DETERMINATION OF METEOROLOGICAL DROUGHT INDEX FOR NORTH-WEST BANGLADESH

Submitted by

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We hereby recommend that the project work prepared by Shyamal Kumar Datta entitled DETERMINATION OF METEOROLOGICAL DROUGHT INDEX FOR NORTH-WEST BANGLADESH be accepted as fulfilling this part of the requirements for the degree of Master of Engineering (Water Resources).

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CERTIFICATE

This is to certify that this project work has been done by me and neither this project nor any part thereof has been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

A drought represents shortage of water during a certain period which may cause adverse impacts to the affected area. This study deals with meteorological drought for the north-west region of Bangladesh. Meteorological drought is defined as the period in which rainfall is below the normal rainfall. The method applied provides a measure of rainfall deficit severeness relative to mean rainfall deficit for a given time series of a point rainfall station.

Rainfall is the only input to this study. Six rainfall stations have been selected on an arbitrary basis from the north-western region of Bangladesh. Rainfall record for the period of 1962-95 for these six stations is available without any missing. For this study rainfall data have been arranged on the fortnightly basis. The reason for choosing fortnightly basis is that irrigation requirement is usually calculated and applied on a 10-day basis but it has been assumed that paddy can sustain on the residual soil moisture for another 4 to 6 days without serious loss of production. Merely by inspecting a rainfall record, it is always not possible to decide in which date a drought begins. Consequently a method have to be applied for deciding whether or not a fortnight of deficient rainfall constituted the onset of a drought. There are several methods of drought analysis exist in the literature. For this study, the analysis developed by Herbst et al. (1966) has been followed for the evaluation of drought. Based on this method, the date of onset and termination as well as duration of drought have been determined for the concerned rainfall stations. Index of drought severity and the weighted drought severity index have also been calculated for the given time series of each station.

It is apparent from the analysis that, there is neither distinct similarity in the date of onset and termination of drought among the stations in the region nor there is a similarity in the drought duration. From the analysis it is also observed for the six stations that the drought duration varies between 11.03 and 28.32 percent time of the time series (1962-95) at different number of spells of occurrences. The severe most drought index value is 2.13 that is obtained for the station Rangpur (R206) during the period 1978-79. The range of values for drought index vary between 0.56 and 2.13 and the weighted drought index between 4.92 and 126.65 for the stations concerned. Here the drought indices calculated enable the intensity of droughts to be compared irrespective of their seasonal occurrence, while the weighted drought indices obtained represent the extent of duration with intensity in the area.

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Chapter 1
INTRODUCTION

1.1 General

Bangladesh is mainly an agricultural based country. Agriculture dominates the economy, generating about 32.8 percent of the Gross Domestic Product (GDP) (Bangladesh Bureau of Statistics 1996). But to a large extent agriculture exists in a climatic environment of uncertainty. Natural calamities like flood, cyclone, tornado, tidal-bore, drought etc. has masked the actual production capability. The above natural calamities are our constant companion. We have, as if, become accustomed to putting up with them. It is the matter of international concern that Bangladesh, one of the poorest and most densely populated country of the world is periodically devastated by catastrophic floods. In this respect, controlling the flood has achieved momentum due to its wide publicity in national as well as in international media. In 1987 and 1988 Bangladesh experienced two of the most severe floods on record. Due to its severe appearance, those two floods have drawn lot of attention not only in disaster preparedness program but also in our national development program. On the other hand, where the recurrent occurrences of drought are setting unprecedented damages to our nature, are getting less attention due to its silent effect and lack luster publicity. However, the effects of drought are silent, the consequences are persistent in nature. Drought adversely affects the economy by reducing, or even eliminating agricultural production, herds of cattle, power generation and domestic and industrial water supply. Developing countries are particularly prone to these adverse effects on two counts: if directly affected by a drought the difficult economic situation in the developing country hinders its ability to take swift action to reduce the disastrous consequences; and if drought strikes a cereal supplying developed country the supply of the commodity to the developing country reduces and its price increases.

Drought may be so severe that famine may ensue, and in some cases the situation may be such that, it could cause the death of millions of human beings. So, prediction and analysis of drought conditions are of great importance. Study of drought is specially important for supplementary irrigation project planning and design.

Drought is a phenomenon that occurs in different parts of the world with unpredictable frequency with the result that countries concerned are often unprepared for the eventuality. As conditions constituting a drought vary in different parts of the world depending on the amount and reliability of rainfall, it is difficult to establish universal drought criteria. Precipitation, streamflow and soil moisture have been used as drought indicators for meteorological, hydrological and agricultural droughts respectively. However, decisions have to be made as to what form of drought is of primary importance (Dracup et al. 1980 a). Though low precipitation is the cause of drought, the impacts of drought can be effectively assessed by also considering other indicators of water availability such as streamflow and groundwater. Furthermore, a shortage of water may occur simply because of substantial evaporation or other water losses despite normal precipitation.

In addition, the concept of drought varies among regions of differing climates. In Bali, any period of 6 days or more without rain is considered a drought, while in Libya, droughts are only recognized after 2 years without rain (Hudson and Hazen 1964). Although a complete analysis of a drought event would respectively include consideration of rainfall, runoff and soil moisture together, most drought studies have focused on only one aspect of drought phenomenon (Whipple 1966; Beard and Kubic 1972; Herbst et al. 1966; Gupta and Duckstein 1975). Daily rainfall record which is the only input for the present analysis, according to Dracup et al. (1980 a) would satisfy one's interest in determining the cause of drought events.

1.2 Definitions of Drought

There is no universally agreed definition of drought but a definition which may generally accepted is "severe water shortage". This definition raises the question somewhat, as it requires a further definition of "shortage" or alternatively the specification of the amount of water needed. Water need depends on the type and number of animal and plant communities. The availability of water depends largely on rainfall. Rainfall is the best single index of drought. Although the definition of drought will vary with the nature and intensity of land and water use, the only objective method of characterizing drought is to specify minimum water needs for a particular purpose. Thus if the minimum water need for a given period of time is met by rainfall of a given amount "x," drought may be said to occur whenever the rainfall during that time interval is less than "x" and the severity of drought is related to the rainfall amount by which the amount is less than the requirement (Gibbs and Maher 1967). Drought by definition consists of a sustained period of deficit perhaps lasting a few months or even many years. Conditions within a drought may vary considerably in space and time in accordance with the irregularity of the rainfall distribution and with the heterogeneity of the hydrological response of the river basins that are affected. The character of drought may be different for different climatological and hydrological regimes that are found in the world. Droughts differ from other meteorological phenomena in their temporal aspect. It is difficult to tell at what date a drought started, what date it is terminated, and thus how long it lasted. What is certain is that this duration can be relatively long by comparison with other meteorological events. The start of a drought depends very much on one's own point of view which is not necessarily the same for the meteorologist as for the hydrologist. Often, termination of a drought is visible and thus easier to determine, particularly when abundant rainfall saturates the ground.

In agriculture drought means a shortage of moisture in the root zone of crops. To a hydrologist it may means below average water levels in streams, reservoirs, groundwater aquifers, or lakes. In an economic sense, drought means a water shortage that affects or disturbs the established production and water use. Although the concepts are based on different viewpoints, they depend upon the effects of prolonged weather conditions with deficient moisture (Frick et al. 1990).

Palmer (1965) stated that drought can be considered as a strictly meteorological phenomenon. Palmer used his drought index to study the aerial distribution of the frequency of occurrence of droughts of various severity. An "absolute drought" is defined for statistical purposes as a period of at least 15 consecutive days without 0.01 inch of rain on any one day, whereas a "partial drought" is a period of 29 consecutive days the mean rainfall of which does not exceed 0.001 inch per day. Hoyt (1942) stated that in humid and semi-arid states drought conditions exist where there is an annual precipitation deficit of 15 percent or more, whereas climatic characteristics of the plains region in relation to the possibility of shelter-belt planting, used two methods as a base (i) full calendar years having less than 75 percent of the normal precipitation and (ii) 4-month droughts in which the precipitation during each month was less than 60 percent of the normal precipitation for that month. Tannehill (1947) defined drought as "a period of 21 days when rainfall is less than 30 percent of normal for the place and time". According to Condra (1944), drought definitions include a period of strong wind, low precipitation, high temperature, and usually low relative humidity. US Weather Bureau defines drought as a lack of rainfall so great and long continued as to affect injuriously the plant and animal life of a place and to deplete water supplies both for domestic purposes and for the operation of power plants, specially in those regions where rainfall is normally sufficient for such purposes (Havens 1954).

1.3 Objectives of the Study

Drought can be considered as a meteorological phenomenon. The present study is going to use fortnightly rainfall data to formulate a meteorological drought. This study will give the drought index that enables the intensity of drought to be compared for a region irrespective of the seasonal occurrences. The north-western region of Bangladesh is selected as the study area for this research. The specific objectives of the study are as follows:

(1) time in which drought have started in a given time series;

(2) time in which drought have terminated in a given time series;

(3) index of drought severity and the weighted drought severity index for the given time series of the region.

1.4 Organization of the Study

The project work contains five chapters. In Chapter 1 a general description of the drought has been presented. Definition of drought phenomena, its effects and variations are described in this chapter. The objective of the study is also given in this chapter.

Chapter 2 contains literature review on drought study. Various methods of drought study previously done by different researchers around the world have been tried to present in this chapter. Different authors studied drought in different fields. The hydrologists studied drought with streamflow data, the meteorologists studied drought with rainfall data and the agriculturists studied drought with soil moisture data . Drought study done by various authors have been furnished in this chapter.

Chapter 3 contains the methodology used in this study. The sources of data and description of the stations have also been described in this chapter. A brief description of the procedure of the current study is given in this chapter.

Chapter 4 is based on the results and discussions of the study. Here the results obtained from the analysis have been briefly described.

Chapter 5 has been given the name as conclusions and recommendations for further work. Here a concluding remark on the study and results obtained have been stated. Various ways how the study can be done further is also stated in this chapter.

Chapter 2
LITERATURE REVIEW

2.1 General

The definition of drought varies with time and place and means different things to different people. Several writers on drought have tried to define drought for various conditions, using such terms as the water supply drought, agricultural drought, climatic drought and hydrologic drought (Subrahmanyam 1967). In very general terms, "drought is a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals and man over sizable area" (Warrick 1975). However, prolonged lack of precipitation is often closely associated with drought (Russel et al. 1970).

Most of the criteria used to identify droughts have been arbitrary because a drought is a "non-event" as opposed to a distinct event such as a flood (Hershfield et al. 1972). Drought has no distinctive onset and is recognizable only after a period of time. In addition, this period is variable because the time required for a drought to develop depends on many interacting variables. Moreover, there is no simple explanation for the occurrence of droughts. In general, the factors which combine to produce droughts are related to atmospheric and oceanic circulation, and to the influence of continental areas. If, for example, climatic conditions are such that the annual rainfall is derived from a few intense rainstorms, then the failure of such storms to occur over an extended period produces the drought. The explanations of droughts are based on physical relationships and interactions of the drought affecting factors, while the descriptions of droughts are based on statistical and analytical methods. Precipitation is one of the inputs to a watershed system and streamflow is one of the outputs. Dracup et al. (1980 a) notes that if one is interested in determining the cause of drought events, attention should be focused on precipitation drought; if one is interested in determining the effects and impacts of drought events, attention should be focused on streamflow drought and agricultural drought. With these distinctions, drought causes become the province of the meteorologist while drought effects become the province of the hydrologist and agriculturist

2.2 Different Methods of Drought Analysis

Likewise flood and other natural calamities drought is a great disaster for the civilization. Several researchers around the world have been showing their interest in the analysis of drought duration, magnitude and severity. Every water user has its own concept of drought. In a broad sense, the problem of drought definition is caused by the conflicting concepts held by a variety of academic fields of study (Dracup et al. 1980 a). While many attempts have been devoted to defining drought, there has been no consensus (Kibler et al. 1987; Chang 1987; Alley 1985). Various researchers working with drought under different disciplines of water resources defined drought according to their own concept. The hydrologist is concerned with drought in the context of a period of below normal streamflow and depleted reservoir storage; the meteorologist is concerned with drought in respect of a period of below normal rainfall or snowfall; the agriculturist is concerned with drought in respect of a period during which soil moisture is insufficient to support crops; and the economist is concerned with drought in respect of a period of low water supply which affects society's productive and consumptive activities.

Thus, various methods of analysis of drought relevant to specific water uses or to specific disciplines have been divided here. Analysis based on hydrological, agricultural, and meteorological domains developed in the past for identification of drought problem are presented in the following sub-sections for better understanding of the drought characteristics. In this regard, broad based statistical tools are applied for the hydrological and meteorological droughts analysis. Agricultural droughts are viewed as the effect arising from the hydrological and meteorological droughts.

Horn (1989) applied the run theory to annual steamflow sequences in Idaho which permitted the assignment of return periods to historical drought events based on the statistical characteristics of the streamflow record. He found that several major periods of streamflow deficits have occurred, with return periods significantly greater than a random sample of the long-term stochastic process. A procedure was developed to present the drought severity called the "drought potential index (DPI)" was introduced by him. When DPI values are mapped and contoured, they clearly represents those regions within the state which have the greatest potential for sustained periods of severe streamflow deficits.

2.2.1 Hydrological Analysis

Knowledge concerning hydrologic drought is an important aspect in the planning of water resource systems and in the allocation of available streamflows among a variety of competing uses. A hydrologic drought is defined as a period of one or more successive years during which streamflow is continuously below a certain threshold value. Many works have been done with streamflow in connection with hydrologic drought. Linsely et al. (1975) defined drought as a period during which streamflows are not adequate to provide the required water supply for a water management system. Gooch (1966) used three components to characterize drought: duration, runoff during drought, and net reservoir-surface evaporation during drought. Based on daily streamflow time series, Chang (1989,1990) defined drought events as a period of flow below specified truncation levels. For a truncation level there may be one, several or no drought events. Different truncation levels can be used to reflect different levels of drought severity. Whipple (1966) applied the station-year method of regional frequency analysis to multiyear hydrologic droughts. Gumble (1963) defined drought as the smallest annual value of daily streamflow. By this definition, a drought event occurs exactly once a year.

A useful method of examining the behavior of annual streamflows sequences is through the use of the theory of runs (Millan and Yevjevich 1971; Guerrero-Salazar and Yevjevich 1975) which establishes a base level (truncation level) of streamflows and examines all of the positive and negative departures from this base. Since the negative departures are of primary interest in drought analysis, the two critical parameters for each drought event become the total duration of a negative run and the magnitude of the cumulative deficit run-sum. This approach permits consideration of both within-year drought event as well as multiple-year (carry over) events. The methodology permits examining drought probabilities that involves the specification of the mean, standard deviation, coefficient of skew, and the first-order serial correlation coefficient for the annual flow sequence.

Sen (1976) derived a method to provide simple analytical solutions to various problems concerning probabilistic and statistical properties of wet and dry periods of streamflow sequences. Sen stated that droughts are representative of dry periods in a streamflow sequence during which successive flow values remain less than a given reference value, x_o. In 1978, Sen established a methodology which is referred to as the "auto-run analysis" to investigate the sequential properties of hydrologic series on the basis of wet and dry spells which are directly related to the run properties. The basic statistical parameter employed is the auto-run coefficient which change the time period between any two observations.

Dracup et al. (1980 b) performed several statistical tests on streamflow series for purpose of analyzing multi-year drought events. The test results and their implications are discussed in relation with the characterization of high-flow and drought event which give an indication of the maximum response of watershed in terms of drought duration and severity during the period of record.

Yevjevich (1967) defined drought based on a stationary time series and the theory of runs. Recently the behavior of droughts, as a part of the long term stochastic stream- flow process, has been examined in some detail, through the use of various types of stochastic streamflow generation models (Horn 1989). Millan and Yevjevich (1971) used different generation and analysis technique to develop a methodology for assessing the return periods associated with historical drought periods on a number of streams throughout the world. Horn (1987) made a research work on the basis of the Millan and Yevjevich and concluded that the theoretical and experimental results obtained by Millan and Yevjevich offer an easily applied methodology for assessing the stochastic behavior of drought. In the past several decades, drought research has expanded and more powerful statistical tools have been brought into play. In this context, it is worth mentioning the studies by Saldarriaga and Yevjevich (1970), Sen (1980), Santos (1981), Chander et al. (1981), Santos et al. (1983), Correia at el.(1985). The method of truncation was also used by Gupta and Duckstein (1975). The concept and effect of the truncation level is most clearly seen when the statistical theory of runs is adopted for the analysis of time series (Yevjevich 1967). By using the statistical terms such as mean or median as the truncation level one can distinguish drought from other hydrological events.

In arriving at a concise drought definition for use in an analysis, it is necessary to stipulate the approach to regionalization that is being employed by Dracup et al. (1980 b). There are three regionalization approach namely (i) do not regionalize the analysis, (ii) define a region according to similar climatic input, similar geomorphic characteristics and geographic proximity; (iii) define a region according to similar statistics of the hydrologic or meteorologic records, regardless of the location of these records.

Shen and Tabios (1995) performed a drought study of the Sacramento River basin using the combined annual flows of the four major rivers contributing to Sacramento River. The analysis was based on the theory of runs considering the presence of reservoirs and without reservoirs.

Khan (1985) presented a paper on drought analysis of aquifer recharge using probability distribution. Here the author applied the commonly used distributions for low flow analysis in case of drought recharge analysis for the unconfined chalk aquifer of the river Itchen catchment in Hampslire, United Kingdom.

Ahmed (1982) studied the return period of the Ganges drought. The study compared the results of drought frequency analysis by several methods and appraised the relative reliability of these methods. Four theoretical distributions had been applied to the same set of low flow data to the Ganges. The distributions used are the Extreme Value Type-I, Pearson Type-III, Log-Pearson Type-III and the Lognormal. He showed that the Log-Pearson Type-III distribution fitted the drought data best.

2.2.2 Agricultural Analysis

Bidwell (1972) studied about the methodology for analyzing agricultural drought. In this study he introduced techniques of constructing and analyzing models to simulate the relationship between hydrologic drought to crop yields.

Hershfield et al. (1972) showed that the frequency of dry day sequences is proposed as a measure of agricultural drought. The occupancy and severity of the drought depend upon the length of sequence in combination with the water content and water holding capacity of the soil and the water-use pattern of the crop.

Victor and Sastry (1984) made an evaluation of agricultural drought using probability distribution of soil moisture index (SMI) for some Kharif crop.

Narayana et al. (1984) performed a statistical study on incidence of drought in relation to agricultural production. Here they showed how yield declined with increase of probability of drought.

Karim (undated) studied about the effect of water stress on crop yield. He calculated stress day (SD), stress day index (SDI), stress index (SI) and drought yield (Ydi) of crop. He also showed the percentage of yield loss due to water stress.

2.2.3 Meteorological Analysis

Palmer (1965) developed the Palmer Drought Index (PDI) to study the areal distribution of the frequency of occurrence of droughts of various severities. He developed a general methodology for evaluating the meteorological anomaly in terms of an index which permits time and space consideration of drought severity. A method for computing the required precipitation is demonstrated. The difference between the actual precipitation and the computed precipitation represents a fairly direct measure of the departure of the moisture aspect of the weather from normal. When these departures are properly weighted, the resulting index numbers appear to be of reasonably comparable to local significance both in space and time.

Very few results of investigations on areal drought coverage are available. Even a descriptive method of areal characteristics of drought has not been well developed. Little has been done on applying the quantitative statistical methods on areal coverage. Pinkayan (1966) studied the probability of occurrence of wet and dry years over a large area. Gibbs and Maher (1967) analyzed the areal extent of past droughts in Australia by classifying the annual precipitation by using the decile range.

The longest period of dry and wet spells and the corresponding largest rain-sum value can be deduced by applying the theory of random number and random variable (Todorovic and Woolshier 1975).

Delleur et al. (1989) and Chang et al. (1984,1987) developed a family of statistical model for the simulation of sequences of dry and wet days. The model is based on the discrete autoregressive-moving average (DARMA) family of stochastic process, which includes the Markov chain as a particular case.

Sastry and Chakravarty (1984) gave an idea about dry-day and dry-week concept and severity of atmospheric drought.

Alam (1994) studied the statistical characteristics of climatic drought which is defined as the difference between potential evapotranspiration and rainfall. Ten-day yearly drought maxima was calculated by him for five rainfall stations in the Teesta Barrage project area.

Sharma (1996) studied the persistent behavior of dry and wet spells during a rainy season, and this persistence behavior was modelled by using a Markov (order 1) process. The Poisson distribution of occurrences of runs coupled with the geometric distribution of length of runs and Weibull distribution of run-sums have been used as building blocks for model formulation.

Herbst et al. (1966) developed a method for the determination of drought of the northern regions of South Africa. By this method the onset and termination of drought event was determined from available monthly rainfall data. The index of drought severity and the weighted drought severity index was also determined by the method. This study has been done following the method developed by Herbst et al. (1966) for the evaluation of drought for north-west region of Bangladesh. This study has been done by using rainfall data on fortnightly basis instead of monthly basis.

Chapter 3
METHODOLOGY

3.1 Sources of Data

Hydrological data are available from a number of organizations like, Bangladesh Water Development Board (BWDB), Bangladesh Agricultural Research Council (BARC), Bangladesh Meteorological Department (BMD), Surface Water Modelling Center (SWMC) etc. For this study daily rainfall data is needed. The main source of daily rainfall data is BWDB. Directorate of Surface Water Hydrology of the BWDB is responsible for the collection, compilation and storage of rainfall data. Rainfall records of 24-hour duration are available in BWDB for a considerable time period for a large number of stations. In order to have a longer record of rainfall for analysis, BWDB always preserve the 24-hour amount in the form of data index cards which were collected from more than 280 raingauge stations in different hydrological districts. For a particular water-year, annual rainfall data, number of rainy days in a year, monthly rainfall data etc. are also available in the data index card.

3.2 Study Region and Stations

Stations for analysis have been selected on the basis of the data available and closeness to study area. On the basis of hydrological unit, Bangladesh may be divided into five regions: (a) North-West (NW), (b) North-East (NE), (c) South-West (SW), (d) South-Central (SC) and (e) South-East (SE). Our study area is in the North-West (NW) region. The stations for analysis are selected on the basis of data availability. Most of the rainfall occurs during May to September with the peak rainfall occur in the month of July. There are as many as 94 rainfall recording stations in the NW region. From the study region, data of six stations namely, (i) Rangpur (R206), (ii) Kaliganj (R177), (iii) Mohipur (R188), (iv) Kaunia (R178), (v) Dinajpur (R168), and (vi) Mithapukur (R186) were selected. Fig.1 shows the rainfall locations in the study region. These six stations were selected from the study region because rainfall data for the period of 1962-95 were available for each of the station without any missing.

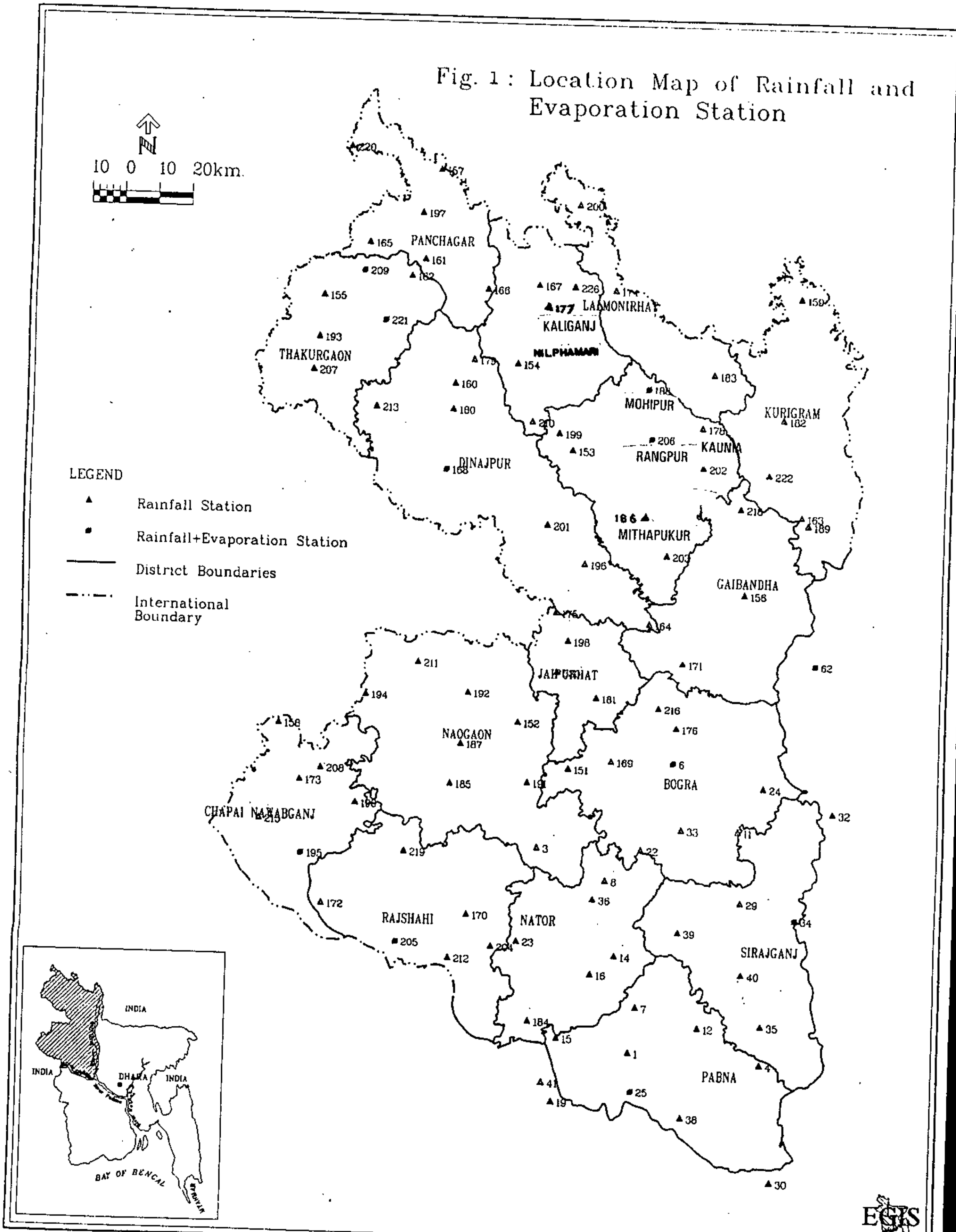

Fig. 1 : Location Map of Rainfall and Evaporation Station

3.3 Description of the Procedure/Methodology

Based on the method of Herbst et al. (1966), it is possible to define drought duration, deficit and the onset and termination of a drought event. Available rainfall data have been collected from BWDB. The monthly rainfall data is devided into two parts; the first part consisting of first fifteen days, and the second part consisting of rest of the days of the month. Each part of a month is termed as fortnight. To measure or quantify the drought, the study also provides drought index and weighted drought severity index for the time series of the region concerned.

3.3.1 Drought Parameters

In order to characterize the drought, the following parameters are derived as follows:

(i) Mean Fortnightly Rainfall (MFR)

Mean rainfall for each fortnight of a month has been calculated by summing the actual rainfall of the particular fortnight for the given time series and dividing the sum by the total number of years of the time series. In this way twenty four mean fortnightly rainfall for the twelve months of a station have been calculated.

(ii) Weighting Factor

Twenty four weighting factors used to calculate the carry-over effects are derived from the following logical relationship developed by Herbst et al. (1966):

$$W(i) = 0.1 \left\{ 1 + \frac{MFR(i)}{\frac{1}{24} \times MAR} \right\} \qquad i=1,2,.........24$$

where,

W(i) = weighting factor for fortnight i;

MFR(i) = mean fortnightly rainfall for fortnight i; and

MAR = mean annual rainfall.

This rather empirical formula has been based on the premise that the carry over effect would be greater in the agriculturally more important periods when the rainfall is higher than in the normally drier periods. By relating the weighting factor to the mean annual rainfall and the mean fortnightly rainfall the above formula is derived. Thus after mean fortnightly rainfall for each month of a year have been calculated and summated to yield the mean annual rainfall, the twenty four weighting factors have been calculated. The weighting factor varies from little more than 0.1 to about 0.4 so that carry-over (even for a month of excessive rainfall) only appreciably affects the first fortnight following it.

(iii) Carry-Over (Excess or Deficit Rainfall)

Carry-over value has been calculated by subtracting the mean fortnightly rainfall for a particular part of a month from the effective rainfall for the same fortnight. Here, effective rainfall has been calculated by algebraic sum of actual rainfall and weighted value, where, weighted value is the multiplication of carry-over value for that fortnight with the weighting factor for the next fortnight. However, for the first fortnight of the initial calculation, the carry-over value is taken as zero. Here positive carry-over value is treated as excess rainfall and the negative carry-over value is treated as deficit rainfall. Since the carry-over value for the first fortnight of the initial calculation is zero, so that the effective rainfall for the first fortnight of the initial calculation is equivalent to the actual rainfall. Starting at the first fortnight of record, the first mean fortnightly rainfall of that month, say April, has been subtracted from the actual rainfall, the difference, whether positive or negative, has been weighted with the factor pertaining to the following fortnight, the product being added algebraically to the actual rainfall of that following fortnight (second fortnight of April). From this amended value of rainfall for second fortnight of April has been subtracted the mean for the fortnight, the difference being weighted by the factor of the following fortnight (first fortnight of May) and carried over to that fortnight. This process has been continued to obtain the effective fortnightly rainfall for the full period of record.

(iv) Mean Fortnightly Deficit (MFD)

Mean fortnightly deficit has been calculated from deficit rainfall (i.e., negative difference). Here, the excess rainfall (i.e., positive difference) is considered as zero in the calculation of mean fortnightly deficit. Thus, summing the deficit rainfall of a particular fortnight for a given time series of a station and dividing the sum by the total number of years of the time series will give mean fortnightly deficit. An example of the calculation of drought parameters for the station R168 (Dinajpur) is given in Appendix A.

(v) Mean Annual Deficit (MAD)

Summation of mean fortnightly deficits (MFD) give the mean annual deficit. MAD value has been used in testing for onset and termination of drought. Another set of parameters necessary for tests of start and termination of drought is the value of highest mean fortnightly rainfall, the sum of the two highest values of mean fortnightly rainfall (MFR), and so on up to the sum of the twenty four values of mean fortnightly rainfall which is equivalent to the mean annual rainfall (Appendix B).

3.3.2 Test for Onset of Drought

The test is based on a comparison of the sum of the negative differences from the point in time at which the test begins, with a sliding scale of 24-values calculated by linear interpolation between the maximum value of mean fortnightly rainfall (MMFR) and the mean annual deficit (MAD). A fortnightly increment x is thus obtained from the formula

$$x = (MAD - MMFR)/23$$

The first value on the sliding scale is equal to MMFR, being the maximum deficit that can occur in a fortnight of a month. The second value on the sliding scale is obtained by adding 1x to MMFR, the third by adding 2x and so on up to MMFR+23x which is equivalent to MAD. Calculation of sliding scales for the concerned stations are shown in the Appendix C.

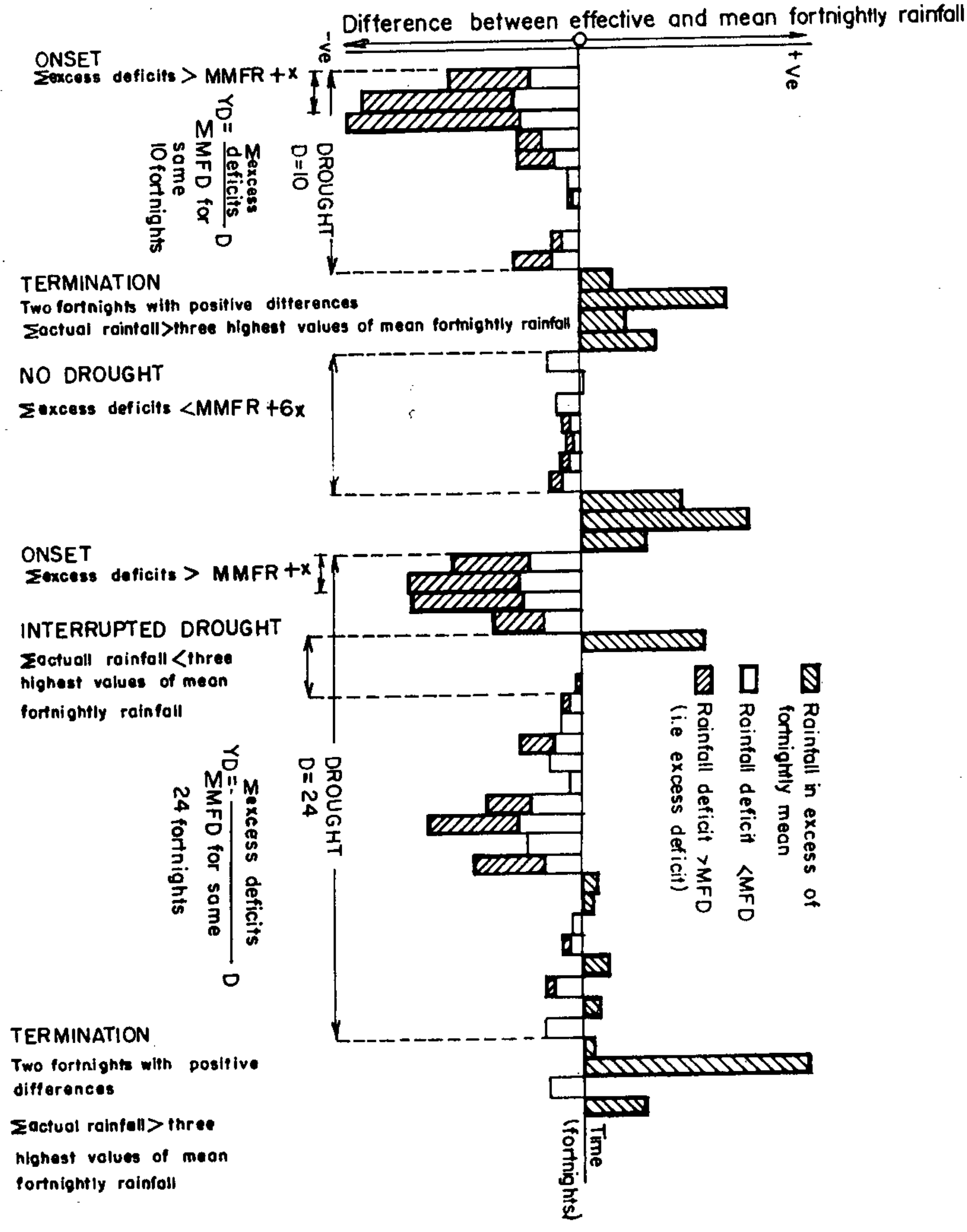

Fig. 2 Conditions determining the onset and termination of droughts.

Firstly, it has been assumed that no drought prevailed prior to the start of the available rainfall record. The difference between effective rainfall (ER) and mean fortnightly rainfall (MFR) for the first fortnight of the initial month has been inspected; if it is positive, the start of a potential drought is not signified so the differences of the succeeding fortnight values are inspected until a period with a negative difference is found, such a fortnight representing the start of a potential drought. Then the absolute value of the excess deficit (i.e., rainfall deficit> mean fortnightly deficit, MFD) is compared with the first value of the sliding scale, namely MMFR, and if the latter is equalled, a drought is deemed to have started. If MMFR is not equalled then the difference between ER and MFR of the next fortnight is inspected and, if negative, has been added to the excess deficit of the first fortnight and compared with the second value on the sliding scale, MMFR + 1x; if this criterion has been exceeded by the absolute value of the two excess deficits combined, a drought is deemed to have started from the first fortnight. In this manner the absolute value of the sum of all excess deficits occurring from the first fortnight of a month over a period of a year has been tested sequentially against the 24-values of the sliding scale. If at any time the summation of absolute value of the excess deficits from the first to the n-th month exceeded the value MMFR+(n-1)x, a drought is deemed to have started from the first month (Fig. 2). But if the condition for a particular period is such that summation of excess deficits from the first to the n-th month does not exceeded the value MMFR+(n-1)x then there is no drought prevailing during the period.

3.3.3 Test for Termination of Drought

In the first instance the test has been applied to the period following the fortnight of the month with a positive difference occurring after the start of a drought. A precondition to be satisfied is that at least one of the two fortnights following the initial fortnight with a positive difference should also have a positive difference. If this condition is satisfied then summing the actual rainfall of three successive fortnights and comparing this with the sum of the three highest values of mean fortnightly rainfall. If the actual rainfall is the higher, the drought is considered to have been terminated (Fig. 2) but if not, then sum of the first four fortnightly actual rainfall compared with the sum of the four highest values of mean fortnightly rainfall, and so on should the drought not yet have been terminated. In this case, if summation of actual rainfall is less than summation of the highest values of mean fortnightly rainfall the drought is considered as temporarily interrupted. As such, either the drought has been terminated or drought condition has been resumed after a temporary interruption.

Once a termination has occurred, testing for the start of the next drought begins at the fortnight of month with a negative difference following the fortnight in which the drought ended.

3.3.4 Evaluation of an Index of Drought Severity

It is often desirable to compare droughts of varying duration and intensity in regions of high or low rainfall irrespective of the seasonal variation in precipitation. For this purpose an index of drought severity may be introduced as follows:

$$\text{Index, } Y = \frac{\text{total deficits beyond the mean fortnightly deficits for the period, D, of the drought}}{\text{sum of the mean fortnightly deficits for the same period}}$$

The weighted drought severity index = Index (Y) x Duration (D)

If the index value for a particular spell of drought of a station for a given time series is high in comparison to the other drought spell(s), it represents that the actual rainfall for that particular spell of drought is low, i.e., during the period the severity of drought is high and vice versa.

Chapter 4
RESULTS AND DISCUSSIONS

In this study a meteorological drought analysis have been performed by using the rainfall data of six rainfall stations of which four are from Rangpur district, one from Nilphamari district, and the rest one from Dinajpur district (Fig. 1). The time series chosen for the study is 1962 to 1995 totalling 34 years on the basis of the available data. From this analysis one can find the overall drought situation of the concerned region. The results of drought onset and termination along with the duration, the index of drought severity and the weighted drought severity index have been presented in Tables 1 to 6. Total duration of drought in years and its percentage out of the period of 1962-95 for all the stations are provided in Table 7. Total duration of drought in years for each station has been calculated by adding the duration of different spells and dividing the sum by 24. The rainfall excess and rainfall deficit values have also been found from the analysis which is furnished for one station in Appendix A. The values of excess deficit (ED) have been calculated by subtracting the rainfall deficit from the mean fortnightly deficit (MFD) values. In this regard, if the ED values obtained from the above subtraction is positive, have been considered as zero. The excess deficit rainfall values have been used in the calculation of the drought severity index and from which weighted drought severity index values are also calculated.

From this study one can easily find the relative picture of rainfall excess and rainfall deficit for a particular station and the period in which these excess and deficit rainfall occurs. One can also find the effective rainfall of a study region. This effective rainfall contributes as carry-over effect to the following fortnight. It is observed from the results that if there is a fortnight with deficit in rainfall, this deficiency in rainfall affects the following fortnight and reduces the value of effective rainfall. Moreover in the case of zero actual rainfall, it is found that the effective rainfall becomes negative when there is a deficit in rainfall in preceding fortnight. On the contrary, if there is a fortnight with excess in rainfall, this excess rainfall increases the effective rainfall of the following fortnight.

From this study we can easily find the date in which a drought have started, as shown in Tables 1 to 6, in a particular area by using sliding scale (Appendix C). It is apparent from

Table. 1 Drought Schedule for the Station R168 (Dinajpur)

Drought Spell No.	Date of Drought Onset	Date of Drought Termination	Duration, D (Number of Fortnight)	Drought Index,Y	Weighted drought Index, YD
1	1 April 1962	1 July 1963	30	0.68	20.40
2	16 October 1971	1 May 1973	37	1.00	37.00
3	1 August 1978	16 July 1979	23	1.34	30.82

Table: 2 Drought Schedule for the Station R177 (Kaliganj)

Drought Spell No.	Date of Drought Onset	Date of Drought Termination	Duration, D (Number of Fortnight)	Drought Index, Y	Weighted Drought Index,YD
1	1 April 1963	1 May 1964	26	1.06	27.56
2	16 September 1966	1 June 1968	42	1.01	42.42
3	1 November 1974	16 May 1977	61	0.96	58.56
4	16 September 1978	16 July 1979	20	1.56	31.20
5	16 November 1993	1 June 1995	37	1.33	49.21

Table.3 Drought Schedule for the Station R178 (Kaunia)

Drougth Spell No.	Date of Drought Onset	Date of Drought Termination	Duration, D (Number of Fortinght)	Drought Index, Y	Weighted Drought Index, YD
1	1 July 1962	16 August 1962	3	1.64	4.92
2	16 November 1964	1 July 1967	63	1.05	66.15
3	1 November 1975	16 May 1977	37	0.92	34.04
4	1 July 1978	16 July 1979	25	1.46	36.50
5	1 January 1994	1 February 1995	26	0.99	25.74

Table.4 Drought Schedule for the Station R186 (Mithapukur)

Drought Spell No.	Date of Drought Onset	Date of Drought Termination	Duration, D (Number of Fortinght)	Drought Index, Y	Weighted Drought Index,YD
1	16 April 1965	16 August 1966	32	0.79	25.28
2	16 October 1971	16 February 1973	32	1.58	50.56
3	16 February 1981	16 December 1983	68	0.56	38.08
4	16 January 1992	16 March 1993	28	1.04	29.12
5	16 October 1993	16 June 1995	40	1.33	53.2

Table.5 Drought Schedule for the Station R188 (Mohipur)

Drought Spell No.	Date of Drought Onset	Date of Drought Termination	Duration, D (Number of Fortnight)	Drought Index, Y	Weighted Drought Index, YD
1	1 April 1962	16 May 1963	27	0.80	21.60
2	16 August 1965	16 October 1966	28	1.05	29.40
3	1 December 1974	1 October 1977	68	0.65	44.20
4	16 June 1989	16 August 1989	4	1.35	5.40
5	1 November 1993	1 July 1995	40	1.41	56.40

Table.6 Drought Schedule for the Station R206 (Rangpur)

Drought Spell No.	Date of Drought Onset	Date of Drought Termination	Duration, D (Number of Fortnight)	Drought Index, Y	Weighted Drought Index, YD
1	1 April 1962	16 June 1968	149	0.85	126.65
2	16 September 1971	16 February 1973	34	1.05	35.70
3	16 November 1978	16 July 1979	16	2.13	34.08
4	1 March 1994	15 July 1995	32	1.17	37.44

Table. 7 Total Duration of Drought and its Percentage for the Period 1962-95.

Stations	Total Duration of Drought in 34 Years	Percent of Duration of Drought in Total 34 Years
R168 (Dinajpur)	3.75	11.03
R177 (Kaliganj)	7.75	22.80
R178 (Kaunia)	6.42	18.88
R186 (Mithapukur)	8.33	24.50
R188 (Mohipur)	6.96	20.47
R206 (Rangpur)	9.63	28.32

the Tables 1 to 6 that, there are 5 spells of drought at stations R177 (Kaliganj), R178 (Kaunia), R186 (Mithapukur) and R188 (Mohipur). While at stations R168 (Dinajpur) and R206 (Rangpur) it has 3 and 4 spells respectively. From the Table 7 it is observed that out of 34-years of data analysis for all the stations, the station R168 (Dinajpur) is affected by about 3.75 years of drought in 3 spells which is about 11.03 percent of the total time series (1962-95). The R177 (Kaliganj) station is affected by about 7.75 years of drought in 5 spells which is about 22.8 percent of the total time series. Drought of about 6.42 years, i.e., 18.88 percent of time in 5 spells have affected the R178 (Kaunia) station. In case of the station R186 (Mithapukur) the affecting period is about 8.33 years in 5 spells which is 24.5 percent of the time series. The station R188 (Mohipur) has been affected by 6.96 years in 5 spells which is 20.47 percent of the study time. While for the station Rangpur (R206), the affecting period of drought is the highest which is 9.63 years in 4 spells, about 28.32 percent of the total time series.

From the analysis it is observed that for the stations R168 (Dinajpur), R188 (Mohipur) and R206 (Rangpur) drought have started at the same time, i.e., on 1 April 1962, while in the case of station R177 (Kaliganj), the first spell of drought has started one year later, i.e., on 1 April 1963 and in case of the station R178 (Kaunia) drought condition shifted to only 3 months forward which is on July 1, 1962. On the other hand, for the station R186 (Mithapukur) the first drought syndrome started about 3 years later, starting on 16 April 1965. It is also apparent from the result that although there is a similarity in the onset of the drought for stations R168, R188, R206 and R178, it have little similarity in the date of termination (Tables 1 to 6). Thus the duration of drought is not same for them. The duration of droughts for the stations R168 and R188 are 30 and 27 fortnights respctively for the first appearence of droughts, while for the station R206 its duration is 149 fortnights which is the largest spell in comparison with all the stations in the time concerned. On the other hand the duration of first spell of drought for the station R178 is only 3 fortnights but have severity index much higher than other 5 stations. Observation of the drought situation for the start of first spell of drought for the stations R177 and R186 indicate that these stations have delayed starting time having durations of 26 and 32 fortnights respectively.

Likewise there is a bit similarity in the onset and termination on the second spell of drought occurrences. The second spell of drought for the stations R168 and R186 have started on 16 October 1971 while this date is 16 September 1971 for the station R206. The second spell of drought for stations R177, R178 and R188 are random. In this connection as an example Fig. 3 has been presented to show the drought duration for the station R168.

It is worth mentioning from the analysis that out of 6 stations, 5 stations have been affected by drought during the period 1993 to 1995. Only R168 station has not been affected by drought during the aforesaid year. This is because of the subnormal rainfall occurring during the year 1993-95 over the stations, R177, R178, R186, R188 and R206.

Other findings of the study are the index of drought severity and weighted drought severity indices. These two information are necessary to compare the droughts of high or low intensity in the region. The intensity of drought index value is related to excess deficit of rainfall. However, the excess deficit of rainfall is related to actual rainfall below normal rainfall occurring during the drought period. The drought severity index for a particular period of a station will be higher if the total excess deficit rainfall value during the drought period is high. In that condition, the period can be said as highly drought affected. Similarly if there is a low value of total excess deficit rainfall, the drought severity index value will be low and it may be said that drought at the station during the period is not so severe. Thus, from the drought index value one can easily understand whether the concerned area during a period is highly drought affected or not. In this regard, it can be said that the higher the deficit rainfall value, the lower the actual rainfall occurring during the period, the higher the drought index value and vice versa.

In our study region it is observed that the drought index value for the six stations varies from a minimum value of 0.56 (in the third drought spell of station R186, Mithapukur) to a maximum values of 2.13 (in the third drought spell of station R206, Rangpur). The index value for the largest duration of drought (149 fortnights) that occurs at the first drought spell of the station R206 (Rangpur) is 0.85. While the index value for the second largest duration of drought (68 fortnights) that occurs at the third drought spell of the stations R186 (Mithapukur) and R188 (Mohipur) are 0.56 and 0.65 respectively. On the other hand the drought index value for a third lower drought duration (16 fortnights) occurring at the third spell of the station R206 (Rangpur) is the maximum value which is 2.13. So it is obvious that the major controlling factor of the index value is the amount of deficiency in rainfall occurrence in the station concerned.

The weighted drought severity index measures the total deficiency of rainfall during the drought period. This weighted value depends on the duration of drought. If the duration of drought is large, the weighted drought severity index is high and vice versa. At the station Rangpur (R206), the weighted drought severity index value for the drought duration of 149 fortnights is the highest value which is 126.65. However, the same value is only 4.92 for the drought duration of 3 fortnights which exists with the calculation of first spell drought at the station R178 (Kaunia).

It has been pointed out that, although the drought of 1993-95 in the Rangpur area (R206) have been focused a lot in the national level, there is another drought during the period 1978-79, which is more severe than the 1993-95 drought because its index value is higher than the preceding drought. It is believed that the drought of the period 1978-79 has not been felt by the people severely. In our country, the existence of drought is felt when there is a shortage of water for irrigation. During the period 1978-79, planting of boro crop was not so extensive. At that time the need for supplementary irrigation requirement may be fulfilled by available surface water and groundwater uses. But during the period 1993-95, people were being motivated for planting boro crop. As the planting of boro crop increases, the need for supplementary irrigation requirement increases simultaneously. Because of low rainfall during the period 1993-95, groundwater level was reduced, surface water was non-existent, and the required amount of water could not be drawn for irrigation. As a result, people felt the existence and severeness of drought during the period 1993-95 so intensely that it become the everyday news item in the media.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The following conclusions may be drawn from the analysis:

1) There is no unique date for the onset of drought. Drought condition at each station starts at different date. Likewise there is no distinct date of drought termination for the stations concerned.

2) For the given time series, the number and duration of drought spells are not same for the concerned stations.

3) The dissimilarity in the onset and termination of drought is due to uneven rainfall occurrences over the stations.

4) Total duration of drought varies from one station to another having maximum duration of 9.63 years at station R206 (Rangpur) that occurred in four spells and the minimum duration of 3.75 years that occurred in three spells at station R168 (Dinajpur) for the given time series (1962-95). So in terms of cumulative drought duration Rangpur (R206) is more vulnerable and Dinajpur (R168) is less vulnerable to drought.

5) Among the drought index values, it is observed that most severe drought occurred at the station R206 (Rangpur) during 16 November 1978 to 1 July 1979 with an index value of 2.13, while less severe drought affected the station R186 (Mithapukur) during the period 16 February 1980 to 1 December 1983 with an index value of 0.56. It again indicates that the Rangpur station (R206) experiences, the severe most drought in its history while Mithapukur (R186) the least for the same time series.

6) Weighted drought severity index value depends on the duration of drought. Maximum weighted drought severity index of 126.65 which is obtained for the station R206 (Rangpur) for the maximum duration of drought of 149 fortnights. Whereas, minimum value of the weighted drought severity index value is 4.92 which is found for the station R178 (Kaunia) for the minimum duration of 3 fortnights. Rangpur again experienced the longest drought period in the aforesaid time series.

5.2 Recommendations for Further Studies

Following recommendations may be made for further studies:

(i) Continuing study on drought analysis and updating the result will be proved useful as more data become available in future.

(ii) Instead of fortnightly drought analysis, 10-day basis of drought analysis may be performed because in our country irrigation requirement is calculated on a 10-day basis.

(iii) In our country, rainfall occurrences vary frequently from one region to another. As a result, drought conditions may also change from one place to another. So in order to know the drought picture of the whole country, similar analysis of drought may be made for other regions of Bangladesh, such as, south-east, south-west, north-east etc.

(iv) In order to be useful in the planning of water resources of a region, onset, termination and duration of drought may be fitted with statistical distributions to simulate the design drought.

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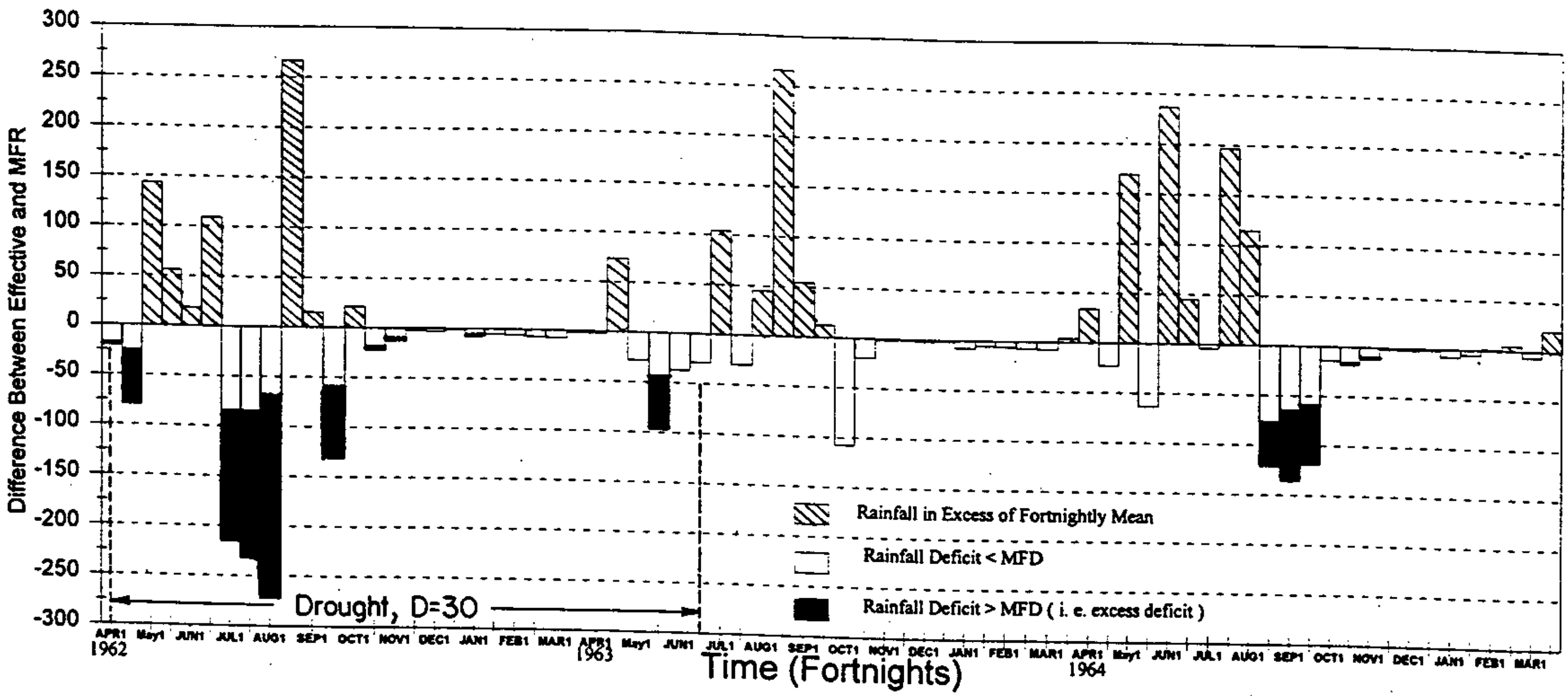
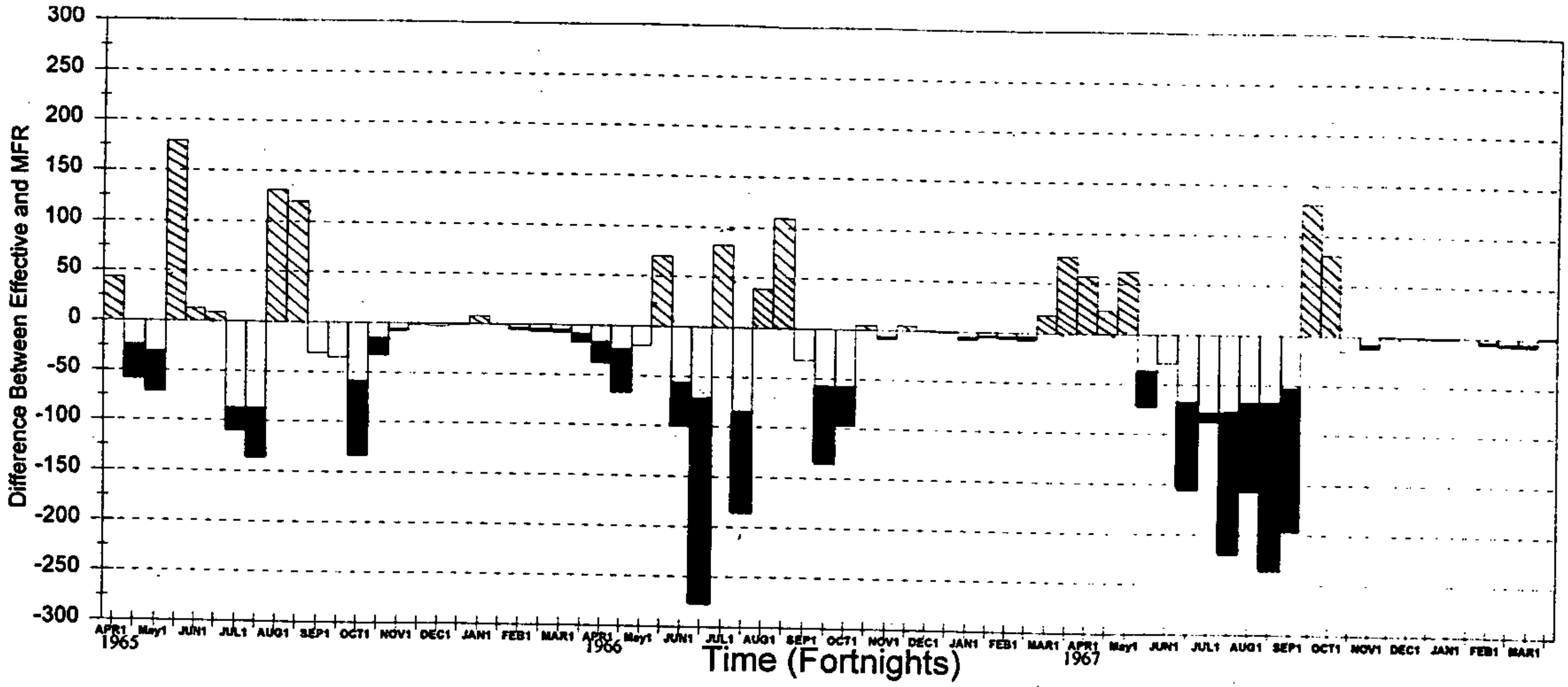


Fig. 3 Drought Duration for Station Dinajpur (R168)



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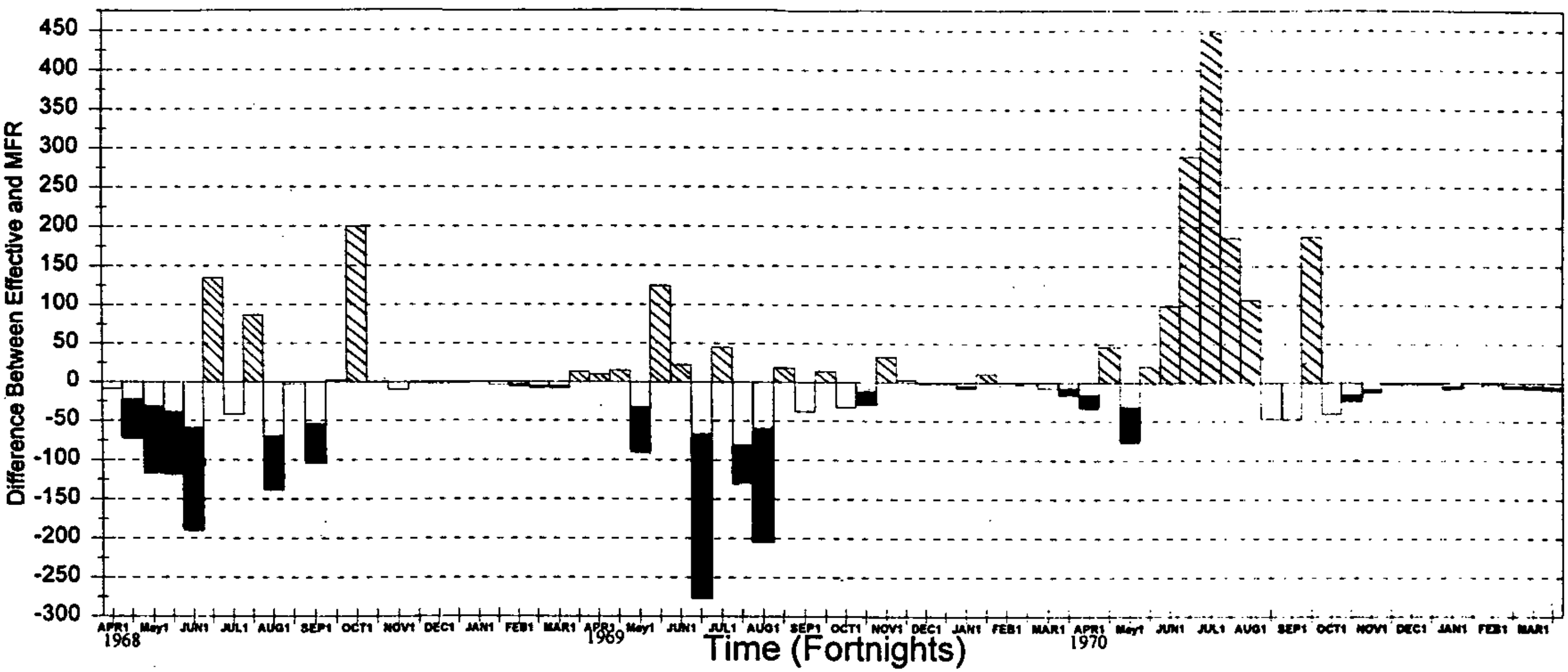

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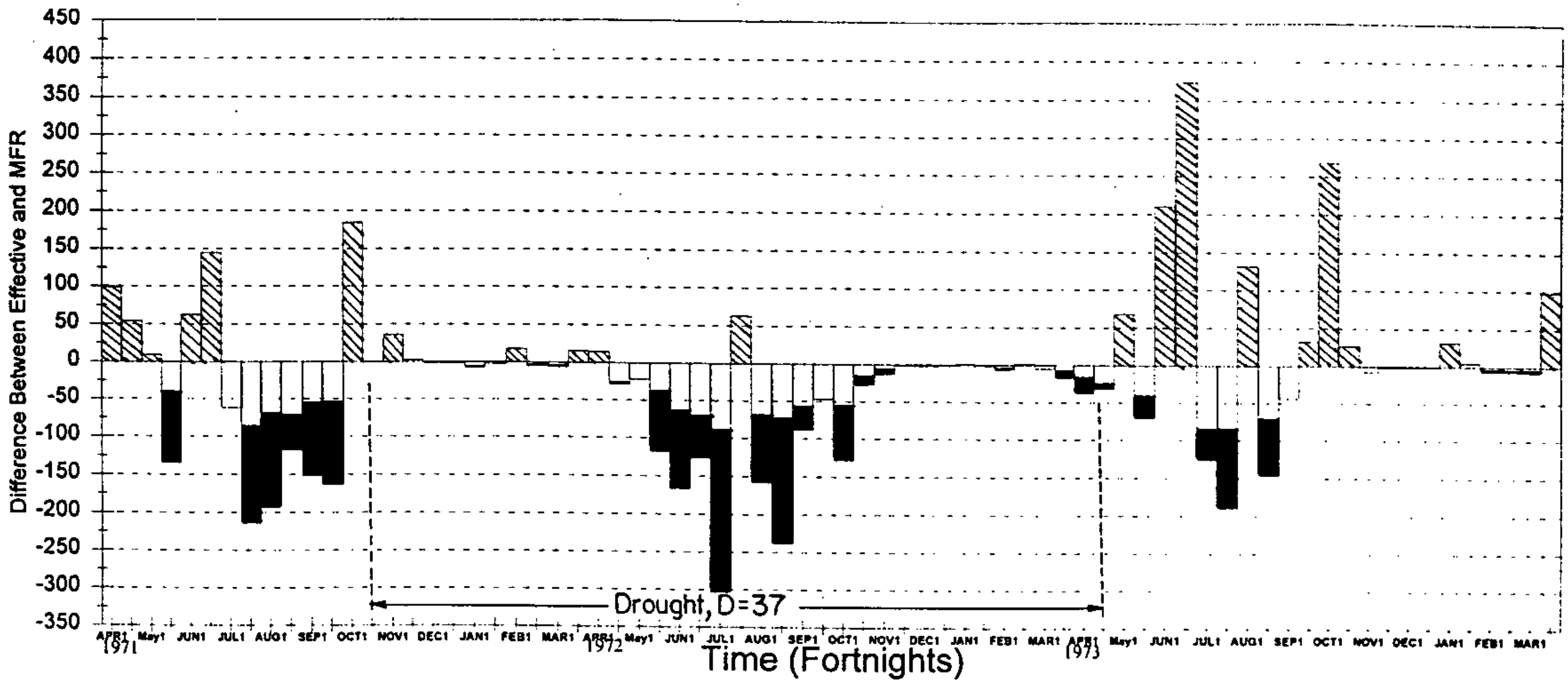

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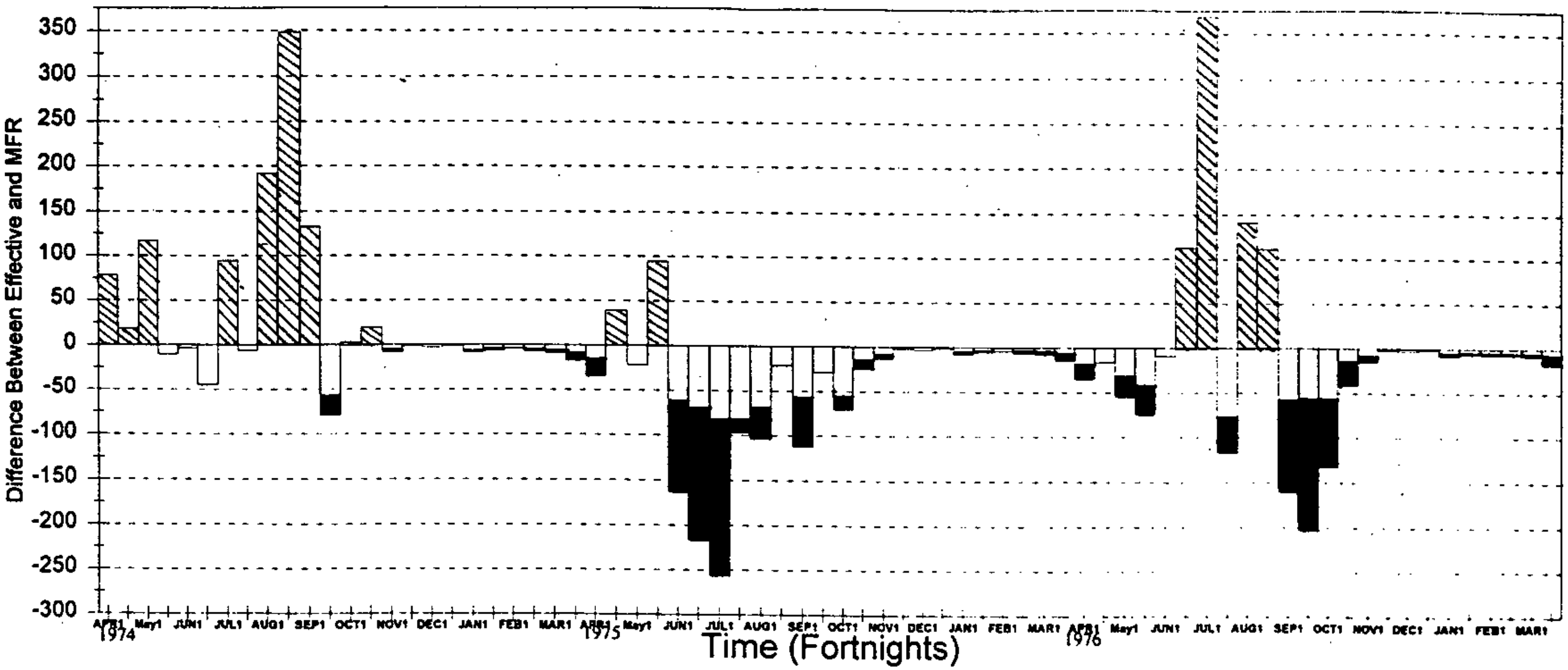

Fig. 3 (Continued)

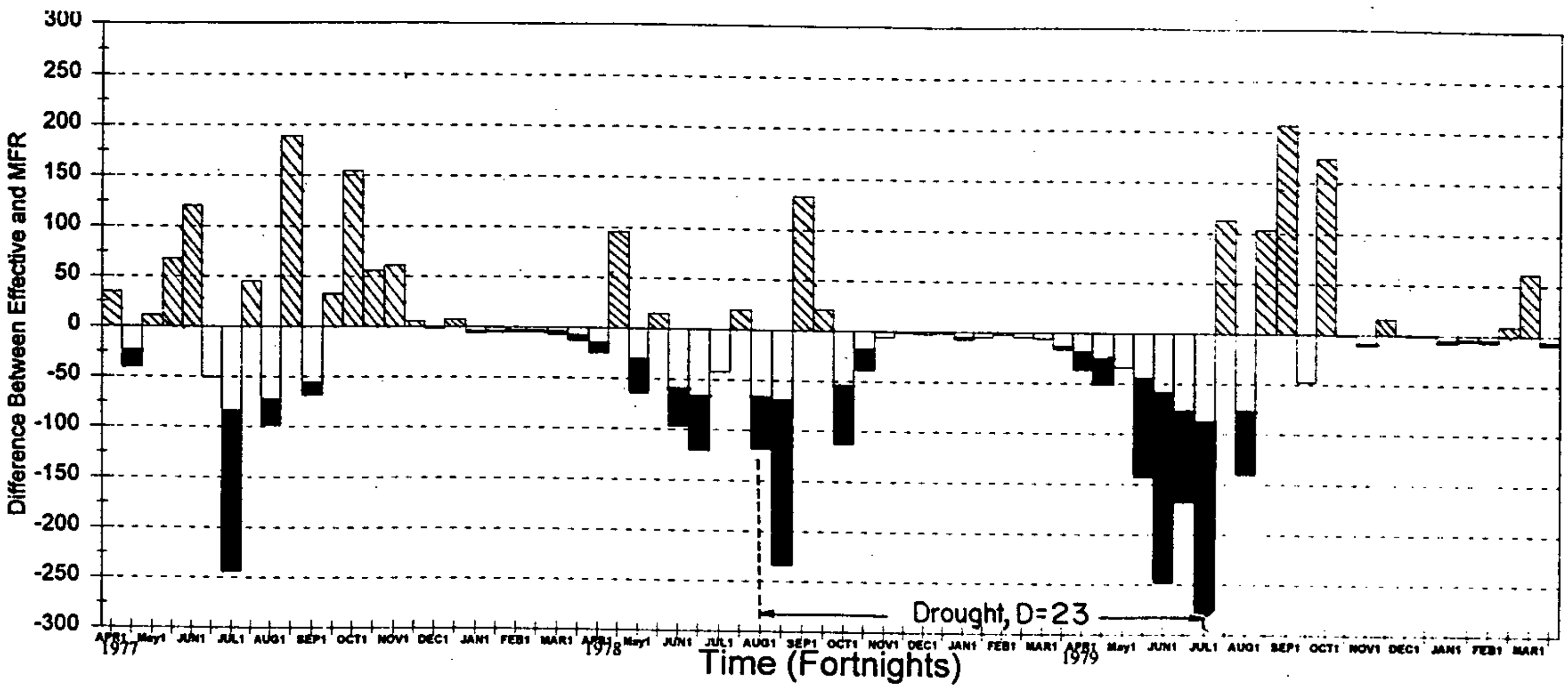

Fig. 3 (Continued)

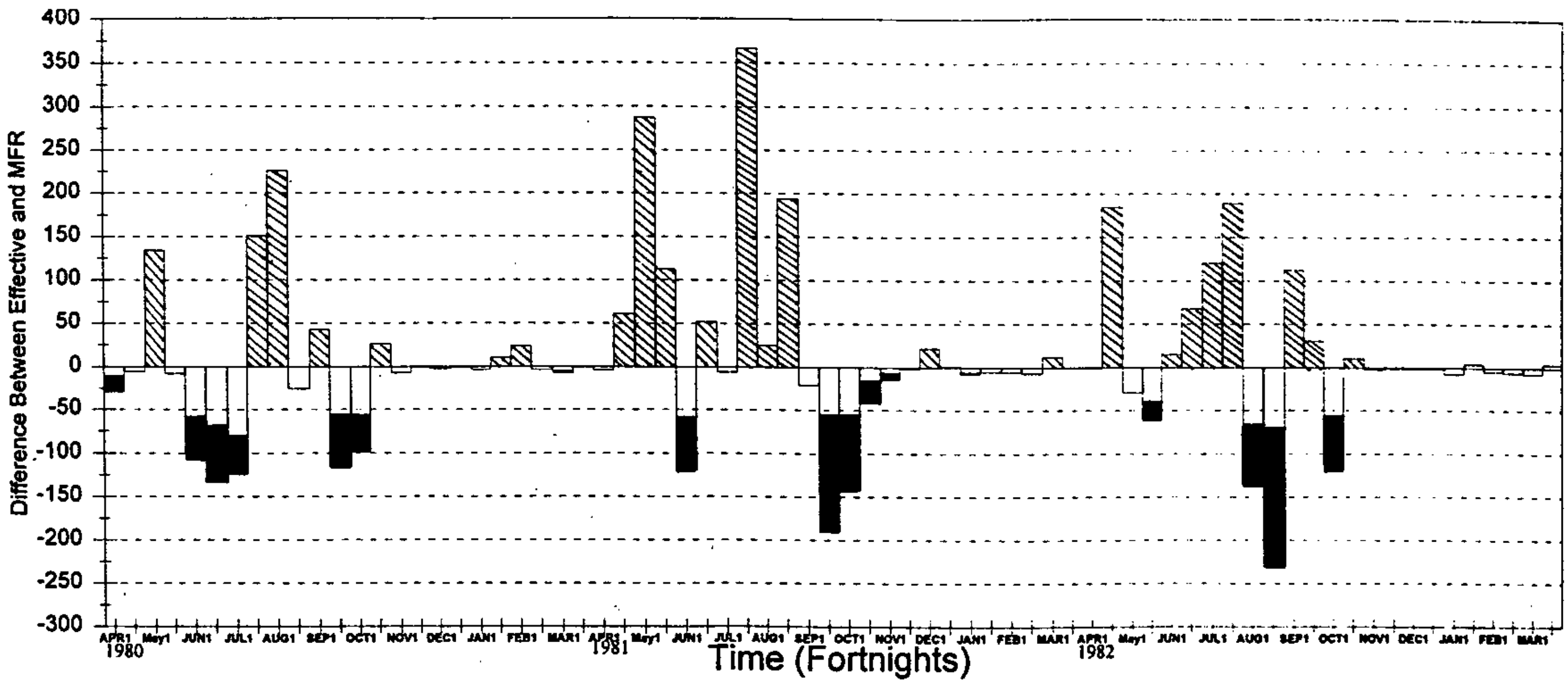

Fig. 3 (Continued)

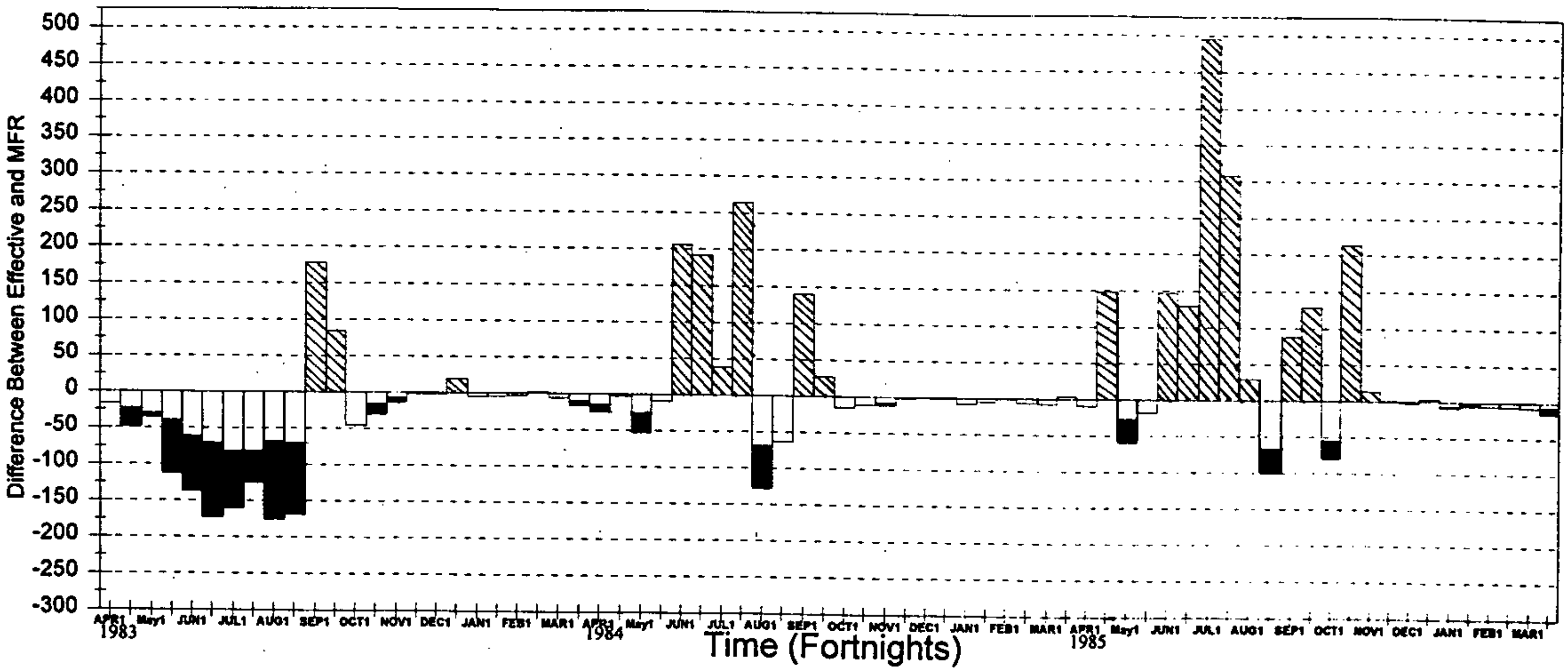

Fig. 3 (Continued)

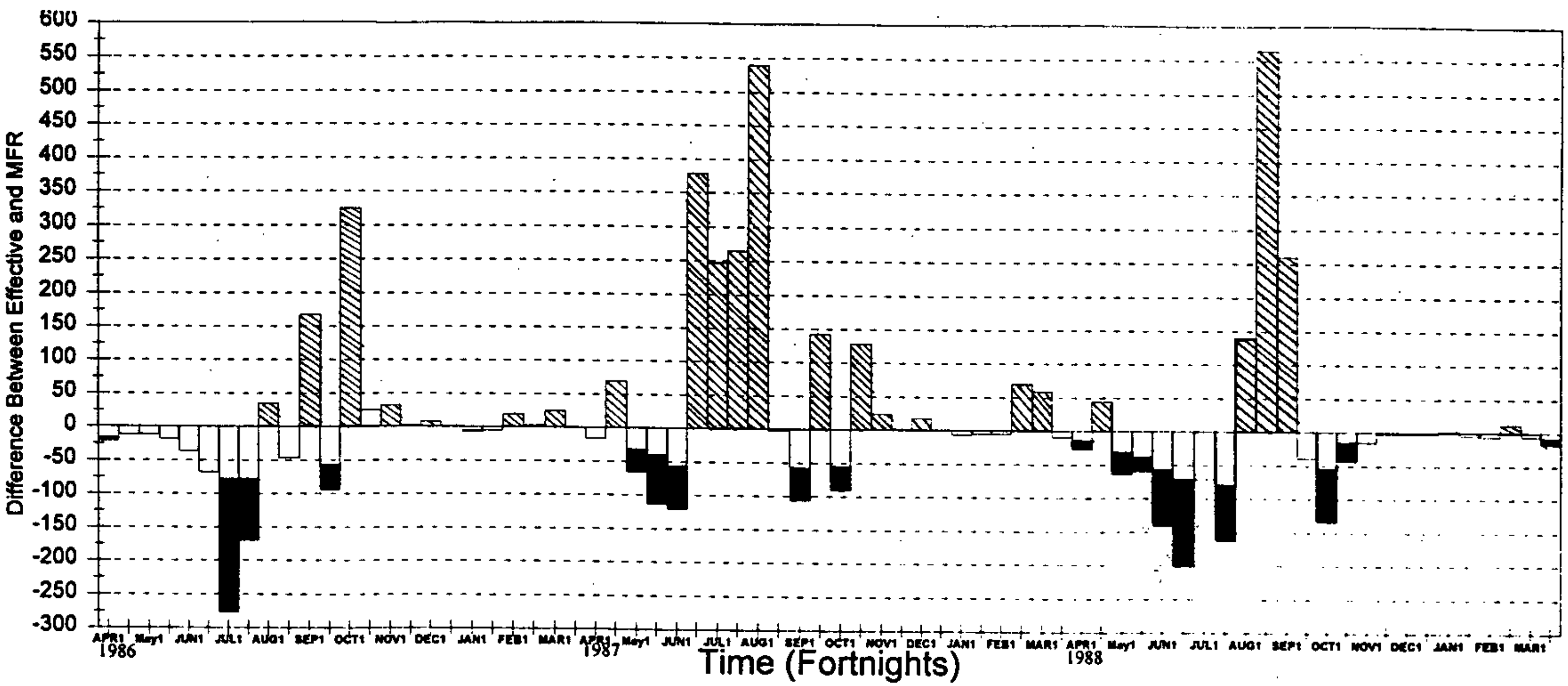

Fig. 3 (Continued)

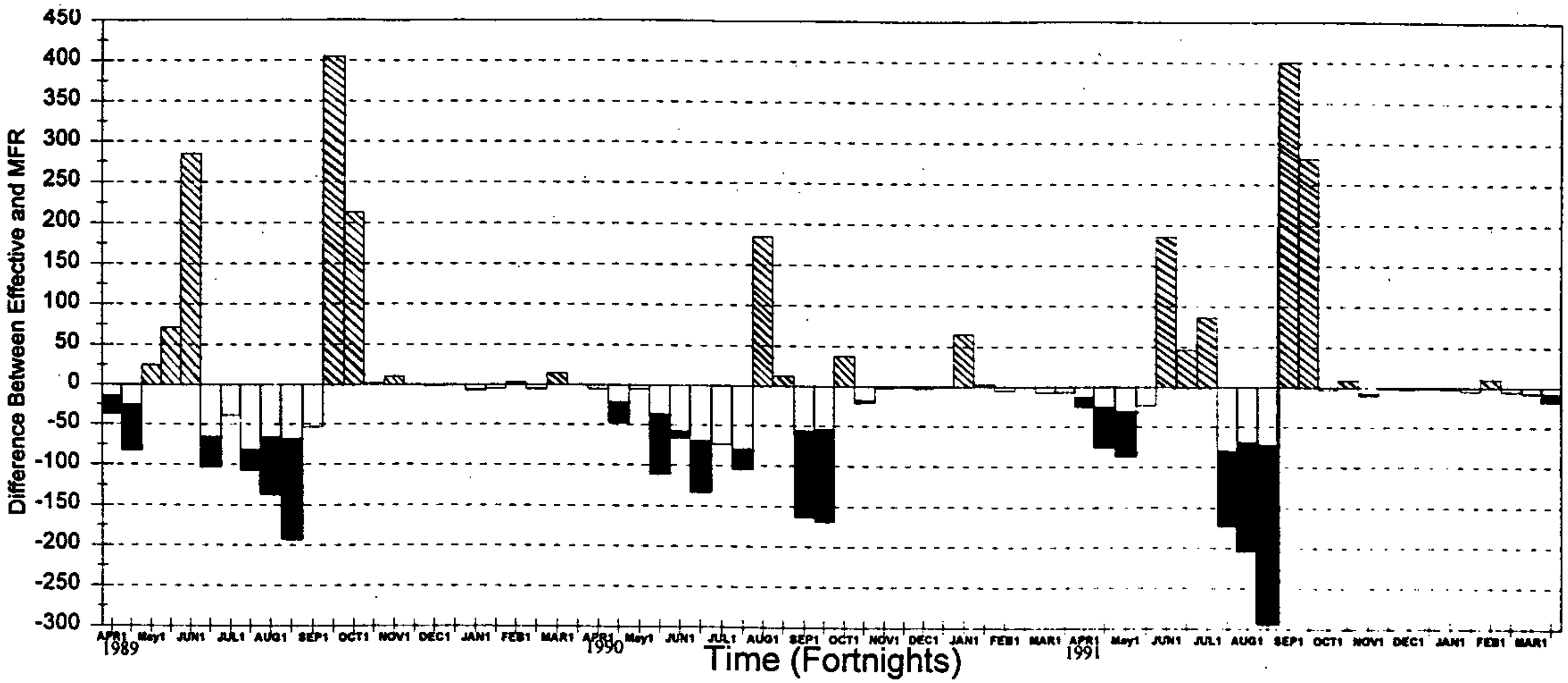

Fig. 3 (Continued)

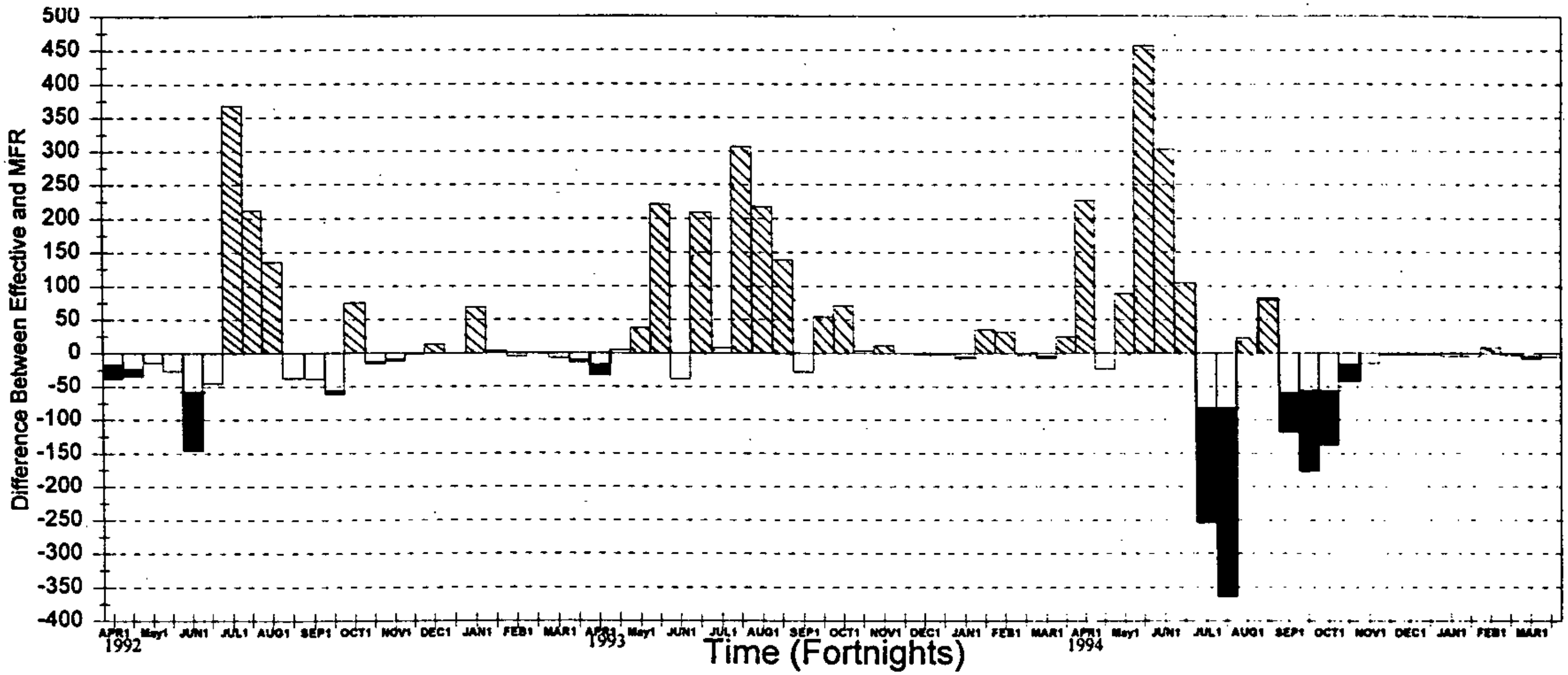

Fig. 3 (Continued)

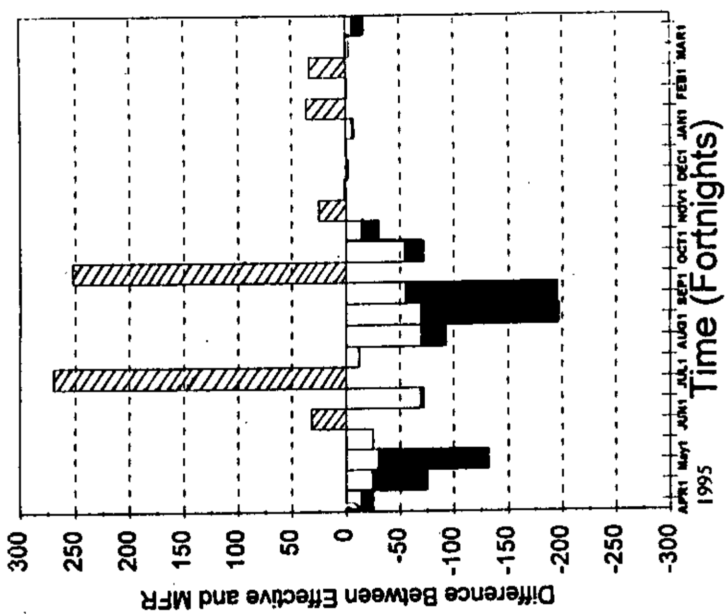

Fig. 3 (Continued)

APPENDIX-A

Drought Parameters for the Station Dinajpur (R168)

Month	MFR(i)	W(i)	MFD(i)
Apr1	20.52	0.12	-17.04
Apr2	76.16	0.17	-25.75
May1	121.54	0.21	-33.87
May2	165.11	0.25	-43.74
Jun1	242.67	0.32	-57.49
Jun2	307.39	0.38	-70.47
Jul1	329.71	0.40	-81.57
Jul2	293.46	0.36	-81.54
Aug1	205.76	0.29	-72.23
Aug2	260.52	0.33	-74.20
Sep1	212.65	0.29	-56.77
Sep2	217.63	0.30	-54.06
Oct1	126.20	0.21	-53.10
Oct2	24.76	0.12	-15.44
Nov1	9.99	0.11	-7.23
Nov2	0.82	0.10	-1.13
Dec1	2.20	0.10	-1.82
Dec2	1.08	0.10	-0.98
Jan1	7.31	0.11	-5.18
Jan2	4.01	0.10	-3.16
Feb1	5.12	0.10	-3.40
Feb2	6.12	0.11	-3.97
Mar1	6.66	0.11	-5.58
Mar2	15.95	0.11	-7.73

MEAN ANNUAL RAINFALL (MAR) = 2663.35

Drought Parameters for the Station Dinajpur (R168)

Year	Month	AR(i)	WV(i)	ER(i)	EXC /DEF	ED(i)
62-63	APR1	0.00	0.00	0.00	-20.52	-3.48
62-63	APR2	0.00	-3.46	-3.46	-79.63	-53.87
62-63	May1	281.50	-16.68	264.82	143.28	0.00
62-63	May2	185.60	35.64	221.24	56.14	0.00
62-63	JUN1	243.10	17.89	260.99	18.32	0.00
62-63	JUN2	409.50	6.91	416.41	109.01	0.00
62-63	JUL1	71.10	43.29	114.39	-215.32	-133.75
62-63	JUL2	140.00	-78.47	61.53	-231.94	-150.40
62-63	AUG1	0.00	-66.20	-66.20	-271.96	-199.73
62-63	AUG2	618.10	-91.04	527.06	266.54	0.00
62-63	SEP1	150.10	77.73	227.83	15.18	0.00
62-63	SEP2	82.10	4.50	86.60	-131.03	-76.97
62-63	OCT1	175.60	-28.00	147.60	21.40	0.00
62-63	OCT2	0.00	2.62	2.62	-22.14	-6.71
62-63	NOV1	0.00	-2.41	-2.41	-12.40	-5.17
62-63	NOV2	0.00	-1.25	-1.25	-2.07	-0.94
62-63	DEC1	0.00	-0.21	-0.21	-2.41	-0.59
62-63	DEC2	0.00	-0.24	-0.24	-1.32	-0.34
62-63	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
62-63	JAN2	0.00	-0.77	-0.77	-4.78	-1.63
62-63	FEB1	0.00	-0.50	-0.50	-5.62	-2.22
62-63	FEB2	0.00	-0.59	-0.59	-6.71	-2.74
62-63	MAR1	0.00	-0.71	-0.71	-7.37	-1.79
62-63	MAR2	15.20	-0.84	14.36	-1.59	0.00
63-64	APR1	20.10	-1.59	18.51	-2.01	0.00
63-64	APR2	149.90	-0.34	149.56	73.40	0.00
63-64	May1	78.40	15.38	93.78	-27.76	0.00
63-64	May2	75.30	-6.91	68.39	-96.71	-52.98
63-64	JUN1	236.70	-30.82	205.88	-36.79	0.00
63-64	JUN2	292.60	-13.87	278.73	-28.67	0.00
63-64	JUL1	444.70	-11.38	433.32	103.60	0.00
63-64	JUL2	226.10	37.76	263.86	-29.60	0.00
63-64	AUG1	259.30	-8.45	250.85	45.09	0.00
63-64	AUG2	511.50	15.09	526.59	266.07	0.00
63-64	SEP1	189.40	77.59	266.99	54.35	0.00
63-64	SEP2	214.10	16.09	230.19	12.56	0.00
63-64	OCT1	16.00	2.68	18.68	-107.52	-54.41
63-64	OCT2	18.50	-13.15	5.35	-19.41	-3.97
63-64	NOV1	11.00	-2.12	8.88	-1.10	0.00
63-64	NOV2	0.00	-0.11	-0.11	-0.93	0.00
63-64	DEC1	0.00	-0.10	-0.10	-2.29	-0.47
63-64	DEC2	0.00	-0.23	-0.23	-1.31	-0.33
63-64	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
63-64	JAN2	0.00	-0.77	-0.77	-4.78	-1.63
63-64	FEB1	0.00	-0.50	-0.50	-5.62	-2.22
63-64	FEB2	0.00	-0.59	-0.59	-6.71	-2.74
63-64	MAR1	0.00	-0.71	-0.71	-7.37	-1.79
63-64	MAR2	20.90	-0.84	20.06	4.11	0.00
64-65	APR1	50.30	4.11	54.41	33.89	0.00
64-65	APR2	47.70	5.71	53.41	-22.75	0.00
64-65	May1	295.70	-4.77	290.93	169.39	0.00
64-65	May2	60.20	42.14	102.34	-62.76	-19.03
64-65	JUN1	499.70	-20.00	479.70	237.02	0.00
64-65	JUN2	263.20	89.36	352.56	45.16	0.00
64-65	JUL1	307.60	17.94	325.54	-4.18	0.00
64-65	JUL2	491.80	-1.52	490.28	196.82	0.00
64-65	AUG1	264.40	56.17	320.57	114.81	0.00
64-65	AUG2	101.40	38.43	139.83	-120.69	-46.48
64-65	SEP1	112.60	-35.19	77.41	-135.24	-78.47
64-65	SEP2	139.40	-40.05	99.35	-118.28	-64.21
64-65	OCT1	137.40	-25.28	112.12	-14.08	0.00
64-65	OCT2	8.90	-1.72	7.18	-17.58	-2.15
64-65	NOV1	0.00	-1.92	-1.92	-11.90	-4.67
64-65	NOV2	0.50	-1.20	-0.70	-1.52	-0.39
64-65	DEC1	0.00	-0.16	-0.16	-2.35	-0.53
64-65	DEC2	0.00	-0.24	-0.24	-1.31	-0.34
64-65	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
64-65	JAN2	0.00	-0.77	-0.77	-4.78	-1.63

Drought Parameters for the Station Dinajpur (R168)

Year	Month	AR(i)	WV(i)	ER(i)	EXC /DEF	ED(i)
64-65	FEB1	7.10	-0.50	6.60	1.48	0.00
64-65	FEB2	11.20	0.16	11.36	5.24	0.00
64-65	MAR1	0.00	0.55	0.55	-6.10	-0.52
64-65	MAR2	37.60	-0.70	36.90	20.96	0.00
65-66	APR1	42.70	20.96	63.66	43.13	0.00
65-66	APR2	10.40	7.27	17.67	-58.49	-32.74
65-66	May1	62.00	-12.26	49.74	-71.80	-37.93
65-66	May2	362.00	-17.86	344.14	179.03	0.00
65-66	JUN1	198.00	57.05	255.05	12.38	0.00
65-66	JUN2	311.60	4.67	316.27	8.87	0.00
65-66	JUL1	216.00	3.52	219.52	-110.19	-28.62
65-66	JUL2	196.90	-40.16	156.74	-136.72	-55.18
65-66	AUG1	375.70	-39.02	336.68	130.92	0.00
65-66	AUG2	336.70	43.83	380.53	120.00	0.00
65-66	SEP1	146.80	35.00	181.80	-30.85	0.00
65-66	SEP2	191.60	-9.14	182.46	-35.16	0.00
65-66	OCT1	0.00	-7.52	-7.52	-133.72	-80.61
65-66	OCT2	8.90	-16.36	-7.46	-32.22	-16.78
65-66	NOV1	6.10	-3.51	2.59	-7.40	-0.17
65-66	NOV2	0.00	-0.75	-0.75	-1.57	-0.44
65-66	DEC1	0.00	-0.16	-0.16	-2.36	-0.54
65-66	DEC2	0.00	-0.24	-0.24	-1.31	-0.34
65-66	JAN1	15.20	-0.14	15.06	7.75	0.00
65-66	JAN2	2.50	0.80	3.30	-0.71	0.00
65-66	FEB1	0.00	-0.07	-0.07	-5.20	-1.80
65-66	FEB2	0.00	-0.55	-0.55	-6.67	-2.70
65-66	MAR1	0.00	-0.71	-0.71	-7.36	-1.78
65-66	MAR2	0.00	-0.84	-0.84	-16.79	-9.06
66-67	APR1	0.00	-16.79	-16.79	-37.31	-20.27
66-67	APR2	15.50	-6.29	9.21	-66.96	-41.20
66-67	May1	116.40	-14.03	102.37	-19.17	0.00
66-67	May2	240.00	-4.77	235.23	70.12	0.00
66-67	JUN1	119.90	22.35	142.25	-100.43	-42.94
66-67	JUN2	68.10	-37.86	30.24	-277.15	-206.69
66-67	JUL1	521.60	-110.06	411.54	81.82	0.00
66-67	JUL2	77.90	29.82	107.72	-185.74	-104.21
66-67	AUG1	297.80	-53.01	244.79	39.02	0.00
66-67	AUG2	356.70	13.06	369.76	109.24	0.00
66-67	SEP1	149.20	31.86	181.06	-31.59	0.00
66-67	SEP2	90.80	-9.35	81.45	-136.18	-82.12
66-67	OCT1	58.40	-29.11	29.29	-96.91	-43.80
66-67	OCT2	41.40	-11.85	29.55	4.79	0.00
66-67	NOV1	1.00	0.52	1.52	-8.46	-1.23
66-67	NOV2	6.90	-0.85	6.05	5.22	0.00
66-67	DEC1	2.30	0.53	2.83	0.64	0.00
66-67	DEC2	0.00	0.06	0.06	-1.01	-0.04
66-67	JAN1	0.00	-0.11	-0.11	-7.42	-2.24
66-67	JAN2	0.00	-0.77	-0.77	-4.78	-1.62
66-67	FEB1	0.00	-0.50	-0.50	-5.62	-2.22
66-67	FEB2	0.00	-0.59	-0.59	-6.71	-2.74
66-67	MAR1	25.40	-0.71	24.69	18.03	0.00
66-67	MAR2	90.60	2.06	92.66	76.72	0.00
67-68	APR1	1.50	76.72	78.22	57.69	0.00
67-68	APR2	89.80	9.73	99.53	23.36	0.00
67-68	May1	178.80	4.90	183.70	62.15	0.00
67-68	May2	76.40	15.46	91.86	-73.24	-29.51
67-68	JUN1	237.40	-23.34	214.06	-28.61	0.00
67-68	JUN2	162.10	-10.79	151.31	-156.08	-85.62
67-68	JUL1	303.90	-61.98	241.92	-87.80	-6.23
67-68	JUL2	105.70	-32.00	73.70	-219.76	-138.22
67-68	AUG1	111.40	-62.72	48.68	-157.08	-84.86
67-68	AUG2	76.50	-52.59	23.91	-236.61	-162.40
67-68	SEP1	84.80	-69.00	15.80	-196.85	-140.08
67-68	SEP2	407.10	-58.29	348.81	131.18	0.00
67-68	OCT1	179.10	28.04	207.14	80.94	0.00
67-68	OCT2	0.00	9.90	9.90	-14.86	0.00
67-68	NOV1	0.00	-1.62	-1.62	-11.61	-4.37
67-68	NOV2	0.00	-1.17	-1.17	-1.99	-0.86

Drought Parameters for the Station Dinajpur (R168)

Year	Month	AR(i)	WV(i)	ER(i)	EXC /DEF	ED(i)
67-68	DEC1	0.00	-0.20	-0.20	-2.40	-0.58
67-68	DEC2	0.00	-0.24	-0.24	-1.32	-0.34
67-68	JAN1	6.10	-0.14	5.96	-1.35	0.00
67-68	JAN2	4.10	-0.14	3.96	-0.05	0.00
67-68	FEB1	0.00	-0.01	-0.01	-5.13	-1.73
67-68	FEB2	0.00	-0.54	-0.54	-6.66	-2.69
67-68	MAR1	0.00	-0.71	-0.71	-7.36	-1.78
67-68	MAR2	18.50	-0.84	17.66	1.71	0.00
68-69	APR1	9.10	1.71	10.81	-9.71	0.00
68-69	APR2	5.10	-1.64	3.46	-72.70	-46.95
68-69	May1	20.10	-15.23	4.87	-116.67	-82.81
68-69	May2	75.60	-29.03	46.57	-118.53	-74.80
68-69	JUN1	90.40	-37.77	52.63	-190.05	-132.56
68-69	JUN2	513.80	-71.65	442.15	134.76	0.00
68-69	JUL1	234.40	53.51	287.91	-41.80	0.00
68-69	JUL2	395.20	-15.23	379.97	86.50	0.00
68-69	AUG1	42.40	24.69	67.09	-138.67	-66.44
68-69	AUG2	304.00	-46.42	257.58	-2.94	0.00
68-69	SEP1	109.50	-0.86	108.64	-104.01	-47.23
68-69	SEP2	250.00	-30.80	219.20	1.57	0.00
68-69	OCT1	325.90	0.34	326.24	200.04	0.00
68-69	OCT2	0.00	24.47	24.47	-0.29	0.00
68-69	NOV1	0.00	-0.03	-0.03	-10.02	-2.79
68-69	NOV2	0.00	-1.01	-1.01	-1.83	-0.70
68-69	DEC1	0.00	-0.19	-0.19	-2.38	-0.57
68-69	DEC2	0.00	-0.24	-0.24	-1.32	-0.34
68-69	JAN1	7.40	-0.14	7.26	-0.05	0.00
68-69	JAN2	0.00	-0.01	-0.01	-4.01	-0.86
68-69	FEB1	1.30	-0.42	0.88	-4.24	-0.84
68-69	FEB2	0.00	-0.45	-0.45	-6.57	-2.60
68-69	MAR1	0.00	-0.70	-0.70	-7.35	-1.77
68-69	MAR2	29.80	-0.84	28.96	13.01	0.00
69-70	APR1	17.30	13.01	30.31	9.79	0.00
69-70	APR2	89.20	1.65	90.85	14.69	0.00
69-70	May1	27.90	3.08	30.98	-90.56	-56.70
69-70	May2	311.90	-22.53	289.37	124.26	0.00
69-70	JUN1	225.60	39.60	265.20	22.53	0.00
69-70	JUN2	21.60	8.49	30.09	-277.30	-206.84
69-70	JUL1	484.50	-110.12	374.38	44.67	0.00
69-70	JUL2	147.90	16.28	164.18	-129.28	-47.75
69-70	AUG1	37.60	-36.90	0.70	-205.06	-132.83
69-70	AUG2	347.70	-68.65	279.05	18.53	0.00
69-70	SEP1	169.40	5.40	174.80	-37.84	0.00
69-70	SEP2	242.80	-11.21	231.59	13.97	0.00
69-70	OCT1	90.70	2.98	93.68	-32.52	0.00
69-70	OCT2	0.00	-3.98	-3.98	-28.74	-13.30
69-70	NOV1	46.00	-3.13	42.87	32.88	0.00
69-70	NOV2	0.00	3.31	3.31	2.49	0.00
69-70	DEC1	0.00	0.25	0.25	-1.94	-0.13
69-70	DEC2	0.00	-0.20	-0.20	-1.27	-0.30
69-70	JAN1	0.00	-0.14	-0.14	-7.45	-2.26
69-70	JAN2	15.80	-0.77	15.03	11.02	0.00
69-70	FEB1	0.00	1.15	1.15	-3.97	-0.57
69-70	FEB2	4.10	-0.42	3.68	-2.44	0.00
69-70	MAR1	0.00	-0.26	-0.26	-6.91	-1.33
69-70	MAR2	0.00	-0.79	-0.79	-16.74	-9.01
70-71	APR1	4.10	-16.74	-12.64	-33.16	-16.12
70-71	APR2	128.00	-5.59	122.41	46.24	0.00
70-71	May1	35.00	9.69	44.69	-76.85	-42.98
70-71	May2	204.90	-19.12	185.78	20.67	0.00
70-71	JUN1	334.80	6.59	341.39	98.72	0.00
70-71	JUN2	558.70	37.22	595.92	288.52	0.00
70-71	JUL1	662.70	114.58	777.28	447.56	0.00
70-71	JUL2	315.90	163.11	479.01	185.55	0.00
70-71	AUG1	259.70	52.96	312.66	106.90	0.00
70-71	AUG2	177.90	35.78	213.68	-46.84	0.00
70-71	SEP1	179.30	-13.66	165.64	-47.01	0.00
70-71	SEP2	418.60	-13.92	404.68	187.05	0.00

Drought Parameters for the Station Dinajpur (R168)

Year	Month	AR(i)	WV(i)	ER(i)	EXC /DEF	ED(i)
70-71	OCT1	46.00	39.98	85.98	-40.22	0.00
70-71	OCT2	5.10	-4.92	0.18	-24.58	-9.14
70-71	NOV1	0.50	-2.68	-2.18	-12.16	-4.93
70-71	NOV2	0.00	-1.23	-1.23	-2.05	-0.92
70-71	DEC1	0.00	-0.21	-0.21	-2.41	-0.59
70-71	DEC2	0.00	-0.24	-0.24	-1.32	-0.34
70-71	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
70-71	JAN2	0.00	-0.77	-0.77	-4.78	-1.63
70-71	FEB1	2.50	-0.50	2.00	-3.12	0.00
70-71	FEB2	0.00	-0.33	-0.33	-6.45	-2.48
70-71	MAR1	0.00	-0.68	-0.68	-7.34	-1.76
70-71	MAR2	7.40	-0.84	6.56	-9.39	-1.66
71-72	APR1	128.60	-9.39	119.21	98.69	0.00
71-72	APR2	113.80	16.64	130.44	54.28	0.00
71-72	May1	119.20	11.37	130.57	9.03	0.00
71-72	May2	28.20	2.25	30.45	-134.66	-90.92
71-72	JUN1	347.70	-42.91	304.79	62.11	0.00
71-72	JUN2	428.20	23.42	451.62	144.22	0.00
71-72	JUL1	210.30	57.27	267.57	-62.14	0.00
71-72	JUL2	102.30	-22.65	79.65	-213.81	-132.27
71-72	AUG1	73.90	-61.02	12.88	-192.89	-120.66
71-72	AUG2	207.00	-64.57	142.43	-118.09	-43.89
71-72	SEP1	95.20	-34.44	60.76	-151.89	-95.11
71-72	SEP2	99.50	-44.97	54.53	-163.10	-109.04
71-72	OCT1	345.00	-34.86	310.14	183.94	0.00
71-72	OCT2	1.80	22.50	24.30	-0.46	0.00
71-72	NOV1	46.00	-0.05	45.95	35.96	0.00
71-72	NOV2	0.00	3.62	3.62	2.80	0.00
71-72	DEC1	0.00	0.29	0.29	-1.91	-0.09
71-72	DEC2	0.00	-0.19	-0.19	-1.27	-0.29
71-72	JAN1	0.00	-0.14	-0.14	-7.45	-2.26
71-72	JAN2	2.50	-0.77	1.73	-2.28	0.00
71-72	FEB1	22.90	-0.24	22.66	17.54	0.00
71-72	FEB2	0.00	1.85	1.85	-4.27	-0.30
71-72	MAR1	0.00	-0.45	-0.45	-7.11	-1.53
71-72	MAR2	32.00	-0.81	31.19	15.24	0.00
72-73	APR1	19.00	15.24	34.24	13.72	0.00
72-73	APR2	44.90	2.31	47.21	-28.95	-3.20
72-73	May1	105.90	-6.07	99.83	-21.71	0.00
72-73	May2	52.60	-5.40	47.20	-117.91	-74.17
72-73	JUN1	113.80	-37.57	76.23	-166.45	-108.96
72-73	JUN2	244.70	-62.75	181.95	-125.44	-54.98
72-73	JUL1	75.90	-49.82	26.08	-303.63	-222.06
72-73	JUL2	467.30	-110.66	356.64	63.18	0.00
72-73	AUG1	30.90	18.03	48.93	-156.83	-84.60
72-73	AUG2	74.70	-52.50	22.20	-238.32	-164.12
72-73	SEP1	194.50	-69.50	125.00	-87.65	-30.88
72-73	SEP2	196.30	-25.95	170.35	-47.28	0.00
72-73	OCT1	7.90	-10.11	-2.21	-128.41	-75.30
72-73	OCT2	13.80	-15.71	-1.91	-26.67	-11.23
72-73	NOV1	0.00	-2.91	-2.91	-12.89	-5.66
72-73	NOV2	0.50	-1.30	-0.80	-1.62	-0.49
72-73	DEC1	0.00	-0.17	-0.17	-2.36	-0.54
72-73	DEC2	0.00	-0.24	-0.24	-1.32	-0.34
72-73	JAN1	8.60	-0.14	8.46	1.15	0.00
72-73	JAN2	1.50	0.12	1.62	-2.39	0.00
72-73	FEB1	0.00	-0.25	-0.25	-5.37	-1.97
72-73	FEB2	7.90	-0.57	7.33	1.21	0.00
72-73	MAR1	2.00	0.13	2.13	-4.53	0.00
72-73	MAR2	0.00	-0.52	-0.52	-16.46	-8.74
73-74	APR1	0.00	-16.46	-16.46	-36.99	-19.95
73-74	APR2	51.00	-6.24	44.76	-31.40	-5.65
73-74	May1	196.10	-6.58	189.52	67.98	0.00
73-74	May2	77.80	16.91	94.71	-70.39	-26.66
73-74	JUN1	475.40	-22.43	452.97	210.29	0.00
73-74	JUN2	601.80	79.28	681.08	373.69	0.00
73-74	JUL1	57.00	148.40	205.40	-124.32	-42.75
73-74	JUL2	150.60	-45.31	105.29	-188.17	-106.63

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73-74	AUG1	391.30	-53.71	337.59	131.83	0.00
73-74	AUG2	70.60	44.13	114.73	-145.79	-71.58
73-74	SEP1	211.40	-42.51	168.89	-43.76	0.00
73-74	SEP2	262.90	-12.96	249.94	32.31	0.00
73-74	OCT1	387.30	6.91	394.21	268.01	0.00
73-74	OCT2	18.30	32.78	51.08	26.32	0.00
73-74	NOV1	0.00	2.87	2.87	-7.12	0.00
73-74	NOV2	1.00	-0.72	0.28	-0.54	0.00
73-74	DEC1	1.10	-0.06	1.04	-1.15	0.00
73-74	DEC2	0.00	-0.12	-0.12	-1.19	-0.22
73-74	JAN1	39.40	-0.13	39.27	31.96	0.00
73-74	JAN2	5.60	3.31	8.91	4.90	0.00
73-74	FEB1	0.00	0.51	0.51	-4.61	-1.21
73-74	FEB2	0.00	-0.49	-0.49	-6.61	-2.64
73-74	MAR1	0.00	-0.70	-0.70	-7.36	-1.78
73-74	MAR2	115.30	-0.84	114.46	98.51	0.00
74-75	APR1	0.00	98.51	98.51	77.99	0.00
74-75	APR2	81.60	13.15	94.75	18.59	0.00
74-75	May1	234.50	3.89	238.39	116.85	0.00
74-75	May2	125.80	29.07	154.87	-10.24	0.00
74-75	JUN1	242.30	-3.26	239.04	-3.64	0.00
74-75	JUN2	264.10	-1.37	262.73	-44.66	0.00
74-75	JUL1	442.20	-17.74	424.46	94.75	0.00
74-75	JUL2	252.20	34.53	286.73	-6.73	0.00
74-75	AUG1	399.80	-1.92	397.88	192.12	0.00
74-75	AUG2	544.00	64.31	608.31	347.79	0.00
74-75	SEP1	244.00	101.42	345.42	132.78	0.00
74-75	SEP2	98.90	39.32	138.22	-79.41	-25.35
74-75	OCT1	145.90	-16.97	128.93	2.73	0.00
74-75	OCT2	44.00	0.33	44.33	19.57	0.00
74-75	NOV1	0.00	2.13	2.13	-7.85	-0.62
74-75	NOV2	0.00	-0.79	-0.79	-1.61	-0.48
74-75	DEC1	0.00	-0.16	-0.16	-2.36	-0.54
74-75	DEC2	0.50	-0.24	0.26	-0.81	0.00
74-75	JAN1	0.00	-0.09	-0.09	-7.40	-2.21
74-75	JAN2	0.00	-0.77	-0.77	-4.78	-1.62
74-75	FEB1	2.10	-0.50	1.60	-3.52	-0.12
74-75	FEB2	0.00	-0.37	-0.37	-6.49	-2.52
74-75	MAR1	0.00	-0.69	-0.69	-7.34	-1.76
74-75	MAR2	0.00	-0.84	-0.84	-16.79	-9.06
75-76	APR1	2.80	-16.79	-13.99	-34.51	-17.47
75-76	APR2	120.90	-5.82	115.08	38.92	0.00
75-76	May1	91.80	8.15	99.95	-21.59	0.00
75-76	May2	264.90	-5.37	259.53	94.42	0.00
75-76	JUN1	49.20	30.09	79.29	-163.38	-105.90
75-76	JUN2	151.50	-61.60	89.90	-217.49	-147.02
75-76	JUL1	159.50	-86.37	73.13	-256.58	-175.01
75-76	JUL2	290.00	-93.51	196.49	-96.97	-15.44
75-76	AUG1	129.50	-27.68	101.82	-103.94	-31.71
75-76	AUG2	274.10	-34.79	239.31	-21.22	0.00
75-76	SEP1	107.00	-6.19	100.81	-111.83	-55.06
75-76	SEP2	222.50	-33.12	189.38	-28.24	0.00
75-76	OCT1	61.70	-6.04	55.66	-70.54	-17.43
75-76	OCT2	8.90	-8.63	0.27	-24.49	-9.05
75-76	NOV1	0.00	-2.67	-2.67	-12.65	-5.42
75-76	NOV2	0.00	-1.27	-1.27	-2.10	-0.97
75-76	DEC1	0.00	-0.21	-0.21	-2.41	-0.59
75-76	DEC2	0.00	-0.24	-0.24	-1.32	-0.34
75-76	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
75-76	JAN2	0.00	-0.77	-0.77	-4.78	-1.63
75-76	FEB1	2.00	-0.50	1.50	-3.62	-0.22
75-76	FEB2	0.00	-0.38	-0.38	-6.50	-2.53
75-76	MAR1	0.00	-0.69	-0.69	-7.35	-1.76
75-76	MAR2	2.80	-0.84	1.96	-13.99	-6.26
76-77	APR1	0.00	-13.99	-13.99	-34.51	-17.47
76-77	APR2	66.30	-5.82	60.48	-15.68	0.00
76-77	May1	70.20	-3.29	66.91	-54.63	-20.76
76-77	May2	104.10	-13.59	90.51	-74.60	-30.86

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Year	Month	AR(i)	WV(i)	ER(i)	EXC./DEF	ED(i)
76-77	JUN1	258.00	-23.77	234.23	-8.45	0.00
76-77	JUN2	423.30	-3.18	420.12	112.72	0.00
76-77	JUL1	653.50	44.76	698.26	368.55	0.00
76-77	JUL2	42.50	134.32	176.82	-116.65	-35.11
76-77	AUG1	380.60	-33.29	347.31	141.55	0.00
76-77	AUG2	324.40	47.38	371.78	111.26	0.00
76-77	SEP1	20.10	32.45	52.55	-160.10	-103.33
76-77	SEP2	61.20	-47.41	13.79	-203.84	-149.77
76-77	OCT1	37.70	-43.56	-5.86	-132.06	-78.96
76-77	OCT2	0.00	-16.15	-16.15	-40.92	-25.48
76-77	NOV1	0.00	-4.46	-4.46	-14.44	-7.21
76-77	NOV2	0.00	-1.46	-1.46	-2.28	-1.15
76-77	DEC1	0.00	-0.23	-0.23	-2.43	-0.61
76-77	DEC2	0.00	-0.25	-0.25	-1.32	-0.34
76-77	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
76-77	JAN2	0.00	-0.77	-0.77	-4.78	-1.63
76-77	FEB1	0.00	-0.50	-0.50	-5.62	-2.22
76-77	FEB2	0.00	-0.59	-0.59	-6.71	-2.74
76-77	MAR1	0.00	-0.71	-0.71	-7.37	-1.79
76-77	MAR2	0.00	-0.84	-0.84	-16.79	-9.06
77-78	APR1	71.80	-16.79	55.01	34.49	0.00
77-78	APR2	30.20	5.82	36.02	-40.15	-14.40
77-78	May1	141.20	-8.41	132.79	11.25	0.00
77-78	May2	229.90	2.80	232.70	67.59	0.00
77-78	JUN1	341.40	21.54	362.94	120.27	0.00
77-78	JUN2	211.80	45.34	257.14	-50.25	0.00
77-78	JUL1	106.20	-19.96	86.24	-243.47	-161.90
77-78	JUL2	427.20	-88.73	338.47	45.01	0.00
77-78	AUG1	95.00	12.85	107.85	-97.92	-25.69
77-78	AUG2	482.10	-32.78	449.32	188.80	0.00
77-78	SEP1	89.30	55.06	144.36	-68.29	-11.52
77-78	SEP2	270.30	-20.22	250.08	32.45	0.00
77-78	OCT1	273.50	6.94	280.44	154.24	0.00
77-78	OCT2	61.80	18.87	80.67	55.90	0.00
77-78	NOV1	64.70	6.09	70.79	60.81	0.00
77-78	NOV2	0.00	6.13	6.13	5.30	0.00
77-78	DEC1	0.00	0.54	0.54	-1.66	0.00
77-78	DEC2	8.60	-0.17	8.43	7.36	0.00
77-78	JAN1	0.00	0.78	0.78	-6.53	-1.34
77-78	JAN2	0.00	-0.68	-0.68	-4.69	-1.53
77-78	FEB1	0.80	-0.49	0.31	-4.81	-1.41
77-78	FEB2	2.00	-0.51	1.49	-4.63	-0.66
77-78	MAR1	0.00	-0.49	-0.49	-7.15	-1.57
77-78	MAR2	4.30	-0.82	3.48	-12.46	-4.74
78-79	APR1	8.40	-12.46	-4.06	-24.58	-7.55
78-79	APR2	176.30	-4.15	172.15	95.99	0.00
78-79	May1	37.60	20.11	57.71	-63.83	-29.96
78-79	May2	195.90	-15.88	180.02	14.91	0.00
78-79	JUN1	141.30	4.75	146.05	-96.62	-39.13
78-79	JUN2	223.40	-36.43	186.97	-120.42	-49.95
78-79	JUL1	335.50	-47.82	287.68	-42.04	0.00
78-79	JUL2	328.30	-15.32	312.98	19.52	0.00
78-79	AUG1	81.60	5.57	87.17	-118.59	-46.36
78-79	AUG2	66.60	-39.70	26.90	-233.62	-159.42
78-79	SEP1	413.40	-68.13	345.27	132.62	0.00
78-79	SEP2	199.70	39.27	238.97	21.34	0.00
78-79	OCT1	8.90	4.56	13.46	-112.74	-59.63
78-79	OCT2	0.00	-13.79	-13.79	-38.55	-23.11
78-79	NOV1	8.30	-4.20	4.10	-5.89	0.00
78-79	NOV2	0.00	-0.59	-0.59	-1.42	-0.29
78-79	DEC1	0.00	-0.14	-0.14	-2.34	-0.52
78-79	DEC2	0.00	-0.24	-0.24	-1.31	-0.34
78-79	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
78-79	JAN2	0.00	-0.77	-0.77	-4.78	-1.63
78-79	FEB1	3.30	-0.50	2.80	-2.32	0.00
78-79	FEB2	1.80	-0.25	1.55	-4.57	-0.59
78-79	MAR1	1.30	-0.48	0.82	-5.84	-0.26
78-79	MAR2	0.50	-0.67	-0.17	-16.11	-8.39

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79-80	APR1	0.00	-16.11	-16.11	-36.64	-19.60
79-80	APR2	31.70	-6.18	25.52	-50.64	-24.89
79-80	May1	98.50	-10.61	87.89	-33.65	0.00
79-80	May2	29.70	-8.37	21.33	-143.78	-100.04
79-80	JUN1	40.70	-45.82	-5.12	-247.79	-190.31
79-80	JUN2	232.10	-93.42	138.68	-168.71	-98.25
79-80	JUL1	119.10	-67.00	52.10	-277.61	-196.04
79-80	JUL2	507.30	-101.17	406.13	112.66	0.00
79-80	AUG1	33.50	32.16	65.66	-140.11	-67.88
79-80	AUG2	410.60	-46.90	363.70	103.18	0.00
79-80	SEP1	389.30	30.09	419.39	206.74	0.00
79-80	SEP2	108.70	61.22	169.92	-47.71	0.00
79-80	OCT1	310.30	-10.20	300.10	173.90	0.00
79-80	OCT2	2.50	21.27	23.77	-0.99	0.00
79-80	NOV1	0.00	-0.11	-0.11	-10.09	-2.86
79-80	NOV2	17.70	-1.02	16.68	15.86	0.00
79-80	DEC1	0.00	1.62	1.62	-0.58	0.00
79-80	DEC2	0.00	-0.06	-0.06	-1.14	-0.16
79-80	JAN1	0.00	-0.12	-0.12	-7.43	-2.25
79-80	JAN2	0.00	-0.77	-0.77	-4.78	-1.62
79-80	FEB1	0.00	-0.50	-0.50	-5.62	-2.22
79-80	FEB2	15.50	-0.59	14.91	8.79	0.00
79-80	MAR1	67.50	0.93	68.43	61.78	0.00
79-80	MAR2	0.00	7.07	7.07	-8.88	-1.15
80-81	APR1	0.00	-8.88	-8.88	-29.40	-12.37
80-81	APR2	75.40	-4.96	70.44	-5.72	0.00
80-81	May1	256.70	-1.20	255.50	133.96	0.00
80-81	May2	123.60	33.33	156.93	-8.18	0.00
80-81	JUN1	138.10	-2.61	135.49	-107.18	-49.69
80-81	JUN2	214.20	-40.41	173.79	-133.60	-63.13
80-81	JUL1	258.90	-53.05	205.85	-123.87	-42.30
80-81	JUL2	489.60	-45.14	444.46	150.99	0.00
80-81	AUG1	388.60	43.10	431.70	225.93	0.00
80-81	AUG2	158.90	75.63	234.53	-25.99	0.00
80-81	SEP1	262.60	-7.58	255.02	42.37	0.00
80-81	SEP2	88.40	12.55	100.95	-116.68	-62.62
80-81	OCT1	53.10	-24.94	28.16	-98.04	-44.93
80-81	OCT2	63.20	-11.99	51.21	26.45	0.00
80-81	NOV1	0.00	2.88	2.88	-7.10	0.00
80-81	NOV2	0.00	-0.72	-0.72	-1.54	-0.41
80-81	DEC1	0.00	-0.16	-0.16	-2.35	-0.54
80-81	DEC2	0.00	-0.24	-0.24	-1.31	-0.34
80-81	JAN1	3.60	-0.14	3.46	-3.85	0.00
80-81	JAN2	14.50	-0.40	14.10	10.09	0.00
80-81	FEB1	27.50	1.06	28.56	23.43	0.00
80-81	FEB2	0.00	2.47	2.47	-3.65	0.00
80-81	MAR1	0.00	-0.39	-0.39	-7.04	-1.46
80-81	MAR2	16.00	-0.81	15.19	-0.75	0.00
81-82	APR1	17.10	-0.75	16.35	-4.17	0.00
81-82	APR2	137.40	-0.70	136.70	60.53	0.00
81-82	May1	395.80	12.68	408.48	286.94	0.00
81-82	May2	206.10	71.39	277.49	112.38	0.00
81-82	JUN1	86.90	35.81	122.71	-119.96	-62.47
81-82	JUN2	404.30	-45.23	359.07	51.68	0.00
81-82	JUL1	302.80	20.52	323.32	-6.39	0.00
81-82	JUL2	662.40	-2.33	660.07	366.61	0.00
81-82	AUG1	125.70	104.64	230.34	24.57	0.00
81-82	AUG2	446.10	8.23	454.33	193.81	0.00
81-82	SEP1	135.10	56.52	191.62	-21.03	0.00
81-82	SEP2	33.30	-6.23	27.07	-190.56	-136.49
81-82	OCT1	25.10	-40.73	-15.63	-141.83	-88.72
81-82	OCT2	0.00	-17.35	-17.35	-42.11	-26.67
81-82	NOV1	0.00	-4.59	-4.59	-14.58	-7.34
81-82	NOV2	0.00	-1.47	-1.47	-2.29	-1.16
81-82	DEC1	24.40	-0.23	24.17	21.97	0.00
81-82	DEC2	0.00	2.22	2.22	1.14	0.00
81-82	JAN1	0.00	0.12	0.12	-7.19	-2.01
81-82	JAN2	0.00	-0.74	-0.74	-4.75	-1.60

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Year	Month	AR(i)	WV(i)	ER(i)	EXC /DEF	ED(i)
81-82	FEB1	0.00	-0.50	-0.50	-5.62	-2.22
81-82	FEB2	0.00	-0.59	-0.59	-6.71	-2.74
81-82	MAR1	19.00	-0.71	18.29	11.63	0.00
81-82	MAR2	14.50	1.33	15.83	-0.12	0.00
82-83	APR1	19.80	-0.12	19.68	-0.84	0.00
82-83	APR2	261.00	-0.14	260.86	184.69	0.00
82-83	May1	53.30	38.70	92.00	-29.54	0.00
82-83	May2	110.50	-7.35	103.15	-61.96	-18.22
82-83	JUN1	277.40	-19.74	257.66	14.98	0.00
82-83	JUN2	369.20	5.65	374.85	67.45	0.00
82-83	JUL1	423.30	26.79	450.09	120.37	0.00
82-83	JUL2	438.60	43.87	482.47	189.01	0.00
82-83	AUG1	15.20	53.95	69.15	-136.62	-64.39
82-83	AUG2	75.40	-45.73	29.67	-230.85	-156.65
82-83	SEP1	392.50	-67.32	325.18	112.53	0.00
82-83	SEP2	215.00	33.32	248.32	30.69	0.00
82-83	OCT1	0.00	6.56	6.56	-119.64	-66.54
82-83	OCT2	49.50	-14.63	34.87	10.10	0.00
82-83	NOV1	6.40	1.10	7.50	-2.48	0.00
82-83	NOV2	0.00	-0.25	-0.25	-1.07	0.00
82-83	DEC1	0.00	-0.11	-0.11	-2.31	-0.49
82-83	DEC2	0.00	-0.23	-0.23	-1.31	-0.33
82-83	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
82-83	JAN2	8.90	-0.77	8.13	4.12	0.00
82-83	FEB1	0.00	0.43	0.43	-4.69	-1.29
82-83	FEB2	0.00	-0.50	-0.50	-6.62	-2.64
82-83	MAR1	0.00	-0.70	-0.70	-7.36	-1.78
82-83	MAR2	20.60	-0.84	19.76	3.81	0.00
83-84	APR1	0.00	3.81	3.81	-16.71	0.00
83-84	APR2	30.50	-2.82	27.68	-48.48	-22.73
83-84	May1	96.00	-10.16	85.84	-35.70	-1.83
83-84	May2	61.50	-8.88	52.62	-112.49	-68.75
83-84	JUN1	141.70	-35.85	105.85	-136.82	-79.34
83-84	JUN2	186.20	-51.58	134.62	-172.78	-102.31
83-84	JUL1	237.50	-68.61	168.89	-160.83	-79.26
83-84	JUL2	228.50	-58.61	169.89	-123.57	-42.04
83-84	AUG1	65.50	-35.27	30.23	-175.53	-103.30
83-84	AUG2	150.50	-58.76	91.74	-168.78	-94.58
83-84	SEP1	439.60	-49.22	390.38	177.73	0.00
83-84	SEP2	249.20	52.63	301.83	84.20	0.00
83-84	OCT1	62.20	18.00	80.20	-46.00	0.00
83-84	OCT2	0.00	-5.63	-5.63	-30.39	-14.95
83-84	NOV1	0.00	-3.31	-3.31	-13.30	-6.07
83-84	NOV2	0.00	-1.34	-1.34	-2.16	-1.03
83-84	DEC1	0.00	-0.22	-0.22	-2.42	-0.60
83-84	DEC2	20.30	-0.24	20.06	18.98	0.00
83-84	JAN1	0.00	2.02	2.02	-5.29	-0.10
83-84	JAN2	0.00	-0.55	-0.55	-4.56	-1.40
83-84	FEB1	1.80	-0.48	1.32	-3.80	-0.40
83-84	FEB2	8.20	-0.40	7.80	1.68	0.00
83-84	MAR1	0.00	0.18	0.18	-6.48	-0.90
83-84	MAR2	0.00	-0.74	-0.74	-16.69	-8.96
84-85	APR1	12.70	-16.69	-3.99	-24.51	-7.47
84-85	APR2	77.50	-4.13	73.37	-2.80	0.00
84-85	May1	70.00	-0.59	69.41	-52.13	-18.26
84-85	May2	168.90	-12.97	155.93	-9.17	0.00
84-85	JUN1	450.90	-2.92	447.98	205.30	0.00
84-85	JUN2	421.80	77.40	499.20	191.80	0.00
84-85	JUL1	292.10	76.17	368.27	38.55	0.00
84-85	JUL2	543.50	14.05	557.55	264.09	0.00
84-85	AUG1	2.50	75.38	77.88	-127.89	-55.66
84-85	AUG2	240.10	-42.81	197.29	-63.23	0.00
84-85	SEP1	371.10	-18.44	352.66	140.01	0.00
84-85	SEP2	203.20	41.46	244.66	27.03	0.00
84-85	OCT1	105.50	5.78	111.28	-14.92	0.00
84-85	OCT2	15.20	-1.83	13.37	-11.39	0.00
84-85	NOV1	0.00	-1.24	-1.24	-11.23	-4.00
84-85	NOV2	0.00	-1.13	-1.13	-1.95	-0.82

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Year	Month	AR(i)	WV(i)	ER(i)	EXC /DEF	ED(i)
84-85	DEC1	1.30	-0.20	1.10	-1.10	0.00
84-85	DEC2	0.00	-0.11	-0.11	-1.19	-0.21
84-85	JAN1	0.00	-0.13	-0.13	-7.44	-2.25
84-85	JAN2	0.00	-0.77	-0.77	-4.78	-1.62
84-85	FEB1	5.10	-0.50	4.60	-0.52	0.00
84-85	FEB2	0.00	-0.06	-0.06	-6.18	-2.21
84-85	MAR1	0.00	-0.65	-0.65	-7.31	-1.73
84-85	MAR2	20.30	-0.84	19.46	3.52	0.00
85-86	APR1	7.90	3.52	11.42	-9.10	0.00
85-86	APR2	225.90	-1.54	224.36	148.20	0.00
85-86	May1	33.00	31.05	64.05	-57.49	-23.62
85-86	May2	161.70	-14.30	147.40	-17.71	0.00
85-86	JUN1	395.70	-5.64	390.06	147.38	0.00
85-86	JUN2	381.50	55.56	437.06	129.67	0.00
85-86	JUL1	773.60	51.49	825.09	495.38	0.00
85-86	JUL2	421.10	180.54	601.64	308.18	0.00
85-86	AUG1	147.10	87.96	235.06	29.30	0.00
85-86	AUG2	150.80	9.81	160.61	-99.91	-25.71
85-86	SEP1	329.70	-29.14	300.56	87.92	0.00
85-86	SEP2	320.30	26.03	346.33	128.70	0.00
85-86	OCT1	19.30	27.51	46.81	-79.39	-26.29
85-86	OCT2	248.20	-9.71	238.49	213.73	0.00
85-86	NOV1	0.00	23.30	23.30	13.31	0.00
85-86	NOV2	0.00	1.34	1.34	0.52	0.00
85-86	DEC1	0.00	0.05	0.05	-2.14	-0.33
85-86	DEC2	4.50	-0.22	4.28	3.21	0.00
85-86	JAN1	0.00	0.34	0.34	-6.97	-1.79
85-86	JAN2	0.00	-0.72	-0.72	-4.73	-1.58
85-86	FEB1	0.00	-0.49	-0.49	-5.62	-2.22
85-86	FEB2	0.00	-0.59	-0.59	-6.71	-2.74
85-86	MAR1	0.00	-0.71	-0.71	-7.37	-1.79
85-86	MAR2	1.50	-0.84	0.66	-15.29	-7.56
86-87	APR1	14.80	-15.29	-0.49	-21.01	-3.97
86-87	APR2	67.70	-3.54	64.16	-12.01	0.00
86-87	May1	112.30	-2.52	109.78	-11.76	0.00
86-87	May2	150.00	-2.92	147.08	-18.03	0.00
86-87	JUN1	211.80	-5.75	206.05	-36.62	0.00
86-87	JUN2	253.50	-13.81	239.69	-67.70	0.00
86-87	JUL1	80.00	-26.88	53.12	-276.60	-195.03
86-87	JUL2	224.40	-100.81	123.59	-169.87	-88.33
86-87	AUG1	289.10	-48.48	240.62	34.86	0.00
86-87	AUG2	202.70	11.67	214.37	-46.15	0.00
86-87	SEP1	393.50	-13.46	380.04	167.39	0.00
86-87	SEP2	73.90	49.57	123.47	-94.16	-40.10
86-87	OCT1	470.60	-20.12	450.48	324.28	0.00
86-87	OCT2	10.20	39.66	49.86	25.10	0.00
86-87	NOV1	39.60	2.74	42.34	32.35	0.00
86-87	NOV2	0.00	3.26	3.26	2.44	0.00
86-87	DEC1	10.40	0.25	10.65	8.45	0.00
86-87	DEC2	1.80	0.85	2.65	1.58	0.00
86-87	JAN1	0.30	0.17	0.47	-6.84	-1.66
86-87	JAN2	0.00	-0.71	-0.71	-4.72	-1.56
86-87	FEB1	24.90	-0.49	24.41	19.28	0.00
86-87	FEB2	6.90	2.03	8.93	2.81	0.00
86-87	MAR1	31.00	0.30	31.30	24.64	0.00
86-87	MAR2	12.70	2.82	15.52	-0.43	0.00
87-88	APR1	5.10	-0.43	4.67	-15.85	0.00
87-88	APR2	148.80	-2.67	146.13	69.96	0.00
87-88	May1	41.70	14.66	56.36	-65.18	-31.32
87-88	May2	68.60	-16.22	52.38	-112.72	-68.99
87-88	JUN1	158.10	-35.92	122.18	-120.50	-63.01
87-88	JUN2	731.10	-45.43	685.67	378.28	0.00
87-88	JUL1	426.60	150.22	576.82	247.10	0.00
87-88	JUL2	468.40	90.06	558.46	264.99	0.00
87-88	AUG1	670.10	75.63	745.73	539.97	0.00
87-88	AUG2	77.50	180.76	258.26	-2.26	0.00
87-88	SEP1	107.70	-0.66	107.04	-105.61	-48.84
87-88	SEP2	391.20	-31.27	359.93	142.30	0.00

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Year	Month	AR(i)	WV(i)	ER(i)	EXC /DEF	ED(i)
87-88	OCT1	5.90	30.41	36.31	-89.89	-36.78
87-88	OCT2	164.50	-10.99	153.51	128.74	0.00
87-88	NOV1	19.80	14.03	33.83	23.85	0.00
87-88	NOV2	0.00	2.40	2.40	1.58	0.00
87-88	DEC1	19.80	0.16	19.96	17.76	0.00
87-88	DEC2	0.00	1.79	1.79	0.72	0.00
87-88	JAN1	1.80	0.08	1.88	-5.44	-0.25
87-88	JAN2	0.00	-0.56	-0.56	-4.57	-1.42
87-88	FEB1	0.80	-0.48	0.32	-4.80	-1.40
87-88	FEB2	76.20	-0.51	75.69	69.57	0.00
87-88	MAR1	58.40	7.37	65.77	59.12	0.00
87-88	MAR2	0.00	6.76	6.76	-9.19	-1.46
88-89	APR1	3.30	-9.19	-5.89	-26.41	-9.37
88-89	APR2	125.20	-4.45	120.75	44.58	0.00
88-89	May1	48.90	9.34	58.24	-63.30	-29.43
88-89	May2	121.80	-15.75	106.05	-59.05	-15.32
88-89	JUN1	120.90	-18.82	102.08	-140.59	-83.11
88-89	JUN2	158.80	-53.00	105.80	-201.60	-131.13
88-89	JUL1	338.70	-80.06	258.64	-71.07	0.00
88-89	JUL2	158.10	-25.90	132.20	-161.26	-79.73
88-89	AUG1	390.90	-46.03	344.87	139.11	0.00
88-89	AUG2	778.90	46.57	825.47	564.95	0.00
88-89	SEP1	308.10	164.75	472.85	260.20	0.00
88-89	SEP2	101.10	77.05	178.15	-39.48	0.00
88-89	OCT1	0.00	-8.44	-8.44	-134.64	-81.53
88-89	OCT2	0.00	-16.47	-16.47	-41.23	-25.79
88-89	NOV1	0.00	-4.49	-4.49	-14.48	-7.25
88-89	NOV2	0.60	-1.46	-0.86	-1.68	-0.55
88-89	DEC1	0.00	-0.17	-0.17	-2.37	-0.55
88-89	DEC2	0.00	-0.24	-0.24	-1.32	-0.34
88-89	JAN1	9.50	-0.14	9.36	2.05	0.00
88-89	JAN2	0.00	0.21	0.21	-3.80	-0.64
88-89	FEB1	0.00	-0.40	-0.40	-5.52	-2.12
88-89	FEB2	18.50	-0.58	17.92	11.80	0.00
88-89	MAR1	0.00	1.25	1.25	-5.41	0.00
88-89	MAR2	0.00	-0.62	-0.62	-16.57	-8.84
89-90	APR1	0.00	-16.57	-16.57	-37.09	-20.05
89-90	APR2	0.00	-6.25	-6.25	-82.42	-56.67
89-90	May1	163.70	-17.27	146.43	24.89	0.00
89-90	May2	230.00	6.19	236.19	71.09	0.00
89-90	JUN1	504.80	22.65	527.45	284.78	0.00
89-90	JUN2	96.80	107.36	204.16	-103.23	-32.77
89-90	JUL1	332.30	-40.99	291.31	-38.41	0.00
89-90	JUL2	199.90	-14.00	185.90	-107.56	-26.02
89-90	AUG1	99.50	-30.70	68.80	-136.96	-64.73
89-90	AUG2	113.90	-45.85	68.05	-192.47	-118.27
89-90	SEP1	215.60	-56.13	159.47	-53.18	0.00
89-90	SEP2	637.50	-15.75	621.75	404.12	0.00
89-90	OCT1	252.50	86.37	338.87	212.67	0.00
89-90	OCT2	0.00	26.01	26.01	1.25	0.00
89-90	NOV1	20.00	0.14	20.14	10.15	0.00
89-90	NOV2	0.00	1.02	1.02	0.20	0.00
89-90	DEC1	0.00	0.02	0.02	-2.18	-0.36
89-90	DEC2	0.00	-0.22	-0.22	-1.30	-0.32
89-90	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
89-90	JAN2	0.00	-0.77	-0.77	-4.78	-1.63
89-90	FEB1	8.80	-0.50	8.30	3.18	0.00
89-90	FEB2	1.00	0.34	1.34	-4.79	-0.81
89-90	MAR1	21.70	-0.51	21.19	14.54	0.00
89-90	MAR2	14.80	1.66	16.46	0.52	0.00
90-91	APR1	15.50	0.52	16.02	-4.51	0.00
90-91	APR2	29.00	-0.76	28.24	-47.92	-22.17
90-91	May1	126.70	-10.04	116.66	-4.88	0.00
90-91	May2	55.30	-1.21	54.09	-111.02	-67.29.
90-91	JUN1	211.90	-35.38	176.52	-66.15	-8.67
90-91	JUN2	199.30	-24.94	174.36	-133.03	-62.57
90-91	JUL1	309.50	-52.83	256.67	-73.04	0.00
90-91	JUL2	215.40	-26.62	188.78	-104.68	-23.15

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Year	Month	AR(i)	WV(i)	ER(i)	EXC /DEF	ED(i)
90-91	AUG1	420.00	-29.88	390.12	184.36	0.00
90-91	AUG2	211.00	61.72	272.72	12.20	0.00
90-91	SEP1	45.50	3.56	49.06	-163.59	-106.82
90-91	SEP2	97.30	-48.44	48.86	-168.77	-114.71
90-91	OCT1	200.00	-36.07	163.93	37.73	0.00
90-91	OCT2	0.00	4.61	4.61	-20.15	-4.71
90-91	NOV1	10.70	-2.20	8.50	-1.48	0.00
90-91	NOV2	0.00	-0.15	-0.15	-0.97	0.00
90-91	DEC1	0.00	-0.10	-0.10	-2.30	-0.48
90-91	DEC2	0.00	-0.23	-0.23	-1.31	-0.33
90-91	JAN1	72.20	-0.14	72.06	64.75	0.00
90-91	JAN2	0.00	6.71	6.71	2.70	0.00
90-91	FEB1	0.00	0.28	0.28	-4.84	-1.44
90-91	FEB2	6.00	-0.51	5.49	-0.63	0.00
90-91	MAR1	0.00	-0.07	-0.07	-6.72	-1.14
90-91	MAR2	10.50	-0.77	9.73	-6.22	0.00
91-92	APR1	1.80	-6.22	-4.42	-24.94	-7.90
91-92	APR2	4.80	-4.21	0.59	-75.57	-49.82
91-92	May1	50.00	-15.83	34.17	-87.37	-53.51
91-92	May2	164.20	-21.74	142.46	-22.64	0.00
91-92	JUN1	435.70	-7.22	428.48	185.81	0.00
91-92	JUN2	283.20	70.05	353.25	45.86	0.00
91-92	JUL1	397.30	18.21	415.51	85.80	0.00
91-92	JUL2	88.50	31.27	119.77	-173.69	-92.16
91-92	AUG1	52.40	-49.58	2.82	-202.94	-130.71
91-92	AUG2	33.60	-67.94	-34.34	-294.86	-220.65
91-92	SEP1	699.00	-85.99	613.01	400.37	0.00
91-92	SEP2	381.00	118.55	499.55	281.92	0.00
91-92	OCT1	63.10	60.25	123.35	-2.85	0.00
91-92	OCT2	34.00	-0.35	33.65	8.89	0.00
91-92	NOV1	0.00	0.97	0.97	-9.02	-1.79
91-92	NOV2	0.80	-0.91	-0.11	-0.93	0.00
91-92	DEC1	0.00	-0.10	-0.10	-2.29	-0.47
91-92	DEC2	0.00	-0.23	-0.23	-1.31	-0.33
91-92	JAN1	5.50	-0.14	5.36	-1.95	0.00
91-92	JAN2	0.00	-0.20	-0.20	-4.21	-1.06
91-92	FEB1	16.00	-0.44	15.56	10.44	0.00
91-92	FEB2	0.00	1.10	1.10	-5.02	-1.05
91-92	MAR1	0.00	-0.53	-0.53	-7.19	-1.61
91-92	MAR2	0.00	-0.82	-0.82	-16.77	-9.04
92-93	APR1	0.00	-16.77	-16.77	-37.29	-20.25
92-93	APR2	47.40	-6.29	41.11	-35.05	-9.30
92-93	May1	115.20	-7.34	107.86	-13.69	0.00
92-93	May2	142.50	-3.40	139.10	-26.01	0.00
92-93	JUN1	104.90	-8.29	96.61	-146.06	-88.58
92-93	JUN2	317.40	-55.07	262.33	-45.06	0.00
92-93	JUL1	715.70	-17.89	697.81	368.09	0.00
92-93	JUL2	371.50	134.15	505.65	212.19	0.00
92-93	AUG1	280.40	60.56	340.96	135.20	0.00
92-93	AUG2	177.70	45.26	222.96	-37.56	0.00
92-93	SEP1	185.20	-10.95	174.25	-38.40	0.00
92-93	SEP2	166.50	-11.37	155.13	-62.50	-8.44
92-93	OCT1	214.20	-13.36	200.84	74.64	0.00
92-93	OCT2	0.00	9.13	9.13	-15.63	-0.19
92-93	NOV1	0.00	-1.70	-1.70	-11.69	-4.46
92-93	NOV2	0.00	-1.18	-1.18	-2.00	-0.87
92-93	DEC1	15.40	-0.20	15.20	13.00	0.00
92-93	DEC2	0.00	1.31	1.31	0.24	0.00
92-93	JAN1	75.90	0.03	75.93	68.61	0.00
92-93	JAN2	0.00	7.11	7.11	3.10	0.00
92-93	FEB1	0.00	0.32	0.32	-4.80	-1.40
92-93	FEB2	7.00	-0.51	6.49	0.37	0.00
92-93	MAR1	0.00	0.04	0.04	-6.62	-1.04
92-93	MAR2	3.00	-0.76	2.24	-13.70	-5.98
93-94	APR1	2.00	-13.70	-11.70	-32.22	-15.19
93-94	APR2	86.50	-5.43	81.07	4.90	0.00
93-94	May1	158.10	1.03	159.13	37.59	0.00
93-94	May2	376.20	9.35	385.55	220.44	0.00

Drought Parameters for the Station Dinajpur (R168)

Year	Month	AR(i)	WV(i)	ER(i)	EXC /DEF	ED(i)
93-94	JUN1	134.00	70.25	204.25	-38.42	0.00
93-94	JUN2	531.00	-14.49	516.51	209.12	0.00
93-94	JUL1	254.30	83.04	337.34	7.63	0.00
93-94	JUL2	597.60	2.78	600.38	306.92	0.00
93-94	AUG1	335.90	87.60	423.50	217.74	0.00
93-94	AUG2	326.40	72.89	399.29	138.77	0.00
93-94	SEP1	144.40	40.47	184.87	-27.78	0.00
93-94	SEP2	280.30	-8.23	272.07	54.44	0.00
93-94	OCT1	185.60	11.64	197.24	71.04	0.00
93-94	OCT2	20.10	8.69	28.79	4.03	0.00
93-94	NOV1	21.10	0.44	21.54	11.55	0.00
93-94	NOV2	0.00	1.16	1.16	0.34	0.00
93-94	DEC1	0.00	0.03	0.03	-2.16	-0.34
93-94	DEC2	0.00	-0.22	-0.22	-1.29	-0.32
93-94	JAN1	0.00	-0.14	-0.14	-7.45	-2.27
93-94	JAN2	40.00	-0.77	39.23	35.22	0.00
93-94	FEB1	33.00	3.68	36.68	31.56	0.00
93-94	FEB2	0.00	3.33	3.33	-2.79	0.00
93-94	MAR1	0.00	-0.30	-0.30	-6.95	-1.37
93-94	MAR2	41.40	-0.80	40.60	24.66	0.00
94-95	APR1	222.00	24.66	246.66	226.14	0.00
94-95	APR2	15.10	38.13	53.23	-22.93	0.00
94-95	May1	215.10	-4.80	210.30	88.75	0.00
94-95	May2	599.10	22.08	621.18	456.07	0.00
94-95	JUN1	400.10	145.34	545.44	302.77	0.00
94-95	JUN2	298.30	114.14	412.44	105.05	0.00
94-95	JUL1	33.90	41.72	75.62	-254.10	-172.53
94-95	JUL2	21.90	-92.60	-70.70	-364.17	-282.63
94-95	AUG1	332.20	-103.94	228.26	22.50	0.00
94-95	AUG2	334.80	7.53	342.33	81.81	0.00
94-95	SEP1	70.00	23.86	93.86	-118.79	-62.02
94-95	SEP2	77.00	-35.17	41.83	-175.80	-121.74
94-95	OCT1	26.40	-37.57	-11.17	-137.37	-84.27
94-95	OCT2	0.00	-16.80	-16.80	-41.56	-26.13
94-95	NOV1	0.00	-4.53	-4.53	-14.52	-7.28
94-95	NOV2	0.00	-1.46	-1.46	-2.29	-1.16
94-95	DEC1	0.00	-0.23	-0.23	-2.43	-0.61
94-95	DEC2	0.00	-0.25	-0.25	-1.32	-0.34
94-95	JAN1	3.10	-0.14	2.96	-4.35	0.00
94-95	JAN2	0.00	-0.45	-0.45	-4.46	-1.30
94-95	FEB1	14.30	-0.47	13.83	8.71	0.00
94-95	FEB2	2.00	0.92	2.92	-3.20	0.00
94-95	MAR1	0.00	-0.34	-0.34	-7.00	-1.41
94-95	MAR2	12.00	-0.80	11.20	-4.75	0.00
95-96	APR1	0.00	-4.75	-4.75	-25.27	-8.23
95-96	APR2	5.10	-4.26	0.84	-75.33	-49.57
95-96	May1	5.10	-15.78	-10.68	-132.22	-98.36
95-96	May2	172.80	-32.89	139.91	-25.20	0.00
95-96	JUN1	282.60	-8.03	274.57	31.90	0.00
95-96	JUN2	222.70	12.02	234.72	-72.67	-2.20
95-96	JUL1	628.10	-28.86	599.24	269.53	0.00
95-96	JUL2	183.20	98.23	281.43	-12.03	0.00
95-96	AUG1	116.40	-3.43	112.97	-92.80	-20.57
95-96	AUG2	94.80	-31.06	63.74	-196.79	-122.58
95-96	SEP1	75.10	-57.39	17.71	-194.93	-138.16
95-96	SEP2	527.70	-57.72	469.98	252.35	0.00
95-96	OCT1	0.00	53.93	53.93	-72.27	-19.16
95-96	OCT2	3.10	-8.84	-5.74	-30.50	-15.06
95-96	NOV1	38.30	-3.32	34.98	24.99	0.00
95-96	NOV2	0.00	2.52	2.52	1.69	0.00
95-96	DEC1	0.00	0.17	0.17	-2.02	-0.21
95-96	DEC2	0.90	-0.20	0.70	-0.38	0.00
95-96	JAN1	0.00	-0.04	-0.04	-7.35	-2.17
95-96	JAN2	40.90	-0.76	40.14	36.13	0.00
95-96	FEB1	0.00	3.78	3.78	-1.34	0.00
95-96	FEB2	39.80	-0.14	39.66	33.54	0.00
95-96	MAR1	0.00	3.55	3.55	-3.10	0.00
95-96	MAR2	0.00	-0.35	-0.35	-16.30	-8.57

APPENDIX-B

Highest and Sum of the Highest Mean Fortnightly Rainfall in Decending Order

Station:R168(Dinajpur)

Highest mean fortnightly rainfall	= 329.71
Sum of 2 highest mean fortnightly rainfall	= 637.1
Sum of 3 highest mean fortnightly rainfall	= 930.56
Sum of 4 highest mean fortnightly rainfall	= 1191.08
Sum of 5 highest mean fortnightly rainfall	= 1433.75
Sum of 6 highest mean fortnightly rainfall	= 1651.38
Sum of 7 highest mean fortnightly rainfall	= 1864.03
Sum of 8 highest mean fortnightly rainfall	= 2069.79
Sum of 9 highest mean fortnightly rainfall	= 2234.90
Sum of 10 highest mean fortnightly rainfall	= 2361.10
Sum of 11 highest mean fortnightly rainfall	= 2482.62
Sum of 12 highest mean fortnightly rainfall	= 2558.80
Sum of 13 highest mean fortnightly rainfall	= 2583.56
Sum of 14 highest mean fortnightly rainfall	= 2604.08
Sum of 15 highest mean fortnightly rainfall	= 2620.03
Sum of 16 highest mean fortnightly rainfall	= 2630.02
Sum of 17 highest mean fortnightly rainfall	= 2637.33
Sum of 18 highest mean fortnightly rainfall	= 2643.99
Sum of 19 highest mean fortnightly rainfall	= 2650.11
Sum of 20 highest mean fortnightly rainfall	= 2655.23
Sum of 21 highest mean fortnightly rainfall	= 2659.24
Sum of 22 highest mean fortnightly rainfall	= 2661.44
Sum of 23 highest mean fortnightly rainfall	= 2662.52
Sum of 24 highest mean fortnightly rainfall	= 2663.35

Highest and Sum of the Highest mean fortnightly rainfall in decending order

Station: R177 (Kaliganj)

mean fortnightly rainfall = 303.07
Sum of 2 highest mean fortnightly rainfall = 583.51
Sum of 3 highest mean fortnightly rainfall = 833.55
Sum of 4 highest mean fortnightly rainfall = 1078.96
Sum of 5 highest mean fortnightly rainfall = 1304.52
Sum of 6 highest mean fortnightly rainfall = 1511.88
Sum of 7 highest mean fortnightly rainfall = 1716.83
Sum of 8 highest mean fortnightly rainfall = 1900.44
Sum of 9 highest mean fortnightly rainfall = 2061.25
Sum of 10 highest mean fortnightly rainfall = 2183.82
Sum of 11 highest mean fortnightly rainfall = 2291.69
Sum of 12 highest mean fortnightly rainfall = 2365.63
Sum of 13 highest mean fortnightly rainfall = 2392.4
Sum of 14 highest mean fortnightly rainfall = 2412.28
Sum of 15 highest mean fortnightly rainfall = 2431.67
Sum of 16 highest mean fortnightly rainfall = 2441.01
Sum of 17 highest mean fortnightly rainfall = 2450.89
Sum of 18 highest mean fortnightly rainfall = 2460.47
Sum of 19 highest mean fortnightly rainfall = 2468.70
Sum of 20 highest mean fortnightly rainfall = 2474.72
Sum of 21 highest mean fortnightly rainfall = 2479.78
Sum of 22 highest mean fortnightly rainfall = 2484.05
Sum of 23 highest mean fortnightly rainfall = 2487.74
Sum of 24 highest mean fortnightly rainfall = 2488.99

Highest and Sum of the Highest mean fortnightly rainfall in decending order

Station: R178 (Kaunia)

mean fortnightly rainfall	= 301.30
Sum of 2 highest mean fortnightly rainfall	= 563.93
Sum of 3 highest mean fortnightly rainfall	= 823.38
Sum of 4 highest mean fortnightly rainfall	= 1077.52
Sum of 5 highest mean fortnightly rainfall	= 1301.49
Sum of 6 highest mean fortnightly rainfall	= 1517.78
Sum of 7 highest mean fortnightly rainfall	= 1711.15
Sum of 8 highest mean fortnightly rainfall	= 1882.52
Sum of 9 highest mean fortnightly rainfall	= 2037.12
Sum of 10 highest mean fortnightly rainfall	= 2172.53
Sum of 11 highest mean fortnightly rainfall	= 2295.39
Sum of 12 highest mean fortnightly rainfall	= 2368.76
Sum of 13 highest mean fortnightly rainfall	= 2399.01
Sum of 14 highest mean fortnightly rainfall	= 2418.49
Sum of 15 highest mean fortnightly rainfall	= 2432.55
Sum of 16 highest mean fortnightly rainfall	= 2444.51
Sum of 17 highest mean fortnightly rainfall	= 2455.09
Sum of 18 highest mean fortnightly rainfall	= 2463.09
Sum of 19 highest mean fortnightly rainfall	= 2467.85
Sum of 20 highest mean fortnightly rainfall	= 2472.56
Sum of 21 highest mean fortnightly rainfall	= 2476.22
Sum of 22 highest mean fortnightly rainfall	= 2479.44
Sum of 23 highest mean fortnightly rainfall	= 2481.43
Sum of 24 highest mean fortnightly rainfall	= 2482.67

Highest and Sum of the Highest mean fortnightly rainfall in decending order

Station: R186 (Mithapukur)

mean fortnightly rainfall = 270.21
Sum of 2 highest mean fortnightly rainfall = 515.42
Sum of 3 highest mean fortnightly rainfall = 746.79
Sum of 4 highest mean fortnightly rainfall = 975.4
Sum of 5 highest mean fortnightly rainfall = 1179.72
Sum of 6 highest mean fortnightly rainfall = 1365.28
Sum of 7 highest mean fortnightly rainfall = 1537.14
Sum of 8 highest mean fortnightly rainfall = 1702.13
Sum of 9 highest mean fortnightly rainfall = 1837.72
Sum of 10 highest mean fortnightly rainfall = 1956.48
Sum of 11 highest mean fortnightly rainfall = 2044.20
Sum of 12 highest mean fortnightly rainfall = 2109.28
Sum of 13 highest mean fortnightly rainfall = 2136.87
Sum of 14 highest mean fortnightly rainfall = 2163.67
Sum of 15 highest mean fortnightly rainfall = 2178.12
Sum of 16 highest mean fortnightly rainfall = 2187.93
Sum of 17 highest mean fortnightly rainfall = 2193.82
Sum of 18 highest mean fortnightly rainfall = 2199.67
Sum of 19 highest mean fortnightly rainfall = 2205.05
Sum of 20 highest mean fortnightly rainfall = 2209.44
Sum of 21 highest mean fortnightly rainfall = 2212.78
Sum of 22 highest mean fortnightly rainfall = 2225.94
Sum of 23 highest mean fortnightly rainfall = 2218.65
Sum of 24 highest mean fortnightly rainfall = 2220.66

Highest and Sum of the Highest Mean Fortnightly Rainfall in Decending Order

Station: R188 (Mohipur)

mean fortnightly rainfall = 262.68
Sum of 2 highest mean fortnightly rainfall = 503.79
Sum of 3 highest mean fortnightly rainfall = 735.16
Sum of 4 highest mean fortnightly rainfall = 963.77
Sum of 5 highest mean fortnightly rainfall = 1168.09
Sum of 6 highest mean fortnightly rainfall = 1353.65
Sum of 7 highest mean fortnightly rainfall = 1525.51
Sum of 8 highest mean fortnightly rainfall = 1690.50
Sum of 9 highest mean fortnightly rainfall = 1826.09
Sum of 10 highest mean fortnightly rainfall = 1944.85
Sum of 11 highest mean fortnightly rainfall = 2032.57
Sum of 12 highest mean fortnightly rainfall = 2097.65
Sum of 13 highest mean fortnightly rainfall = 2125.24
Sum of 14 highest mean fortnightly rainfall = 2152.04
Sum of 15 highest mean fortnightly rainfall = 2166.49
Sum of 16 highest mean fortnightly rainfall = 2176.30
Sum of 17 highest mean fortnightly rainfall = 2182.19
Sum of 18 highest mean fortnightly rainfall = 2188.04
Sum of 19 highest mean fortnightly rainfall = 2193.42
Sum of 20 highest mean fortnightly rainfall = 2197.81
Sum of 21 highest mean fortnightly rainfall = 2201.15
Sum of 22 highest mean fortnightly rainfall = 22204.31
Sum of 23 highest mean fortnightly rainfall = 2207.02
Sum of 24 highest mean fortnightly rainfall = 2209.04

Highest and Sum of the Highest Mean Fortnightly Rainfall in Decending Order

Station: R206 (Rangpur)

mean fortnightly rainfall = 249.36
Sum of 2 highest mean fortnightly rainfall = 497.19
Sum of 3 highest mean fortnightly rainfall = 731.58
Sum of 4 highest mean fortnightly rainfall = 953.38
Sum of 5 highest mean fortnightly rainfall = 1154.70
Sum of 6 highest mean fortnightly rainfall = 1331.66
Sum of 7 highest mean fortnightly rainfall = 1504.28
Sum of 8 highest mean fortnightly rainfall = 1663.35
Sum of 9 highest mean fortnightly rainfall = 1816.63
Sum of 10 highest mean fortnightly rainfall = 1932.21
Sum of 11 highest mean fortnightly rainfall = 2040.47
Sum of 12 highest mean fortnightly rainfall = 2099.64
Sum of 13 highest mean fortnightly rainfall = 2127.17
Sum of 14 highest mean fortnightly rainfall = 2150.32
Sum of 15 highest mean fortnightly rainfall = 2169.81
Sum of 16 highest mean fortnightly rainfall = 2180.11
Sum of 17 highest mean fortnightly rainfall = 2190.29
Sum of 18 highest mean fortnightly rainfall = 2195.41
Sum of 19 highest mean fortnightly rainfall = 2100.58
Sum of 20 highest mean fortnightly rainfall = 2205.59
Sum of 21 highest mean fortnightly rainfall = 2209.65
Sum of 22 highest mean fortnightly rainfall = 2212.24
Sum of 23 highest mean fortnightly rainfall = 2214.58
Sum of 24 highest mean fortnightly rainfall = 2216.90

APPENDIX-C

Sliding Scale to Determine the Drought Onset

Station: R168 (Dinajpur)
Time series: 1962-1995
Fortnightly increment, x = (MAD-MMFR)/23
= (777.45-329.71)/23
= 19.47

1st	sliding scale	= MMFR	= 329.71
2nd	sliding scale	= MMFR+1x	= 349.18
3rd	sliding scale	= MMFR+2x	= 368.65
4th	sliding scale	= MMFR+3x	= 388.12
5th	sliding scale	= MMFR+4x	= 407.59
6th	sliding scale	= MMFR+5x	= 427.16
7th	sliding scale	= MMFR+6x	= 446.53
8th	sliding scale	= MMFR+7x	= 466.00
9th	sliding scale	= MMFR+8x	= 485.47
10th	sliding scale	= MMFR+9x	= 504.94
11th	sliding scale	= MMFR+10x	= 524.41
12th	sliding scale	= MMFR+11x	= 543.88
13th	sliding scale	= MMFR+12x	= 563.35
14th	sliding scale	= MMFR+13x	= 581.82
15th	sliding scale	= MMFR+14x	= 602.29
16th	sliding scale	= MMFR+15x	= 621.76
17th	sliding scale	= MMFR+16x	= 641.23
18th	sliding scale	= MMFR+17x	= 660.70
19th	sliding scale	= MMFR+18x	= 680.17
20th	sliding scale	= MMFR+19x	= 699.64
21st	sliding scale	= MMFR+20x	= 719.11
22nd	sliding scale	= MMFR+21x	= 738.58
23rd	sliding scale	= MMFR+22x	= 755.05
24th	sliding scale	= MMFR+23x	= 777.45

Sliding Scale to Determine the Drought Onset

Station: R177 (Kaliganj)
Time series: 1962-1995
Fortnightly increment, x = (MAD-MMFR)/23
= (781.26-303.07)/23
= 20.79

1st	sliding scale =	MMFR	= 303.07
2nd	sliding scale =	MMFR+1x	= 323.86
3rd	sliding scale =	MMFR+2x	= 344.65
4th	sliding scale =	MMFR+3x	= 365.44
5th	sliding scale =	MMFR+4x	= 386.23
6th	sliding scale =	MMFR+5x	= 407.02
7th	sliding scale =	MMFR+6x	= 427.81
8th	sliding scale =	MMFR+7x	= 448.60
9th	sliding scale =	MMFR+8x	= 469.39
10th	sliding scale =	MMFR+9x	= 490.18
11th	sliding scale =	MMFR+10x	= 510.97
12th	sliding scale =	MMFR+11x	= 531.76
13th	sliding scale =	MMFR+12x	= 552.55
14th	sliding scale =	MMFR+13x	= 573.34
15th	sliding scale =	MMFR+14x	= 594.13
16th	sliding scale =	MMFR+15x	= 614.92
17th	sliding scale =	MMFR+16x	= 635.71
18th	sliding scale =	MMFR+17x	= 656.50
19th	sliding scale =	MMFR+18x	= 677.29
20th	sliding scale =	MMFR+19x	= 698.08
21st	sliding scale =	MMFR+20x	= 718.87
22nd	sliding scale =	MMFR+21x	= 739.66
23rd	sliding scale =	MMFR+22x	= 760.45
24th	sliding scale =	MMFR+23x	= 781.25

Sliding Scale to Determine the Drought Onset

Station: R178 (Kaunia)
Time series: 1962-1995
Fortnightly increment, x = (MAD-MMFR)/23
= (783.3-301.3)/23
= 20.956

1st	sliding scale	= MMFR	= 301.3
2nd	sliding scale	= MMFR+1x	= 322.26
3rd	sliding scale	= MMFR+2x	= 343.21
4th	sliding scale	= MMFR+3x	= 364.17
5th	sliding scale	= MMFR+4x	= 385.12
6th	sliding scale	= MMFR+5x	= 406.08
7th	sliding scale	= MMFR+6x	= 427.03
8th	sliding scale	= MMFR+7x	= 447.99
9th	sliding scale	= MMFR+8x	= 468.95
10th	sliding scale	= MMFR+9x	= 489.90
11th	sliding scale	= MMFR+10x	= 510.86
12th	sliding scale	= MMFR+11x	= 531.82
13th	sliding scale	= MMFR+12x	= 552.77
14th	sliding scale	= MMFR+13x	= 573.73
15th	sliding scale	= MMFR+14x	= 594.68
16th	sliding scale	= MMFR+15x	= 615.64
17th	sliding scale	= MMFR+16x	= 636.60
18th	sliding scale	= MMFR+17x	= 657.55
19th	sliding scale	= MMFR+18x	= 678.51
20th	sliding scale	= MMFR+19x	= 699.46
21st	sliding scale	= MMFR+20x	= 720.42
22nd	sliding scale	= MMFR+21x	= 741.37
23rd	sliding scale	= MMFR+22x	= 762.33
24th	sliding scale	= MMFR+23x	= 783.29

Sliding Scale to Determine the Drought Onset

Station: R186 (Mithapukur)
Time series: 1962-1995
Fortnightly increment, x = (MAD-MMFR)/23
= (762.99-270.21)/23
= 21.425

1st	sliding scale	= MMFR	=	270.21
2nd	sliding scale	= MMFR+1x	=	291.63
3rd	sliding scale	= MMFR+2x	=	313.06
4th	sliding scale	= MMFR+3x	=	334.49
5th	sliding scale	= MMFR+4x	=	355.91
6th	sliding scale	= MMFR+5x	=	377.33
7th	sliding scale	= MMFR+6x	=	398.76
8th	sliding scale	= MMFR+7x	=	420.18
9th	sliding scale	= MMFR+8x	=	441.61
10th	sliding scale	= MMFR+9x	=	463.03
11th	sliding scale	= MMFR+10x	=	484.46
12th	sliding scale	= MMFR+11x	=	505.88
13th	sliding scale	= MMFR+12x	=	527.31
14th	sliding scale	= MMFR+13x	=	548.73
15th	sliding scale	= MMFR+14x	=	570.16
16th	sliding scale	= MMFR+15x	=	591.58
17th	sliding scale	= MMFR+16x	=	613.00
18th	sliding scale	= MMFR+17x	=	634.43
19th	sliding scale	= MMFR+18x	=	655.86
20th	sliding scale	= MMFR+19x	=	677.28
21st	sliding scale	= MMFR+20x	=	698.71
22nd	sliding scale	= MMFR+21x	=	720.13
23rd	sliding scale	= MMFR+22x	=	741.56
24th	sliding scale	= MMFR+23x	=	762.99

Sliding Scale to Determine the Drought Onset

Station: R188 (Mohipur)
Time series: 1962-1995
Fortnightly increment, x = (MAD-MMFR)/23
= (742.66-284.02)/23
= 19.94

1st	sliding scale =	MMFR	= 284.02
2nd	sliding scale =	MMFR+1x	= 303.96
3rd	sliding scale =	MMFR+2x	= 323.90
4th	sliding scale =	MMFR+3x	= 343.84
5th	sliding scale =	MMFR+4x	= 363.78
6th	sliding scale =	MMFR+5x	= 383.72
7th	sliding scale =	MMFR+6x	= 403.66
8th	sliding scale =	MMFR+7x	= 423.60
9th	sliding scale =	MMFR+8x	= 443.54
10th	sliding scale =	MMFR+9x	= 463.48
11th	sliding scale =	MMFR+10x	= 483.42
12th	sliding scale =	MMFR+11x	= 503.36
13th	sliding scale =	MMFR+12x	= 523.30
14th	sliding scale =	MMFR+13x	= 543.24
15th	sliding scale =	MMFR+14x	= 563.18
16th	sliding scale =	MMFR+15x	= 583.12
17th	sliding scale =	MMFR+16x	= 603.06
18th	sliding scale =	MMFR+17x	= 623.00
19th	sliding scale =	MMFR+18x	= 642.94
20th	sliding scale =	MMFR+19x	= 662.88
21st	sliding scale =	MMFR+20x	= 682.82
22nd	sliding scale =	MMFR+21x	= 702.76
23rd	sliding scale =	MMFR+22x	= 722.70
24th	sliding scale =	MMFR+23x	= 742.64

Sliding Scale to Determine Onset of Drought

Station: R206 (Rangpur)
Time series: 1962-1995
Fortnightly increment, x = (MAD-MMFR)/23
= (663.29-249.36)/23
= 18.0

1st	sliding scale =	MMFR	= 249.36
2nd	sliding scale =	MMFR+1x	= 267.36
3rd	sliding scale =	MMFR+2x	= 285.36
4th	sliding scale =	MMFR+3x	= 303.36
5th	sliding scale =	MMFR+4x	= 321.36
6th	sliding scale =	MMFR+5x	= 339.36
7th	sliding scale =	MMFR+6x	= 357.36
8th	sliding scale =	MMFR+7x	= 375.36
9th	sliding scale =	MMFR+8x	= 393.36
10th	sliding scale =	MMFR+9x	= 411.36
11th	sliding scale =	MMFR+10x	= 429.36
12th	sliding scale =	MMFR+11x	= 447.36
13th	sliding scale =	MMFR+12x	= 465.36
14th	sliding scale =	MMFR+13x	= 483.36
15th	sliding scale =	MMFR+14x	= 501.36
16th	sliding scale =	MMFR+15x	= 519.36
17th	sliding scale =	MMFR+16x	= 537.36
18th	sliding scale =	MMFR+17x	= 555.36
19th	sliding scale =	MMFR+18x	= 573.36
20th	sliding scale =	MMFR+19x	= 591.36
21st	sliding scale =	MMFR+20x	= 609.36
22nd	sliding scale =	MMFR+21x	= 627.36
23rd	sliding scale =	MMFR+22x	= 645.36
24th	sliding scale =	MMFR+23x	= 663.36