DROUGHT ASSESSMENT IN BANGLADESH

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ABSTRACT: Drought is perhaps one of the most widely investigated climatic events in climate-society interactions, because it directly affects societies through changes in the abundance and availability of food and fiber, water resources and energy supply. Dryness or Drought (in case of extreme dryness) has become an important national issue in Bangladesh in recent years. The drought assessment study involved the identification of areas, experiencing no dryness condition to drought condition, throughout the country. Analysis on rainfall and temperature data from the year of 1996 to 2000, provided the basis of developing drought maps and this incorporated significant uses of Geographic Information System (GIS). Analyzing the changing pattern of dryness condition between two years (1996 and 1999), nature of the slope of dryness has been identified for different regions of the country. Drought assessment will assist in decision making as well as policy planning especially for the agriculture sector of the country.

KEY WORDS: Drought; Drought Maps; Slope of Dryness; Threshold Value; Persistent Dryness

1. INTRODUCTION

A drought, can be called as a weather hazard, is often underestimated for two reasons. (i) Droughts have a slow rate of onset and, (ii) They have less visual impact on us. However, the long term outcome of a drought can be widespread and very devastating. However, drought may have different impacts on different regions. Droughts in industrialized countries are not life-threatening situations. But it can often mean the difference between life and death in many countries, such as in Bangladesh.

Drought disasters in Bangladesh have been occurring with increasing frequency in recent years. The principal land use pattern in Bangladesh is agriculture and the primary crop is rice, which requires a lot of water for growth. Therefore drought hazard studying in this region is important for migration and agriculture planning.

Assessment of drought is one of the important items for the mitigation of its effects. But this assessment is quite difficult in this country, as most of the information regarding the climatological parameters, such as rainfall, temperature, humidity, soil moisture etc are not updated regularly. However, based on the available data on rainfall and temperature, dryness conditions have been identified and defined for four seasons, named pre-monsoon, monsoon, post-monsoon and winter.

2. OBJECTIVE

The objective of this study was to identify the criteria for classifying dryness conditions; the changing pattern in dryness over the years; and the areas exposed to increasing, decreasing and persistent dryness conditions over the country.

3. STUDY AREA

The study area is 68007 km^2, which covers 22 districts among 64 districts of Bangladesh. Its position is between latitude 20° 34′ - 26° 38′ N, longitude 88° 01′ - 92° 41′ E. For the convenience of analysis the terrain of the country has been divided into five regions named, central, north-western, north-eastern, south-western and south-eastern regions. Among 34 BMD (Bangladesh Meteorological Department) stations for measuring rainfall and temperature, 22 stations have been selected for convenience of the study. The selected stations are Dhaka, Mynmensigh, Comilla, Tangail, Chandpur from central region; Dinajpur, Rangpur, Rajshahi, Bogra, Chuadanga from north-western region; Sylhet, Rangamati from north-eastern region; Barisal, Bhola, Khulna, Faridpur, Madaripur, Satkhira, Patuakhali, Jessore from south-western region and Feni, Cox's Bazar, Chittagong from south-eastern region of the country (Figure 1).

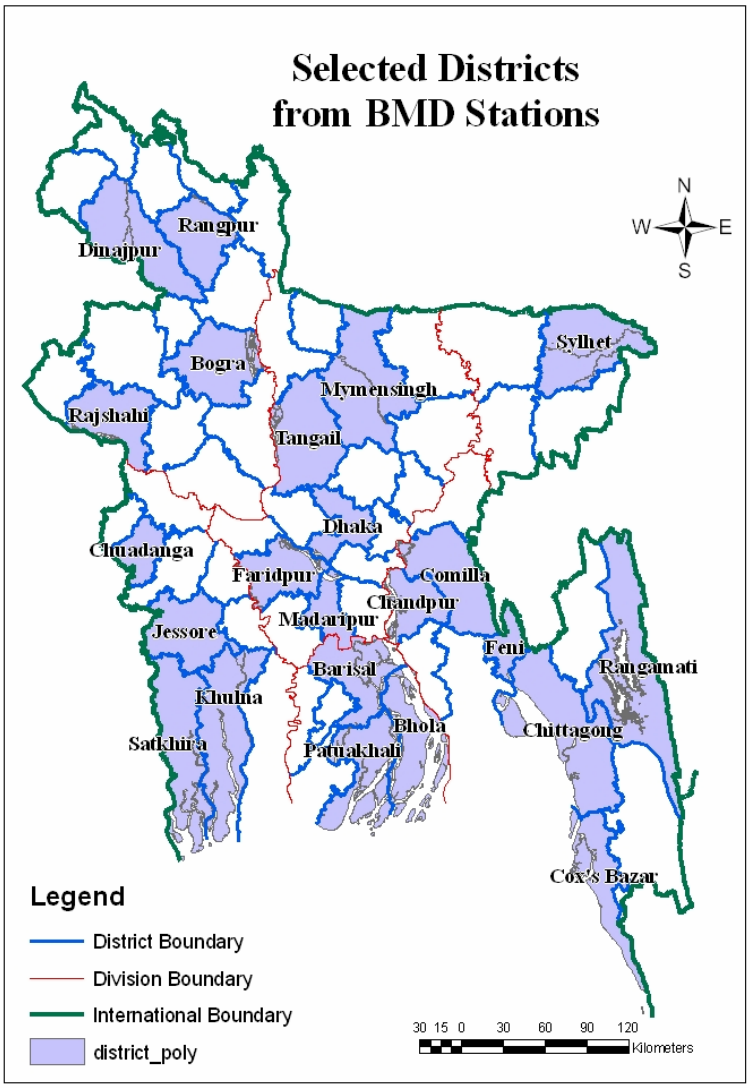


Figure 1: Profile of Study Area

4. METHODOLOGY

4.1 Categorizing Available Data

Each year rainfall and temperature data has been categorized into four different seasons as follows:

- Pre-monsoon (March – May)
- Monsoon (June – September)
- Post-monsoon (October – November)
- Winter (December – February)

4.2 Calculation for Threshold Values and defining dryness conditions

Threshold value, considering rainfall or temperature may be considered as a reference value, deviation from which will indicate the extent of dryness and drought in extreme conditions. The values vary depending on seasons and locations.

Let, the threshold rainfall value in the pre-monsoon season for a particular district is to be calculated. Now the calculations are explained with an example in Table 1.

Table 1: Calculation of Threshold Value for a particular location

Year	Pre-monsoon Rainfall (mm)	Deviation from Average	Negative Deviation
1996	210	210 -155 = 55	
1997	110	110 -155 = -45	-45
1998	130	130 -155 = -25	-25
1999	105	105 -155 = -50	-50
2000	220	220 -155 = 65	
	Average = 155		**Sum = -40**

Threshold rainfall = ∑(Seasonal average + Average of negative deviations)

= 155 – 40

= 115 mm

From Table 1, minimum seasonal rainfall is 105 mm (in 1999). Now the difference between 115 and 105 is divided by 2, to get the limiting values of 105, 110 and 115. Then the results were interpreted as follows:

- Seasonal rainfall > 115 mm, indicates no dryness
- 110 mm < Seasonal Rainfall <115 mm, indicates semi-arid condition
- 105 mm < Seasonal Rainfall <110 mm, indicates arid condition
- Seasonal Rainfall < 105 mm, indicates drought condition

Similar procedures have been adopted in calculating threshold temperature values except considering the average of positive deviations along with the seasonal average temperature. To define the ranges of temperature for different dryness conditions, maximum seasonal temperatures have been used.

To represent the dryness of a region, the terms - Semi-arid, Arid and Drought should be highlighted. In fact, drought demonstrates the extreme condition of dryness and thus requires much attention.

Semi-arid areas are defined as areas falling within the rainfall zones of 300-600 mm (FAO, 1987). Because of the short growing periods (75-119 growing days), these areas are not suitable for cultivation. Rainfall patterns are unpredictable and are subject to great fluctuations in these areas. On the other hand, arid areas are defined as areas falling within the rainfall zones of 0-300 mm (FAO, 1987). Because of the short growing periods (1-74 growing days), these areas are also not suitable for cultivation. Here also the rainfall patterns are unpredictable and are subject to great fluctuations. In this study, semi-arid and arid areas have been defined depending on the deviation of rainfall or temperature from the threshold values.

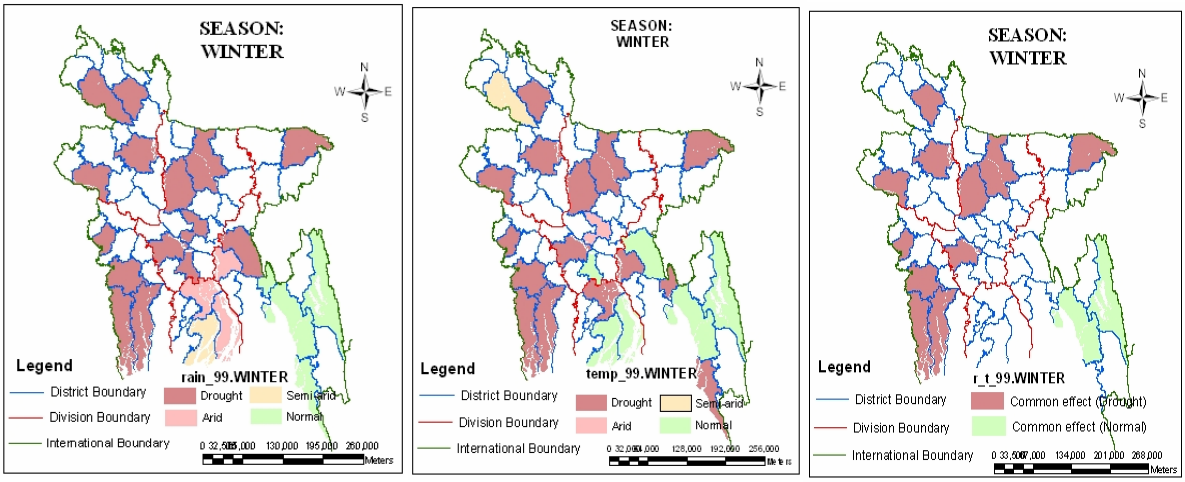
Generally people perceive drought as the shortage of desired rainfall especially in the cropping period. But there are several definitions of drought from different perspectives. According to United Nations (1994), drought means the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems.

Identifying a distinction among different types of droughts and their impacts can be very important for developing drought-coping mechanisms. Generally three types of droughts are identified, (i) Meteorological Drought; (ii) Agricultural Drought; and (iii) Hydrological Drought. The consideration of this study was the meteorological drought, which is caused by (i) reduction in rainfall of a specified (or desired) amount such as some percentage reduction of a long term average, and (ii) increase in temperature of a specified (or desired) amount such as some percentage increase of a long term average (Glantz and Degefu, 1990).

5. ANALYSIS AND RESULT

5.1 Evaluation of dryness considering rainfall and temperature

For the available data from 1996 to 2000, separate drought maps have been developed for four seasons considering rainfall and temperature, using GIS. Then these maps have been superimposed to find maps showing dry areas from the consideration of both rainfall and temperature. The drought maps for winter 1999, have been demonstrated in Figure 2 as an instance.



(a) **(b)** **(c)**

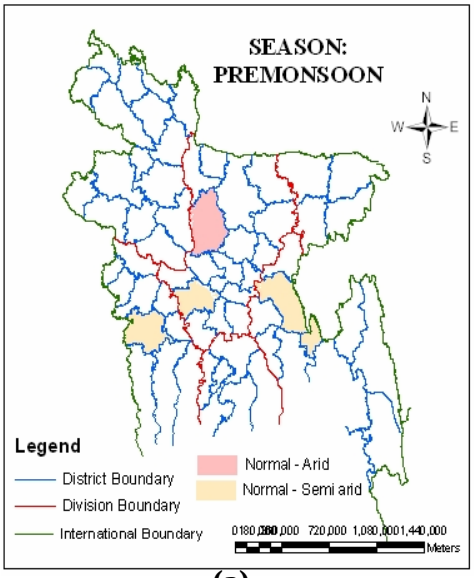
Figure 2: **(a)** Drought map considering rainfall in winter 1999
(b) Drought map considering temperature in winter 1999
(c) Drought map considering both rainfall and temperature in winter 1999

From the observation of Figure 2, it is evident that both rainfall and temperature data for winter 1999 indicate the same dryness condition in most of the districts except Dhaka, Dinajpur, Comilla, Chandpur, Madaripur, Barisal, Patuakhali, Bhola and Cox's Bazar. Therefore, a particular area may seem to be dry considering one parameter, while it may not be dry according to other parameter. The areas, where both parameters suggested dryness or drought condition would suffer the worst from the most adverse impacts.

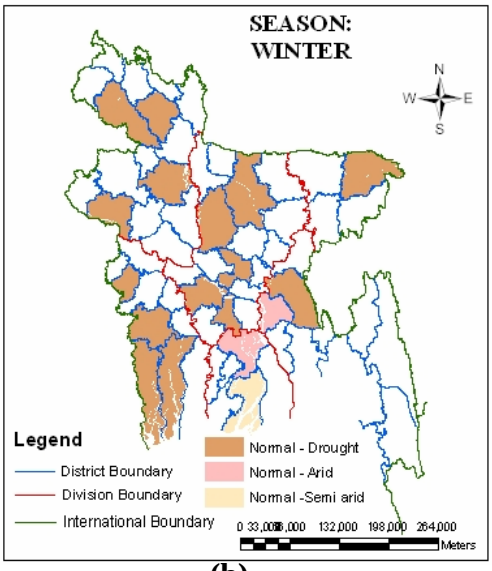
5.2 Evaluation of Slope of Dryness

In this study, 'Slope of Dryness' has been defined as the change in dryness pattern for a particular area with time, in other word change in dryness rate for a definite area. A positive slope indicates the increase of dryness, a negative slope indicates the decrease of dryness and a zero slope means no change in dryness condition. Therefore, it can be inferred from these definitions that negative slope of dryness is desirable from the perspective of agriculture of the country, whereas a positive slope indicates potential threat to it.

Comparing the drought maps for 1996 rainfall and 1999 rainfall, several types of maps of maps has been developed, which include maps showing overall change of dryness pattern throughout the study area, areas exposed to increasing dryness condition, areas exposed to decreasing dryness condition, areas with no change in dryness condition and areas exposed to drought. Comparing drought maps for 1996 temperature and 1999 temperature, similar types of maps have been developed. These maps aids in clear visualization of areas threatened to increasing dryness and drought in extreme cases. Figures 3 and 4, shown here, are representatives of these maps.

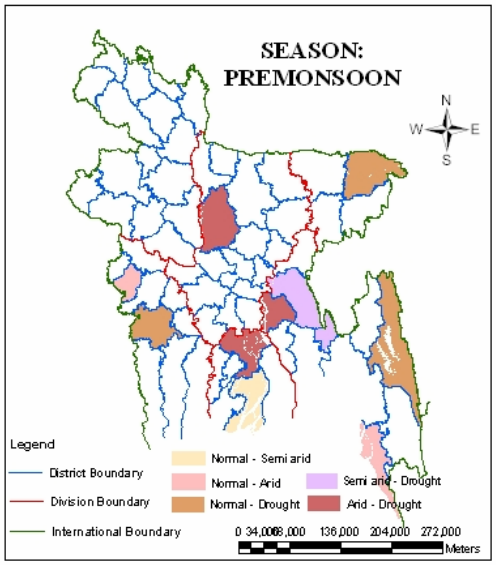


(a)

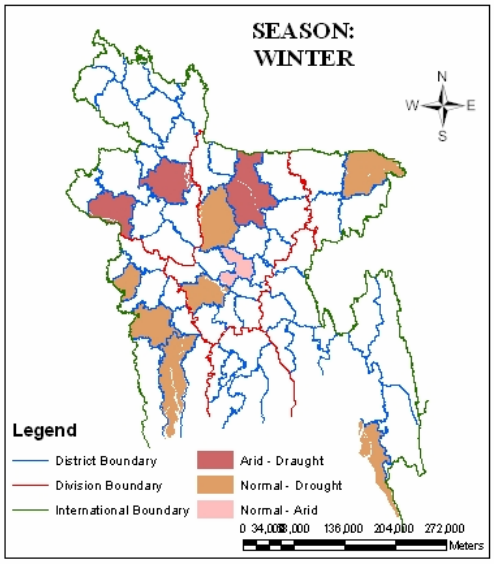


(b)

Figure 3:
(a) Areas exposed to increased dryness (for pre-monsoon rainfall, 1996 and 1999)
(b) Areas exposed to increased dryness (for winter rainfall, 1996 and 1999)



(a)



(b)

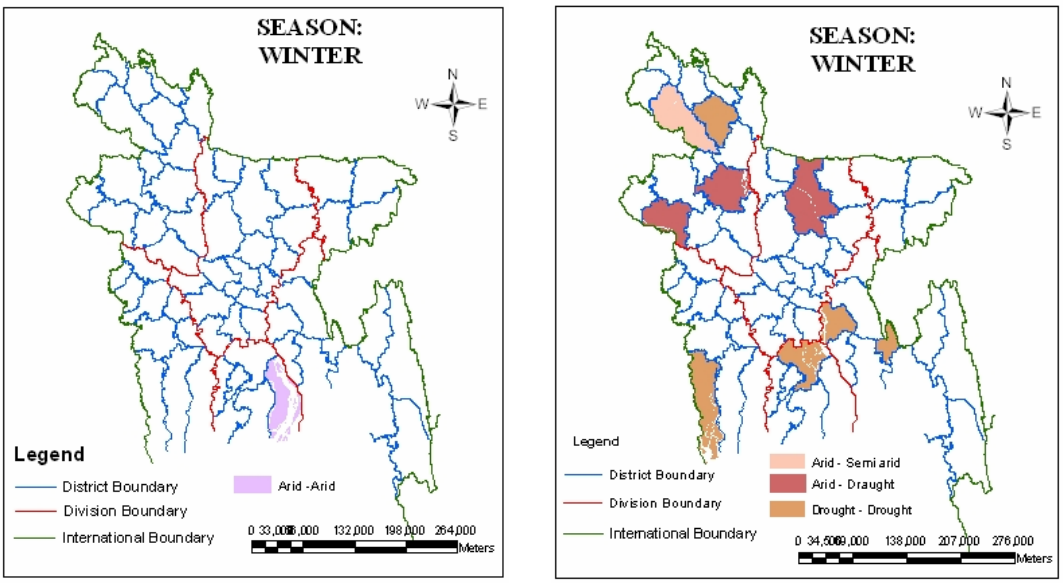
Figure 4: (a) Areas exposed to increased dryness
(for pre-monsoon temperature, 1996 and 1999)
(b) Areas exposed to increased dryness
(for winter temperature, 1996 and 1999)

From Figures 3(a) and 3(b), it is observed that areas exposed to increasing dryness in winter is more than that in pre-monsoon from the consideration of rainfall of 1996 and

1999. On the other hand, considering temperature of 1996 and 1999, rate of dryness increasing is more in pre-monsoon season.

5.3 Identification of areas with Persistent Dryness

For both of the parameters, rainfall and temperature, comparing the data of 1996 and 1999, the areas, which suffered from dryness in both of the years, have been identified. These areas have been named as areas with persistent dryness.



(a) **(b)**

Figure 5: (a) Areas exposed to persistent dryness
(for winter rainfall, 1996 and 1999)
(b) Areas exposed to persistent dryness
(for winter temperature, 1996 and 1999)

From Figure 5(a), it is found that if rainfall is considered then persistent dryness occurred in Bhola, where the dryness condition continued to be arid both in 1996 and 1999. Figure 5(b) reveals that nine districts experienced persistent dryness condition, where all of them exposed from lower dryness to extreme dryness, i.e. drought.Again, it should be noted that most of these areas lie in the north-western region of the country.

6. CONCLUSION

Consideration of two parameters rainfall and temperature may yield different dryness condition for a same area in the same reason. The study reveals that distribution of dry areas was erratic. More dry conditions occurred during pre-monsoon and winter. During the monsoon generally dryness was reduced in most of the areas. Therefore, slope of dryness is positive during pre-monsoon and winter, whereas it is negative during monsoon. There are some areas, which experience persistent dryness during winter and pre-monsoon.

This study involved the analysis of rainfall and temperature data for drought assessment. In fact, many other parameters, such as soil moisture, humidity, sunshine

hour etc are also related to the assessment of dryness condition of a region. Therefore, the study provided a limited insight to the drought assessment for Bangladesh.

7. RECOMENDATION FOR FURTHER STUDY

A more comprehensive study can be performed considering more climatological parameters to assess the different dryness condition better. The pattern of rainy days and no rainy days for different regions of the country can be addressed and the availability of rain water for agricultural purpose can be estimated. The trend of seasonal rainfall intensity over the area, within which the rain fell, which shows spatial variation of rainfall, can be identified. Then these analyses can provide a basis for comparison with IPCC analysis.

8. ADAPATATION MEASURES

- Adaptation should be embedded in integrated water management approaches, which allow for a consideration of all environmental, economic and social aspects.

- Action is required at all levels –policy, implementation and operational.

- Water management and the implementation of water policy needs to be capable to respond to unexpected developments caused by climate change.

- Strategies for adaptation need to be developed and implemented in a flexible way, in order to take into account further progress of scientific knowledge.

- The regions or areas, showing decreasing trend in monsoon rainfall, should get proper and careful consideration from agricultural point of view.

- Rainwater harvesting can be adopted to manage the excess rainfall during a season and supply water during the period of shortage.

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