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1-hour rainfall of India for different return periods

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ABSTRACT. Based on the hourly tabulations of rainfall for 99 observatory stations in India equipped with recording raingauges, return period values of 1-hour rainfall for 2, 5, 10 and 50 years have been computed and maps prepared. The maps are presented and the important features of the 1-hour rainfall of India as seen from these maps are discussed.

1. Introduction

For the planning and construction of railway and road bridges and their protection works with a view to economy on the one hand and safety on the other, quantitative knowledge is required of the probable maximum discharge of water under the bridges. The discharge depends upon (1) drainage basin factors, such as size, shape and slope of the basin, location of the basin with respect to storm path, nature of the soil etc and (2) storm factors such as the intensity, duration and sequence of rainfall and its distribution over the catchment area during successive time intervals.

For the computation of discharges from catchments of small area, the rainfall that is important is short-duration rainfall, occurring over fractions of an hour to a few hours, depending upon the size of the catchment and the time of concentration. In this note, maps showing the 1-hour rainfall for return periods of 2, 5, 10, 25 and 50 years are presented. Studies of rainfall for other durations are in progress and these will be published separately later.

2. Data

Hourly tabulations of rainfall for 99 observatory stations equipped with recording raingauges were used for this study. Fig. 1 shows the location of the stations and Table 1 gives the list of stations and period of data for each station. Of these 16 stations had data for 16-20 years, 39 stations for 11-15 years and 44 stations for 10 years or less. It would have been better if the period and volume of data had been identical for all stations. This could not be achieved in view of the need to utilise the data of the maximum number of stations for obtaining the best possible coverage for the country. It has also to be borne in mind that it will take several years for so much data to accumulate as to have a uniform series for all stations. It may be recalled in this connection that in an earlier study Parthasarathy and Gurbachan Singh (1961) had used data for 38 stations for periods varying from 5 to 15 years.

3. Method of analysis

Gumbel's extreme value technique was applied for the computation of the return period values. The Gumbel technique is sufficiently well known and hence details of the same are not being given here. The values have been fitted by the method of least squares. The clock-hour values were taken as they are and annual series have been used. Hershfield (1961) has found for the United States of America that 1·13 times a rainfall value for a particular return period based on a series of annual maximum clock-hour rainfalls was equivalent to the amount for the same return period obtained from a series of 60-minute rainfalls.

A study of this aspect covering not only clock-hour rainfall but also observational day rainfall is in progress. Preliminary results have however indicated that Hershfield's result is broadly applicable to Indian data also.

Figs. 2-6 show the 1-hour rainfall in return periods of 2 years, 5 years, 10 years, 25 years and 50 years.

4. Results

(1) The maps of 1-hour rainfall for the different return periods are broadly similar. However, the maps, particularly those for the lower return periods, reflect the influence, in the causation of intense heavy rainfall, of (a) cyclonic storms along the Tamil Nadu and Andhra Pradesh coasts (b) monsoon depressions along the Orissa-West Bengal coasts and along the westnorthwesterly tracks of the monsoon depressions after they cross the Orissa coast (c) periodic surges in monsoon intensity over the

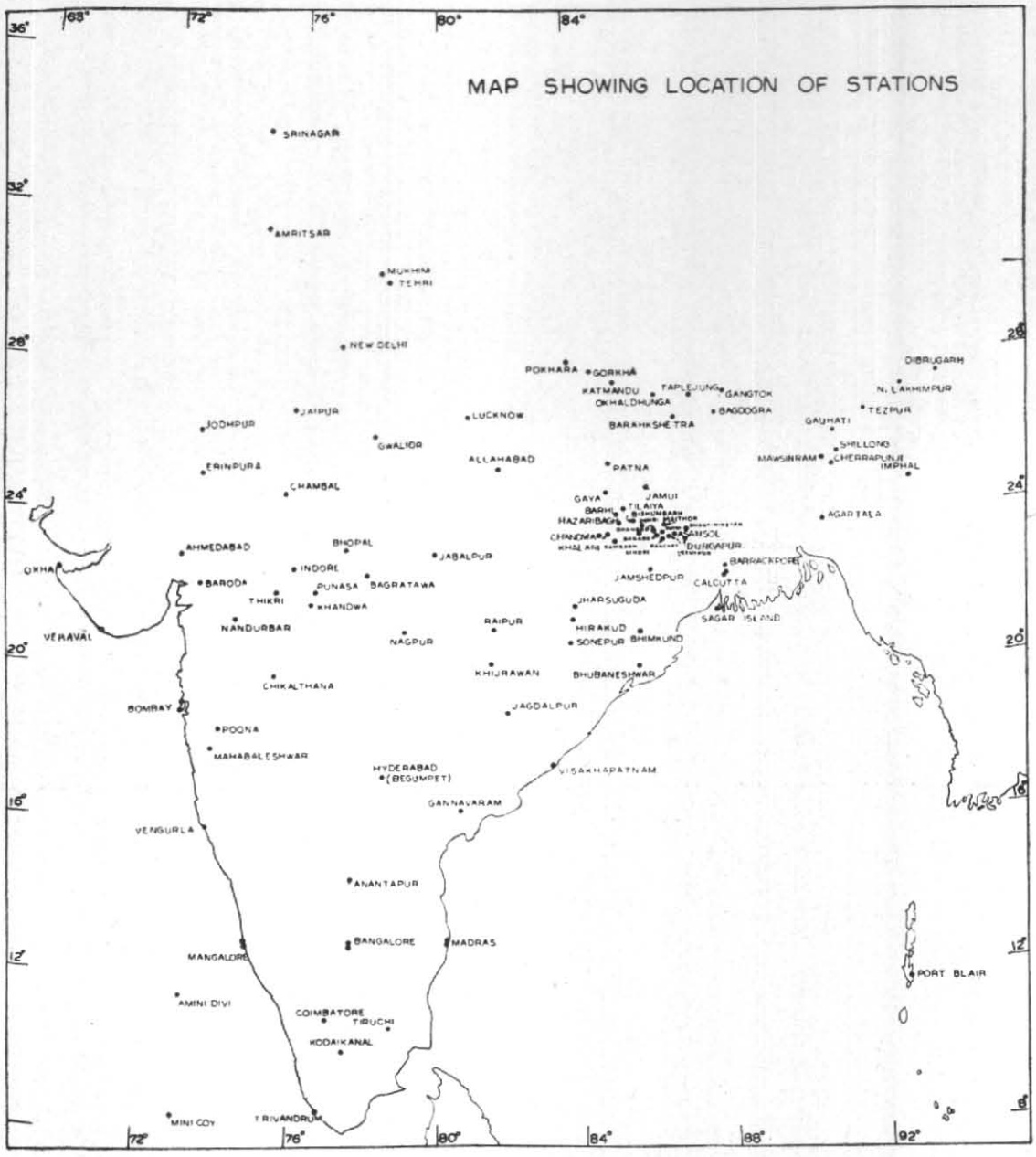

Fig. 1. Map showing the location of stations

west coast of India due to periodic shifts and pulsations in the easterly jet streams (Koteswaram 1958) (d) cyclonic micro-vortices near the Maharashtra and Saurashtra coasts during the monsoon season (George 1956) and (e) orography. The influences of the frequently occurring short period disturbances are comparatively less marked in the higher return period maps. This is to be expected since the very heavy rainfall with a long return period, need not be associated with the frequently occurring weather disturbances but may be due to the combined effect of a number of causes, some of which may be of a long term nature.

(2) Although west Rajasthan is an arid region, it can receive 7-8 cm of rain in one hour in intense heavy spells.

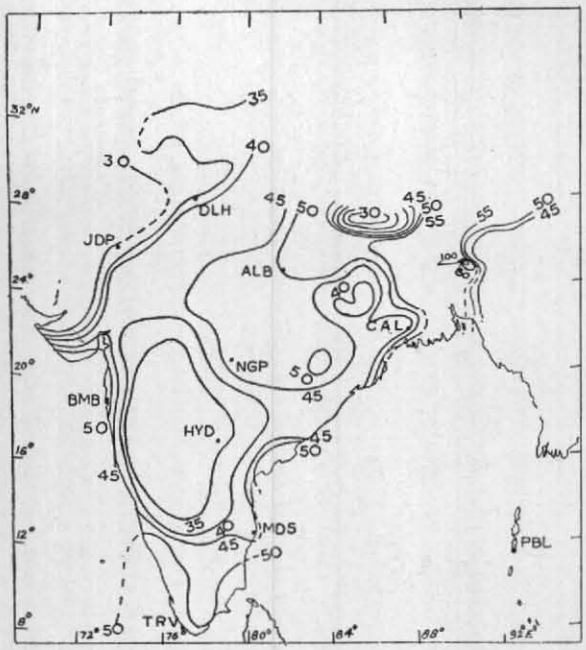

Fig. 2. 2-Year 1-hour maximum rainfall (mm)

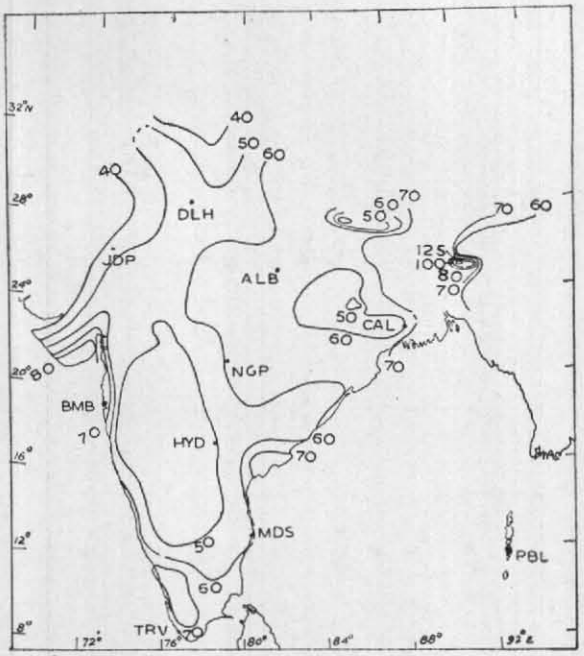

Fig. 3. 5-year 1-hour maximum rainfall (mm)

TABLE 1

Stations and period of data used

Station	Period of data (yrs)	Station	Period of data (yrs)	Station	Period of data (yrs)	Station	Period of data (yrs)
Assam		*Bihar*		*Jammu & Kashmir*		Vengurla	14
Agartala	14	Barhi	5	Srinagar	12	*Andhra Pradesh*	
Cherrapunji	14	Bishungarh	13	*Rajasthan*		Anantapur	4
Dibrugarh	11	Bokaro	14	Chambal	5	Begumpet	19
Gauhati	11	Chandwa	11	Erinpura	5	Gunnavaram	5
Imphal	10	Dhanbad	8	Jaipur	16	Visakhapatanam	15
Mawsynram	8	Dumri	10	Jodhpur	18	*Tamil Nadu*	
North Lakhimpur	10	Gaya	19	*Madhya Pradesh*		Coimbatore	4
Shillong	10	Hazaribagh	15	Bagratawa	15	Kodaikanal	19
Tezpur	8	Jamshedpur	19	Bhopal	13	Nungambakkam	10
West Bengal		Jamui	9	Gwalior	5	Meenambakkam	20
Alipore	19	Khalari	4	Indore	3	Tiruchirapalli	13
Asansol	14	Maithon	6	Jabalpur	14	*Mysore*	
Bagdogra	3	Patna	4	Jagdalpur	14	Bajpe	8
Barrackpore	9	Putki	6	Khandwa	10	Bangalore C.O.	17
Dum Dum	19	Ramgarh	13	Khijrawan	6	Bangalore F.O.	13
Durgapur	10	Sindri	4	Punasa	11	Mangalore	13
Luchipur	5	Tilaiya	10	Raipur	5	*Kerala*	
Panchet Hills	13	*Uttar Pradesh*		Thikri	15	Trivandrum	14
Sagar Island	19	Allahabad	19	*Gujarat*		*Arabian Sea/Bay Islands*	
Shantiniketan	7	Lucknow	14	Ahmedabad	14	Amini Devi	4
Orissa		Mukhim	9	Baroda	13	Minicoy	5
Bhimkund	9	Tehri	10	Okha	3	Port Blair	15
Bhubneswar	5	*Punjab and Delhi*		Veraval	12	*Nepal and Sikkim*	
Hirakud	13	New Delhi	19	*Maharashtra*		Barahakshetra	15
Jharsaguda	13	Amritsar	15	Aurangabad	13	Gangtok	11
Sonepur	9			Colaba	19	Gorkha	6
				Mahabaleshwar	14	Kathmandu	13
				Nagpur	19	Okhaldhunga	9
				Nandurbar	11	Pokhara	7
				Poona	18	Taplejung	10
				Santacruz	13		

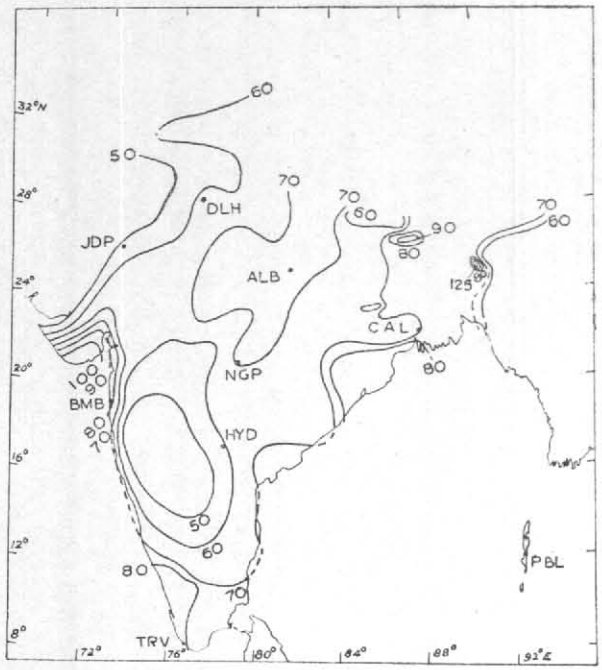

Fig. 4. 10-year, 1-hour maximum rainfall (mm)

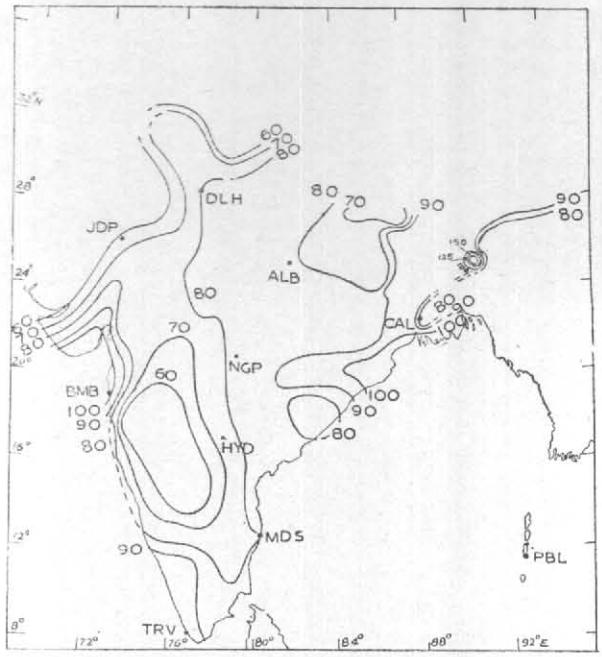

Fig. 5. 25-year 1-hour maximum rainfall (mm)

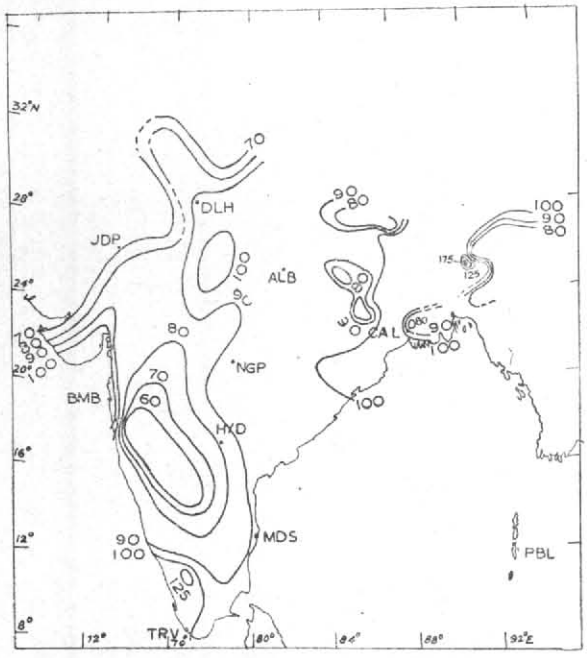

Fig. 6. 50-year, 1-hour maximum rainfall (mm)

(3) Similarly the semi-arid zones of interior Maharashtra, Rayalaseema and north Mysore can also receive intense falls of 6-8 cm in one hour.

(4) The Cherrapunji area can receive as much as 17-18 cm of rain in one hour.

(5) Most of coastal Saurashtra is similar to north Konkan from the point of view of liability to heavy rainfall in short spells of one hour although their normal annual rainfall, liability to drought etc are quite different.

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