. The average annual rainfall in these areas range from 620 to 740 mm with 26 to 40% variability (Table 1). The soil water balance (Fig.3a,b) for Nalgonda and Nellore stations representing red and coastal alluvial soils depict the crop growing season. The LGP in this zone ranges from 120-150 days with probability of 61 to 70 per cent. There is considerable reduction in total rainfall in drought years in these areas (Table 2). The chances of getting 120 to 150 days LGP was observed to be 6 to 7 years out of 10 years. The possibility of getting 2-3 dry spells are likely in June, July and August months. September month is found favourable with least or no dry spell during growing season. These areas are situated in NARP zones of 1,3,4 and 5 of Andhra Pradesh.

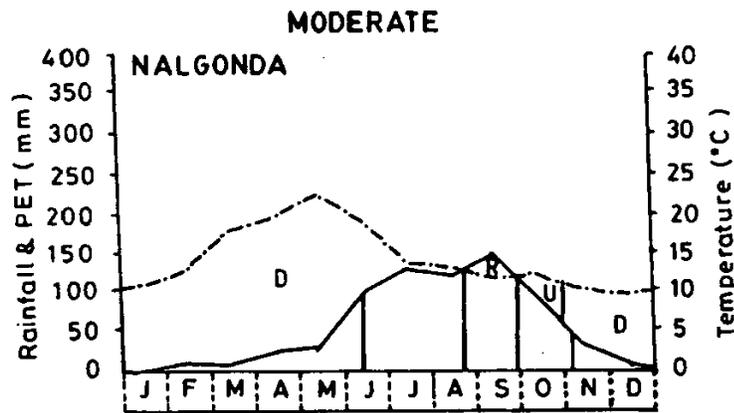


Fig. 3 a

LGP 144 days

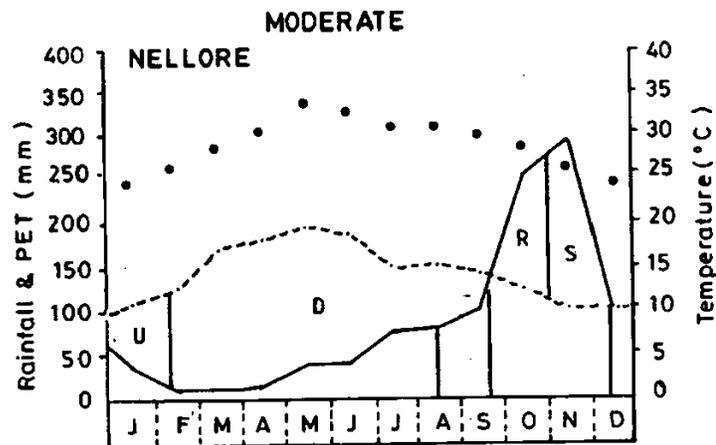


Fig. 3 b

174 LGP days

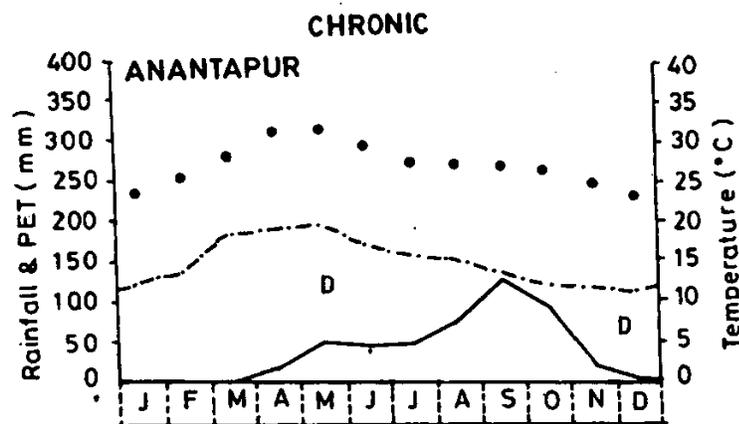


Fig. 3 c

LGP 74 days

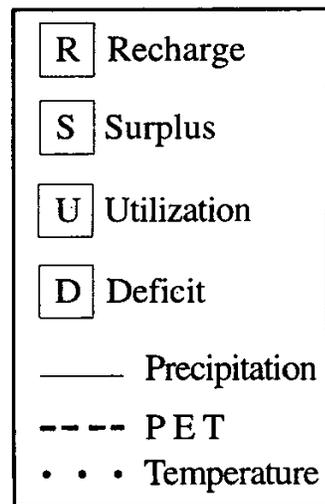


Fig. 3 Soil water balance in different drought prone zones

Table 1. Characteristic features of droughts in Andhra Pradesh

Kind of drought	Geographic distribution (District and Taluks)	Area (M. ha.)	Mean annual rainfall (mm) with variability	Length of growing period with probability	Frequency of drought occurrence
Mild	Chittoor district : Vayalpadu, Punganur, Madanapalli., Nalgonda district : Bhongir., Medak district : Siddipet., Rangareddi district : Ibrahim patan., Warangal district : Jangaon., Guntur district : Palnadu., Prakasam district : Darsi, occurring in Agro-climatic zones of 1.3.4 and 5.	1.96 (7.1%)	700-750 (<25%)	150-180 (50-60%)	Once in 8 to 10 years
Moderate	Anantapur district : Kadiri., Kurnool district : Nadyal, Nandikotkur., Cuddapah district : Proddutur, Cuddapah, Rayachoti., Chittoor district : Palamner, Punganur, Vayalpadu., Mahabubnagar district : Alampur, Kolhapur, Nagarkurnool, Wanparti, Atmakur, Makhtal, Korangal, Shadnagar., Nalgonda district : Nalgonda, Miryalguda, Ramannapeta, Devarakonda., Rangareddi district : Ibrahimpatan, Shahbad., Guntur district : Vinukonda, Palnadu., Prakasam district : Markapur, Podili, Kandukur and Darsi, Nellore district : Udayagiri, occurring in Agro-climatic zones of 1.3.4 and 5.	4.73 (17.2%)	620-740 (26-40%)	120-150 (61-70%)	Once in 5 to 8 years
Severe	Anantapur district : Gooty, Kadiri., Kurnool district : Dhone, Kurnool, Adoni, Atmakur, Banaganpalli, Nandyal, Pattikonda., Cuddapah district : Kamalapuram, Pulivendala, Rayachoti, Jammalamadugu, Rajampet., Mahabubnagar district : Kalwakurthi, Achampet, Gadwal., Nalgonda district : Devarakonda., Prakasam district : Kanigiri Markapur, and Darsi, occurring in Agro-climatic zones of 1.3.5, and 6.	2.91 (10.6%)	540-700 (26-50%)	90-120 (60-81%)	Once in 3 to 5 years
Chronic	Anantapur district : Rayadurg, Kalyandurg, Tadipatri, Dharmavaram, Penukonda, Madakasira, Hindupur., Kurnool district : Alur, Koilkuntla, Pattikonda, Banaganpalli., Cuddapah district : Jammalamadugu, Pulivendula., Mahabubnagar district : Gadwal, occurring in Agro-climatic zone 6.	1.93 (7%)	450-600 (>50%)	70-90 (>90%)	Once in 3 years

Table 2. Rainfall variation in normal Vs drought years in drought prone areas

Type of drought prone area		Rainfall distribution (mm)				Annual rainfall (mm)
		June	July	August	September	
Mild	NY	105.0	179.0	171.0	139.0	799.0
	DY	72.4	95.5	96.5	65.3	481.0
Moderate	NY	56.6	82.6	99.7	157.2	733.2
	DY	55.3	56.2	36.8	81.3	452.3
Severe	NY	77.0	87.8	111.6	177.1	700.2
	DY	52.1	62.8	71.7	88.6	411.1
Chronic	NY	68.0	82.7	100.3	160.3	613.3
	DY	52.3	55.4	93.1	84.1	394.3

Note : NY - Normal year, DY - Drought year

Severe agricultural drought-prone zone: This zone comprises about 2.91 M ha (10.6% of TGA) spread over 22 taluks fully or partly in Anantpur, Kurnool, Cuddapah, Mahbubnagar, Nalgonda and Prakasam districts (Table 1). The average annual rainfall in these areas range from 540-700 mm with 26-50% variability. The soil water balance representing black soils indicates the period of crop growing season. The length of growing period in this zone ranges from 90-120 days with 60 to 81 per cent probability (Table 1). There is drastic reduction in total rainfall in drought years compared to normal years (Table 2). The trend of getting LGP of 90-120 days was observed to be 6 to 8 years out of 10 years. The possibility of getting 2-3 dry spells are likely in June, July and August months (Fig. 2). September month is favourable with least or no dry spell during growing season. These areas are situated in NARP zones of 1,3,5 and 6 of Andhra Pradesh.

Chronic agricultural drought-prone zone: This zone comprises about 1.93 M ha (7% of TGA) spread over (Table 1) 14 taluks fully or partly in Anantapur, Kurnool, Mahbubnagar and Cuddapah districts. These areas receive mean annual rainfall of less than 600 mm which vary from as low as 450 mm in Rayadurg taluk of Anantapur district to 585mm in Gadwal taluk of Mahbubnagar district with more than 50 % variability (Table 1). The frequency of drought occurrence is once in three years which is in agreement with the findings of Srivastava *et al.* (1987). The soil water balance (Fig.3c) for Anantapur station representing red soils indicates that precipitation is deficit during the crop growing season. There is a drastic reduction in total rainfall in drought years compared to normal years (Table 2). The length of growing period in this zone ranges from 70-90 days with 90 to 92 per cent probability. The chances of getting LGP of 70 to 90 days during crop growing season was observed to be 9 out of 10 years. The possibility of getting 2-3 dry spells are likely in June, July and August months (Fig. 2). September month is favourable with least or no dry spell during growing season. These areas are located in NARP zone 6 of Andhra Pradesh.

The region-wise distribution of agricultural drought-prone areas in the state (Table 3) indicated that the largest area is concentrated in Rayalaseema region (85%) followed by Telangana region (33.4%) and least in the Coastal region (21.2%). Based on the extent, frequency and intensity of occurrence of drought, the present study concludes that major part of Rayalaseema region can be categorised as severe to chronic, more than half of Telangana region as moderate and a small extent of coastal region as moderate to mild drought-prone areas of the state.

Table 3. Distribution and extent of agricultural drought-prone areas in Andhra Pradesh

District/ Region	TGA	Chronic	Severe	Moderate	Mild	Total	% of Districts
	------(M. ha.)-----						
Rayalaseema Region							
Anantpur	1.90	1.32	0.39	0.19	--	1.90	100.0
Kurnool	1.77	0.42	0.71	0.47	--	1.60	91.7
Cuddapah	1.54	0.19	0.45	0.38	0.14	1.16	76.1
Chittoor	1.52	--	0.09	0.42	0.57	1.08	72.2
Rayalaseema	6.73	1.93	1.64	1.44	0.71	5.74	85.0
Telangana Region							
Mahbubnagar	1.84	--	0.38	1.23	0.23	1.84	100.0
Ranga Reddi	0.75	--	--	0.14	0.19	0.33	44.0
Medak	0.97	--	--	--	0.14	0.14	14.7
Nalgonda	1.42	--	0.19	0.62	0.28	1.09	77.3
Warangal	1.29	--	--	--	0.23	0.23	18.5
Karimnagar	1.18	--	--	0.23	--	0.23	20.2
Telangana	7.45	--	0.57	2.22	1.07	3.86	33.4
Coastal Region							
Nellore	1.31	--	0.04	0.33	--	0.37	29.1
Prakasam	1.76	--	0.62	0.38	0.09	1.09	62.4
Guntur	1.14	--	0.04	0.38	0.09	0.51	46.0
Coastal	4.21	--	0.70	1.09	0.18	1.97	21.2
State (ha)	27.5	1.93	2.91	4.73	1.96	11.57	
Percentage	100.0	7.0	10.6	17.2	7.1	41.9	

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