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Recent Rainfall Conditions in Madhupur Tract of Bangladesh

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Rainfall data recorded at IPSA/BSMRAU Meteorological Station, Salna, Gazipur, Bangladesh, for 13 years from 1988 to 2000 was evaluated. The stable but decreasing tendency of annual rainfall was indicated. The decreasing tendency was most conspicuous for October and February. This is alarming from the viewpoint of crop production. Decrease in October rainfall makes rabi cropping difficult in the rainfed condition, because rainfed cultivation of upland rabi crops is performed by utilizing soil water stored in the monsoon season. December and January are already in small rainfall, and decrease in February rainfall brings about the condition of essentially no rainfall in consecutive 3 months. It may make cropping more risky in the rabi season. Re–examination of the present results is desired by using rainfall data recorded at other meteorological stations.

INTRODUCTION

Bangladesh is a country of the Ganges–Brahmaputra delta. It is located in the northeastern part (20° 34'–26° 88' N, 80° 01'–92° 41' E) of the Indian subcontinent with an area of 144,000 km^2 and a huge population of 130 million. About 60% of the national land are cropped. Main crop is rice, classified as aus, amam and boro depending on the growing season, and occupies about 80% of the cropped land. In dry–cool winter season, different vegetables, pulse, oil crops and wheat are grown, in addition to boro rice cultivated on irrigated land.

Climate of Bangladesh is dominated by tropical to subtropical monsoon. According to the climatic conditions, the whole year is grouped into three seasons: pre–kharif, kharif and rabi (Ahsan and Karim, 1988). The pre–kharif (pre–monsoon) season is in between the dry and monsoon seasons, covering April and May. Air temperature is highest in the year, and considerable rainfall starts to occur. The kharif season is the monsoon season, covering June through October in Bangladesh. Air temperature is high, and rainfall exceeds potential evapotranspiration (PET). The rabi season is the dry–cool winter season, covering November, December, January, February and March. Different crops can be grown, but lack of water limits the crop cultivation on the irrigated land.

In the previous paper (Karim and Egashira, 1994), agroclimatic conditions of terrace soil area (Madhupur Tract) of Bangladesh were characterized. Meteorological data, including rainfall, air temperature, solar radiation, evaporation and relative humidity, was

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recorded at Meteorological Station of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU since 1998; former Institute of Postgraduate Studies in Agriculture (IPSA)) for 6 years from 1988 to 1993. Non–uniform rainfall distribution and the large year–to–year variability were indicated, while other agroclimatic parameters were suitable to crop production. Rainfall distribution in a year was so uneven that limited rainfall occurred in the rabi season, creating a severe water–stress condition of a soil.

BSMRAU is located in the center of Madhupur Tract (24° 05' N, 90° 16' E) at an elevation of 8.4 m and 40 km north of Dhaka, the capital. Madhupur Tract region (28) is one of 30 agroecological regions in Bangladesh, which are divided depending on the differences in the combination of the four levels of environmental information, namely, physiography, soils, land levels in relation to flooding, and agroclimatology (FAO, 1988). Madhupur Tract comprises the upland terrace (5 to 25 m above MSL) and mainly stands a few m above flood–levels on adjoining floodplains. Madhupur Tract is located in the heart of Dhaka Division, occupying 4,244 km^2. It is a region of complex relief and soils developed over Madhupur Clay which is probably a Mio–Pliocene marine or coastal formation and was block–uplifted above sea level in late Pleistocene, followed by more or less intensive soil weathering (Saheed, 1984).

In the current study, following to the previous paper (Karim and Egashira, 1994), rainfall data recorded at BSMRAU Meteorological Station for 13 years from 1988 to 2000 was analyzed. Analysis was done for rainfall only, because 1) other climatic parameters do not become limiting factors to crop production; 2) rainfall data has the high reliability; and 3) rainfall is an important water resource in Bangladesh. The present analysis was carried out at BSMRAU during dispatch of the first author as a JICA short–term expert of soil science from February to April 2001 in "IPSA Project Aftercare".

Table 1. Monthly rainfall (mm) at BSMRAU Meteorological Station from 1988 to 2000.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1988	0	51	40	114	628	363	326	248	144	206	166	2	2288
89	0	21	3	59	208	260	529	61	288	378	0	0	1807
90	1	31	119	184	183	279	483	176	254	177	20	4	1911
91	11	31	18	21	561	299	226	345	894	392	0	137	2935
92	13	26	0	23	154	208	489	199	233	68	7	0	1420
93	0	30	30	303	513	443	504	345	375	257	0	0	2800
94	2	38	63	185	233	359	240	306	87	93	3	0	1609
95	4	14	3	34	187	319	530	384	300	111	106	0	1992
96	0	22	38	241	288	307	239	215	238	261	0	0	1849
97	0	33	81	182	157	392	487	302	332	3	6	22	1997
98	30	2	70	193	291	99	893	365	123	40	93	0	2199
99	0	0	0	11	381	229	408	375	198	148	90	0	1840
2000	11	14	30	224	287	243	250	237	184	310	0	0	1790
Ave.	6	24	38	136	313	292	431	274	281	188	38	13	2034
CV(%)	158	59	96	72	51	30	43	35	72	67	148	298	21

Monthly rainfall of January through July in 1998 was referred to Bangladesh Rice Research Institute Meteorological Station due to missing of daily rainfall record.
Ave.: average.
CV: coefficient of variation calculated as (standard–deviation/average).

MONTHLY RAINFALL DATA

Daily rainfall recorded at BSMRAU Meteorological Station was summed up and is presented as monthly rainfall in Table 1.

RESULTS AND DISCUSSION

Annual rainfall

The averaged annual rainfall from 1988 to 2000 was 2034 mm with a range from 1420 to 2935 mm. Coefficient of variation calculated as an index of the year-to-year variability was 21%. Mean annual rainfall in Madhupur Tract increases from around 2000 mm in the south to more than 2300 mm in the north (FAO, 1988). The value of 2034 mm is in between them and near to the value in the south (Dhaka). Among 13 years only 4 years showed annual rainfall exceeding 2000 mm. As clarified from Table 1, the year of annual rainfall exceeding 2000 mm included 1 or 2 months having monthly rainfall over 500 mm.

Annual rainfall was compared between the periods of 1988 to 1993 and 1994 to 2000:

Year	Ave. (mm)	CV (%)	Rate of year having annual rainfall over 2000 mm	Number of month having monthly rainfall over 500 mm
88 to 93	2194	27	3/6	6
94 to 00	1897	10	1/7	2

In the period of 1994 to 2000, compared to the period of 1988 to 1993, the averaged annual rainfall decreased by 300 mm and the year-to-year variability became smaller. This condition can be ascribed to decrease in the number of month having monthly rainfall over 500 mm in the kharif season and indicates the stable but decreasing tendency of annual rainfall in recent years, if there is no missing of record of daily rainfall.

Rainfall in the pre-kharif and kharif seasons

The pre-kharif and kharif seasons cover April through October. Among the 7 months, the averaged monthly rainfall was highest for July (431 mm) followed by May (313 mm). In the 5 months of May through September, the averaged monthly rainfall was over 270 mm in individual month and was higher than the maximum monthly PET of 190 mm, calculated by the Thornthwaite method (Karim and Egashira, 1994), by more than 1.4 times. In these 5 months, even if rainfall in a month was below PET, rainfall of the following month(s) would cover the shortage of soil water. It is interesting to note that monthly rainfall exceeding 500 mm has occurred only in May, July and September. This is leading to the zigzag distribution of monthly rainfall within the 5 months and to the lower coefficient of variation for June and August.

Concerning cropping, rainfall in April and October is important. The low rainfall in April results in delay of the pre-kharif rainfall and the low rainfall in October leads to early ceasing of the kharif rainfall. The averaged monthly rainfall of April and October was 136 and 188 mm, respectively. The averaged monthly rainfall was below monthly

PET in April (150–175 mm) but exceeded it in October (130–150 mm) (Karim and Egashira, 1994).

Rainfall of April and October was compared between the periods of 1988 to 1993 and 1994 to 2000:

April

Year	Ave. (mm)	CV (%)	Rate of month having rainfall over PET
88 to 93	117	94	2/6
94 to 00	153	60	5/7

October

Year	Ave. (mm)	CV (%)	Rate of month having rainfall below PET
88 to 93	246	50	1/6
94 to 00	138	81	4/7

In April, the rainfall condition was found to be better for the period of 1994 to 2000 than for the period of 1988 to 1993: the higher averaged monthly rainfall, the lower coefficient of variation and the higher rate of month having rainfall over PET for the former. Rainfall over PET means the start of storage of water in soil after exhausting of soil water in the rabi season. In contrast to April, the rainfall condition in October became clearly worse in the period of 1994 to 2000: namely, the averaged monthly rainfall decreased by 110 mm, the year-to-year variability increased and the rate of month having rainfall below PET increased.

In October, rainfall below PET means consumption of soil water stored in the kharif season. Decrease in the content of soil water is enhanced by the increased difference between PET and rainfall. Soil water storage capacity (SWSC) is variable with texture and bulk density of a soil and rooting depth, and estimated to be in a range of 30 and 100 mm for soils in Madhupur Tract. If PET exceeds a sum of rainfall and SWSC, it means no remaining of water in soil for rabi crops. This is probably the case for 1997 and 1998. Decrease of rainfall in October makes rabi cropping difficult in the rainfed condition which relies on the water stored in soil in the kharif season.

Rainfall in the rabi season

The dry–cool rabi season covers November through March in Bangladesh. As shown in Table 1, rainfall of the rabi months is characterized by the limited amount and its high year–to–year variability. The averaged monthly rainfall was 38, 13, 6, 24 and 38 mm for November, December, January, February and March, respectively, and was considerably lower than the respective monthly PETs of around 70–110, 35–50, 25–40, 45–80 and 90–145 (Karim and Egashira, 1994).

Rainfall in November has a somewhat different characteristic from the other months. Thirteen years of November could be clearly divided into 4 years having monthly rainfall over 90 mm and the remaining 9 years below 20 mm. In the rainfall over 90 mm most of it took place in one day as heavy rainfall: if it rains in November, it is a rain-storm. Such heavy rainfall is rather harmful to rabi cropping and may cause uprooting or dying of newly germinated or just transplanted seedlings. Therefore, the rainfall condition in November is not favorable from the viewpoint of cropping.

The average and coefficient of variation of monthly rainfall in December, January, February and March were compared between the periods of 1988 to 1993 and 1994 to 2000:

Year	December		January		February		March	
	Ave. (mm)	CV (%)	Ave. (mm)	CV (%)	Ave. (mm)	CV (%)	Ave. (mm)	CV (%)
88 to 93	24 (1)	233 (149)	4	147	32	32	35	125
94 to 00	3	265	7	164	18	82	41	79

Figures in the parenthesis in December in the period of 88 to 93 were calculated by excluding 137 mm in 1991.

In March, the rainfall condition was better in the period of 1994 to 2000. This better condition was followed by April. December and January are already in the severe rainless condition. If we exclude 137 mm in December 1991, the averaged monthly rainfall was below or around 5 mm in both periods. No rainfall was recorded in 9 out of the last 13 years in December and in 6 years in January.

In February, the rainfall condition became worse in the period of 1994 to 2000. The averaged monthly rainfall in the period of 1994 to 2000 was about half of that in the period of 1988 to 1993 with showing the increased year-to-year variability. In the 00–01 rabi season no rainfall occurred in December and January and only 4 mm in February. February is approaching December and January in the rainfall condition. This means essentially no rainfall in consecutive 3 months and makes cropping more risky in the rabi season. The land is thirsty in December and January and is becoming thirsty in February.

Severe drought condition in the 00–01 rabi season

The lowest rainfall record in the rabi season at BSMRAU Meteorological Station since 1988 is 24 mm of the 94–95 season. In the 98–99 rabi season, 93 mm of rainfall occurred in November but no rainfall was recorded in the following 4 months of December through March. In the 00–01 rabi season, no rainfall was recorded in November, December and January. Four mm of rainfall occurred on February 26 and 27, but no rainfall was recorded again in March, though there was some rainfall on March 28 in the Salna area. As a result, total rainfall in the 00–01 rabi season was to a great extent below the record of the 94–95 rabi season.

According to the newspaper of "The Independent" published on March 23, 2001, all over the country is suffered from a prolonged and severe drought. Rainfall in the country is much below normal this year. Normal rainfall in March is 44 and 28 mm in Dhaka and Rajshahi, respectively, but only 2 and 7 mm of rainfall were recorded until March 22. Reports available from different districts say that boro and rabi crops like onion have already dried up in the fields as the irrigation system is not working due to lack of water. Even the deep tubewells remain inoperative as ground water level has gone down at many places. Power pumps are also lying idle as there is no surface water for irrigation. Standing crops on vast areas in Rajbari, Manikganj, Kushtia, Meherpur, Chuadanga, Jhenaidah, Faridpur, Madaripur, Pabna, Rajshahi, Sirajganj, Rangpur and other northern districts have been largely affected by the drought.

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