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A STUDY OF HEAVY RAINFALL OF 22-23 AUGUST, 1990 OVER VIDARBHA REGION OF MAHARASHTRA

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ABSTRACT: The rainstorm of 22-23 August, 1990 over the Vidarbha region of Maharashtra has been analysed by the Depth-Area-Duration (DAD) technique. this reinstorm was associated with the passage of a deep depression from the central Bay of Bengal. DAD values obtained from this rainstorm have been compared with DAD values of the similar rainstorms of past which have occurred over this region. The comparison revealed that this rainstorm has given higher raindepths than those of some of the past severe rainstorms upto an area of 10,000 sq.km. Estimated values of 1-day maximum rainfall of 100-year return period for 4 stations surpassed the observed 1-day rainfall values of those stations during this rainstorm period. The information given in this paper will be useful to the hydrologists for planning and design of water resources projects in the Vidarbha region of Maharashtra.

INTRODUCTION :

Heavy rainfall experienced over Maharashtra during the monsoon season of 1990 was examined. It was found that during 22-23 August, 1990 heavy to very heavy rainfall were reported by many stations located in the vidarbha region of Maharashtra. This heavy rainfall was mostly due to a depression formed over the north and adjoining central Bay of Bengal on 20th August, 1994. It crossed the Orissa coast as a deep depression on 21 August. The torrential rain claimed as many as 60 human lives and disrupted road and rail communications over different parts of Vidarbha. Amravati town was cut-off as the bridge on the river Wardha was submerged (Gupta et al, 1991).

Considering the loss of life and destruction to properties caused by the heavy rainfall during the above period, an attempt has been made in this study to analyse the heavy rainspell of 22-23 August, 1990.

METEOROLOGICAL SITUATIONS RESPONSIBLE FOR CAUSING HEAVY RAINFALL DURING 22-23 AUGUST, 1990 OVER VIDARBHA REGION

A depression formed in the morning of 20th August as a result of an upper air cyclonic ciruculation over the north and adjoining central Bay. It crossed north Orissa coast around noon of 21 August as a deep depression and further moving in a westnorth-westerly direction weakened and merged with the seasonal low over west Rajasthan. Fig.1 shows the track of the Bay depression during its travel across the country from 20 August to 24 August.

A cyclonic circulation in the lower and middle

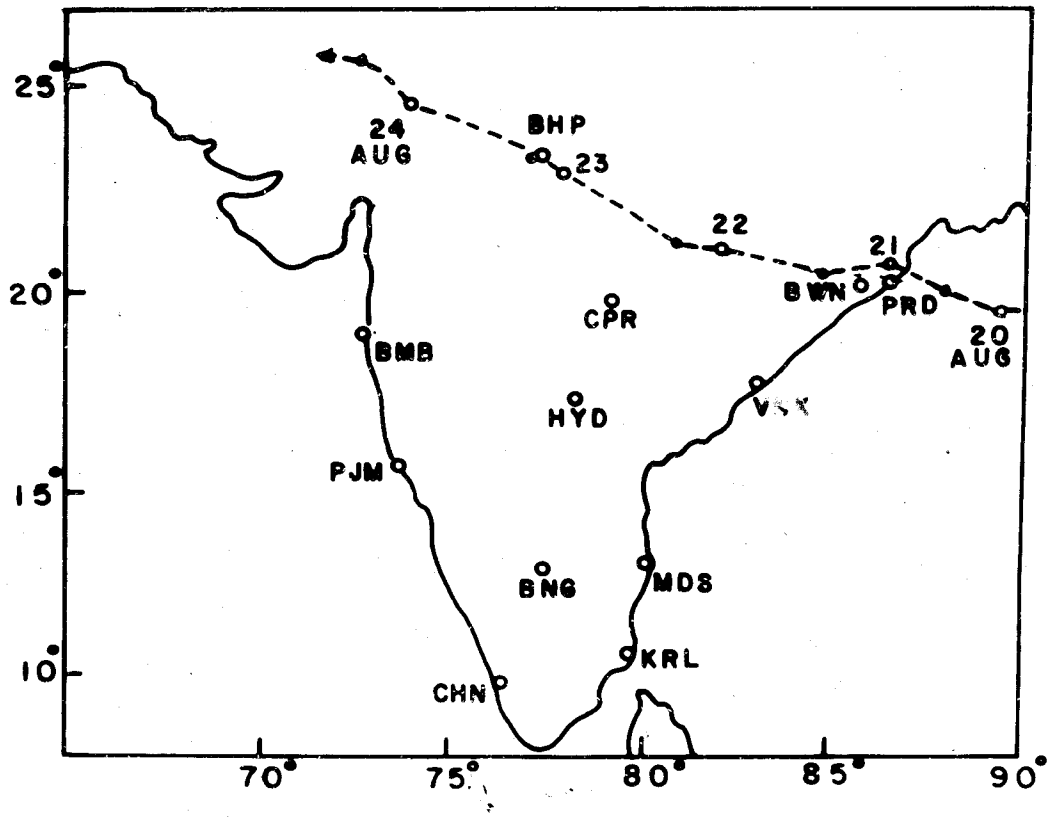

Fig. 1 : Track of the August, 1990 depression from the Bay of Bengal

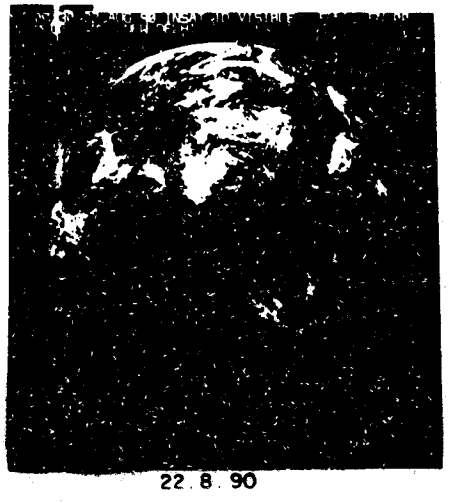

Fig. 2 : INSAT-1D satellite cloud patterns on 22 August, 1990 over Indian region

tropospheric levels between 3.1 and 5.8 km a.s.l. over south Gujarat and adjoining north Maharashtra, remained stationary during 21-22 August.

The above situations resulted in formation of dense rain bearing clouds over Maharashtra region which in turn caused very heavy rainfall during 22-23 August over Vidarbha. Fig.2 shows the INSAT - 1D satellite cloud patterns on 22 August, 1990.

RAINFALL DATA USED:

Daily rainfall data of state raingauge stations numbering about 250 distributed uniformly over different parts of Maharashtra state was collected from the Agriculture Department, Pune for the period 21-25 August, 1990. In addition, rainfall data of 10 observatory stations in and around vidarbha region of Maharashtra state was also collected from the Weather Central, IMD, Pune. The INSAT - 1D picture was also collected from the weather central office of IMD, Pune.

The rainfall data mentioned above formed as the basic input for the analysis in the present study.

RAINFALL DISTRIBUTION ASSOCIATED WITH THE RAINSPELL OF 22-23 AUGUST, 1990 :

While scrutinizing the daily rainfall data of monsoon 1990 over Maharashtra, it was found that many stations received heavy to very heavy rainfall during 22-23 August over Vidarbha region. A list of stations from the affected region which recorded 30 cm or more rainfall in 2 days has been made and the same is given in Table 1. This table also gives 100-year 1-day rainfall (Dhar et al, 1980; Rakhecha et al, 1991) and one-day probable maximum precipitation (PMP) (IITM, 1989) values for these stations.

Table 1 :

List of stations which recorded 30 cm or more in two days (22-23 August,1990) over Vidarbha

SR. No.	Name of the Station	District	Rainfall (cm) 22.8.90	23.8.90	Total rainfall (cm)	100-year 1-day rainfall (cm)	1-day PMP (cm)
1.	Chanda	Chanda	12.2	21.3	33.5	25	60
2.	Mul	"	31.0	14.9	45.9	30	65
3.	Gondapimpri	"	17.1	12.6	29.7	26	60
4.	Nalesar	"	20.3	9.5	29.8	26	62
5.	Sindewahi	"	25.4	5.9	31.3	25	67
6.	Gadchiroli	Gadchiroli	29.6	8.3	37.9	29	65
7.	Kurkheda	"	21.8	10.1	31.9	24	63
8.	Armori	"	30.2	4.5	34.7	28	70
9.	Chamorshi	"	16.3	14.5	30.8	30	64

This table shows that four stations recorded 1-day rainfall which have exceeded their respective 100-year 1-day rainfall.

DEPTH-AREA-DURATION (DAD) ANALYSIS OF AUGUST, 1990 RAINSTORM:

By underaking the DAD analysis of a rainstorms, a three dimensional relationship was obtained between i) maximum average raindepths, ii) over standard areas affected by the rainstorm in iii) different time intervals. The technique of DAD analysis has been explained in various publications like a) rainfall of eastern USA (Miami Conservancy Dist., 1936), b) WMO Manual for Depth-Area-duration (DAD) analysis (1969), c) Manualj of Hydrometeorology (1972) and other text books on Hydrology and Hydrometeorology.

DAD data of rainstorms forms the basic input for any hydrological investigation like estimation of spillway desing flood, probable maximum flood (PMF), forecasting of floods and estimation of waterways under bridges and culverts, etc. In USA, Canada, Australia and other advanced countries of the world, such data is already available in published volumes which are brought up-to-date every year.

Considering above, in order to know the areal extent and raindepths yielded by 22-23 August, 1990 rainstorm, it has been analysied by DAD technique for maximum 1-day (22 Aug.) and 2-day (22-23 Aug.). The centre of this rainstorm was at MUl (Lat. 20^0 04' Long. 79^0 41') (Dist. Chanda) which recorded 31.0 cm of rainfall on 22 August, 1990. Figs.3 and 4 show the isohyetal patterns of 1 and 2-day durations over the Vidarbha region of Maharashtra. Areal raindepths obtained from the DAD analysis for 1 and 2-day over different size areas up to 50,000 sq.km. are given in Table 2.

Table 2:

DAD statistics (cm) of 22-23 August,1990 rainstorm over Vidarbha region.

Rainstorm	Areas in hundreds of square kilometers											
	Point	1	2	5	10	30	50	100	200	300	400	500
22.8.90 (1-day)	31.0	30.9	30.5	30.2	29.7	27.5	25.3	21.7	17.3	-	-	-
22-23.8.90 (2-day)	46.5	45.5	45.3	44.9	43.7	40.0	37.7	34.3	29.5	26.0	23.0	21.3

It is seen from this table that in 1-day it gave 17.3 cm raindepth over 20,000 sq.km. area while in 2-day it gave 21.3 cm raindepth over 50,000 sq.km area.

Kulkarni et al (1991), while analysing the severe rainstorm of 23-25 July,1989 over Maharashtra, have given the DAD statistics of severe rainstorms over the state for durations of 1 to 3 days up to an area of 50,000 sq.km. The DAD data of 22-23 August, 1990 for 1 and 2-day durations has been compared with the similar data of past severe rainStorms over the Maharashtra state. This comparison has shown that the 1-day areal raindepths of August, 1990 has given higher raindepths than those of July, 1989 rainstorm over areas of 1000 to 10,000 sq.km and for 2-day from point to 5000 sq.km. Thus, it can be considered as one of the severe rainstorms for this region.

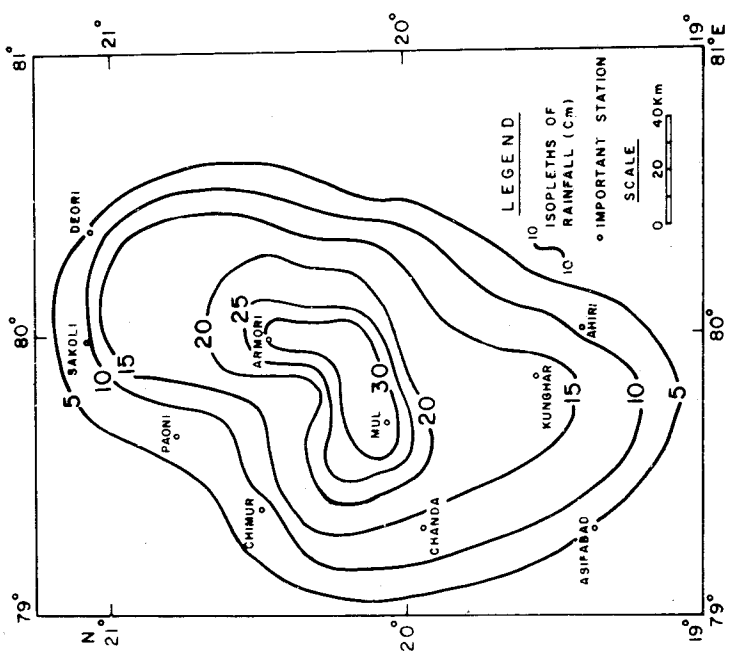

Fig. 3 : Isohyetal pattern of 1-day (22 August,1990) rainstorm over Vidarbha region of Maharashtra

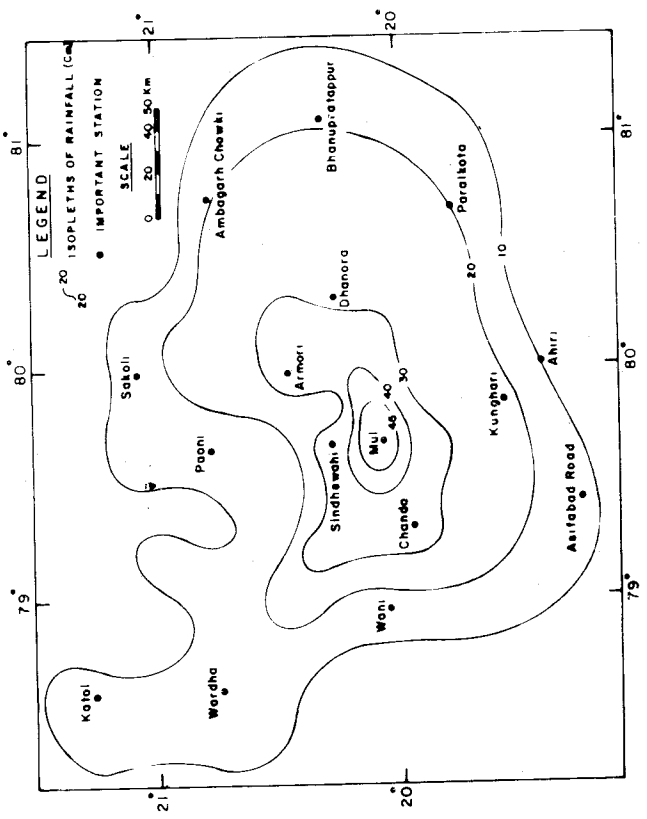

Fig. 4 : Isohyetal pattern of 2-day (22-23 August,1990) rainstorm over Vidarbha region of Maharashtra

RELATIONSHIP BETWEEN POINT TO AREAL RAINFALL FOR ESTIMATING AREAL RAINDEPTHS FORM POINT RAINFALL :

The isohyetal pattern (Figs. 3 & 4) show that the maximum intensity of rainfall in a storm occurs at a point at the centre of the rainstorm and outside this, the intensity gradually decreases. Thus, the maximum rainfall at the centre of the rainstorm appears to bear a definite relationship to the average amount of rainfall inside the area enclosed by an isohyet. Dhar and Bhattacharya(1977) have developed a non-linear mathematical relationship which relates point rainfall of a rainstorm to areal rainfall by considering all the major rainstorms which occurred in different parts of north India, taking into account the rainfall data of 80-year period. Similar relationship has been obtained for August, 1990 rainstorm by considering 4 recent rainstorms (i.e. 23-25 july, 1989; 22-23 August,1990; 8-10 June, 1991 and 2-3 Sept.,1992) over Marathwada, Vidarbha sub-divisions of Maharashtra. The relationship can be expressed as :

$$P = P_{\cdot} e^{-k a n}$$

Where P = Average rainfall over an area A

P = the maximum point rainfall experienced in the rainstorm area and

k & n = are constants whose values vary with the duration of a rainstorm.

As such, if the Depth-Area-Duration curve associated with the rainstorm of 22-23 Aug.,1990 is available then it can be used to convert storm centre rainfall into areal rainfall depths. The depth-area models of 1 and 2 day durations for Agugst, 1990 rainstorm have been obtained as :

$$P_1 = P_{m1}\, e^{-0.00046}\, A^{0.95} \quad \ldots. (1)$$

$$P_2 = P_{m2}\, e^{-0.000584}\, A^{0.65} \quad \ldots. (2)$$

Where P_1 and P_2 are the average rainfall depths over an area A (in sq.kms) and P_{m1} and P_{m2} are the maximum central raindepths (cm) for 1 and 2-day durations. The K and n constants for different durations in the equation were evaluated by the least square technique.

Table 3 : Comparison of raindepth vlues obtained by DAD analysis and by the model for 1 and 2-day durations of 22-23 August, 1990 rainstorm

Area (sq.km)	Raindepth values for 22nd August 1990		Raindepths values for 22-23 August 1990	
	DAD method (cm)	by model (cm)	DAD method (cm)	by model (cm)
Point	31.0	31.0	46.0	46.0
100	30.9	30.9	45.5	45.5
200	30.5	30.8	45.3	45.2
500	30.2	30.5	44.8	44.5
1000	29.7	30.0	43.7	43.7
3000	27.5	28.3	40.0	41.4
5000	25.3	26.7	37.7	39.7

The above models can be used to convert the rainstorms' central rainfall to areal rainfall. Estimated raindepths as obtained for different standard areas by using the above relationships for August, 1990 rainstorm are given in Table 3. Actural raindepths for these standard areas as obtained by the DAD technique are also given for comparison.

From this table it can be seen that the relationships held reasonably good for 1 and 2-day durations up to an area of 5000 sq.kms.

SUMMARY AND CONCLUSIONS :

From the foregoing the following facts emerged:

1. The heavy rainfall over Vidarbha region of Maharashtra during 22-23 August,1990 was caused due to a Bay depression during 20-24 August, 1990.
2. Four stations recorded 1-day rainfall which were more than their respective 100-year 1-day rainfall.
3. Comparison of DAD values of this rainstorm with similar data from other past severe rainstorms over this region has shown the 22-23 August,1990 rainstorm has given higher raindepths than those of July,1989 rainstorm over areas of 1000 to 10,000 sq.km for 1-day duration and point to 5000 sq.km for 2-day duration. Although the rainstorm of 22-23 August,1990 over Vidarbha region was not unprecedented it can be considered as one of the severe rainstorms of the region.
4. A relationship has been developed between point to areal rainfall for obtaining areal raindepths from point rainfall. The relationship holds reasonably good upto an area of 5,000 sq.km for 1 and 2-day durations.

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