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Analysis of Rainfall Data of Silchar, Assam

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Abstract:

Water is essential for all socio-economic development and for maintaining healthy ecosystems. The present study is an attempt to make a preliminary analysis of the rainfall patterns in Silchar over the last two decades. The study throws some light over the annual and monthly rainfall in this area that is influenced by the South West Monsoon as well as the pre-monsoon rains. The study reveals the significant role played by heavy rainstorms in governing the rainfall-flood regime in this area. This assumes considerable significance in the backdrop of global climate change altering the weather patterns in this area. The average annual rainfall in Silchar during 1986-2007 over a 22 year period was 3001.2 mm. The highest rainfall occurred in 1989 (4042.9 mm) followed by 1991 (3890.8 mm), while the lowest rainfall was in 1988 (1856.9 mm) and that in 2006 (2328.9) being the second lowest. It can also be observed that the highest rainfall occurred in the month of July in 9 years out of the 22 years. It was observed that the number of Heavy Rainfall Events is found to be the highest in the year 2007 which is a flood year and the least is found in the year 2006 which is a drought year.

Key words: global climate change, Heavy Rainfall Events, rainfall patterns, South West Monsoon.

Introduction

Climatology studies the spatial distribution of average values of climatic elements, e.g., temperature, rainfall, pressure and winds, humidity and evapotranspiration etc. and their relation to man's activities. Weather is the state of atmosphere.

It consists of short term variations of atmospheric conditions. Climate on the other hand, is concerned with the average weather conditions. India is fortunate to enjoy the heavy rainfall spells in all the seasons due to both tropical and extra-tropical weather systems. The summer or the southwest monsoon season (June-September) is the main rainy season contributing about 75-80 % of the annual rainfall. Although, the contributions fromother seasons, viz. the winter (January-February), pre-monsoon (March-May) and the post or north-east monsoon (October-December) to all India rainfall are not very significant, they are quite important for the particular regions. Main weather systems which bring rainfall to the region are monsoon low pressure areas, depressions, thunderstorms, tropical cyclones, western disturbances etc. (Pant and Rupa Kumar, 1997). The typical orography of the region also influences the intensity and distribution of the rainfalThe climate of a specific area is represented by the statistical collection of its weather conditions during a specific interval of time (Awasthi, 1995). Rainfall occupies an important position in the climatic studies of any region. It is a product of climatic phenomena such as evaporation, condensation, vapour pressure and formation of cloud. It plays an important role in the assessment of climatic water balance of a region. It claims a first place in the practical importance as it controls humidity and aridity of a region, and consequently the agricultural efficiency. Moreover, it also plays a major role in the assessment of floods and drought events of a region. Because of its practical and climatological implications, it is vital to place interest on its characteristics -amounts, monthly and seasonal variations, percentage, intensity, variability and its areal distribution (Awasthi, 1995). In view of the paramount importance of the rainfall from economic, societal and scientific points, extensive work has been carried out over the years on its various facets like trends, disaster events, spatio-temporal variability, seasonal contributions etc. (e.g. Sinha Ray and De, 2003; Sen Roy and Balling, 2004; Francis and Gadgil, 2006; Guhathakurta and Rajeevan, 2008). Goswami et al. (2006) used grid point data at 100 km resolution (Rajeevan et al., 2006) and demonstrated a significant increasing trend in the frequency and the magnitude of extreme monsoon rain events in central India over the past 50 years. These instances are attributed to the warming global surface (Goswami et al., 2006) and the tropical Indian ocean (Ajayamohan and Rao, 2008). Changes in rainfall patterns can have impact on water levels in the existing water bodies. An increase in the average global temperature is very likely to lead to more evaporation and precipitation. However, it is difficult to predict and measure the precise changes in the hydrological cycle because of the complex processes of evaporation, transport, and precipitation and also because of the limited quality of the data, short periods of measurements, and gaps in time series. In spite of these limitations, some specific changes in the amounts and patterns of precipitation have been found over the last few decades. In addition to these global changes, a few regional changes in the mean precipitation have been observed. Several analyses of precipitation observations indicate that rainstorm intensity has increased over the past decades. Keeping in view the above facts, the present study is carried out to analyse the rainfall pattern of Silchar, Cachar district, Assam, over the last 22 years (1986-2007).

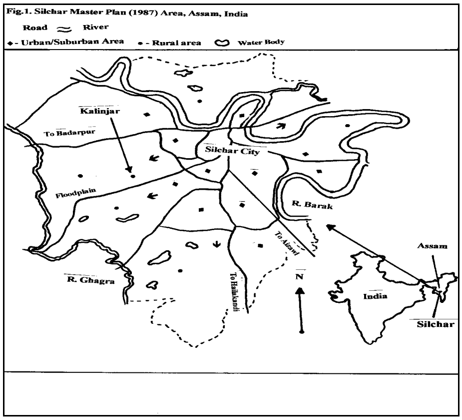
Materials and Methods

Rainfall data for Silchar, Cachar district, Assam (24^0 50' N; 92^0 40' E) (Figure 1) for a period of 22 years from 1986-2007 was collected from the Regional Meteorological Centre, India Meteorological Department, Government of India, LGBI Airport, Guwahati- 781015 on 23-08-2008. Monthly rainfall data was collected for 22 years from 1986-2007. Additionally daily rainfall data was also collected for 10 years from 1998-2007. By analyzing the data, annual and monthly pattern and magnitude of rainfall, as well as number of Heavy Rainfall Events (50 mm or more rainfall per day) (Karl *et al.*, 1997) as well as rainstorms (25 mm or more per day for at least 2 consecutive days) in a given year during 1998-2007 were calculated [http://meteozen.blogspot.com/2006/01/study-of-major-rainstorms-_113671875352319878.html].

Results and Discussion

The monthly rainfall analysis during 1986-2007 over a 22 year period showed that the average annual rainfall in Silchar during this period was 3001.2 mm. The highest rainfall occurred in 1989 (4042.9 mm) followed by 1991 (3890.8 mm), while the lowest rainfall was in 1988 (1856.9 mm) and that in 2006 (2328.9) being the second lowest. It can also be observed that the highest rainfall occurred in the month of July in 9 years out of the 22 years, followed by the month of June (7 years), April (3 years), May (2 years) and August (1 year). During this 22 year period, the highest mean rainfall of 520.19 mm occurred in the month of July, followed by June (509.12 mm), May (405.82 mm), August (392.06 mm), September (372.48 mm), April (322.02 mm), October (188.9 mm) and March (174.65 mm), while the months of November, December and January experienced relatively low rainfall (36.11, 14.48 and 10.02 mm, respectively). The highest mean rainfall for a given month during this period occurred in July (520.19 mm), followed by June (509.12 mm), while the lowest rainfall occurred in January (10.02 mm), with December recording the next lowest value (14.48 mm). Figure 2 shows the annual rainfall pattern during 1986-2007. It may be seen that the annual rainfall after reaching a peak in the late 1980s exhibited a gradual declining trend in the 1990s and 2000s, albeit with considerable fluctuations. Again, 59.7 % rainfall was found to occur during the monsoon months of June-September, 32 % occurred in the pre-monsoon months of February-May, while only 8.3 % occurred in the post-monsoon-winter months of October-January (Fig. 3).

Fig.1. Silchar Master Plan (1987) Area, Assam, India



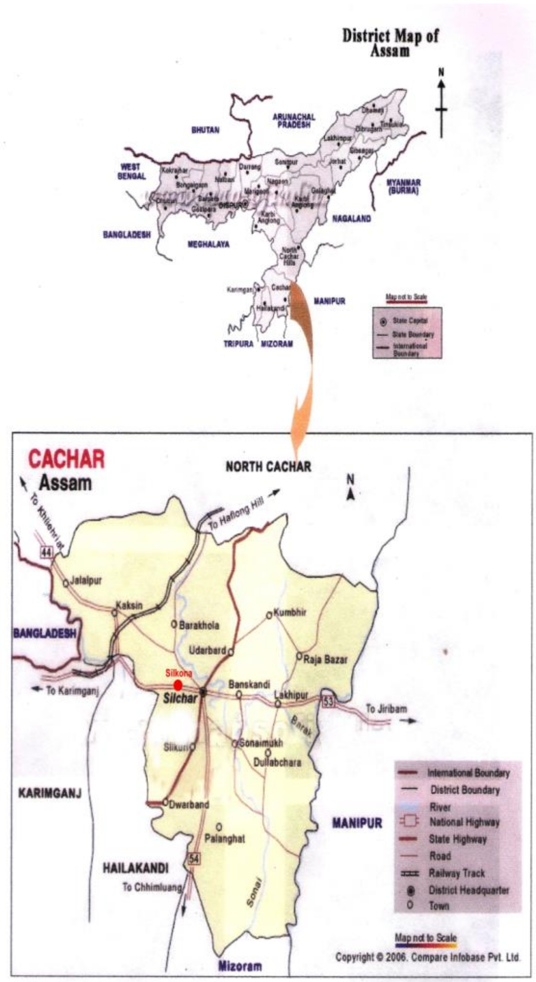


Fig. 1. Map of Silchar Master Plan Area

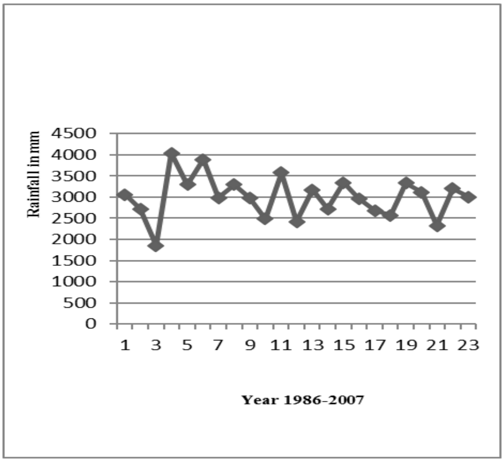


Fig. 2. Annual Rainfall (mm) in Silchar during 1986-2007

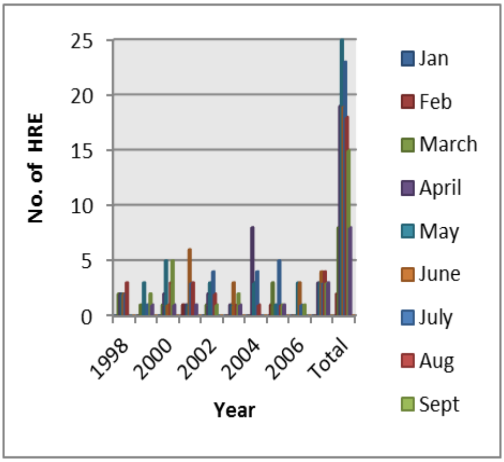


Fig. 4. Monthwise Distribution of Heavy Rainfall Events during 1998-2007 at Silchar

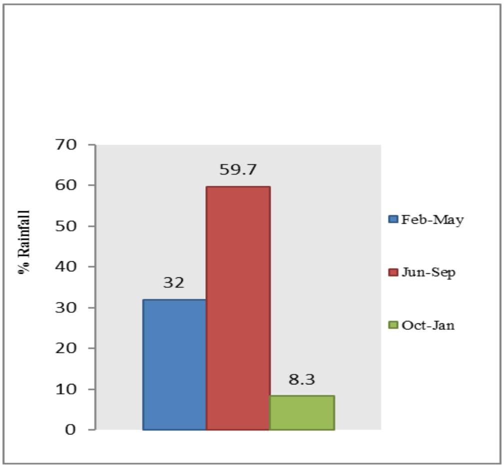


Fig. 3. Seasonal Percentage of Rainfall in Silchar (1986-2007)

TABLE I: Number of Heavy Rainfall Events (HRE) from 1998-2007

Year	**Total Annual Rainfall**	**No. of HRE**
1998	3173.5	13
1999	2717.5	08
2000	3338.1	18
2001	2968.8	16
2002	2623.1	13
2003	2566.3	09
2004	3334.6	16
2005	2882.8	13
2006	2328.9	08
2007	3198.1	23
Total (1998-2007)		137

The heaviest rainfall in any given month during the study period was found to occur in July 1989, followed by June1991 and April 2004 (1021.6, 943.8 and 883.1 mm, respectively). From Table I it can be observed that the number of Heavy Rainfall Events is found to be the highest in the year 2007 which is a flood year and the least is found in the year 2006 which is a drought year. The years 1998, 2000, 2004 and 2007 having 13, 18, 16 and 23 heavy rainfall events, respectively, were flood years, while the years 1999, 2003, 2006 having 8, 9 and 8 heavy rainfall events were drought years, so far as Silchar area is concerned. The total number of HREs during this period was 137, of which 16 events had experienced rainfall of 100 mm or more per day. Fig. 4 further reveals that the highest number of HREs took place in the month of May (25 events) followed by July (23), June (19) and August (18). No HRE took place in November-January. It was also found on data analysis that the contributions of heavy rainfall events (HRE) to total rainfall during 1998-2007 was the highest in 2007 (45.1 %), followed by that in 2001 and 2000 (43.2 and 40.4 %, respectively). However, barring 1999 and 2003 (19.1 and 23.9 %, respectively), HREs contributed more than 30 % of the total rainfall in all the other years (Figure 5). The total number of rainstorms (25 mm or more for at least 2 days) during 1998-2007 was found to be 78, with 2-day rainstorms occurring 57 times, 3- day rainstorms 14 times, and 4-day or more rainstorms 7 times. Of the latter, 4-day rainstorms occurred on 3 occasions (March 1998, August 1998, and June 2007); 5-day rainstorms on 2 occasions (June 1999 and September 2007); while a 6-day and a 8-day rainstorm occurred in May 2000 and April 2004, respectively. The highest number of such events occurred in 1999 (12 storms) followed by that in 2005 (11 storms), while only one rainstorm occurred in 2004. It has been experienced that rainfall varies from season to season and from place to place. This has major implications on agriculture.

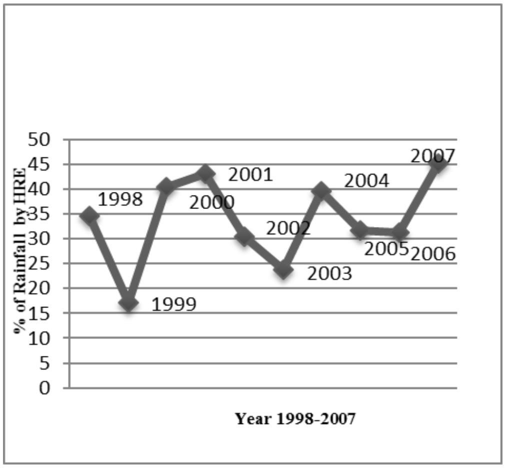


Fig. 5. Percentage of Total Rainfall by Heavy Rainfall Events (HRE) during 1998-2007

Therefore, greater emphasis has been laid on the pattern of seasonal distribution of rainfall. Rainfall varies from month to month because of the different climatic conditions over the area. Where rainfall is governed by the South West Monsoon, the months of June-September account for about 60 per cent of the total annual rainfall. On the other hand, January and December are the months of the lowest rainfall. The main causes for the temporal and spatial variations of rainfall are the atmospheric disturbances such as thunderstorms. Duration of rain at any region depends on the number, size and rate of thunderstorm cells. In winter season thunderstorm rain is the least. In summer season, thunder activity increases gradually. In the post- monsoon season, heavy rainfall roughly occurs in the areas of thunderstorm cell. The annual and monthly rainfall analysis for Silchar between 1986-2007 shows the average annual rainfall of this area to be 3001.2 mm (Figure 1), revealing that Silchar experiences high rainfall, being located in the humid tropical region influenced by the South West Monsoon. About 60 % of this total annual rainfall occurs in the monsoon months of June-September, as the monsoon arrives in this area in early June. The pre-monsoon (February-May) rains are also heavy, contributing 32 % of the total annual rainfall. In contrast, the post-monsoon and winter months of October-January contributed a mere 8.3 % of the total annual rainfall. The importance of pre-monsoon rains can also be discerned from the fact that the highest mean rainfall during the 20-year period of 1986-2007 occurred in the month of July (520.19 mm), followed by June (509.12 mm), while the next highest rainfall was in the pre-monsoon month of May (405.82 mm), which experienced heavier rainfall than that in the other two monsoon months of August and September. The pre-monsoon rains are due to considerable thunderstorm activity in pre-monsoon months, especially in May. A similar pattern is seen in the neighbouring Brahmaputra Valley where the average rainfall in May (338 mm) is comparable in magnitude to the rainfall of any of the monsoon months [http://meteozen.blogspot.com/2006/01/study-of-major-rainstorms-_113671875352319878.html]. However, pre-monsoon rains in Barak Valley are even heavier than that in Brahmaputra Valley. The factors that lead to the prevalence of thunderstorms – also called nor'westers or westerlies – locally called 'Kalbaisakhi' in Barak Valley are as follows. From the month of February, the land surface is steadily heated and the temperature rises. Local depressions are formed where strong convection develops especially in the afternoon hours of the day with stormy weather in the evening or night. A similar pattern of thunderstorm formation is also observed in the Brahmaputra Valley [http://neclimate.blogspot.com/].

Another interesting feature of the pre-monsoon and monsoon rainfall in Barak Valley, which is similar to that in Assam, as well as the other parts of the country, is that the rainfall during each month is made up of a few spells of above normal rainfall with normal or even below normal rainfall during the rest of the month. This type of distribution of the monsoon rainfall causes floods in certain periods of the month even when the total monthly rainfall itself is just normal or even below normal. It is a general feature of rainfall, and one which is not necessarily confined to the tropics, that a small proportion of intense storms of short duration produce most of the total rainfall. Thus, 10 to 15% of rain days account for 50% of the rainfall, 25 to 30% of rain days account for 75% of the rainfall, and 50% of days with the smallest rain amounts account for only 10% of the total. The present study estimated the number of Heavy Rainfall Events (HRE) in Silchar during a 10-year period of 1998-2007. HREs are defined as rainfall events with 50 mm or more rainfall per day. Figure 5 reveals that HREs accounted for 19.1-45.1 per cent of the total rainfall in Silchar during the study period. This is a high value as in the United States for example, 10 percent of the annual precipitation falls during very heavy rainstorms (at least 50 mm per day). Figure 4 reveals that the highest number of HREs occurred during the pre-monsoon month of May (25 events) followed by the monsoon month of July. This is again indicative of the increasingly significant role played by the pre-monsoon thunderstorms in determining the weather patterns of Silchar in particular and Barak Valley as a whole. A study of rainfall patterns in Brahmaputra Valley during 1901-1960 reveals that the number of rainstorms (25 mm or more rainfall per day extending over at least 2 consecutive days) was 103 (mean of 1.72 rainstorms per year) during this sixty year period [http://meteozen.blogspot.com/2006/01/study-of-major-rainstorms-113671875352319878.html]. It has been estimated during the present study that the number of such events in Silchar during 1998-2007 was 78 with a mean of 7.8 per year.

Conclusions

While it would be premature to draw any firm conclusions from this data, it is at least an indication of the possible increasing trend of extreme weather events that may perhaps be linked to climate change.

Although relatively few studies have examined the relation between climate change and flow regime of rivers, it is nevertheless apprehended that a 2^0 C rise in temperature could increase the average flood discharge in Ganga, Brahmaputra and Meghna rivers by 15, 6 and 19 %, respectively. North East India, especially the Brahmaputra, the Barak and the Manipur Valleys are extremely flood-prone. In recent years, these areas have experienced devastating floods in 2004, 2005 and 2007, with an intervening drought year in 2006. Man-induced environmental factors such as deforestation in the catchments of rivers, increased siltation of river-bed and declining carrying capacity, wetland reclamation and degradation, and encroachment of floodplains by human settlements have greatly increased the flood risk in these valleys. In the event of heavy precipitation events in the hills of North East India becoming more frequent due to climate change, flood risk in the valley areas and flash flood and landslide risks in the hills are likely to be augmented. We can cite the recent instance of a heavy rainfall event in Mizoram causing River Rukni, a south bank tributary of Barak, to create unprecedented havoc in parts of Cachar district, Assam, in September, 2007. It is also being observed that conventional flood control strategies that rely heavily on structural measures like embankments are proving increasingly inadequate in minimizing flood damages. Innovative and effective risk management practices in this sector, therefore, need to be developed on a priority basis in the North East and other risk-prone regions of India.

Acknowledgment

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