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Changing conditions of temperature and precipitation in Malda District in the last century: Trends and Characteristics

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Abstract:

In the prevailing realm of the scenario of global warming and human-induced climate change, researches dealing with changing trends and characteristics of weather and climate parameters have assumed greater attention. Amongst the climate parameters, the most significant include temperature and precipitation. This is because amongst all other climatic parameters, it is only the temperature and precipitation which have a direct implication on then human kind. A majority of researchers across the globe opine that in the last century, various anthropogenic reasons have resulted into increasing of the temperature of the earth to a considerable extent. So, the primary objective of the present study is to analyse the actual trend in the temperature and precipitation of the Malda District of the Indian State of West Bengal. The time period selected for the study is from 1901 – 2000. The raw data were collected from the website www.interwaterportal.com. The study attempts to ascertain whether there is any change in the long-term temperature and precipitation and also the decadal variation in temperature and precipitation in this area. Another objective of this paper is to determine the temperature-precipitation relationship. Linear regression technique was applied to understand the relationship and the trend of the relationship with respect to time. Also, the data were analysed in accordance with their normality in order to determine the erratic (if any) pattern of precipitation and temperature distributions. This was done by the Shapiro Wilk Test. One of the important findings of this study was that there was no significant statistical pattern in the temporal distribution of temperature and precipitation.

Keywords: Climate change, temperature, precipitation, trend, Malda District

Introduction:

The atmosphere is in a state of constant turmoil. The characteristics of atmosphere show both spatial and temporal variations and these changes may be internally induced within the earth's atmospheric system or externally caused by extraterrestrial factors. Whatever be the

causes of these changes, they bring about a change in the patterns of weather and climate when these changes are spread over an area for a long period of time, can cause a shift in the type of climate prevailing in the area. This change in climate is called climatic change (Siddhartha, 2008).

Climate change is a complex system caused due to the changes in different components of weather and climate such as temperature, rainfall, cloud cover, evaporation etc. Now-a-days, climate change is a common topic to initiate a conversation almost everywhere because of its direct effect on daily life. But during the last few decades, due to climate change, environment is changing abruptly which becomes the concern of the scientific community and to think about the impact of climate change on the survivability and future development of mankind (Dhorde, 2007).

During the last few decades global warming has become an ever-increasing concern because of its direct effect on climate change. According to the scientific community, during the last few decades due to different natural and anthropogenic reasons temperature is increasing which leads to global warming as well as climate change affecting the amount of precipitation also. Therefore, the question is being asked as to what extent the temperature is increasing? Is there any relationship with the changing amount of precipitation? And so on. Currently, study related to this have gained immense importance as everybody think that human society will be more affected by this in future.

The earth's climate is never stable and keeps on varying. Temperatures vary from year to year and over much longer time scales. There have been periods in the earth's history when the regional temperatures were much higher and much lower than at present. For example, the period between1550 to 1850 is recognized as the Little Ice Age. After this, temperatures started increasing over large areas of the earth. Most of this increase has occurred in two periods from about 1900 to 1950 and since 1980 onwards.

During the last century the surface air temperature over India has shown significant increasing trend (Hingane, et al. 1985). However, this is not consistent for the entire country, particularly in the northwest and northeast India the temperatures show cooling trends also. This overall increase in the temperature was attributed to increase in maximum temperature by Hingane et al. (1985). However, later studies by Sinha Ray et al. (1997) have shown that this

trend is partly due to the rise in minimum temperature related to urbanization. These studies however have either considered only annual temperatures or average seasonal temperatures.

Significantly, changes in global precipitation amount have been observed with the increasing global surface temperature. According to Jones and Hulme (1996) and Hulme et al. (1998) global land precipitation has increased by about 2% since the beginning of the 20th Century. The increase is statistically significant but has been neither spatially nor temporary uniform (Karl and Knight, 1998; Doherty et al; 1999). IPCC (2001) notes that global precipitation trends were positive throughout the last Century. However, the trends vary with region and season (Forland et al. 1996, Schonwiese and Rapp, 1997, Hulme et al., 1998; Rodriguez-Puebla et al., 1998; Trenberth, 1998; Doherty et al., 1999; Gonzalez-Rouco et al., 2000; Osborn et al., 2000;).

Rainfall fluctuations, on the other hand, show region-wise mixed trends all over India, for example, no significant trend was observed for the south west coast (Koteswaram and Alvi, 1969) and Gujarat (Chowdhury and Abhayankar, 1979). Significant positive trends have been observed for Central India (Agarwal, 1952; Parthasarathy and Dhar, 1974), south west India (Pramanik and Jagannathan, 1953; Parthasarathy and Dhar, 1974; Krishnan 1984; Alvi and Koteswaram, 1985; Rupa Kumar et al., 1992), north east India (Pramanik and Jagannathan, 1953; Parthasarathy and Dhar, 1974) and north west India (Parthasarathy and Dhar, 1974; Rupa Kumar et al., 1992). Significant negative trends were reported for the south peninsula (Pramanik and Jagannathan, 1953; Parthasarathy and Dhar, 1974; Krishnan 1984; Soman et al., 1988; Rupa Kumar et al., 1992) and Central India (Alvi and Koteswaram, 1985). Subbaramayya and Naidu (1992) made a detailed analysis of the monsoon rainfall for various sub-divisions of India and according to them a decreasing trend had been found till the end of the 19th Century, which was followed by an increasing trend till the middle of the 20th Century and then the trend reversed again till 1970 and a change towards an increase thereafter. The duration of trends was found to vary by a few years for different regions.

With this background, it was thought to assess the long-term trends in some weather parameters, particularly maximum temperature, minimum temperature and precipitation. The present study tries to find out that in what extent the mean maximum temperature, mean minimum temperature and mean precipitation is increased/decreased and it has any relationship with global warming or not. The study considers Malda District of West Bengal, Eastern India

for which 100 years of data is available. The study tries to ascertain whether there is any change in the long-term temperature and precipitation and also tries to find the decadal variation in mean temperature, mean precipitation and the temperature-precipitation relationship.

Study Area:

The study is confined to the district of Malda in the northern part of the Indian state of West Bengal. Although part of a very old settled region "Pundrabardhan" and "Gour" (Sengupta, 1969), Malda came into being as a separately constituted district within the province of erstwhile Bengal of British India in the year 1813. It was achieved by an act of amalgamation of two of the southern Thanas (local term for Police Station) of the erstwhile (Pre-Independence) Dinajpur District, with three drawn from the eastern Rajshahi District and four from the western Purnia District of Bihar. Spreading across an area of 3,733km^2 with a population of 39.89 lakh as of 2011, the district covers 4.7% of the total area of the state and is home to about 4.1% of total state population (Census, 2011). Located between the latitudes 24°40′20″ N and 25°32′8″ N and longitudes 87°45′50″ E to 88°28′10″ E, the district is bounded in the south by the Murshidabad District and by the Uttar Dinajpur District in the north, in the east by the international border of Bangladesh, by the state of Bihar to its west, by the Dakshin Dinajpur District in the northeast and the state of Jharkhand to its southwest (Census, 2011). Geomorphologically, this part was the most ancient delta of the river Ganga. The name Moribund Delta justifies this statement (Bagchi, 1944). Physiographically, three sub regions can be identified within the district. The region of mature alluvium that has given North Bengal its old historical name '*Barendri*' is known today as '*Barind*'. This region is made up of ancient alluvial humps that are remnants of old riverine floodplains, subject to inundation and renewed silting. The major portion of this region contains two sharply rising and isolated topographic units that fall within the district, which comprises Old Malda and Gazole Blocks in the Mahananda-Tangan interfluve area, and Habibpur and Bamangola Blocks in the Tangan-Punarbhava interfluves. The remainder of the district covers an adjacent tract of flat low land between the 27m and 21m contours, forming the local catchments of the north to south classified into two additional physiographic regions, known locally as the *Tal* and the *Diara*. Spanning the blocks of Manikchak, Kaliachak 1, 2& 3 and English Bazar within the district, the *Diara* is a relatively well drained flatland formed by the deposition of newer alluvium in the transitional zone between the upland *Barind* and the

marshy *Tal* Tracts. The *Tal* is mostly composed of bog lands formed in many marshy pockets around vestigial inland drainages. The streams of this zone have constantly switched over to new courses, leaving many dead or dying channels that retain water flow only during the monsoon season. Consequently, the *Tal* is strewn with innumerable marshes, paleo-channels and oxbow lakes (locally known as *Beels)*. Most of the Tal Tract remains submerged under considerable depth of water during the monsoon and comprises the Ratua-I, Ratua-II, Chanchal-I, Chanchal-II, Harishchandrapur- I and Harishchandrapur-II Community Development Blocks. The region is fortunate to have excellent soil conditions and irrigation facilities.

In Malda District, agriculture is the primary economic activity. The district has a favorable condition for agriculture in terms of physical and cultural factors. A large variety of food and cash crops, both Kharif and Rabi are grown here for commercial purposes. The land is ideal for mulberry and mango cultivation and these are the two main commercial crops in the district.

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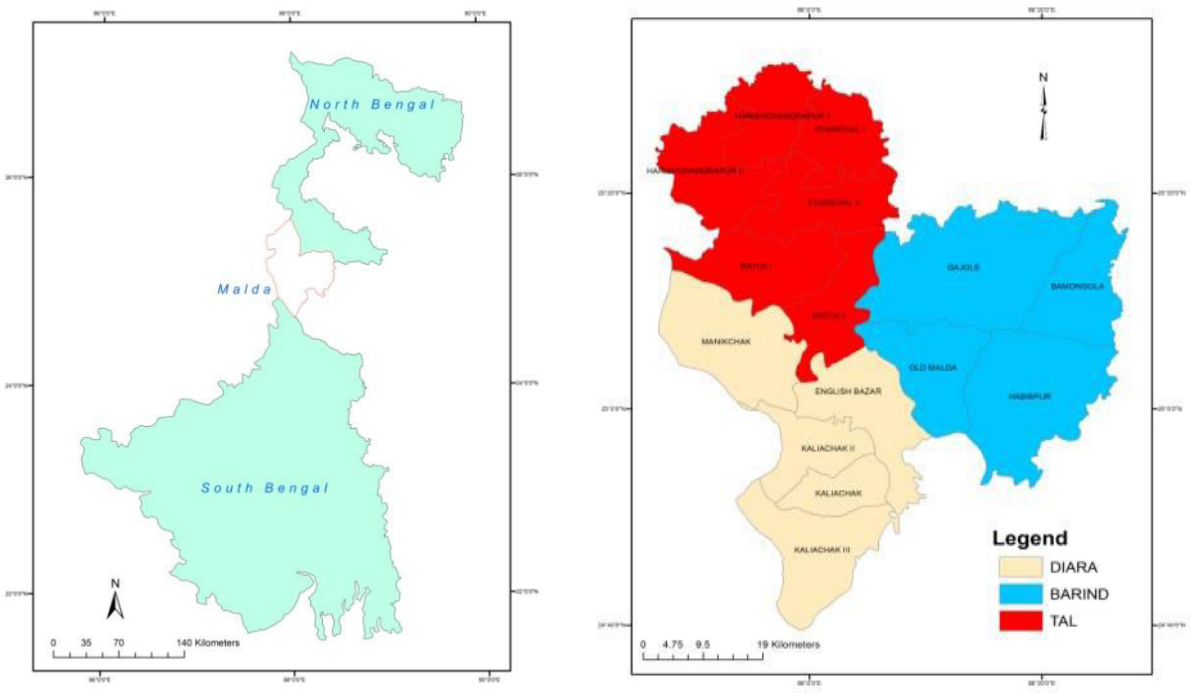

Fig 1: Location Map

Data and Methods:

Data related to different climatic parameters such as maximum temperature, minimum temperature and precipitation were acquired from www.indiawaterportal.com. The data are obtained on monthly basis for the available period between 1901 and 2000. Standard statistical methods have been used to analyze the data. . Linear regression model is used to determine the long-term trend analysis and temperature-precipitation relationship. Furthermore, the Shapiro-Wilk Statistical Test was carried out in SPSS to understand the normalcy distribution of the data and to identify the decades which were erratic in nature in the 20th Century, Malda district, West Bengal.

Results

Trends in Temperature:

Global mean surface temperatures are useful indicators of climate change and variability, changes in daily maximum and minimum temperature provide more information than the mean alone. This is because trends in the mean surface temperature can be due to changes in either maximum or minimum temperature, or relative changes in both.

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Maximum Temperature is the highest temperature recorded during a specified period of time at a particular place and Mean Maximum Temperature is the long-term average daily maximum air temperature observed during a calendar month and over the year.

Minimum Temperature is the lowest temperature recorded during a specified period of time at a particular place and Mean Minimum Temperature is the long-term average daily minimum air temperature observed during a calendar month and over the year.

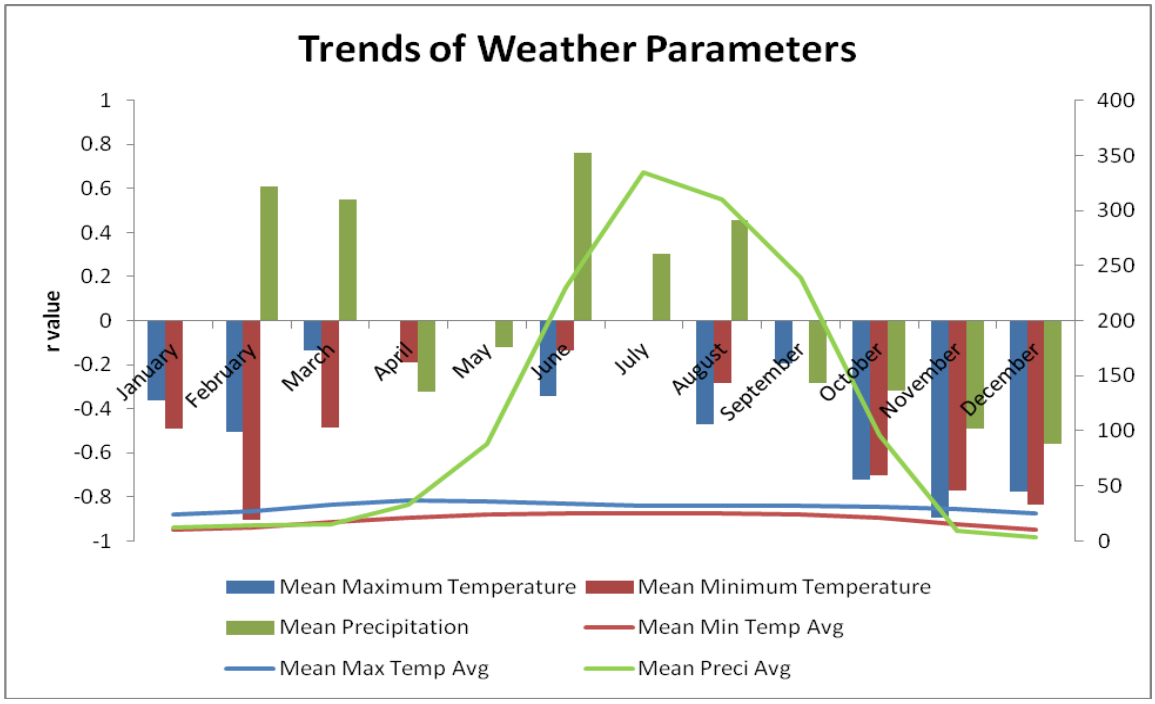

Fig 2 : Month wise Trends of Mean Maximum Temperature, Minimum Temperature and Precipitation (1901-2000).

From the Fig-2, we can say that in case of mean maximum temperature the decreasing trend is observed in the months of, February, August, October, November and December whereas in the month of January, March, June and September slightly decreasing trend is observed and in April, May and July we can say that there is absence of any specific trend. Also in case of mean minimum temperature the decreasing trend is found in the months of January, February, March, October, November and December whereas in the month of April, June and August slightly decreasing trend is observed and in May, July and September we can say that there is absence of any specific trend.

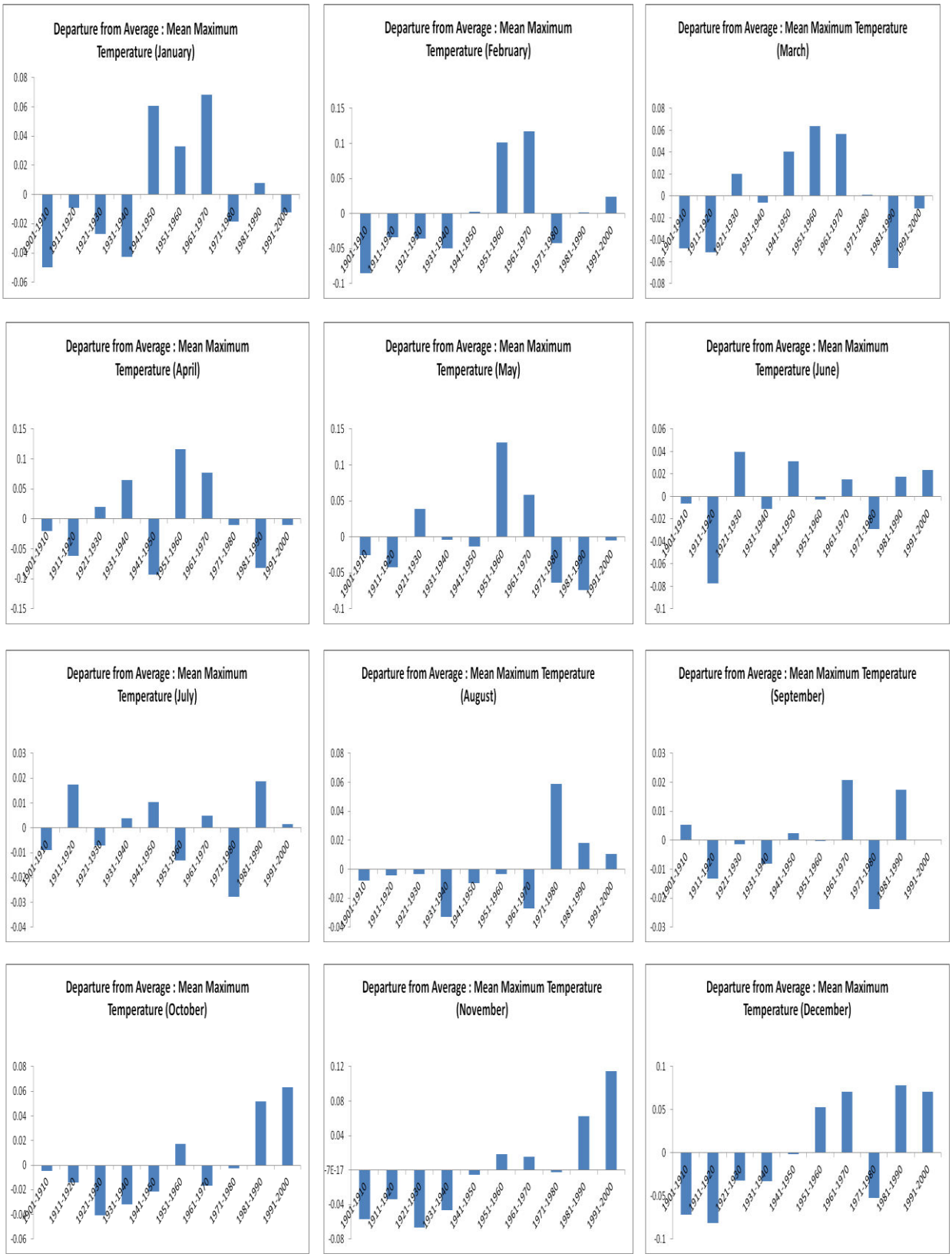

Fig 3: Month wise Departure from Average – Mean Maximum Temperature (1901 – 2000).

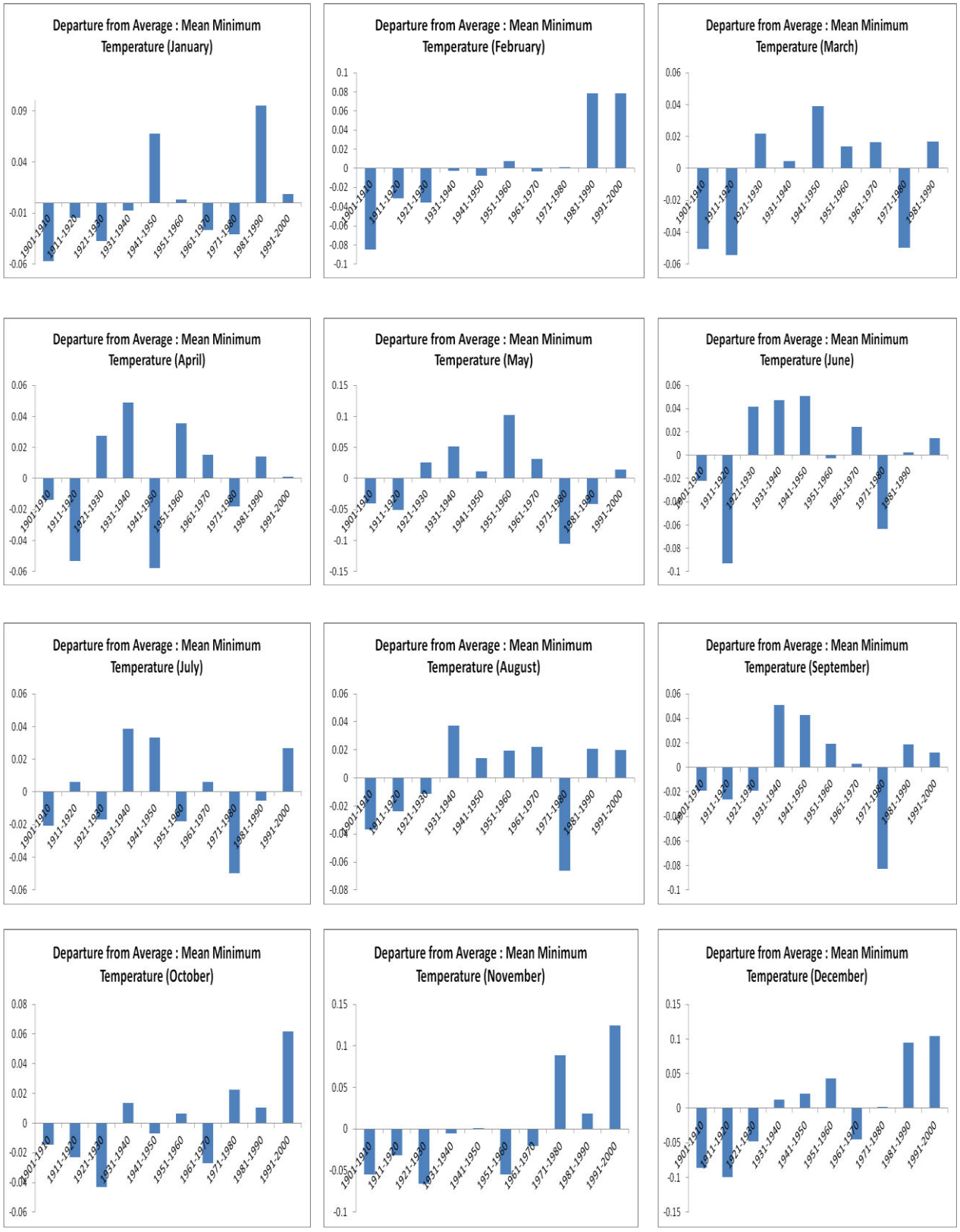

Fig 4: Month wise Departure from Average – Mean Minimum Temperature (1901 – 2000).

From Fig-3, in case of Mean Maximum Temperature, we observed that a cyclical trend is exist in the months of January, February, March, May and December, whereas from Fig-4, in case of Mean Minimum Temperature, we found that a cyclical trend is exist in the months of January, March, May, June, August, September and December which is compatible with the world climatic phenomena.

With the help of Shapiro-Wilk statistical method, we try to find out the normalcy distribution in the data range. From the Shapiro-Wilk significance test, in case of Mean Maximum Temperature (Fig-5), we found that the first four decades and the 80's and 90's decades of 20^{th} Century were more erratic in nature compare to the other decades, whereas in case of Mean Minimum Temperature (Fig-6), the first decade and the 80's decade of 20^{th} Century were more erratic in nature compare to the other decades which implies that the summers were more hotter and winters were colder in those decades.

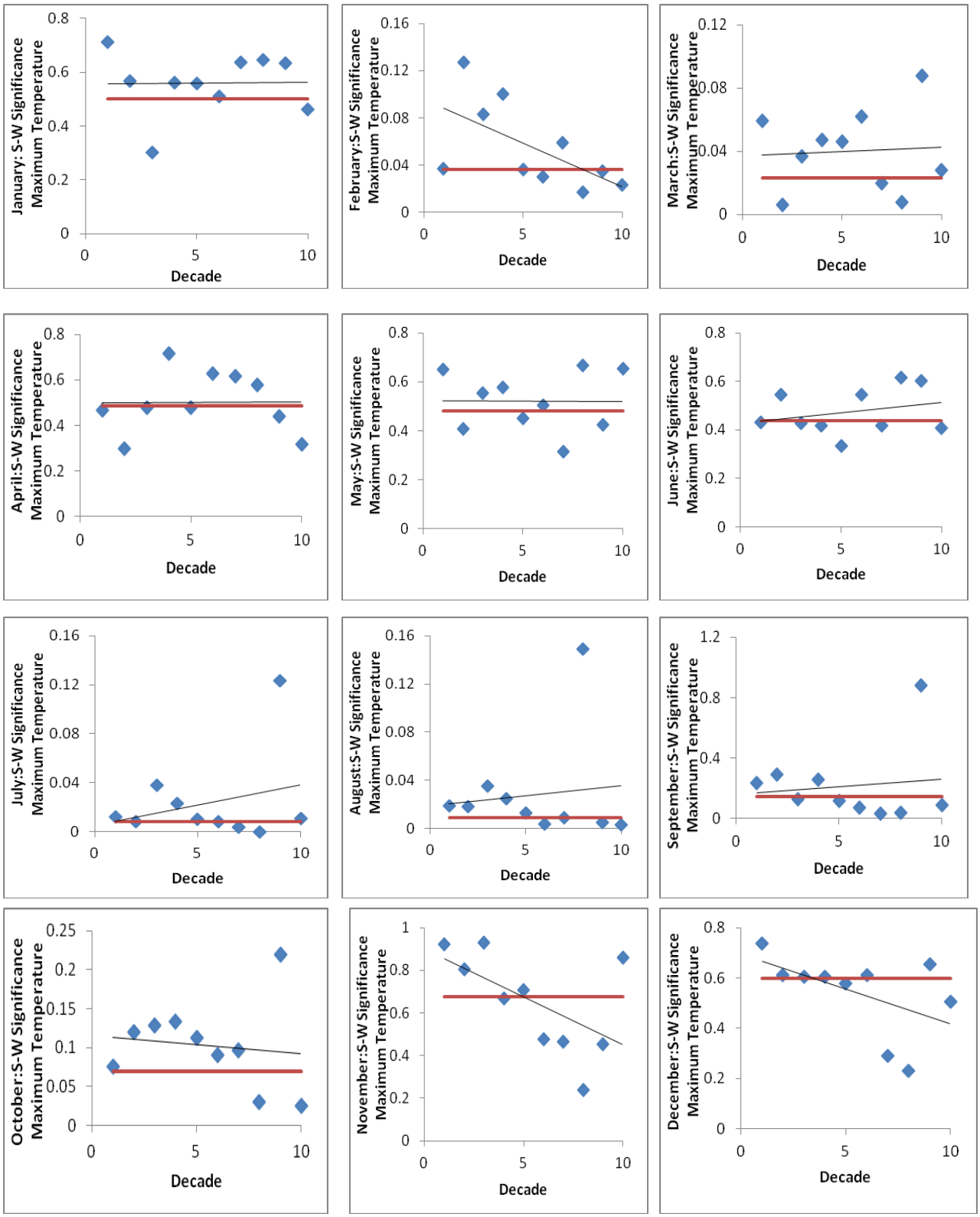

Fig 5: Month wise Linear Correlation Between Shapiro-Wilk Significance Maximum Temperature Value and Decade (1901 – 2000).

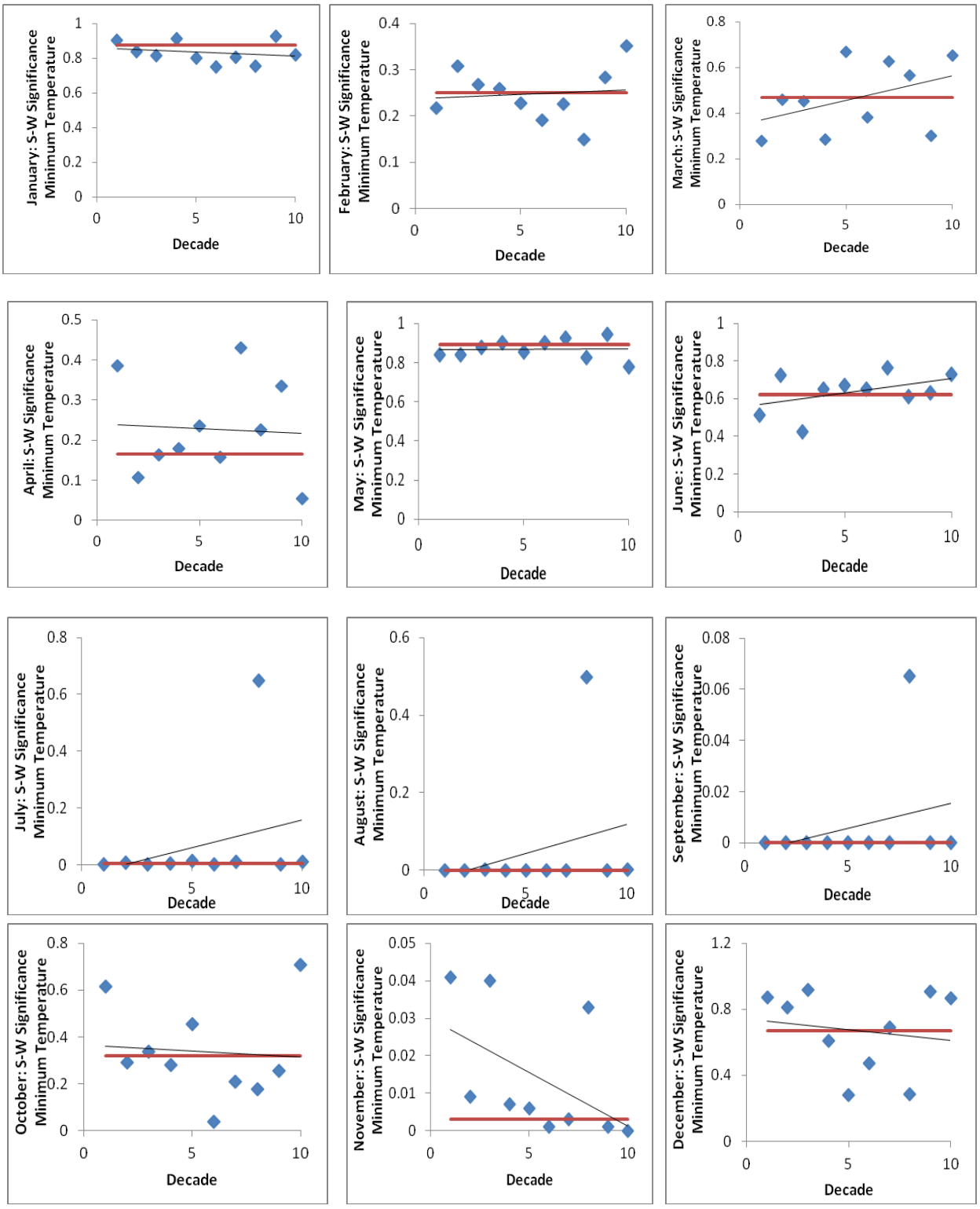

Fig 6: Month wise Linear Correlation Between Shapiro-Wilk Significance Minimum Temperature Value and Decade (1901 – 2000).

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Trends in Precipitation:

Among the various climatic parameters, besides temperature, amount and timing of precipitation is also a major concern to all as the debate on climate change is not focused only on the increased global temperatures and their trends but also encompasses on the trends of precipitation also.

From the Fig-2, we can say that in case of mean precipitation the increasing trend is observed in the months of February, March, June and August whereas in the month of November and December decreasing trend is observed and in January we can say that there is absence of any specific trend.

From Fig-7, in case of Mean Precipitation, we found that a cyclical trend is exist in the months of April, May and July which is compatible with the precipitation pattern of India.

From Fig-8, in case of Mean Precipitation, we observed that the first two decades and the 50's, 80's and 90's decades of 20^{th} Century were more erratic in nature compare to the other decades.

Temperature – Precipitation Relationship:

The change in precipitation would affect the temperature, so it is more appropriate to study the relationship between precipitation amount and temperature.

The results obtained from the analysis of Fig-9, it is clearly observed that a negative relationship is exist between precipitation and temperature which implies increase in precipitation is associated with decrease in temperature and vice-versa. But these results when compared with the precipitation and temperature trends do not indicate the same relationship.

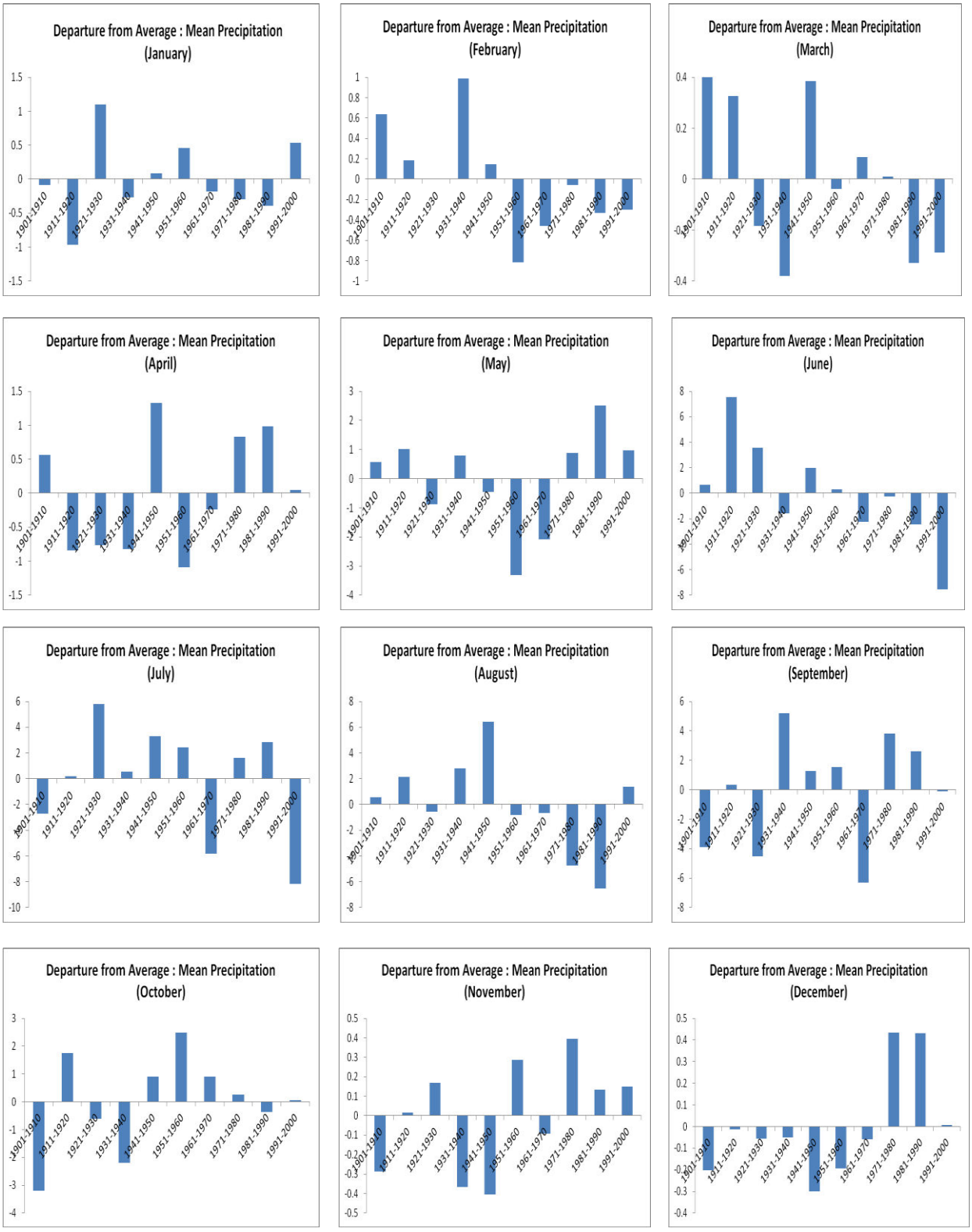

Fig 7: Month wise Departure from Average – Mean Precipitation (1901 – 2000).

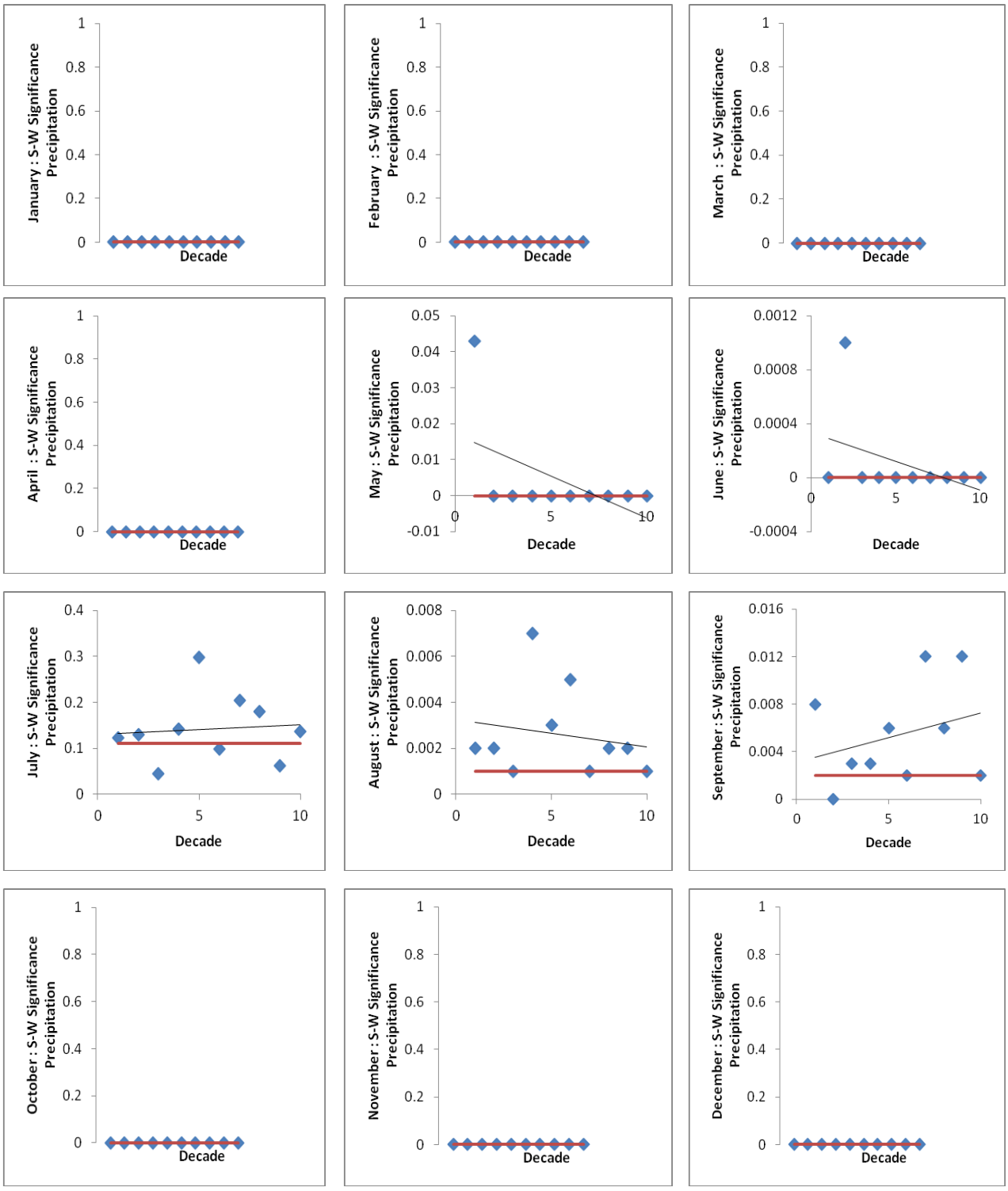

Fig 8: Month wise Linear Correlation Between Shapiro-Wilk Significance Precipitation Value and Decade (1901 – 2000).

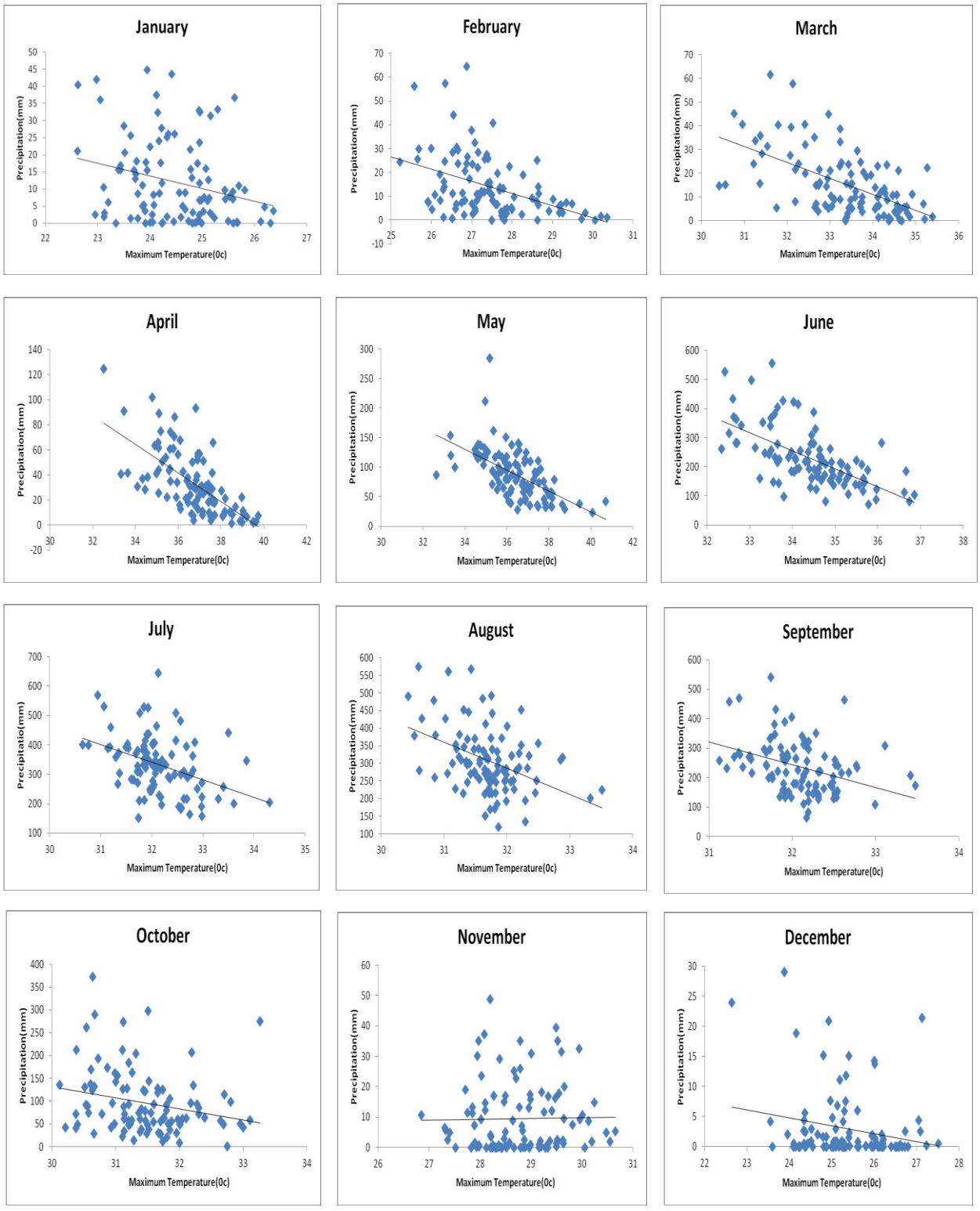

Fig 9 : Relationship Between Maximum Temperature and Precipitation in the 20th Century (1901 – 2000).

Discussion:

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In response to the importance of climate change in general and global warming in particular, considerable scientific efforts have been undertaken to evaluate the temperature and precipitation trends and assess their impact on environment. Local temperature is one of the major climatic elements to record the changes in the atmospheric environment in urban areas. Therefore, climate change in terms of temperature, precipitation and related scientific responses call for in-depth and cause effect strategies. This will enable the government to respond to climate change through scientific action plan at regional level and therefore, there is a need to adopt a regional approach to climate change assessment. With this in mind, in the present study attempt is made to understand the long-term trends in temperature and precipitation to seek answer to the question "Is there temperature is increasing in Malda district? Has it any relationship with the changing amount of precipitation? And is it related with the global warming as well as climate change?" It was observed that the month of February, October, November and December show the decreasing trend whereas in case of May and July there is absence of any specific trend for both mean maximum and mean minimum temperature analysis. January, March, May and December display a cyclical trend for both mean maximum and mean minimum temperature. In case of precipitation, increasing trends in precipitation was observed in the months of February, March, June and August while decreasing trend is noted for November and December. Shapiro-Wilk Test for data normalcy reveals that the first decade and the 80's decade were erratic in nature for both mean maximum and mean minimum temperature. Cyclical trends are observed in the months of April, May and July. Negative relationship exists between precipitation and temperature.

Conclusion:

Global Warming and climate change are important and burning issues in the last few decades. The process has been all the more enhanced due to increasing amounts of emission of greenhouse gases due to rising trends in industrialization and urbanization. However, the study in Malda District of West Bengal in the last century reveals that there has been no definite trend of increase/ decrease in temperature and precipitation also. Rather, most of the months reveal that the temperature has initially increased during 1940-50s and in the 1960s, 70s and 80s the temperatures registered a decline and after 1980s, it has increased. There may be a possibility that the variations in the aerosol concentration may have played a part. But systematic temporal information on such aerosol concentration is lacking. Climate exerts a profound influence on the

civilization and culture of people, their way of life, environment, economy and society. Climate and society together constitute an interactive loop with the climate creating significant socio-economic impact on the society both in the short term and long term (Kulshrestha, 1997). The present study helps us to assess the trends in mean maximum, mean minimum temperatures and mean precipitation during the last century in Malda District. In the prevailing climate change paradigm, there is growing debate as to whether the human-induced global warming is real or not. This is because the temperature increase or decrease is not consistent across the world. Malda District is not showing any consistent increase in temperature and precipitation in the last100 years. It is pertinent to mention here that the district is predominantly agricultural and rural economy. It appears that the absence of industrial and urban areas may have played a part in the results.

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