

The drought year of 1979 — A critical appraisal with reference to the semi-arid region of Delhi

C. V. S. SASTRI

*Division of Agricultural Physics,
Indian Agricultural Research Institute, New Delhi*

सार — 1979 में, भारतीय उप-महादीप में दक्षिण-पश्चिम मानसून की विफलता के परिणामस्वरूप देश के अधिकांश भागों में एक बार फिर व्यापक तौर पर भीषण सूखा पड़ा। इस दशक (1971-1980) के भीषणतम सूखा वर्ष के दौरान कृषि उत्पादन में, विशेषकर शुष्क क्षेत्रों के उत्पादन में उल्लेखनीय गिरावट आई। यहां दिल्ली के अर्ध-शुष्क क्षेत्र में सूखा प्राचलों के उन विचरणों की, जिनके कारण इस वर्ष गम्भीर सूखे की स्थिति आई, सूक्ष्मता से जांच की गई है। इस वर्ष रबी और खरीफ की फसलों के मौसम में इस क्षेत्र में फसल की आम बढ़वार पर अलग-अलग और सामूहिक प्रभाव को समझने की दृष्टि से अपवाह-जल संतुलन अवयवों का साप्ताहिक आधार पर अध्ययन किया गया है। जल बजटिंग प्रक्रिया और संचयी जलीय अभाव के आरेखों की सहायता से 1979 के दौरान जल संतुलन प्राचलों का इस दशक के सामान्य, सर्वाधिक गीले और सर्वाधिक सूखे वर्षों से तुलना की गई है और उस पर विचार-विमर्श भी किया गया है।

ABSTRACT. The failure of southwest monsoon over the Indian sub-continent during 1979, has once again resulted in widespread severe drought conditions in most parts of the country. Agricultural production especially, in the dryland tracts has decreased considerably, during the year of worst drought in this decade (1971-80). In the semi-arid region of Delhi, the variations in drought parameters that led to the acute drought situation in this year have been critically examined. During the Kharif and Rabi seasons, the run off water balance components have been studied on a weekly basis with a view to understand the impact both individually and collectively on general crop growth in the region. A comparison of the water balance parameters during 1979, with those of a normal, wettest and driest years in the decade as determined from water budgeting procedure and also from cumulative water deficit diagrams has been presented and discussed.

1. Introduction

Droughts, resulting from scanty and ill-distributed rainfall, form one of the serious natural calamities which frequently inflict one part or the other of the world. Deficient rainfall not only adversely affects the agricultural production but also results in lowering of water levels in reservoirs as well as in hydroelectric dams and underground water, causing havoc in more than one way among people and livestock. Particularly, India, with its diverse climatic conditions and large agricultural lands purely dependent on the southwest monsoon rainfall, suffers too often from failure of the monsoon and the consequent droughts. In the decade 1971-80, the country experienced three severe droughts, which affected a major portion of the sub-continent.

For a proper understanding of the nature of droughts and for correct estimation of their severities, the water balance approach has been well tested and recommended by earlier workers (Subrahmanyam 1967, Subrahmanyam and Sastri 1969a and 1969b, George

and Ramasastri 1971) in India. In this paper the frequency and severities of droughts that have occurred in the semi-arid region of Delhi have been studied through the water balance procedure with emphasis on the year 1979, which recorded the lowest annual rainfall in recent years.

2. Materials and methods

Monthly water balances for the 40-year period 1941-1980 at Delhi representing the semi-arid region are worked out employing the widely accepted water budgeting procedure of Thornthwaite and Mather (1957). The meteorological data recorded at the meteorological observatory of the Indian Agricultural Research Institute (IARI), New Delhi is made use of for this purpose. From the annual values of water deficiency, the indices of aridity (Thornthwaite 1948), have been worked out for all the years by expressing them as percentage ratios of the respective annual water needs. Drought years have been identified from the departures of the aridity index from the median value. Categorization of drought severities is made

TABLE 1

Years of drought in the Delhi region and their severities

Disastrous	Severe	Large	Moderate
1941	1943	1979	1965
1951	1947	1949	1980
	1974	1942	1966
	1946		1960
	1952		1945
	1953		1956
	1973		1963
			1959
Total 2	7	3	8

NOTE : Drought years are given in order of descending severities in each category

following the scheme suggested and employed by Subrahmanyam and Sastri (1969a). Drought years have been classified as moderate, large, severe and disastrous depending upon their intensities.

For the year 1979, which received an annual rainfall of 500 mm, the lowest yearly total in the decade 1971-80, analysis of drought has been made on a weekly basis. During kharif and rabi seasons, weekly water balances have been worked out and aridity indices have been computed. Drought severities were evaluated week after week from the weekly aridity anomalies. In the Delhi region, the southwest monsoon begins on 29 June and lasts upto 15 September. Hence the analysis for the kharif season is confined to the period 26 June 1979 to 30 September 1979 (14 weeks). For the rabi season it was done from 1 October 1979 to 6 May 1980 (31 weeks). The field capacity of soils in the Delhi region is taken as 200 mm (upto 1 m depth), for working out the water balances. Some of the meteorological data required for the analysis has been taken from the meteorological observatory of the India Meteorological Department (IMD), Lodi Road, New Delhi.

3. Results and discussion

The analysis of droughts, as already indicated, is mainly based on the aridity index which takes into account the actual water deficiency as well as the water need, and its departure from the median. Years of drought and their severities in the Delhi region are given in Table 1.

During the 40-year period 1941-80, at Delhi there were 20 drought years of which 2 were disastrous, 7 severe, 3 large and 8 moderate. The two disastrous

TABLE 2

Decadal frequency of drought years in the Delhi region

Decade	No. of droughts				
	Disastrous	Severe	Large	Moderate	Total
1941-50	1	3	2	1	7
1951-60	1	2	0	3	6
1961-70	0	0	0	3	3
1971-80	0	2	1	1	4

drought occurred in the years 1941 and 1951. In those two years not only the rainfall was less than 50% of the normal, even the water need was much higher. These two aspects resulted in the disastrous drought conditions. The number of severe droughts was also considerable. The decadal frequency, the number of drought years in each successive decade intervals (Table 2), indicates that the first two decades of study were equally bad in the sense that they experienced 7 and 6 total droughts respectively of which one in each was disastrous. The following decade, 1961-70 was comparatively free from droughts. It had recorded three droughts of mild nature only. Thus, there was reduction both in the number as well as the intensity of droughts from 1941 to 1970. Again in the decade 1971-80, there were four droughts of which 2 were severe (1973, 74), 1 large (1979) and 1 moderate (1980).

The drought that was recorded in 1979 was particularly noteworthy, as the annual rainfall was only 500 mm, the lowest ever recorded during the last two decades while the water need was highest. The southwest monsoon failed over most part of the country and widespread severe drought conditions and crop damage were reported from most of the States. According to newspaper reports and reports from Govt. agencies, crop damage ranged from 40 to 80% in most of the north Indian States. Acute drinking water scarcity was also experienced. The annual aridity indices of the three significant drought years in the decade 1971-80 are 60.9 (1973), 62.2 (1974) and 59.4 (1979). This shows that the severities of droughts for the three years on an annual basis are more or less the same. But on an examination of the monthly water balances, it was observed that in the

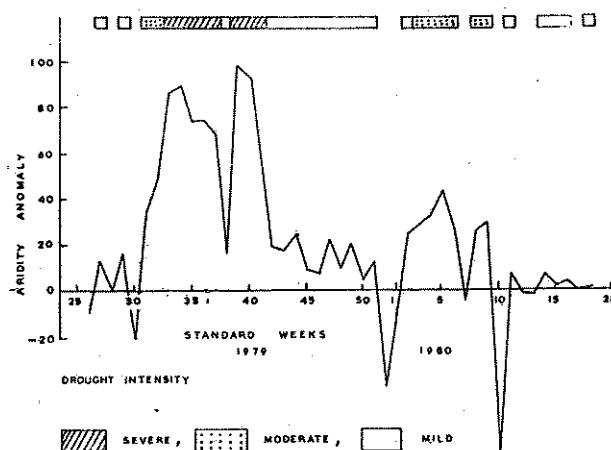


Fig. 1. Weekly drought intensity during kharif and rabi seasons for the year 1979-80 in the Delhi region

year 1979 the monthly water deficiencies were relatively higher and continuous all through the kharif season; whereas in the other two years they were not only comparatively low but even *nil* in the months of July (1974) and August (1973), during the middle of the season. Thus, the higher monthly water deficiencies which prevailed throughout the kharif season of 1979 led to acute crop damage and human sufferings referred above, although the annual aridity index of this year was slightly less than that of either 1973 or 1974. This emphasises that the effect of drought on crop growth and yield cannot be assessed by simple annual totals of rainfall or water need; and that a more detailed study is needed.

In order to understand the nature and severity of drought of the year 1979, which caused widespread damage as indicated in the above paragraph, more intensive study during the kharif and rabi seasons was taken up. The weekly water balances (Thorntwaite and Mather 1957) were determined and drought severities (weekly) were assessed by the aridity anomaly method using the following criteria :

Drought intensity	Aridity anomaly
Mild	1-25
Moderate	26-50
Severe	More than 50

Fig. 1 represents the weekly droughts during the kharif and rabi seasons of 1979-80. The drought has occurred in four distinct phases. The first phase was spread over almost the entire kharif season. Out of the 14 weeks, drought was severe for 6 weeks, moderate for 2 weeks and mild for 3 weeks. Only 3 weeks were free from drought. The mild drought started on 29th week turned severe by 33rd week and continued till the end of the season,

The severe phase continued till the middle of October and then there was a prolonged spell of mild drought, covering 10 weeks till the end of December. Then there was relief for just two weeks (52nd and 1st weeks) due to slight rain and third phase of drought started from 2nd week (8 January) and continued upto the end of 9th week (20 February). The drought was of moderate category. In the fourth phase, drought which was mild, was for 5 weeks during March and April '80. On the whole during the rabi season, out of 31 weeks, only 2 weeks suffered from severe drought, but mild and moderate droughts were more or less continuous covering 22 weeks. Out of the total 45 weeks analysed, there was drought for 35 weeks (all categories) and 10 weeks were free from drought. Among the 35 weekly droughts, which occurred in all four phases, 8 were severe, 8 moderate and 9 mild.

Another method by which this drought situation was analysed is using cumulative diagram of deficiency anomaly. Here also the occurrence of four individual drought spells with different intensities was brought out.

4. Conclusions

During the 40 year period, 1941-80 in the Delhi region there were 20 drought years of which 2 were disastrous, 7 severe, 3 large and 8 moderate. The decade 1961-70 was comparatively free from severe droughts. During 1971-80 there were four droughts and from experience 1979 turned out to be the worst year. The weekly water balance analysis indicated that the drought of 1979 was severe during the kharif season affecting the crop production adversely. The

mild and moderate droughts of rabi season also had an equally bad effect because of their longer duration. A total of 35 weeks out of 45 weeks were affected by droughts of all intensities.

References

George, C. J. and Ramasastri, K. S., 1971, India Met. Dep., Pre-publ. Sci. Rep. No. 185, p. 6.

Penman, H. L., 1948, *Proc. Roy. Soc. London (A)*, 193, pp. 120-145.

Subrahmanyam, V. P., 1967, World Meteorological Organisation IHD, Reports on WMO/IHD Projects, Rep. No. 2, Secretariat of the WMO, Geneva, p. 52.

Subrahmanyam, V. P. and Sastri, C. V. S., 1969 (a), *J. met. Soc. Japan*, Sec. II, 8, 4, pp. 239-244.

Subrahmanyam, V. P. and Sastri, C. V. S., 1969(b), *Ann. Arid Zone*, 8, 1, pp. 18-22.

Thornthwaite, C. W., 1948, *George. Rev.*, 38, 1, pp. 55-94.

Thornthwaite, C. W. and Mather, J. R., 1957, *Publ. in Clim. Drexel Inst. Tech.*, X, 3, p. 311.