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STREAM FLOW ANALYSIS FOR HYDROLOGICAL DROUGHT OF KRISHNA BASIN

Permod K. Verma* A.K. Sikka** R.D. Singh***

ABSTRACT

Drought is generally viewed as the occurrence of below normal natural water availability for the place & time. To a hydrologist, it means below average content in streams, reservoirs, lakes, tanks, ground water aquifers & soil moisture. Although a drought originates from precipitation deficit, a severe water shortage does not necessarily coincide with a severe shortage in the precipitation because of the complexities of the processes responsible for transforming precipitation into hydrological and agricultural waters. The deficits in surface water are reflected through low stream flows. Stream flow is one of the important hydrological parameters as it not only reflects the precipitation deficiency but also the catchment characteristics, land use & vegetation which are responsible for generating runoff. The drought phenomenon can thus be better studied from the stream flow of a basins for which local singularities are eliminated.

In this paper stream flow data (for 20 years) of five selected sites namely T. Rampuram, Bawapuram, Haralahalli, Narsingpur, Karad in Krishna basin has been analysed to study the hydrological aspects of drought (i.e. severity, duration & magnitude) mainly with respect to 1983-84, 1984-85 1985-86. The drought analysis has been done using simple streamflow indices based upon long term mean and standard deviation, comparision of mean, minimum and actual monthly streamflow hydrograph, as a measure of hydrological drought.

1.0 INTRODUCTION

Drought is generally viewed as the occurrence of below normal water availability for the place and time. Drought can be classified as agricultural drought, meteorological drought and hydrological drought. The meteorologist is concerned with drought in the context of a period of below normal precipitation to an agriculturist, drought means a prolonged shortage of soil moisture in crop root zone and to a hydrologist, it means below average context in streams, reservoirs, lakes, tanks and ground water aquifer. The phenomenon of drought appears to have received less attention by scientific community, particularly when contrasted with its counterpart, floods. More so,

*Scientist 'B', National Institute of Hydrology, Roorkee
**Scientist (S-2), Central Soil & Water Conservation Research & Training Institute, Dehradun
*** Scientist 'C', National Institute of Hydrology, Roorkee

in our country, mostly the emphasis has been given towards meteorological drought, followed by agricultural drought. The occurrance of drought due to severe water shortage does not necessarily coincide with a severe shortage in rainfall because of the complexities of the processes responsible for transforming rainfall into hydrological and agricultural water, . The hydrological aspects of drought are generally poor understood and have not been scientifically studied in a systematic way. There is a need to study hydrological aspects of drought using hydrological variables such as rainfall, streamflow, soil moisture and ground water levels.

1. 1 Hydrological Drought

The definition of hydrological drought has been given by many researchers. Whipple (1966) defined a drought year as one in which the aggregate runoff is less than the long term average runoff. Yevjevich (1967) defined the term hydrological drought as "The deficiency in water supply, or deficiency in precipitation, effective precipitation, runoff or in accumulated water in various storage capacities". Linsley et al (1975) defined hydrological drought as "a period during which streamflows are inadequate to supply established uses under a given water management system". Six types of hydrological drought have been distinguished based upon variation in duration, season of year or severity by Beran and Rodier (1985) it is evident from various definition that streamflow is one of the important parameters to study drought as it represents the resulted runoff from a basin or catchment after various manifestation and gives the volume of water available in various water resources. The deficiency is surface water is reflected through low streamflows which is a measure of drought. The drought phenomenon therefore be better studied by analysing low streamflows or a basin for which local singularities are also eliminated. When flow in a stream is either too low or extended over a significant period that it does not meet the need of specific user, it is said that drought has set in. Therefore, hydrological drought can be better studied by analysing streamflows.

2.0 DATA

In Krishna basin the daily discharge data of 5 sub-basin of the gauging site namely T. Ramapuram, Bawapuram, Harahalli Narsingpur, Karad for a period of 20 years from (1966 to 1986) has been used for analysis of hydrologic drought. The site description alongwith catchment area is given in table 1. The size of catchment used in the study varies from 5462 sq.km. to 67, 180 sq.km. as indicated in table 1. The location of these sites is shown in figure 1.

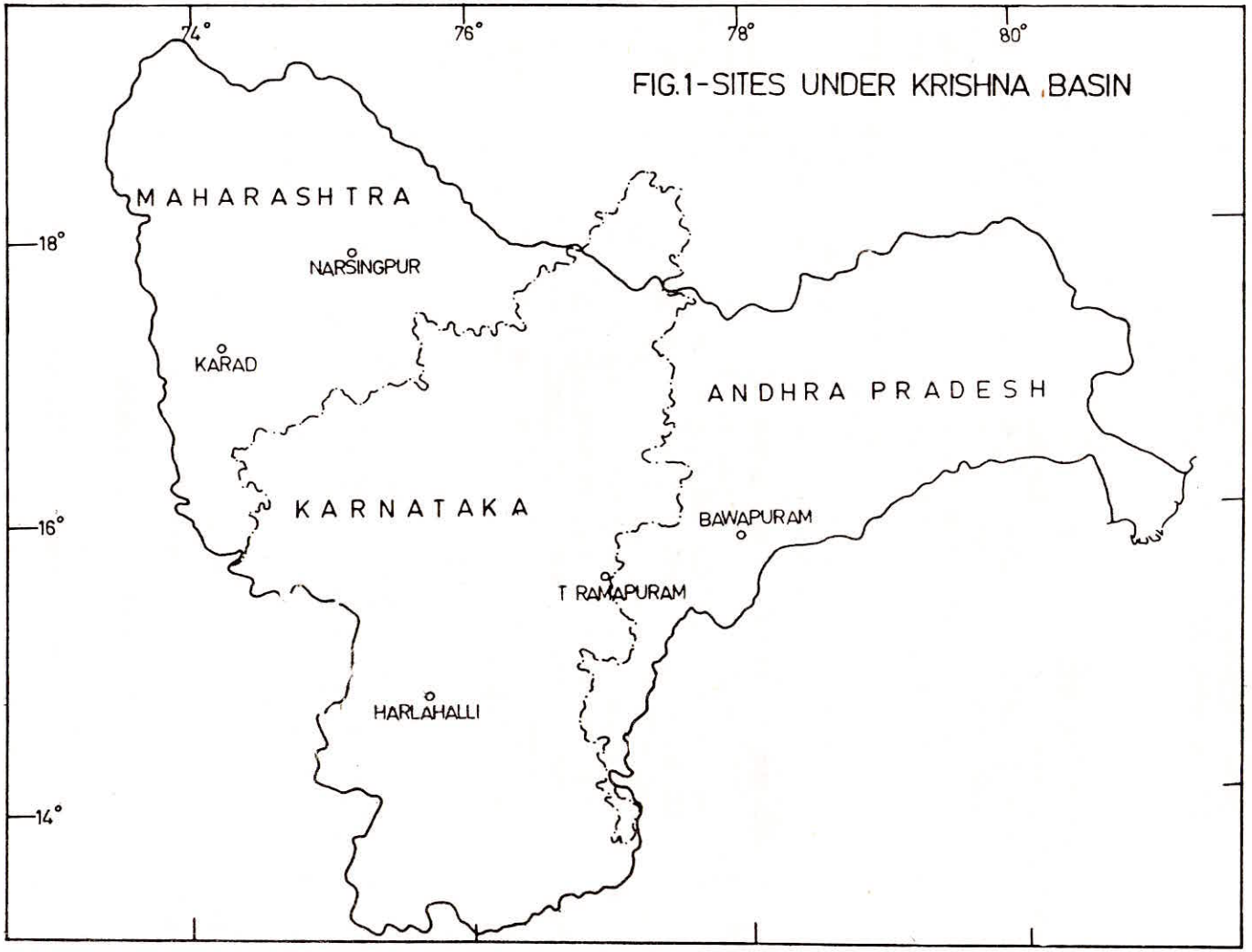

FIG.1-SITES UNDER KRISHNA BASIN

Table - 1

Site	State	District	River	Basin	Drainage area
.Ramapuram	Karnataka	Bellary	Tungabhadra	Krishna	23,500Km^2
Bawapuram	Andhra Pradesh	Kurnool	Tungabha-dra	Krishna	67,180Km^2
Harahalli	Karnataka	Dharwar	Tungabhadra	Krishna	14,582Km^2
Narsingpur	Maharastra	Sholapur	Bhima	Krishna	22,856Km^2
Karad	Maharastra	Satara	Krishna	Krishna	5462 Km^2

3.0 METHODOLOGY

The streamflow data has been analysed to evolve suitable hydrologic drought indices to find out extend of drought. The methods used in the analysis are discussed below.

3.1 Simple Indices

(a) A commonly used index to study hydrological aspects of drought is to compare the runoff depth or volume for a given duration. i.e, fortnight. month or a year with long term mean or standard period normal value for the given duration. It is considered that if the runoff is found to be less than 75% of normal runoff, year would be considered as drought year and if it occurs in 25 or more than 25 % of year, then the areas would be considered to be drought prone. Drought is classified as severe drought and moderate drought depending upon percentage deparature as given below:

percentage departure>50% - Severe
percentage departure 25-50% - Moderate

(b) Based on statistics of data

Another measure of hydrologic drought is the deep shortage of water which has been defined as deviation of annual stream flow from mean volume by or at least one standard deviation (Zvi 1987) Mean, standard deviation and coefficient of variation of the annual flow data have been estimated and the severity of drought has been estimated based on the above approach.

3.2 Hydrograph Analysis

The magnitude of low flows can be presented in several ways of which is used to illustrate a different aspect. For most engineers and scientists in the water industry. The hydrograph of river flow gives an immediate feel for the position. The continous monthly flow hydrograph for year 1984-85 and 1985-86 are plotted and compared with discontinous values of mean flow flow and minimum previously recorded values in last 20 years (1966-1986).

4.0 RESULT AND DISCUSSION

By using simple indices methodology, the deviation of annual flow from normal flow value of various site has been estimated and given in table 2.

Table : 2

Deviation of annual flow from normal for selected sites

Year	.T.Ramapuram	Bawapuram	Harahalli	Narsingpur	Karad
1982	-5.76	-14.3	-6.0	-59	-38.4
1983	-12.23	-18.2	-7.1	+0.6	-20.5
1984	-51.12	-32.4	-6.0	-21.5	-21.7
1985	-63.69	-78.4	-23.5	-59.3	-38.4

It is evident from the table 2 that T. Ramapuram, Bawapuram and Narsingpur site fall in the category of severe drought condition during 1985-86. At Haralahalli and Karad condition of moderate drought prevail during 1985-86. It is also confirmed with revenue report of these sub-basins and production data for the respective year.

Annual volume of streamflow and their statistics are given in table 3. It is evident from the table that coefficient of variation of annual flow values is minimum (0.243567) for the gauging site Haralahalli while the annual flow at Bawapuram gauging site is having the maximum coefficient of variation (0.5814204). Based on methodology suggested in section 3.1(b), the occurrence of deep shortage have been computed and listed in table 4 using symbol "d". It indicates that occurrences of deep shortage of water of gauging site T. Ramapuram, Bawapuram, Narsingpur and Karad in the year 1985 which shows the severe drought situation in four sub basin out of five considered in study. It is also observed from the table 4 that occurrence of deep shortage has continued for 2 years (1984,1985) for the two gauging site i.e. T. Ramapuram and Bawapuram.

The plotted hydrographs are shown in figure 2,3,4,5 and 6 which illustrates a marked difference between the response of river flows in 1984-85, 1985-86 and meanflows for the selected subbasins. All the selected subbasins were affected by drought situation during 1984-85, and 1985-86. It can be seen from the figure 2,3,4,5 and 6 that T. Ramapuram and Bawapuram faced severe drought condition during 1985-86 and also facing drought for the last 2 years in succession.

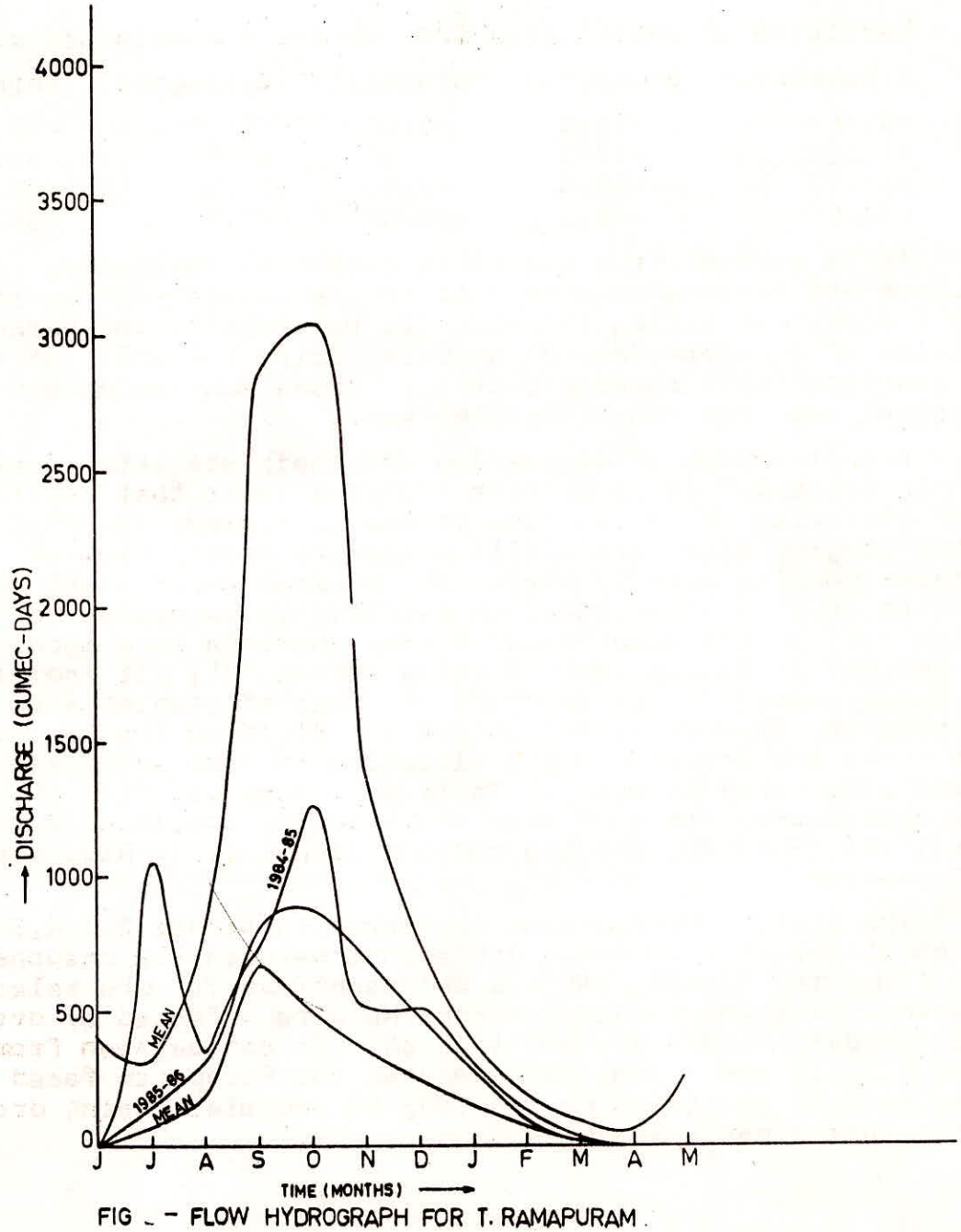

FIG _ - FLOW HYDROGRAPH FOR T. RAMAPURAM.

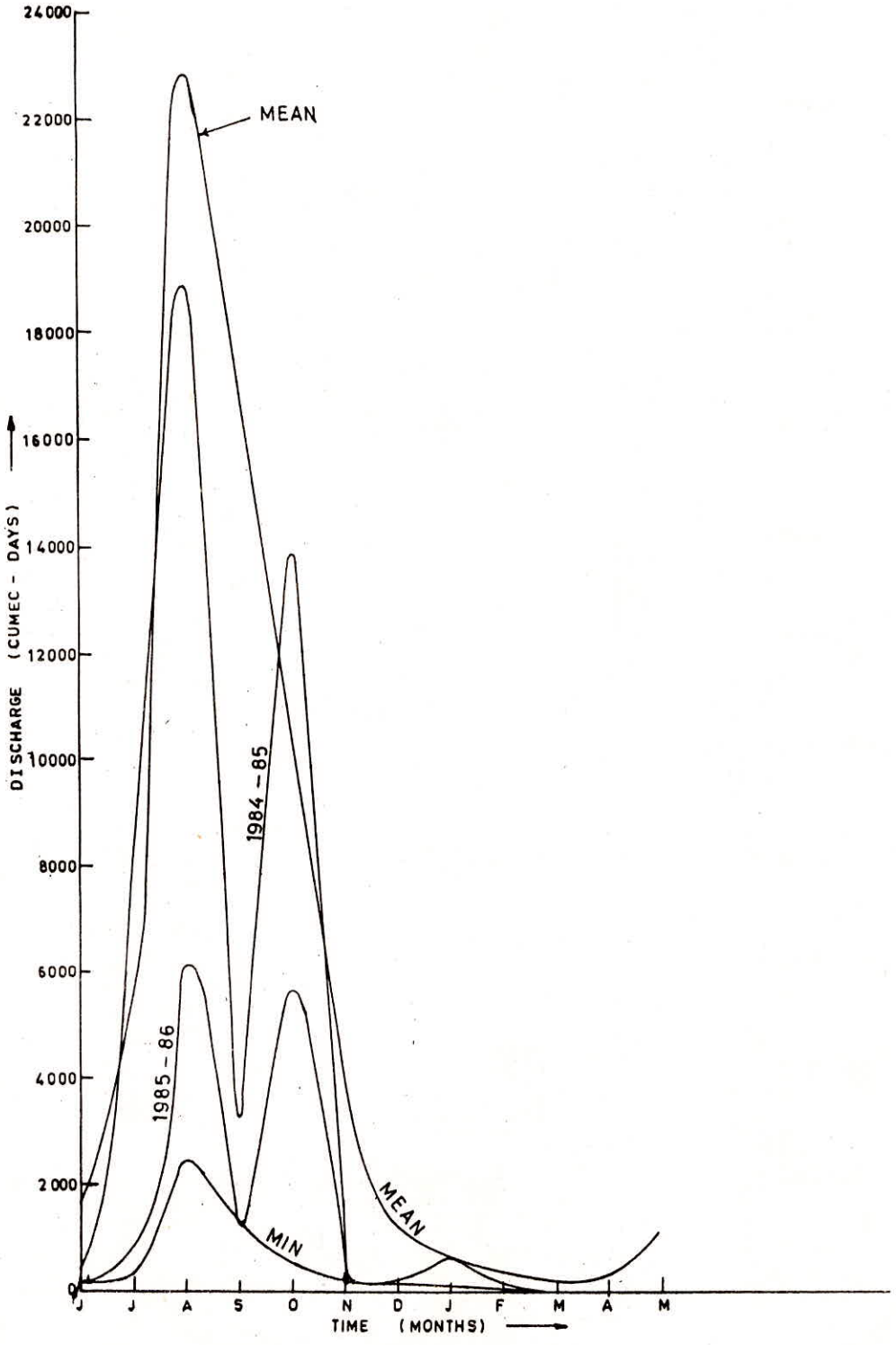

FIG. 3 – FLOW HYDROGRAPH FOR BAWAPURAM

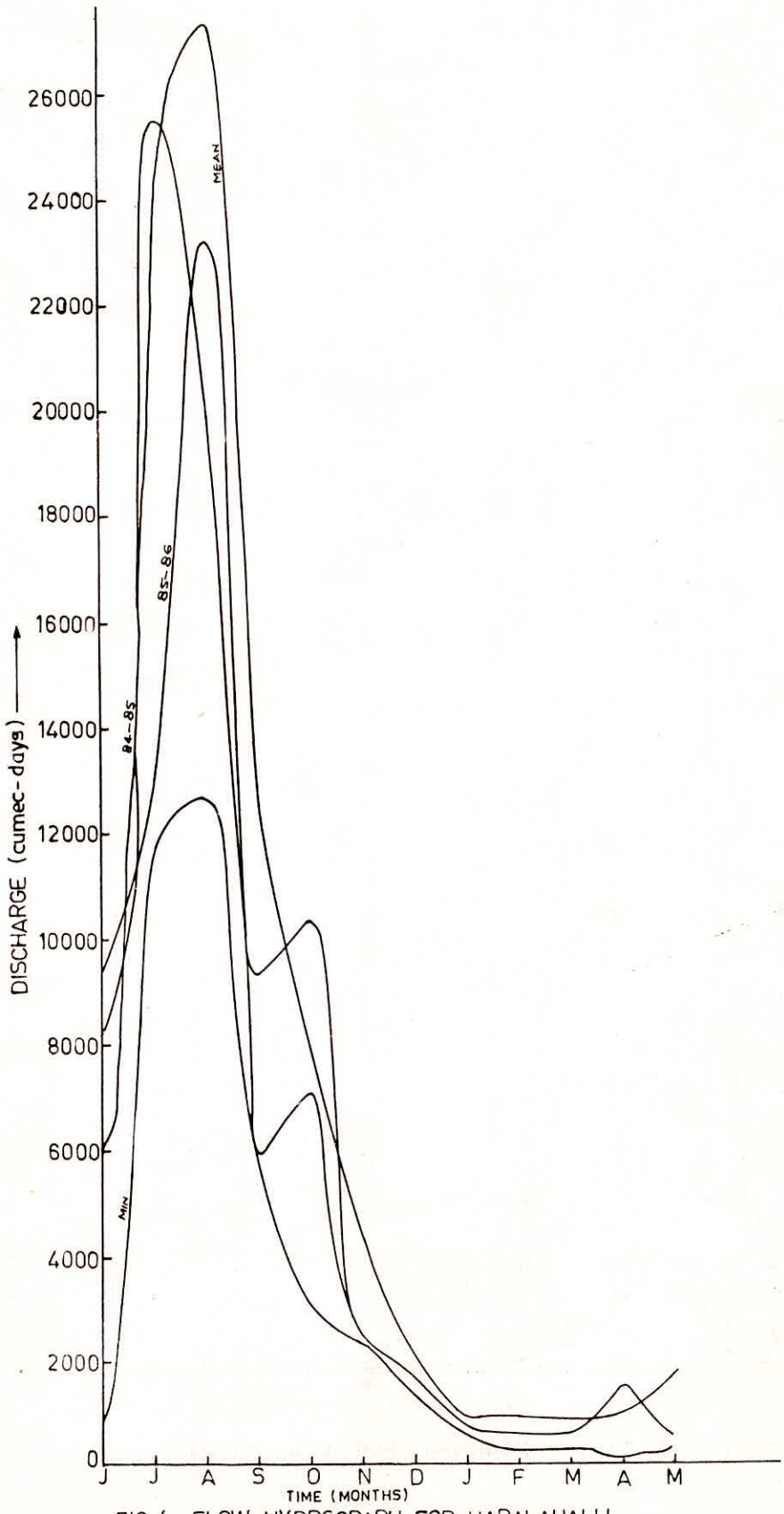

FIG. 4 FLOW HYDROGRAPH FOR HARALAHALLI

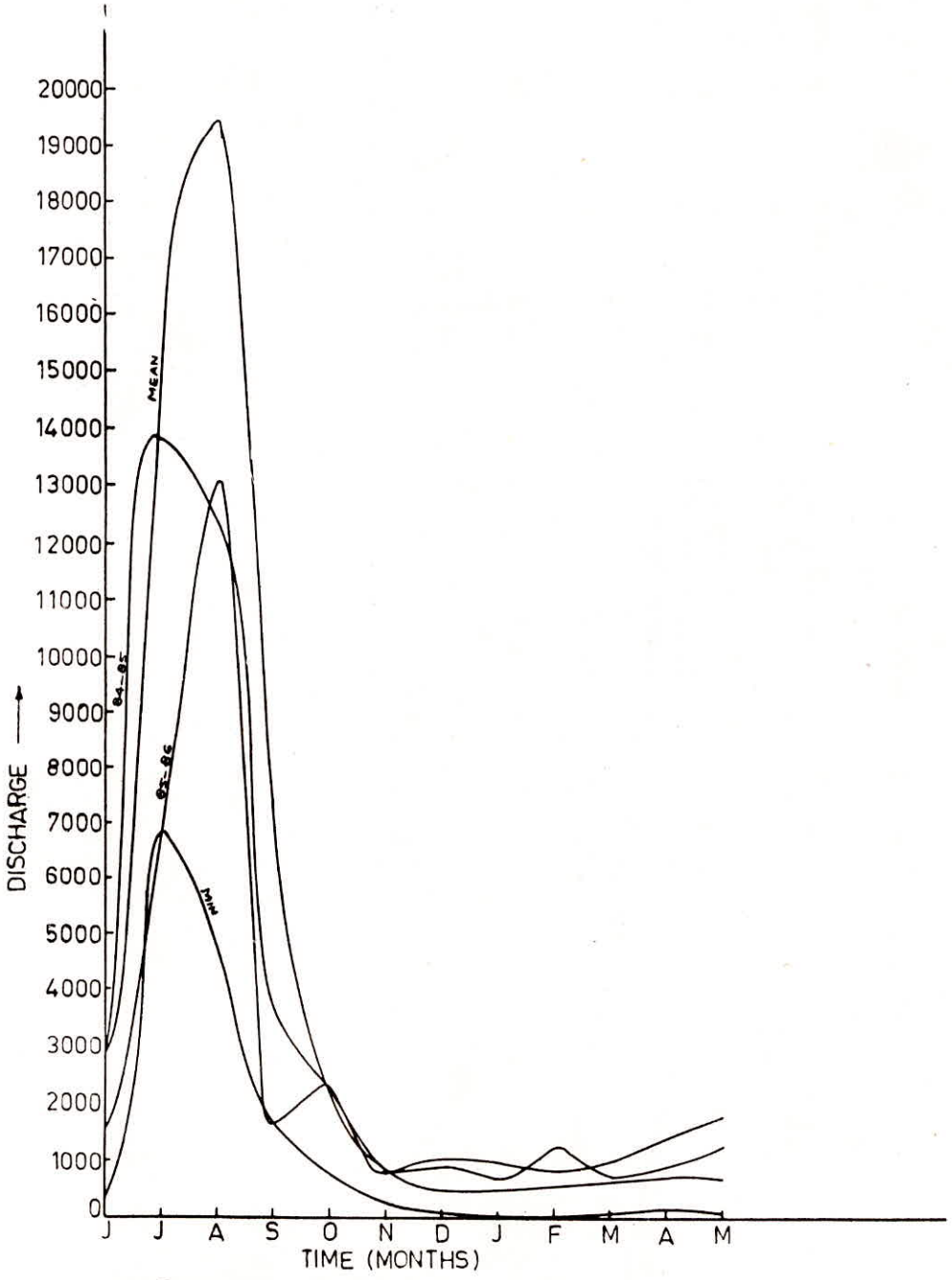

FIG.5 – FLOW HYDROGRAPH FOR KARAD

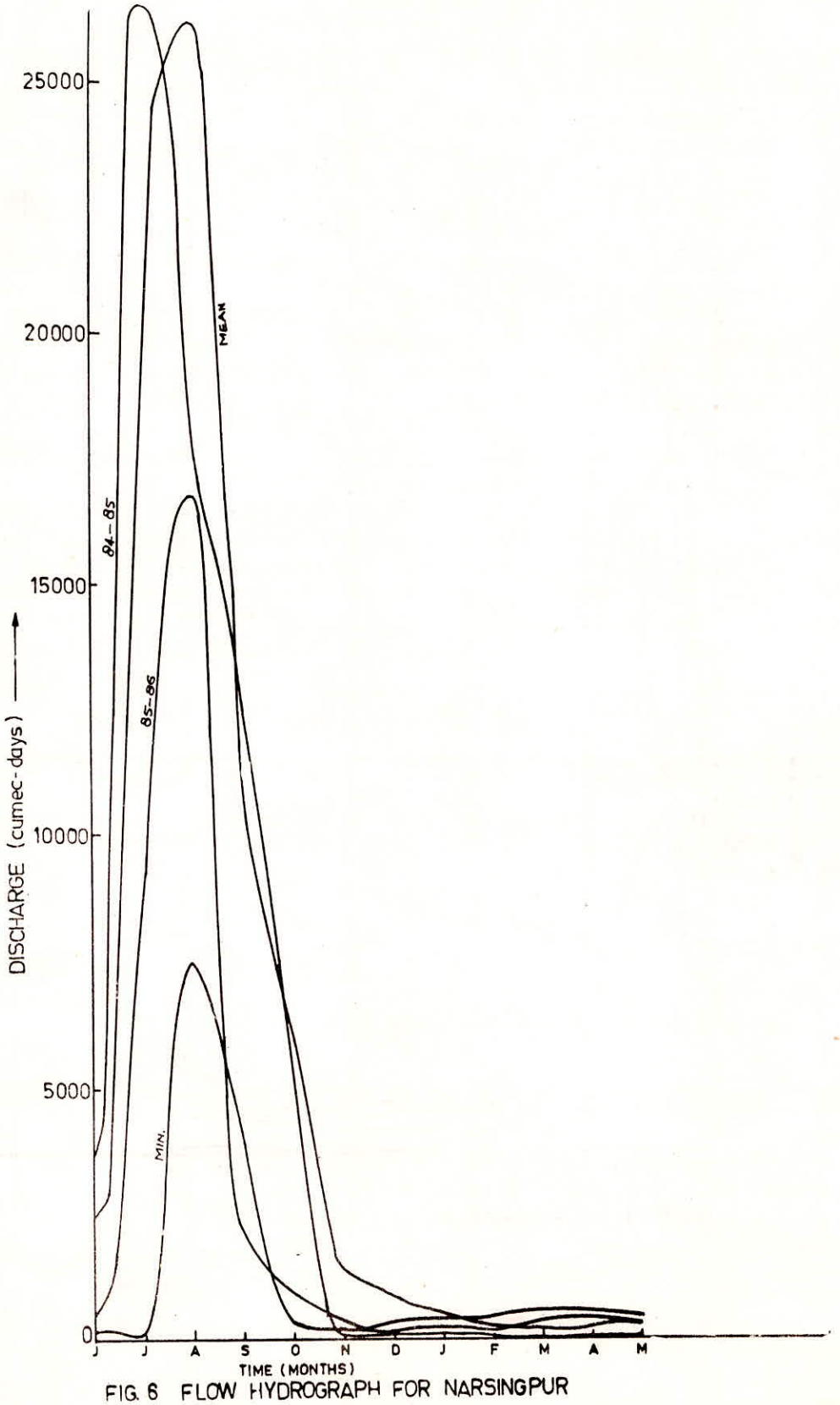

FIG. 6 FLOW HYDROGRAPH FOR NARSINGPUR

Table 3

Annual volumes of streamflow and their statistics

Site/Year	T.Ramapuram	Bawapuram	Harlahalli	Narsingpur	Karad
1966	10328.50	44924.00	-	-	47482.93
1967	5497.47	56970.50	78517.89	76484.50	68798.87
1968	12132.80	70488.34	77122.11	60043.54	44803.23
1969	8738.40	82913.51	99226.60	120355.03	80144.66
1970	12196.30	118953.11	108490.13	73888.30	60930.61
1971	11044.20	51965.30	83760.38	85686.61	49870.00
1972	9012.00	31428.90	69750.41	36190.41	28765.14
1973	11871.68	67713.30	83712.60	94226.50	57286.10
1974	12898.80	70692.30	74890.00	67412.00	39796.40
1975	28173.60	171520.11	121432.62	93528.71	61146.89
1976	5033.11	11508.70	56765.11	123629.31	80865.18
1977	11032.91	42935.70	75956.20	66930.11	53550.90
1978	12683.46	137101.50	140778.81	73972.31	60260.20
1979	9408.30	44946.60	69837.30	80052.51	55846.50
1980	6293.80	105132.50	118822.01	86754.91	62773.70
1981	17871.30	81047.11	89617.81	90163.70	44288.80
1982	10073.30	58454.11	82166.91	30739.00	32108.50
1983	9381.30	55880.91	81184.21	75485.50	41409.79
1984	5224.00	47157.00	82109.20	58837.61	40831.40
1985	3880.20	14714.43	66834.20	30447.40	32092.60
Annual Mean	10688.78	68322.40	87419.72	74990.00	52152.62
Standard deviation	5386.73	39724.04	21289.91	25500.78	14785.80
Coefficient of variation	0.4992837	0.58142	0.243567	0.340051	0.2835102

Table 4

Occurance of deep shortage

Year/ site	1966 -1971	72	73	74	75	76	77	78	79	80	81	82	83	84	85
T.Ramapuram						d								d	d
Bawapuram						d								d	d
Haralahalli						d									
Narsingpur		d										d			d
Karad		d										d			d

5.0 Conclusion

Various low flow indices developed are able to describe the drought phenomenon of quantatively and qualitatively. Inspection of the low flow indices, derived for various sub-basins reveals that the drought conditions occurred in the year 1984 and 1985.

Methodology and indices defined here will be suitable for application in various hydrological situations. Such studies should be carried out using the flow data of various sub-basins located in drought prone areas of the country in order to study the hydrological drought.

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