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Study of frequency of anomalies in arrival of late or early Monsoon and Western Disturbances due to climate change in Bahawalpur city from 1960-2012

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Abstract: Monsoon is the major system that brings heavy rainfall in South East Asia. Its timely arrival brings prosperity to the inhabitants while its delay or early arrival may cause disastrous droughts or floods. Global warming is disturbing the climatic factors and monsoon rainfall is not indifferent. Data of average monthly rainfall for 52 years from 1960-2012 was collected from the Meteorological Department of Pakistan. Global warming is agreed upon the phenomenon, hence its effects on the rainfall pattern is sure as these two variables are interlinked. This study is going to focus on the anomalies occur in rainfall pattern of monsoon and winter rainfall called Western Disturbances. This single variable was plotted decade wise to note the number of extreme rainfall on decadal time scale using an Excel worksheet. Two decades were plotted on one graph and summer and winter months are plotted on different graphs. At least one conspicuous peak value can be seen in each decade in both winter and summer rainfall. The findings of this study reveal that in the last 3 decades the anomalies are more frequent than the previous decades.

Keywords: Bahawalpur, rainfall, anomalies, monsoon.

1. INTRODUCTION

Climatic anomalies are rife throughout the globe and effects of these irregularities can be felt regionally as well as globally. Monsoon rainfall is a major rainfall system that brings prosperity to the farmers of the Southeast Asia, meanwhile early monsoon and late monsoon cause a serious damage to the crops. Disruption in monsoon season is hazardous and ensuing quoted studies elaborate that the frequency of anomalies is increasing on the decadal and centennial time scales.

Although climate change and global warming are a natural phenomenon supported by the historical evidence, but still it is a rigorously researched and discussed issues. The most ignominious reason of increase in temperature in the 20th century was blamed upon the anthropogenic activities. Cyclone formations and irregularities in rainfall pattern are related repercussions of global warming throughout the globe. In Southeast Asia global warming is closely linked to the seasonal atmospheric flow during the monsoon season with varying degree of fuzziness.

The comparison of decadal variation of precipitation and temperature anomalies before the 1970s found general increases which were mostly varying. But beyond the 1970s, global precipitation anomalies showed increases that almost corresponded with increases in global temperature anomalies for the same period. There are frequent changes and a shift westward of the Indian summer monsoon. Although precipitation is observed to be 70% below normal levels, in some areas the topography affects the intensity of rainfall. These shifting phenomena of the other monsoon season in the region are impacting on the variability of rainfall and the onset of monsoons in Southeast Asia and is predicted to delay for 15 days the onset of the monsoon in the future. The variability of monsoon rainfall in the SEA region is observed to be a decade and the frequency and intensity of intermittent flooding of some areas during the monsoon season have serious consequences for the human, financial, infrastructure and food security of the region. (Agnihotri, *et al.* 2011)

Before the 1970s, temperature anomalies and decadal variation of precipitation showed a general increase but mostly were irregular. After 1970s, there exists a regular increase in the global precipitation when there is an increase in global temperature. Frequent changes and westward shift of Indian Summer Monsoon (ISM) is conspicuous. In some areas precipitation is calculated to be 70% less than what is usually used to be. The westward shifting is also inducing the variation in rainfall while the commencement of monsoons in South East Asia is predicted to delay for fifteen days in the future. Variations are seen to be a decade and frequency and intensity of irregular flooding are the serious repercussions of the monsoon season that damages infrastructure and food security of the region meanwhile destructing the human life and causing serious financial losses. (Loo, Billa, and Singh, 2014).

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2. MATERIALS AND METHODS

Study Area: Bahawalpur is the study area for this research study. Bahawalpur district is located at the farthest south eastern part of the Punjab province, which is located on 28.83 N and 71.66 E. The region surrounding Bahawalpur to the west, called the Sindh, is a fertile alluvial tract in the Sutlej River valley that is irrigated by flood waters, planted with groves of date palms, and thickly populated Arid climate prevails all over the area. Monsoon rainfall is the major system that brings heavy rainfall during the summer months June, July and August. Western Disturbances also cause the light shower during the winter month December and January **Fig: 1**.

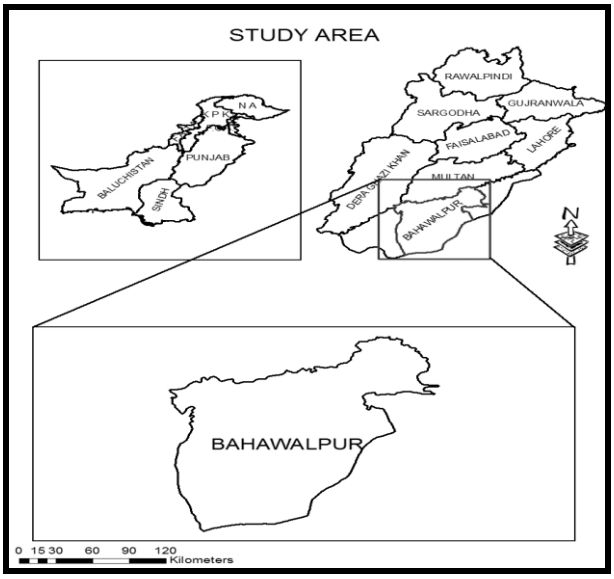


Fig: 1 Geographical location of Bahawalpur. 2014

Data of average monthly rainfall from 1960 to 2012 was collected from the Meteorological Department of Pakistan. To see the anomalous on decadal scale the average monthly rainfall was plotted with 2 decades data on one graph. Data received from the MET Department of Pakistan contains certain years when data was not available and where data was not available MET Department's data assigned -100 value to the average monthly rainfall for that particular month, so unavailable data is plotted with -100 which shows a value below zero and it must be understood from the graph that data was unavailable with the concerned department.

Literature Review

Active phase (AP) has quite a significant role in the mean seasonal rainfall in the Western Edge of the South-Asian Monsoon (WESAM). Before APs upper level warm anomaly can be seen over north Hindu Kush-Himalaya (HKH) which has given rise by the surface heating. Low-level anticyclone will be located at the east of warming and this will cause a convergence of moisture into WESAM region, as the heating kept on and convergence become stronger. (Syed, *et al.,* 2010)

Understanding of Natural climate variability bears much significance and efforts are made to justify that climate change is not due the anthropogenic activities. Both regional and global climates are suspected to vary, although irregularly with the Total Solar Irradiance (TSI) at decadal to centennial time scales. This study shows that irregular dry periods of the Indian monsoon are directly coincident with negative TSI derivative. (Rajesh, *et al.,,* 2011).

The frequency of occurrence of heavy rains exceeding 50 mm in 24 hours is a normal feature over the foothills of the Himalayas during the South Asian summer monsoon (June–September) (Rasul et al., 2005).The Himalayas are the major orographic barrier that separates Northern humid and southern arid regions. Indian summer monsoon transport moisture from the Bay of Bengal and cause really heavy rainfall when coupled with mountain front. Monsoon conveyer belt ends near the Sutlej Valley in the North West Himalaya where rainfall maxima move to the lower elevations. North West Himalaya consists of a climatic transition zone and most of the Indian summer monsoon strength concentrated in this area. Rainfall in these regions quickly triggered extensive erosional processes. These events have a decode recurrence interval in the existing monsoon circulation. (Bookhagen, *et al.* 2005).

The Indian Summer Monsoon (ISM) starts from June and ends in September and this system bring rainfall all over Indian continents primarily due to Land Sea heating between the Indian Ocean and large Asian land mass. ISM is controlled by low pressure zones over northwest sector and High Pressure zones on Mascarene and Tibet. Fluctuation in Indian Summer Monsoon Rainfall depends upon the change in wind circulation and temperature distribution, therefore it is quite important that to understand change in intensity and pattern of ISMR under warmer climate, it is necessary to quantitatively and qualitatively assess the change in wind circulation and distribution of temperature. (Parth *et al.,,* 2012).

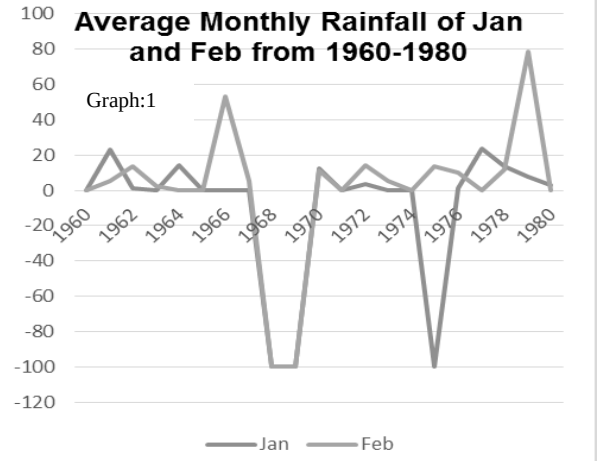
3. RESULTS AND DISCUSSION

Data Analysis and Findings:

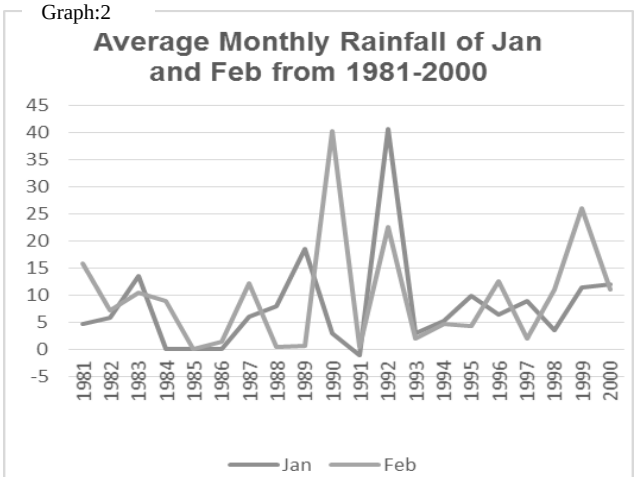
Graphs clearly depict that in every decade there is at least one peak value. In **Graph 1-4** shows the average monthly rainfall plotted from 1962-2012, Graph 1 and shows the data of 20, 20 years each while the Graph 3 shows the data of 12 years. Concentrating

on the anomalies, **Graph 1** shows very less irregular curve and showing only two peak values while **Graphs 2 - 4** show quite irregular curves showing more peak values. Looking at Graph 3 to 4 in the first two decades, there is only one peak value while all other value is quite small (Graph 3) while in Graph 4 curves shows more irregularities while in Graph 4curves of August shows regular increasing trend the last almost 10 years.

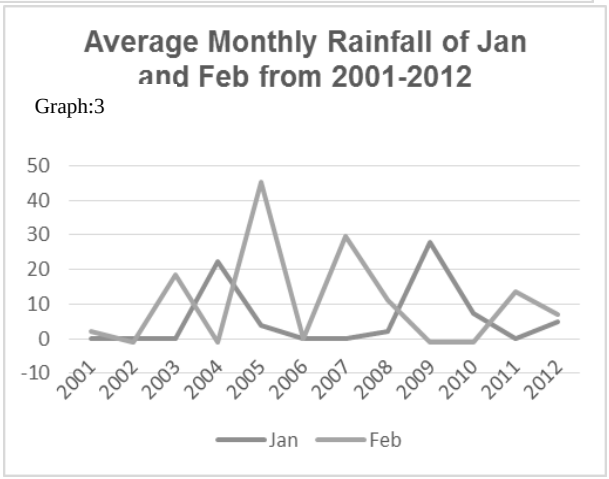
Graph:1



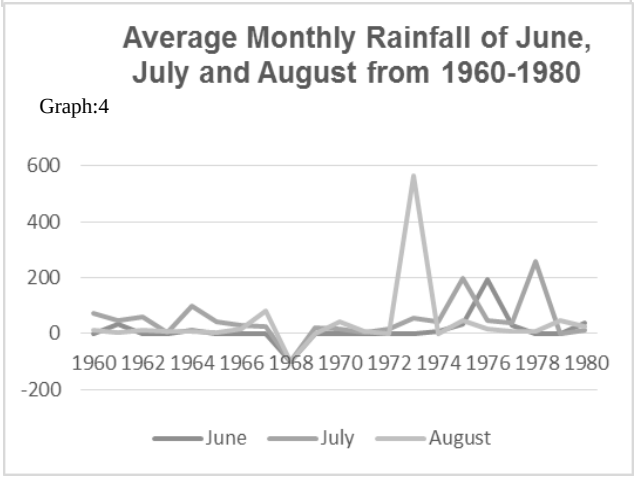
Graph:2



Graph:3



Graph:4



4. CONCLUSION

During the decade 1960 to 1970 and 1971 to 1980 abrupt peak values are present both in the monsoon months and winter showers while the rest of the curve doesn't quite irregular as most of the year show almost the same amount of rainfall, but in last three decades irregular curves show that anomalies are present both in summer and winter months and last decade shows most peak value in summer months. Whatsoever the reason may be but uniform irregularity is present in the amount of rainfall both in summer and winter months. Heavy rains exceeding 50 mm (sometimes 100 mm) in a day are common during the monsoon season in northeastern humid and sub-humid regions of Pakistan and Kashmir which is experienced as the gateway of the monsoon in the nation. Nevertheless, such events only occasionally occur southward where the climate is mainly arid These anomalies give rise to uncertainties and hence forth pre-monsoon droughts and post monsoon floods are quite conspicuous in this area.

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