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Hydrometeorological Considerations for Rainwater Management during Drought Years in Peninsular India

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Peninsular India is located in the tropics; its climate ranges from arid conditions in the rain shadow region (under the influence of Eastern Ghats along the east coast and Western Ghats along the west coast) to humid conditions in regions adjoining the west coast. The average annual rainfall in the region varies from about 500 mm in the interior parts to more than 3000 mm on the crest of Western Ghats. The rainy season commences during the month of June because of the onset of the southwest monsoon near the tip of peninsular India. The southwest monsoon ends during September. The rainy season continues up to the end of November because of the northeast monsoon in the southeastern parts of peninsular India. Crop production under rainfed conditions in the arid and semiarid regions is often affected by droughts during the monsoon season because of prolonged dry spells associated with break monsoon conditions. Sometimes, heavy rainfall occurs even in the drier regions because of severe cyclonic activity in the Bay of Bengal. Rainwater management is crucial for improving productivity, particularly during the years of drought. Therefore the daily rainfall data of two typical locations representing both arid and semiarid climates were analyzed to evolve the basis for rainwater management to improve crop production in drylands.

Description of Locations

Anantapur (14°41' N, 77°44' E, and 348 m above mean sea level [a.m.s.l.]), located in the arid region of Andhra Pradesh, receives annual rainfall ranging from 176 mm (1984) to 915 mm (1988), with an average of 565 mm. The soils in the region are shallow alfisols, and groundnut (*Arachis hypogea l.*) of 100–120 days duration is grown extensively during the months of July to October. The average rainfall during the cropping season is 379 mm, with extreme values of 138 mm during 1984 and 719 mm during 1988. Bangalore (12°58' N, 77°35' E, and 921 m a.m.s.l.), located in the semiarid region of Karnataka state, receives an average annual rainfall of 892 mm. Annual totals in Bangalore ranged from 528 mm during 1990 to 1328 mm during 1991. The soils in the region are alfisols, and finger millet (*Eleusine coracona l. gaertn*) of 130 to 140 days duration is grown extensively under rainfed conditions during the months of July to November. The average seasonal rainfall from July to October is 585 mm, ranging from 316 mm during 1990 to 952 mm during 1988.

Hydrometeorological Features

An analysis of the rainfall data recorded at Anantapur and Bangalore during the 10-year periods 1973–82 and 1983–92 indicates that mean seasonal rainfall decreased slightly and the coefficient of variation of the seasonal rainfall during the period 1983–92 increased (Table 1). Thus, the seasonal rainfall was more erratic during the recent period, resulting in frequent droughts.

Generally, these two locations will receive heavy rainfall for a period of up to 4 or 5 days whenever there is a severe depression or cyclone in the Bay of Bengal. In the absence of such activity, there will be considerable reduction in the monthly or seasonal rainfall (Table 2).

In India, a day receiving rainfall of 2.5 mm or more is considered a rainy day. If the rainfall occurs on consecutive days, it is referred to as a wet spell. The maximum amount of rainfall received in a wet spell during any season in different years was identified along with the month of its occurrence for both these locations.

The maximum amount of rainfall received during a wet spell in the years with different amounts of seasonal rainfall is shown in Figure 1. A parabolic relationship was observed between the maximum amount of rainfall during a wet spell (y mm) and the seasonal rainfall (x mm), as the following equations illustrate:

	Bangalore		Anantapur	
Period	**Mean Seasonal Rainfall (mm)**	**Coefficient of Variation (%)**	**Mean Seasonal Rainfall (mm)**	**Coefficient of Variation (%)**
1973–82	**591**	**25**	**381**	**40**
1983–92	**579**	**33**	**377**	**50**

Table 1. Seasonal rainfall and its variability during the cropping season under rainfed conditions.

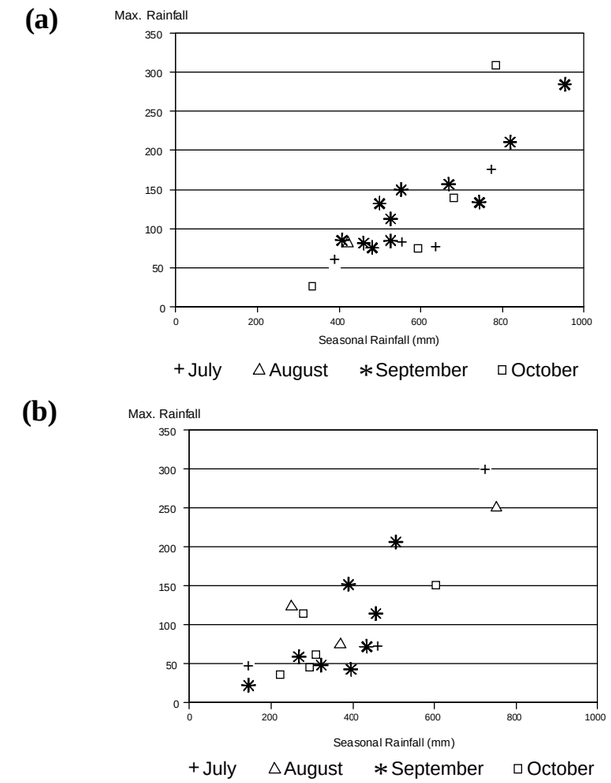

Figure 1. Maximum amount of rainfall during a wet spell in relation to seasonal rainfall for (a) Bangalore and (b) Anantapur.

Anantapur:
$Y = 70.20 - 0.2036x + 0.0006773x^2$ ($r^2 = 0.7108$)

Bangalore:
$Y = 49.02 - 0.1064x + 0.0003775x^2$ ($r^2 = 0.7244$)

At Bangalore, where the seasonal rainfall is 585 mm, wet spells with rainfall around 150 mm or more were found to occur during the years with seasonal rainfall exceeding 625 mm, indicating that good seasons were associated with an occasionally heavy wet spell. During the seasons having less than 625 mm of rainfall, wet spells with less than 100 mm of rainfall were more frequent. The maximum amounts of rainfall during the wet spells were found to occur mostly during September and October (15 out of 20 seasons).

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Station	Parameter	Rainfall in mm: Jul.	Aug.	Sep.	Oct.	Season
Bangalore	Highest amount	272	205	455	541	952
	Lowest amount	21	48	67	28	316
	Mean	115	112	209	149	585
Anantapur	Highest amount	454	343	359	325	719
	Lowest amount	1	0	2	20	138
	Mean	68	70	142	88	379

Table 2. Extremes in monthly and seasonal rainfall, 1973–92.

At Anantapur, the maximum amount of rainfall received during a wet spell was more than 100 mm even during the years with seasonal rainfall of about 250 mm, although it was less than 100 mm in most cases during the years with seasonal rainfall of up to 450 mm. During the years with seasonal rainfall exceeding 450 mm, a single wet spell can contribute more than 150 mm to seasonal rainfall. Rainfall of more than 250 mm during a wet spell was observed in the early part of the season (July–August) during the years with seasonal rainfall exceeding 600 mm.

Conclusions

Irrespective of the amount of average seasonal rainfall, the maximum rainfall that can be expected during the normal or deficit season in arid and semiarid areas is generally less than 100 mm. To improve crop productivity during the normal or deficit seasons, in situ moisture conservation measures are more appropriate. Wet spells contributing more than 150 mm of rain can generally be anticipated during above-normal seasons. Rainwater harvesting and recycling will be of use during such years for improving the productivity of fruit crops and tree-based farming systems rather than arable crops.