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Analysis of Meteorological Drought and Its Trend in Bankura District of West Bengal, India

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Abstract—*Western tract of West Bengal generally includes five districts namely Bankura, Purulia, Birbhum, Paschim Bardhaman and Paschim Medinipure excluding Ghatal sub-division. Bankura district of the western part of West Bengal receives more or less 1400 mm rainfall annually but this is known as the drought prone area of the state. According to the criteria followed by the India Meteorological Department, this region cannot be termed as drought prone. But the dryness of the region is the hard reality which is mainly due to its undulating topography which promotes speedy surface run off. After a short span of heavy shower water moves as surface run off making the top soil dry very soon. Applying the criteria of India Meteorological Department, an attempt has been made to identify the recent trend and frequency of occurrences of meteorological drought in Bankura district of West Bengal from June to September (1960-2009). The present study has also been initiated to identify the rainfall trend and its anomaly during monsoon and its relation with the trend of meteorological drought from 1960-2009.*

Keywords*: Undulating topography, rainfall anomaly, surface run off, meteorological drought.*

1. INTRODUCTION

The south western part of west Bengal is generally identified as the most backward and under developed region of the state which is mainly due to its adverse climatic condition which generally satisfies the following points: 1) Very low rainfall 2) drought proneness 3) extremity of weather and climate and 4) unfavourable climate for agriculture. Average annual rainfall of this region is 1446.4 mm which varies from 1218.8 mm at Burrabazar in Purulia to 1704.0 mm at Pingla in Paschim Medinipure [6].

After 69 years of independence Bankura district is characterized by poor socio economic condition and less cropping intensity[6]. This district receives considerable amount of rainfall (more or less 1400 mm) which is sometimes higher compared to the Gangetic alluvial and coastal saline zone of West Bengal.

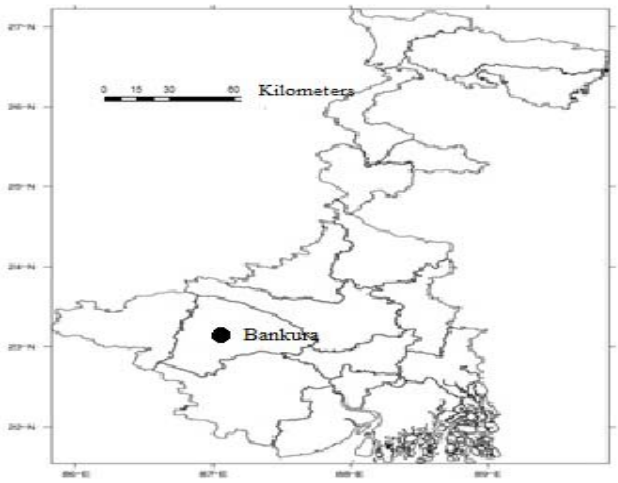

Figure 1: Location map of the study area

Numerous literatures are there to identify the nature and characteristics of different types of drought. Shamsuddin Shahid and Houshang Behrawan (2008) [3] assessed the drought risk in the western part of Bangladesh. Kar and Saha (2012) [7] also analysed the meteorological drought of West Bengal using standardized Precipitation Index (SPI).

2. OBJECTIVES

The study has been initiated to fulfill the following objectives:

1. To identify the frequency of meteorological drought from 1960 to 2009 during monsoon.
2. To find out the decadal trend of meteorological drought from 1960-2009.
3. To analyze the trend of monsoon rainfall and its anomaly in Bankura.
4. To mitigate water scarcity by scientific use of natural resources.

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3. MATERIALS AND METHODS

Adopting the criteria laid down by the India Meteorological Department (percent by normal), an attempt has been made to identify the meteorological drought characteristics of Bankura district in West Bengal. The study is based on both secondary as well as primary sources of data. Relevant data have been collected through field survey and published literature. The preliminary knowledge about the study area has been collected from district gazetteers. Relevant data regarding the study area has been collected from published literatures in the form of books and journals. For the purpose of identifying the trend of meteorological drought, 100 years (1910-2009) data of rainfall have been collected from Agricultural Meteorology Division of the State Agriculture Department, Government of West Bengal and India Meteorological Department, Alipur.

A number of statistical techniques viz. moving average and semi average methods have been applied to identify the trend of rainfall during June, July, August and September (monsoon months).Moving average techniques have been used to investigate how the trend of drought has sequentially changed over the time period of 100 years (1910-2009).

4. CONCEPT OF DROUGHT AND ITS CRITERIA

Drought is the combined effect of meteorological (reduced rainfall) and hydrological (reduced available water supply) factors that results into agricultural drought (reduced crop yield) [8]. Based on its nature, droughts may be classified into four different categories, viz., meteorological, hydrological, agricultural and socio-economic [5].

Various disciplines have defined drought in their own ways according to the fields of their concern.

Meteorological Drought

A meteorologist defines a meteorological drought as a situation when there is a significant (more than 25%) decrease from normal precipitation.

Criteria for Identification of Drought

India Meteorological Department

India Meteorological Department considers the occurrence of drought if the rainfall during a year or a southwest monsoon season (June-September) over the area is less than 25 percent of the normal.

Percent by Normal

The percent of normal precipitation is one of the simplest measurements of rainfall for a location. Analyses using the percent of normal are very effective when used for a single region or a single season [8]. In India IMD declares drought based on percent below normal rainfall.

$$\text{Percent by normal} = \frac{(\text{Actual-Normal})}{\text{Normal}} \times 100$$

Table 1: Drought categories

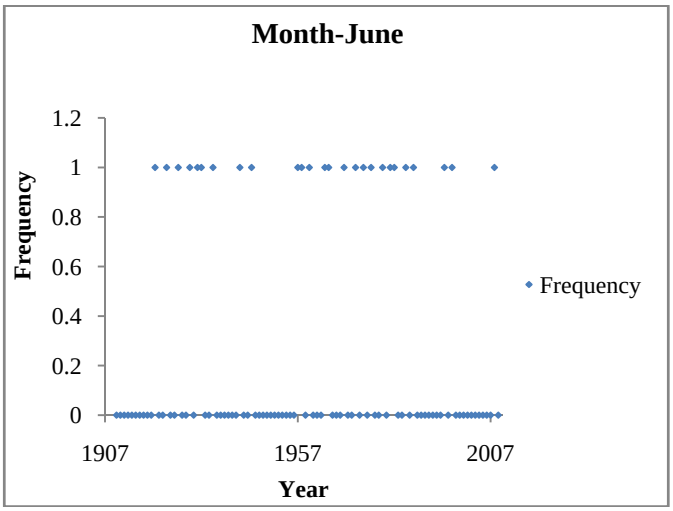
Percent normal	
+/-19%	Normal
-20 to -59%	Moderate drought
>-60%	Severe drought

(Source: Samra, 2004) [8]

According to IMD's criteria, a negative deviation up to 19% will be considered as normal situation. Rainfall deviation from -19% to -59 and more than -60%is considered as moderate drought and severe drought respectively.

5. FREQUENCY OF METEOROLOGICAL DROUGHT IN BANKURA (1910-2009)

An attempt has been made to identify the frequency of meteorological drought during June, July, August and September which are basically the monsoon months. In the month of June the district experiences drought in 26 years in the last 100 years. The situation improves in the month of July where the district faces 21 years of meteorological drought from 1910-2009. Second half of monsoon maintains a steady condition in terms of occurrence of meteorological drought. The frequency of meteorological drought is 20 and 24 for the months of August and September respectively.



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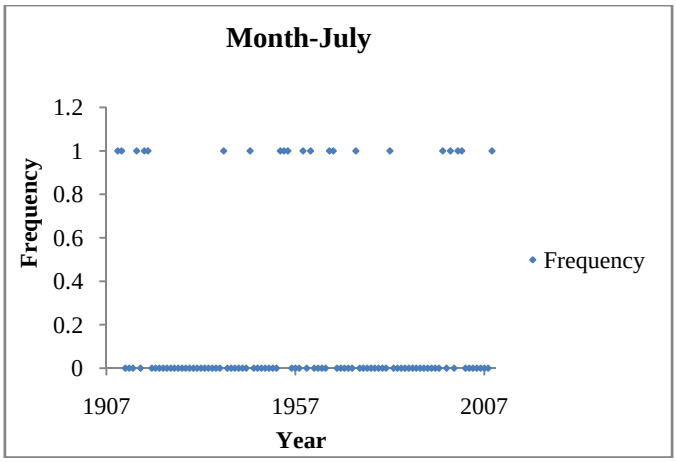
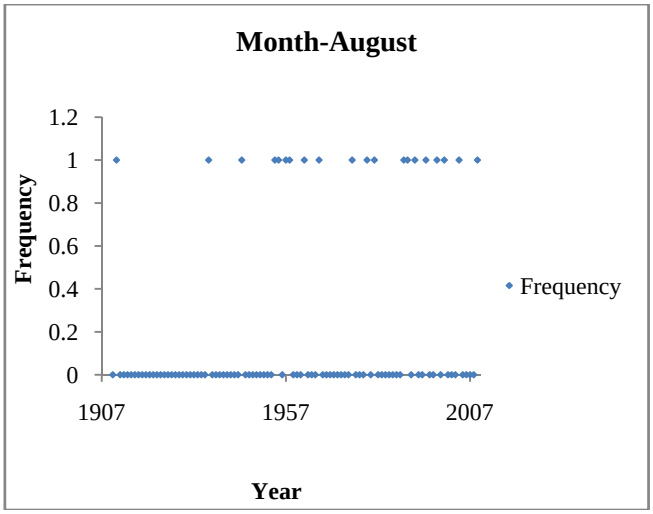




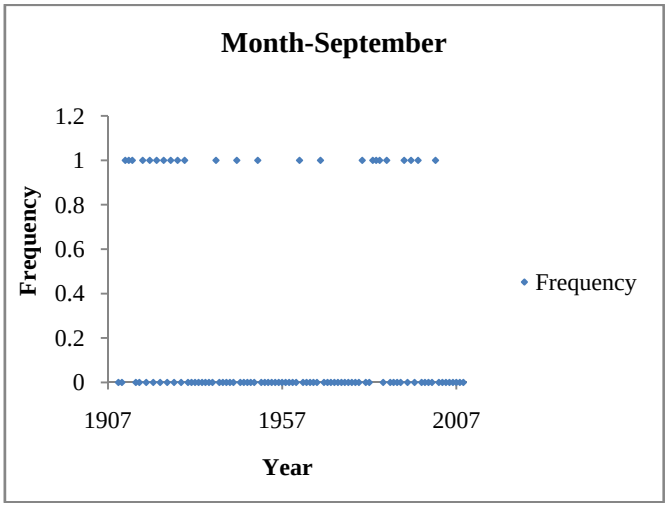
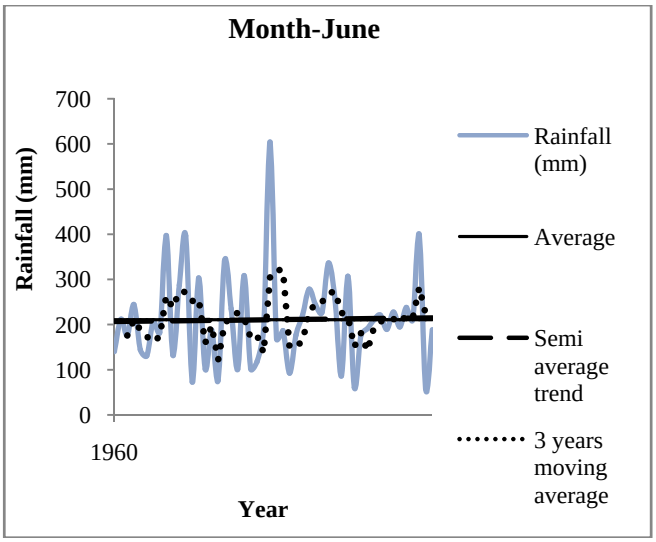
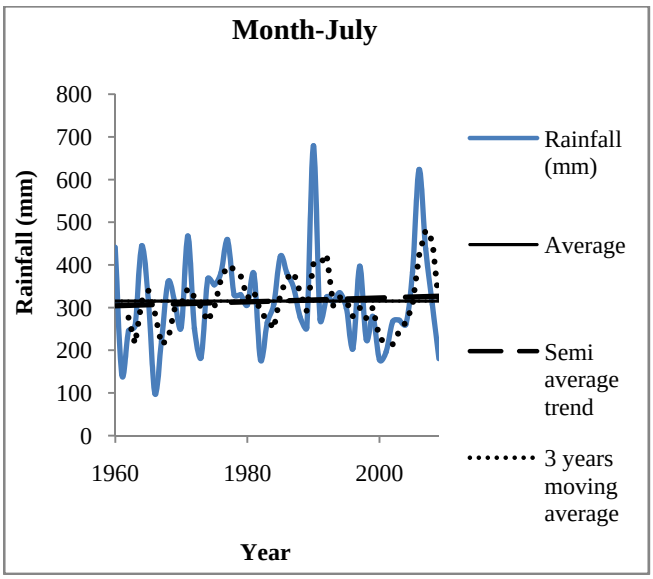
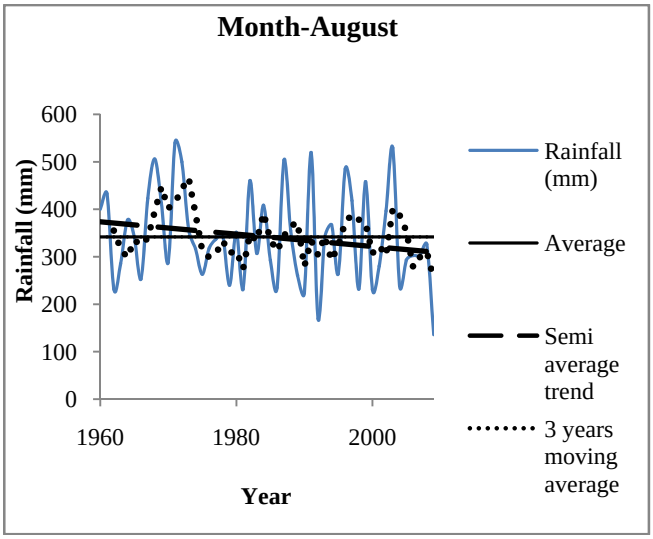


Figure 2. Frequency of meteorological drought in Bankura during monsoon.







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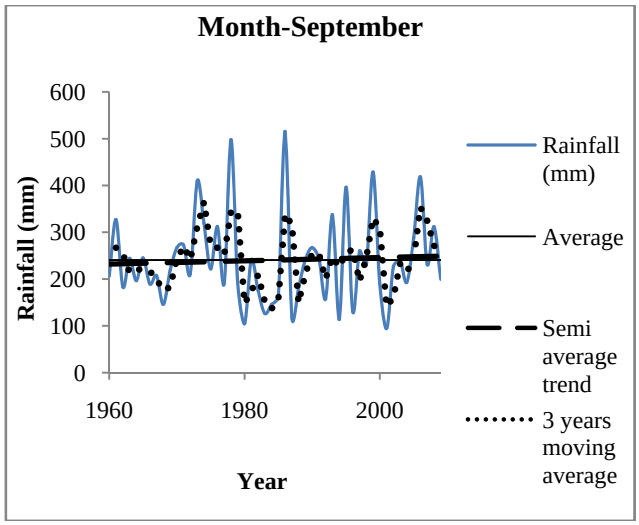
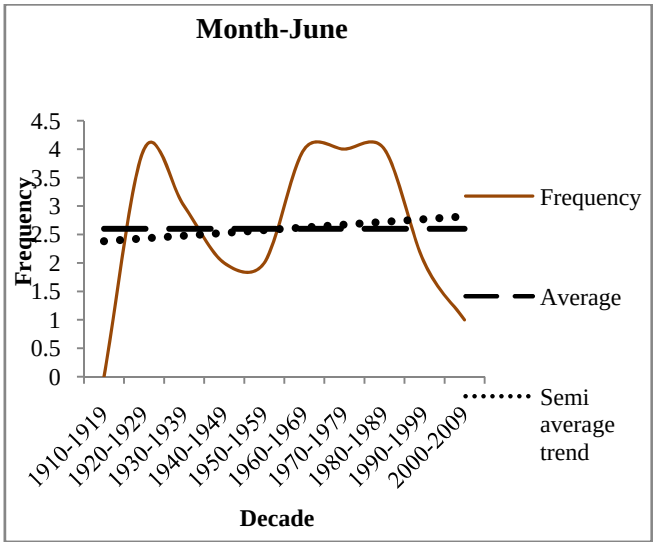
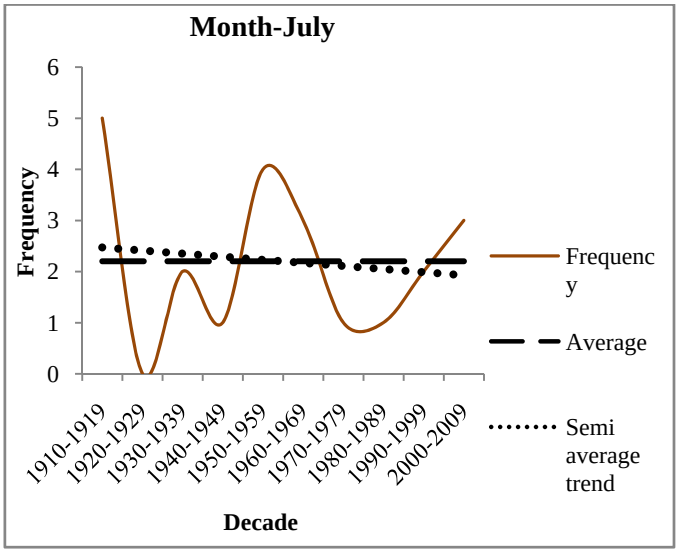
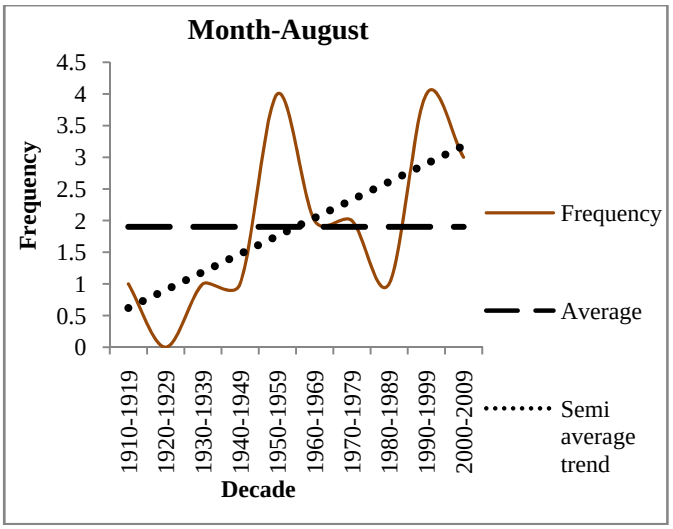


Figure 3. Rainfall trend of Bankura from 1960-2009







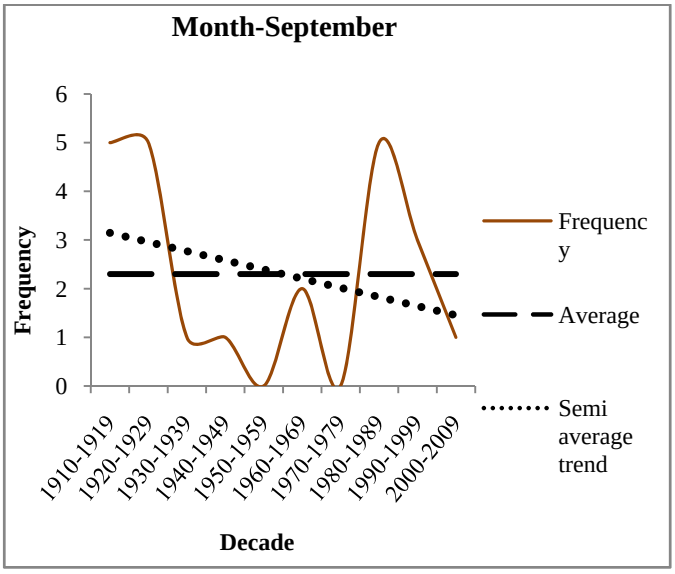
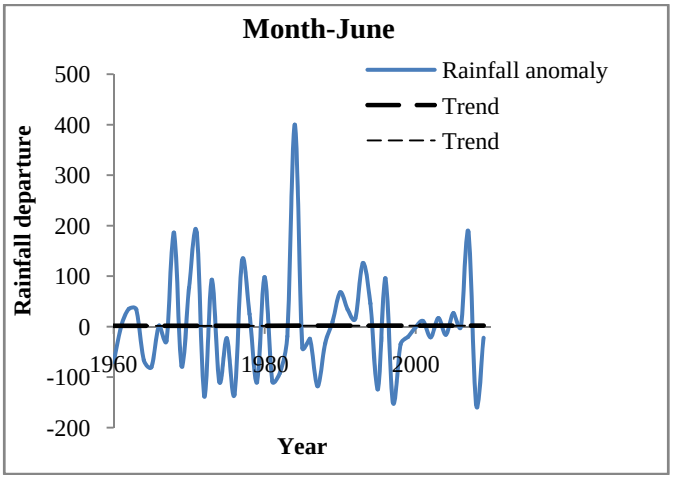


Figure 4: Decadal trend of meteorological drought in Bankura from 1910-2009



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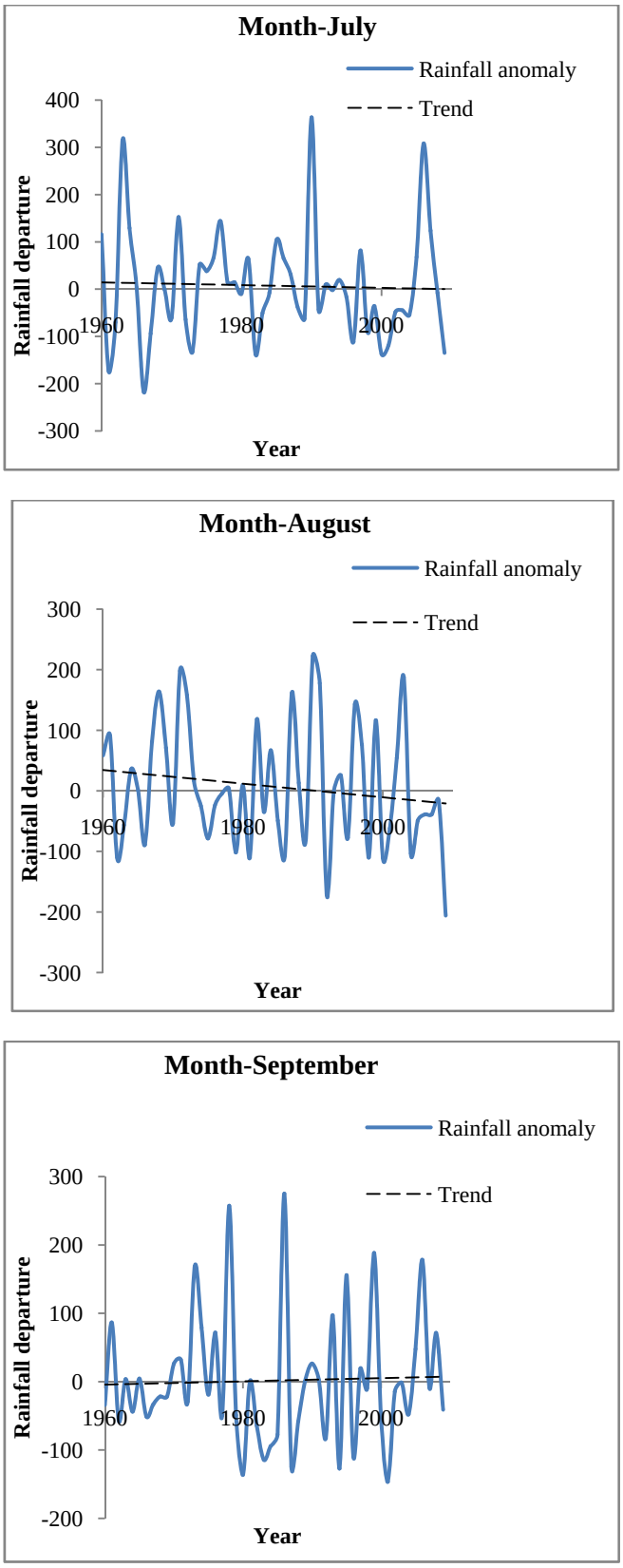

Figure 5: Rainfall anomaly of Bankura during monsoon from 1960-2009.

Table 2: Trend of meteorological drought and monsoonal rainfall in Bankura.

Months	Frequency (1910-2009)	Decadal trend (1910-2009)	Rainfall trend (1960-2009)	Rainfall departure (1960-2009)
June	26	Rising	Rising	No change
July	21	Declining	Rising	Declining
August	20	Rising	Declining	Declining
September	24	Declining	Rising	Rising

6. ANALYSIS

Drought is an inevitable phenomena in the western tract of West Bengal vis a vis the undulating red and lateritic zone of West Bengal. Southwest monsoon is the main source of rainfall in Bankura like the other parts of the state. Though the district receives rainfall during Winter, post monsoon and summer due to western disturbances, post monsoon cyclones that form over Bay of Bengal during October and November and nor'wester respectively but it accounts for only 3% during winter, 8-9% during post monsoon and 12% during summer. The analysis of meteorological drought in the last 100 years (1910-2009) brings out the fact that the frequency of meteorological drought is maximum for the month of June. This month experiences 26 meteorological droughts during last 100 years. Though the rainfall analysis shows a rising trend for the month of June but the decadal trend of meteorological drought from 1910-2009 is rising which may be explained as a result of lack of water conservation measures. In the month of July, the frequency of meteorological drought declines to 21 in the last 100 years. The rainfall analysis and decadal trend of meteorological drought indicates a rising and declining trend respectively. August, the mid monsoon month indicates a rising trend of monsoon rainfall which is associated with the declining decadal trend of meteorological drought. The month September indicates a declining decadal trend of meteorological drought.

7. MITIGATION OF WATER SCARCITY BY SCIENTIFIC USE OF NATURAL RESOURCE

Some essential conditions are needed for the successful development of agriculture like adequate water, favourable temperature regime, fertile soil and adequate sunshine. Rainfall is the prime natural factor which determines the crop production under rainfed condition, where almost all the agricultural operations depend upon the probability of receiving certain amount of rainfall [11]. Here a number of risks are involved in crop production like uncertainty of rainfall and occurrence of recurrent droughts. Moisture regime is an important determinant of crop growth in any agro climatic region. Water stress for a few days during maturity and sensitive period of crop growth is very much harmful for crop growth. It is true that this region is not favourable for

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long duration variety of rice cultivation through the year but to make the highly diversified soil, undulating terrain and harsh climate favourable for the agriculture some steps are to be taken which includes:

a) Water conservation during monsoon and its proper utilization during non rainy season.

b) Proper techniques in the field to prevent the soil erosion.

c) Land use and crop planning according to the slope and nature of land.

Nature has created some ideal conditions for the cultivation of different crops in different areas. But the use of natural resources depends on the technological knowhow of that area. Mishra et al. (2006) [2] found that the area is not suitable for rice cultivation throughout the year but the climate and topographic condition of the area provides an ideal condition for cotton cultivation. The large diurnal range of temperature and bright sunshine hours are suitable for boll development of cotton. So it is very essential to provide the climatic data and information to the farming community so that they can take the necessary steps for the cultivation of crops. Otherwise there will be huge gap between estimated and actual productivity.

Here speedy surface run off, recurrent drought, poor soil moisture regime, exploitation of ground water, lack of water conservation techniques and above all the absence of technological knowhow are the major hindrances for the higher production and productivity.

The seasonality of rainfall, lack of enough ground water storage and absence of irrigation of the region does not allow the cultivation of long duration maturity variety of rice. For that the short duration maturity variety of rice should be introduced. The large diurnal range of temperature and availability of bright sunshine will help to introduce cash crops.

8. CONCLUSION: SUGGESTIONS FOR ADAPTATION

A study about climate change adaptation in arid region of West Bengal has been done by Mishra et al. (2012) [6]. Since drought is a natural phenomenon, its occurrence cannot be stopped. Rather the trend analysis of last 50 years indicates that the frequency is likely to increase in the coming years. Considering the meteorological factors and socio economic status of the people some long and short term measures like rescheduling of crop calendar is urgent to address this crisis. Mallick, Jana, Sardar and Ghosh (2014) [9, 10] identified a promising very early rice genotypes for the red and lateritic zone of West Bengal. It should be kept in mind that the district receives considerable amount of rainfall during monsoon and other seasons after the top soil becomes dry after a short spell of heavy shower So, the main strategy of mitigation should be the scientific use water resource.

Besides, appropriate criteria for identification of drought is necessary for each agro-climate region considering rainfall, soil moisture regime, ground water potentials, socio economic condition of the people, weekly assured rainfall and surface run off [2]. For the undulating terrain plot to plot water conservation techniques should be adopted in the fields at all level.

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