

CHAPTER II.

CLIMATE AND RAINFALL.

CLIMATE.

Muzaffarpur district enjoys generally a bracing and healthy climate. The range of temperature is not so great as in the Patna Division in the south; and though the heat is greater than in the delta districts of Bengal proper, the comparative dryness of the atmosphere renders its effects less enervating.

The year may be divided into three well defined periods, viz., the cold weather, the hot weather and the rainy season. The first commences early in November and lasts till nearly the end of March; for though the days then begin to be hot, the nights and early mornings continue to be comparatively cool and fresh. The climate is delightful during this part of the year; the days are bright, warm and invigorating and as soon as the sun sets, the temperature falls. The hot season commencing in April is ushered in by dust-storms. The heat is intense in May and unless broken by frequent rain, continues to increase until the gathering of clouds heralds the approach of the rainy season.

The rain starts about the middle of June. Sometimes, a few days' downpour is succeeded by a week or ten days of fair weather before the rains really break. This first outburst is termed the *chhotā barsat*. The rains continue till the end of September or the middle of October, when the saturated ground begins to dry. This is considered to be the most trying season of the year as the air is hot and moist, while the sun's rays are still powerful. The temperature then diminishes and by November the mornings become perceptibly cool when the winter season commences.

RAINFALL.

The district has 18 stations for which rainfall data are available. The average monthly and annual rainfall, monthly rainfall expressed as a percentage of the annual, and the average number of rainy days (having 0.10 inch or more of rain) for the district and for all the stations are given in Table 1. The averages are based on data collected up to 1940.

The district enjoys good rainfall with an annual average of 46 inches, most parts of the district receiving over 45 inches. The rainfall varies from 38 inches in the southernmost part of the district near Raghapur to 52 inches in the areas of Bairagnia and Sitamarhi in the north. The town of Muzaffarpur gets about 48 inches in a year.

The main rainy months with one inch or more are from May to October. Pre-monsoon showers in May account for about 5 per cent of the annual rainfall followed by 16 per cent in June; July and August are the rainiest months of the year and combined they receive over 50 per cent of the total annual rainfall. September is more rainy than June. As in May, the rainfall during October is also 5 per cent. Thus, over 85 per cent of the annual rainfall occurs during the monsoon months of June to September.

The average number of days of rain of 10 cents or more for the district is 46 with 50 or more over a large area. The number of rainy days of 1 cent or more is about 70. The average rainfall on a rainy day of 1 cent or more is about 0.6 inch.

Annual rainfall data of all the raingauge stations for the fifty-year period 1901—50 have been analysed and Table 2 gives the frequencies of annual rainfall in different ranges at these stations. The table also includes for each of the raingauge stations the standard deviation, co-efficient of variability (%) and the highest and the lowest rainfall values expressed as percentage of the mean.

Although the rainfall in the district is good the variations from year to year are rather large. At one of the stations the highest annual rainfall has exceeded twice the average and another has recorded as low a rainfall as 25 per cent of the average. Generally, however, none of the stations has had during the fifty-year period 1901—50 more than twice or fallen below a third of the average. The co-efficient of variability is high and of the order of 30 per cent.

Table 3 gives the frequencies in different ranges of heavy rainfall of over 3 inches in a day which has occurred at the different stations in the district based on data up to 1920. Table 4 gives occasions of heavy rainfall of over 10 inches in 24 hours, at different stations in the district based on data up to 1950. It also gives the rainfall on the previous and succeeding days.

On an average the district gets two to three falls in a year exceeding 3 inches in 24 hours. Falls of 10 inches or more may occur once in 15 to 20 years. All the stations for which the data are included in Table 4 show that they have received more than 10 inches in 24 hours. The heaviest fall in 24 hours in the district has occurred at Belsand on the 18th September 1924, the amount being 15.30 inches.

TEMPERATURE AND OTHER WEATHER CONDITIONS.

Muzaffarpur is the only station in the district which has temperature, cloud and wind data, though they relate to a period of about 20 years from 1886. Wherever necessary, the data of Darbhanga, the nearest observatory station, are supplemented.

Temperature.

The temperature data of Muzaffarpur appear in Table 5.

The mean annual temperature in this district is 77°F. Temperature begins to rise rapidly from March and attains the highest records in the months of April and May which are the hottest months of the year. The mean maximum temperature in these months is 96°F to 97°F and on individual days maximum temperatures of the order of 110°F are not uncommon. This rising trend in temperature is changed with the onset of the monsoon in the second week of June. The variations during the monsoon months of June to September are small. Temperature begins to fall markedly after the withdrawal of the monsoon in October and the lowest temperature is recorded in January and February with a mean minimum temperature of 49°F to 52°F in these months. The lowest temperature in this area is likely to be of the order of 35°F. The district has only a single maximum of temperature (in the year) as compared to stations in the coastal belt where generally a secondary maximum in the transition month of October occurs.

The mean annual range of temperature is 20°F with the highest value of 28°F in the month of March.

Relative humidity.

The dry bulb and wet bulb temperatures in °F and relative humidity (%) for Muzaffarpur and Darbhanga are given in Table 6.

The average annual humidity in the morning is 80(%) and in the evening 55 to 60%. The highest humidity is recorded in the monsoon months when on individual days the atmosphere may be saturated. The lowest values of humidity occur in the months of March and April. The humidities on individual days may be as low as 10 to 15%. The cloud amount is shown in Table 7.

Outside the monsoon months the skies are practically clear (less than 2/10ths).

SURFACE WINDS.

Average percentage frequencies of number of days of wind from different directions, throughout the year at Muzaffarpur are given in Table 8.

The wind speeds are generally low throughout the year. Calm conditions prevail during October to January. Winds blow from a westerly direction from January to March while easterly winds are predominant beyond this period till the end of September.

Normal monthly and annual rainfall and number of rainy

Station.	1	2	3	4	5	6	7
January.	February.	March.	April.	May.	June.		
Sitamarhi	A .. 0.53	0.52	0.59	0.84	3.13	8.30	
	B .. 1.0	1.0	1.1	1.6	5.9	16.7	
	C .. 1.1	1.5	1.0	1.5	4.7	9.1	
Muzaffarpur	A .. 0.52	0.57	0.38	0.48	1.98	7.70	
	B .. 1.1	1.2	0.8	1.0	4.1	15.9	
	C .. 1.1	1.7	0.9	0.9	3.1	8.1	
Hajipur	A .. 0.57	0.71	0.41	0.32	1.35	6.71	
	B .. 1.3	1.6	0.9	0.7	3.1	15.2	
	C .. 1.3	1.5	1.0	0.7	2.2	7.6	
Paru	A .. 0.40	0.55	0.38	0.27	1.45	5.90	
	B .. 1.0	1.3	0.9	0.7	3.5	14.2	
	C .. 1.0	1.4	0.9	0.5	2.2	6.9	
Mahua	A .. 0.53	0.71	0.32	0.33	1.65	6.92	
	B .. 1.2	1.5	0.7	0.7	3.6	15.1	
	C .. 1.1	1.7	0.9	0.7	2.3	7.5	
Sheohar	A .. 0.50	0.50	0.43	0.53	2.27	7.41	
	B .. 1.1	1.1	0.9	1.1	4.9	16.1	
	C .. 0.9	1.3	1.0	1.2	3.3	7.4	
Pupri	A .. 0.44	0.54	0.44	0.75	2.57	7.65	
	B .. 0.9	1.1	0.9	1.6	5.4	16.1	
	C .. 0.9	1.3	0.9	1.4	3.6	7.8	
Raghopur	A .. 0.43	0.54	0.40	0.21	0.95	5.44	
	B .. 1.1	1.4	1.1	0.6	2.5	14.5	
	C .. 0.8	1.2	0.9	0.4	1.2	6.1	
Sahebganj	A .. 0.11	1.01	0.20	0.22	1.77	6.98	
	B .. 0.2	2.1	0.4	0.5	3.7	14.4	
	C .. 0.3	2.2	0.8	0.7	2.2	6.9	

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1.

days for Muzaffarpur District (data used up to 1940).

July.	August.	September.	October.	November.	December.	Annual.
8	9	10	11	12	13	*14

13.72	11.97	9.67	2.59	0.19	0.16	52.71
16.0	22.7	18.3	4.9	0.4	0.3	..
12.7	12.6	9.1	2.6	0.3	0.4	56.6
12.78	12.56	8.65	2.41	0.29	0.12	48.44
26.4	25.9	17.9	5.0	0.6	0.2	..
14.1	13.6	9.5	2.5	0.5	0.3	56.2
11.52	11.77	8.06	2.43	0.25	0.13	44.23
26.0	26.6	18.2	5.5	0.6	0.3	..
13.8	13.1	9.2	2.8	0.5	0.3	55.0
11.29	11.57	7.64	1.73	0.19	0.11	41.48
27.2	27.9	18.4	4.2	0.5	0.3	..
12.1	11.9	8.1	2.2	0.4	0.2	47.8
11.78	12.57	8.49	2.13	0.29	0.12	45.84
25.7	27.4	18.5	4.6	0.6	0.3	..
13.6	13.8	9.2	2.3	0.4	0.3	53.8
11.45	11.31	9.08	2.27	0.24	0.16	46.14
24.8	24.5	19.7	4.9	0.5	0.3	..
11.4	11.5	8.3	2.1	0.4	0.3	49.1
12.53	12.15	8.03	1.99	0.20	0.10	47.39
26.4	25.6	16.19	4.2	0.4	0.2	..
10.8	11.7	7.7	2.2	0.3	0.2	48.8
9.23	10.90	7.19	1.64	0.45	0.19	37.57
24.6	29.0	19.1	4.4	1.2	0.5	..
9.8	11.0	6.5	1.9	0.6	0.3	40.7
12.83	12.88	10.01	2.04	0.27	0.11	48.43
26.5	26.6	20.7	4.2	0.6	0.2	..
12.1	13.5	10.4	2.5	0.4	0.2	52.2

MUZAFARPUR.

A—Normal rainfall in inches.
B—Monthly rainfall as percentage of annual normal.
C—Normal number of rainy days (a rainy day is one of 0.10" or more of rain).

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I—concl.

	July.	August.	September.	October.	November.	December.	Annual.
8	9	10	11	12	13	14	
12.37	10.95	9.45	1.95	0.51	0.20	44.92	27.5
27.5	24.4	21.0	4.3	1.1	0.4	..	50.1
12.4	12.2	8.6	2.2	0.5	0.4	50.1	14.48
14.48	11.89	9.74	2.34	0.48	0.22	50.10	28.9
28.9	23.7	19.4	4.7	1.0	0.4	..	12.8
12.8	11.9	8.3	2.2	0.6	0.4	49.6	10.56
10.56	11.43	0.50	1.47	0.34	0.18	41.42	25.5
25.5	27.6	20.5	3.5	0.8	0.4	..	12.9
12.9	14.2	9.5	2.0	0.6	0.4	53.8	12.29
12.29	10.53	8.31	1.57	0.26	0.12	45.49	27.0
27.0	23.1	18.3	3.5	0.6	0.3	..	10.5
10.5	10.1	8.0	2.2	0.4	0.3	46.5	12.56
12.56	11.20	8.35	2.02	0.06	0.14	47.82	26.3
26.3	23.4	17.5	4.2	0.1	0.3	..	10.1
10.1	10.0	7.6	1.9	0.2	0.3	45.2	13.96
13.96	12.25	9.38	1.95	0.21	0.17	52.79	26.4
26.4	23.2	17.8	3.7	0.4	0.3	..	11.9
11.9	12.3	8.4	2.1	0.3	0.3	53.0	12.03
12.03	11.50	9.40	2.39	0.33	0.16	48.16	25.0
25.0	23.9	19.5	5.0	0.7	0.4	..	11.2
11.2	12.6	8.5	2.0	0.3	0.3	49.4	14.39
14.39	11.29	11.53	1.65	0.11	0.09	47.84	30.1
30.1	23.6	24.1	3.5	0.2	0.2	..	12.3
12.3	11.4	9.0	1.6	0.1	0.2	46.3	11.50
11.50	12.18	8.34	1.20	0.65	0.17	43.11	26.7
26.7	28.3	19.4	2.8	1.5	0.4	52.8	13.4
13.4	3.8	9.6	2.0	0.7	0.5	..	12.29
12.29	11.72	8.88	1.99	0.30	0.15	46.33	26.5
26.5	25.3	19.2	4.3	0.7	0.3	..	12.1
12.1	12.3	8.6	2.2	0.4	0.3	44.6	..

TABLE
Frequency of annual rainfall in specified

Inches.	Sitamarhi.	Muzaffar- pur.	Paru.	Mahua.	Sheohar.	Purri.	Ragho- pur.
1	2	3	4	5	6	7	8

5.01—10.00	..	..	..	..	..	..	1
10.01—15.00	..	..	..	..	..	..	..
15.01—20.00	..	..	..	..	1	..	1
20.01—25.00	..	1	6	..	..	1	1
25.01—30.00	..	1	4	2	2	2	5
30.01—35.00	..	..	4	5	3	3	8
35.01—40.00	..	6	6	10	10	7	4
40.01—45.00	..	6	5	4	4	5	7
45.01—50.00	..	8	8	7	6	5	1
50.01—55.00	..	6	8	5	3	9	1
55.01—60.00	..	7	6	1	5	4	2
60.01—65.00	..	6	4	..	4	3	..
65.01—70.00	..	3	2	..	1	1	..
70.01—75.00	..	2	1	..	2	1	1
75.01—80.00	..	2	..	..	4	2	..
80.01—85.00	..	2	..	..	..	..	..
85.01—90.00	..	1	..	..	1	..	..
90.01—95.00	..	..	..	..	..	..	..
95.01—100.00	..	..	..	..	..	..	..
100.01—105.00	..	..	..	..	..	..	..
105.01—110.00	..	..	..	..	..	1	..
Number of years	50	49	40	46	46	44	32
Mean rainfall in inches.	54.81	47.00	38.58	45.25	50.13	49.79	36.64
Standard Devia- tion.	13.53	12.04	9.75	11.18	15.70	15.34	12.32
Coefficient of variability.	24.7	25.6	25.3	24.7	31.3	30.8	33.6
Highest rainfall as percentage of mean.	88.80	71.16	58.86	70.41	87.46	105.52	72.52
Highest rainfall as percentage of lowest rainfall ..	162	161	151	156	174	212	198
Lowest rainfall as percentage of mean.	27.30	20.47	21.95	25.92	19.39	24.13	8.99
Lowest rainfall ..	50	44	57	57	39	48	25

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2.
Limits period (1901—1950).

Minapur. Saheb- Katra. Lalgarh. Sursand. Sorbarsa. Bairagnia. Belsand. Hajipur.

9	10	11	12	13	14	15	16	17
..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..
..	..	..	1	..	..	..	..	..
1	..	..	3	1	..	..	1	..
2	1	..	5	2	2	..	1	6
7	1	4	6	5	4	3	3	7
7	3	5	7	4	2	3	5	7
6	3	7	3	8	3	1	8	7
7	..	6	8	3	7	6	4	10
4	6	5	2	4	6	9	4	9
3	2	3	1	6	4	6	1	1
1	..	3	1	..	3	1	2	2
1	..	1	..	1	1	2	1	1
..	..	1	..	..	..	1	..	..
..	..	2	..	..	..	2	3	..
..	..	1	..	..	..	1	..	..
..	..	1	..	..	..	..	..	..
..	..	..	..	..	..	1	..	..
..	..	..	..	..	..	1	..	..
..	..	..	..	..	..	..	..	..
39	16	39	37	34	32	37	33	50
42.90	45.83	50.80	38.46	43.90	47.37	55.89	47.07	42.46
10.50	9.83	14.65	10.40	10.82	10.99	15.45	14.15	10.25
24.5	21.4	28.8	27.0	24.6	23.2	27.7	30.1	24.1
68.24	59.79	85.92	64.77	67.40	66.07	98.21	79.95	69.92
159	130	169	168	154	139	176	170	165
20.64	28.52	30.13	18.71	22.90	27.29	33.63	21.04	25.66
48	62	59	49	52	58	60	45	60

TABLE 3.
Frequency of heavy rain.

Station.	Number of years.	3" to 4".	4" to 5".	5" to 6".	6" to 7".	7" to 8".	8" to 9".	9" to 10".	10" to 11".	11" to 12".	12" to 13".	13" to 14".	14" to 15".
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sitamarhi ..	30	50	18	10	5	2	1	..	1	1	..	..	..
Muzaffarpur ..	30	36	17	10	..	3	..	..	..	1	..	1	..
Hajipur ..	30	37	13	8	2	1	1	..	1	..	1	..	..
Paru ..	30	26	21	4	..	2	..	..	..	..	..	..	..
Mahua ..	30	41	16	13	4	1	1	..	..	..	..	..	..
Sheohar ..	30	22	7	4	..	1	..	..	..	..	..	..	..
Pupri ..	30	48	14	6	2	..	..	..	1	1	..	..	..
Raghopur ..	12	15	5	4	2	2	1	..	..	..	..	..	..
Minapur ..	11	19	7	1	1	1	..	..	..	..	..	..	..
Katra ..	11	19	6	2	3	1	1	..	..	1	..	..	..
Lalganj ..	11	10	5	2	3	..	..	..	1	..	..	..	..
Sursand ..	11	10	2	4	..	2	1	..	..	..	..	..	..
Sonbarsa ..	11	12	7	4	..	1	..	..	..	..	..	..	..
Bairagnia ..	11	19	8	6	..	..	1	..	..	..	..	..	..

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TABLE 4.

Heavy rainfall of over 10 inches in 24 hours.

(This table is based on data up to 1950.)

Station.	Date.	Previous day.	Of date.	Next day.
Hajipur	.. 25th June 1897 ..	2.98	10.70	2.51
Muzaffarpur	.. 10th August 1904	0.20	13.20	0
Sitamarhi	.. 31st July 1905 ..	1.03	11.65	2.75
Sitamarhi	.. 30th September 1905	0.05	10.65	0.86
Pupri	.. 30th September 1905	0.32	11.05	0
Pupri	.. 13th August 1906	2.55	10.15	6.80
Pupri	.. 18th September 1935	0	10.01	1.80
Muzaffarpur.	.. 25th June 1913 ..	0	11.50	0.21
Katra	.. 18th September 1913	0	11.00	0
Lalganj	.. 12th September 1915	0	10.93	0.45
Hajipur	.. 8th September 1918	4.15	12.00	0.10
Kurnaul	.. 7th September 1918	0.85	12.10	2.50
Muzaffarpur	.. 15th September 1921	1.85	12.35	0
Sheohar	.. 18th September 1924	0.20	12.50	9.50
Belsand	.. 18th September 1924	8.20	15.30	0
Katra	.. 11th July 1933 ..	6.40	14.80	0
Sitamarhi	.. 18th September 1935	3.70	12.63	2.72
Sheohar	.. 28th June 1938 ..	0.90	15.57	5.16
Belsand	.. 28th June 1938 ..	0.43	10.40	3.60
Katra.	.. 4th August 1941.	1.40	10.35	0
Sahebganj	.. 3rd September 1946	0	12.00	0.14
Sitamarhi	.. 19th July 1949 ..	0.54	10.00	2.50
Katra	.. 30th October 1949	0.75	10.00	0
Bairagnia	.. 16th August 1950	0	10.50	0.60

TABLE 6.

Months.	Muzaffarpur 08.00 hrs.	Darkhanga 08.00 hrs.	17.00 hrs.
<i>Dry Bulb Temperature °F.</i>			
January	54.3	55.8	68.7
February	58.4	59.6	74.1
March	69.4	71.6	85.2
April	79.2	80.8	96.2
May	82.8	83.0	92.3
June	83.3	83.5	89.5
July	82.4	83.0	87.3
August	82.0	82.7	86.4
September	81.9	79.2	86.1
October	77.8	80.1	84.0
November	66.7	68.5	76.1
December	56.4	58.1	69.0
Annual	72.9	73.8	82.9
<i>Wet Bulb Temperature °F.</i>			
January	52.6	53.5	60.2
February	55.3	55.5	64.1
March	62.3	62.4	66.4
April	71.0	70.8	71.2
May	76.4	74.9	78.0
June	79.3	78.8	81.0
July	79.9	79.7	81.0
August	79.7	79.2	81.0
September	79.1	74.7	80.4
October	74.1	74.0	76.1
November	63.5	64.2	68.2
December	54.4	55.8	62.0
Annual	69.0	68.6	72.0
<i>Relative Humidity (%).</i>			
January	89	85	58
February	81	76	57
March	65	57	34
April	65	59	26
May	73	67	52
June	83	80	69
July	89	86	75
August	90	85	79
September	88	80	78
October	83	74	69
November	83	78	65
December	87	86	66
Annual	81	76	60

TABLE 7.

Months.	Muzaffarpur 08.00 hrs.	Darbhanga 08.00 hrs.	17.00 hrs.
<i>Cloud Amount.</i>			
January ...	1.4	2.0	1.6
February ...	1.3	2.1	2.9
March ...	0.9	1.6	1.4
April ...	1.0	1.7	1.7
May ...	1.4	3.0	2.1
June ...	3.8	6.0	4.5
July ...	5.5	7.6	6.3
August ...	5.4	7.6	7.2
September ...	3.7	5.9	6.1
October ...	1.4	2.4	2.3
November ...	0.5	1.2	1.2
December ...	0.5	1.1	1.7
Annual ...	2.2	3.5	3.2

TABLE 8.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	2	3	4	5	6	7	8	9	10	11	12	13
North	1	1	1	0	2	2	1	0	1	0	1	1
North-east	11	4	5	8	8	11	5	8	5	3	2	1
East	5	8	15	31	41	38	33	33	25	12	5	3
South-east	3	4	10	21	31	26	25	24	20	9	4	1
South ...	1	1	1	1	0	1	1	1	1	1	0	0
South-west	11	11	14	4	0	1	2	2	2	2	2	5
West ...	16	18	22	11	1	2	4	3	6	7	8	11
North-west	7	8	8	6	3	3	4	3	5	5	5	5
Calm ...	56	46	25	18	14	16	23	26	35	61	73	73