Long term Analysis of Rainfall data of Fatehabad Districts of Haryana

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***Abstract*- One of the important scientific challenges faced by researchers worldwide is to have a better understanding about climate change and its effect at a regional scale. is one of the important climatic variables responsible for climate change. Rainfall pattern at regional scale can be well studied to ascertain the climate change which is a global phenomenon. However, for all the regions the changes are unequal and have localized intensity. The effect can be further well studied in tropical semi arid regions which are most likely to be affected by climate change. Fatehabad district of Haryana state is situated in northern part of India and agriculture plays a vital role in the state's economy which is greatly dependent on rainfall. Any change in rainfall pattern due to climate change can adversely affect the agricultural production. Therefore, it should be quantified at a local scale. Keeping this in mind, an attempt has been made to analyze the temporal variability in rainfall pattern and trend over a period of 113 years (1901-2013) for Fatehabad district of state of Haryana. Long period (1901-2013) rainfall has been analyzed thoroughly for temporal variation at annual and seasonal time step. Various descriptive statistics, computation of running average normal rainfall, deviation from normal rainfall, decadal frequency analysis for deficient and excess rainfall were used for analysis. The results of the analysis indicate the average rainfall is 360mm with a standard deviation of 105.33mm. About 78% of the annual normal rainfall is received during the south-west monsoon period. The rainfall has increased for all seasons except winter during and deficient and excess rainfall have occurred almost with equal frequency during the study period.**

Keywords: Rainfall, monsoon, seasonal variation, decadal rainfall, normal rainfall

I. INTRODUCTION

The rainfall received in an area is an important parameter which determines the availability of required quantity of water to meet various types demand including agricultural, industrial, domestic water supply and power generation as well [1]. Thus, rainfall has profound effect on the agriculture and related industry and power generation of the country like India. In a nutshell the economy, energy and food security of the country is largely being controlled by availability of adequate amount of water or normal rainfall. The amount rainfall hugely varies over time and space in India. In India, rainfall generally occurs in monsoon season (June-September) with erratic rainfall during rest of the months of the year. Thus, proper attention should be given towards the variation of rainfall since it affects the food production and availability of fresh water [2]. Moreover due to changing global meteorological phenomena and climate change the unset and offset of monsoon has also badly affected over the last few decades. Studies have shown that change in the rainfall pattern has considerably affected the water and agriculture sector of Asia Pacific region [3]. Thus rainfall variation can be considered as indirect indicator of global/regional level climate change. The changed pattern of monsoon rainfall accompanied by population growth, increased urbanization frequently causes extreme events like floods, draughts.

Therefore, several studies have been carried out worldwide to analyze spatial and temporal variations in rainfall [4], [5], [6]. In line of the above facts, the present study attempts to address the following objectives: (a) to expore the temporal variation in rainall pattern of Fatehabad district of haryan during 1901-2013, (b) to analyze the variation in normall rainfall over the study period, (c) season and annual deviation in rainfall, and (d) to explore the frequencyof flood and dry years at decadal scale.

According to the report of Intergovernmental Panel on Climate change (IPCC) [7], the seasonal, annual and spatial variation in precipitation trends were observed during past decades in all over Asia. It has been observed that precipitation has increased with in 10° N to 30° N for few decades from the year 1900 onwards and a decrease has noticed after 1970. A decreasing rainfall trend was noticed in the tropical areas from 10° N to 10° S. whereas the tropical and sub-tropical regions were facing increased draughts due to decrease in precipitation since 1970. Increasing summer rainfall was found in eastern Australia during 1950s. This study gives Fatehabad district information on rainfall trend on long term basis and the impact of climate change in different parts of Haryana which will be helpful for a water resources manager in the planning and management of water resources for sustainable development.

II. STUDY AREA

Fatehabad is located at 29.52°N 75.45°E. It is located in the south western part of Haryana. It is surrounded by Punjab in north, district Hisar in south, district Jind in east & Rajasthan in the west. The geographical area of the

district is 2520 Km² covering around 5.4% of the state of Haryana. It has an average elevation of 208 meters (682 feet). Ghaggar River is passing through Northern western part of the district. The district has adequate drainage facilities which prevent the district from floods. The water of the river and drains is being harvested for crop production. The climate of Fatehabad district is very hot in summer and very cold during winters. Temperature ranges from -1 to 48 degree Celsius. Annual rain fall is around 280 mm. Topography of the district is plain and sand dunes. Soils are sandy, sandy loam and clay. Paddy-wheat and cotton-wheat is the main crop rotation followed in the district.

III. MATERIALS AND METHODS

In line with framed objectives the methodology has been divided into three major parts such as: (a) Data collection and input, (b) Data processing function and (c) Presentation of output.

Historical monthly rainfall data of Fatehabad district for the period 113 years from 1901 to 2013 has been obtained from the Indian Meteorological Department (IMD) and India Water Portal [8]. The monthly rainfall data collected were categorized into seasonal data: monsoon (June-September), post monsoon (October and November), winter (December- February) and pre monsoon (March-May). Descriptive statistics such mean monthly, seasonal and annual Standard Deviation (SD) and Coefficient of Variation (CV) were computed at seasonal and annual time step to obtain the distribution of rainfall in different seasons with their % sharing.

In order to explore the historical changes in normal rainfall of the district a 30 year running average of were determined. This information was later on used for determining the percentage deviation in rainfall amount in a particular year at seasonal and annual time steps. Finally, the decadal frequency of drought and excess rainfall were determined.

IV. RESULTS AND DISCUSSION

A. Descriptive statistics

Rainfall characteristics of the Fatehabad district determined using long term (1900-2013) rainfall monthly rainfall data are presented in the Table 1. The table shows that July and August are the months during which the study area receives maximum rainfall while rainfall is least during October and November. Rainfall during July is the highest (111.31 mm) and contributes 30.86 % of annual rainfall (360.62 mm), followed by August (29.62 %) and September (13.71 %). Least amounts of rainfall are observed during the month of November (2.94 mm) followed by October (3.16 mm), which contribute only 0.83 and 0.87 % to the annual rainfall respectively.

Historical data indicates that there is huge uncertainty in the amount of rainfall during these two months or post monsoon seasons followed by pre monsoon months or seasons. The uncertainty in rainfall is least in the month of July.

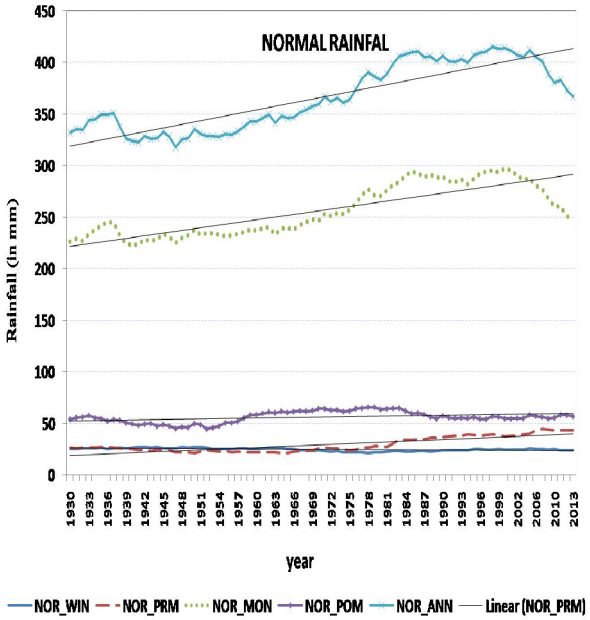
Table 1 Descriptive statistics of rainfall data of Fatehabad district (1901–2013)

Month/ season	Mean (mm)	SD (mm)	CV (%)	% of annual rainfall
January	9.61	8.14	84.66	2.69
February	10.39	9.23	88.77	2.91
March	9.19	9.07	98.72	2.57
April	7.56	7.56	100.00	2.11
May	12.56	11.61	92.40	3.51
June	33.13	24.60	74.25	9.27
July	111.31	56.95	51.16	31.13
August	106.84	55.63	52.07	29.88
September	49.47	35.79	72.34	13.84
October	3.17	3.77	119.14	0.89
November	2.95	5.59	189.61	0.82
December	4.43	5.74	129.53	1.24
Winter (Dec–Feb)	24.16	14.43	59.70	6.76
Pre-Mon (Mar–May)	30.28	20.97	69.24	8.47
Monsoon (Jun–Sep)	279.08	122.53	43.91	78.06
Post-Mon (Oct– Nov)	5.89	6.96	118.21	1.65
Annual	357.53	105.34	29.46	100.00

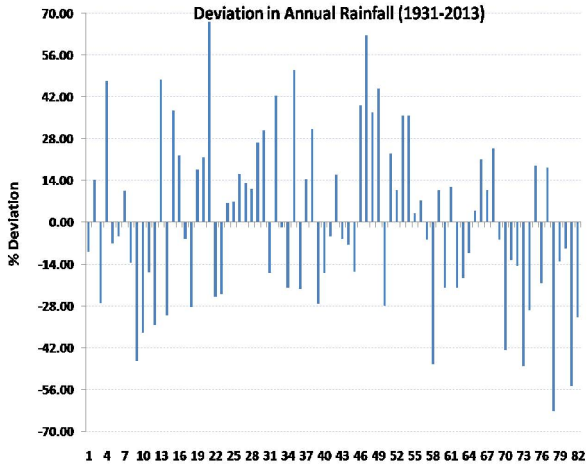
The monsoon season contribute around 78% of annual rainfall of the region followed by premonsoon season which contribute 8.5% of annual rainfall. Although monsoon season has maximum variability of amount of rainfall but it has least uncertainty in amount rainfall compared to other season prevailing the study area. Significant relationship between SD and CV has been observed during the months of highest rainfall (July and august). The average annual normal rainfall over the Fatehabad from 1901 to 2013 is 360.62 mm with a standard deviation of 105.33 mm. The coefficient of variation of annual rainfall is 29.20 % indicating that it is moderately variable.

B. Normal rainfall

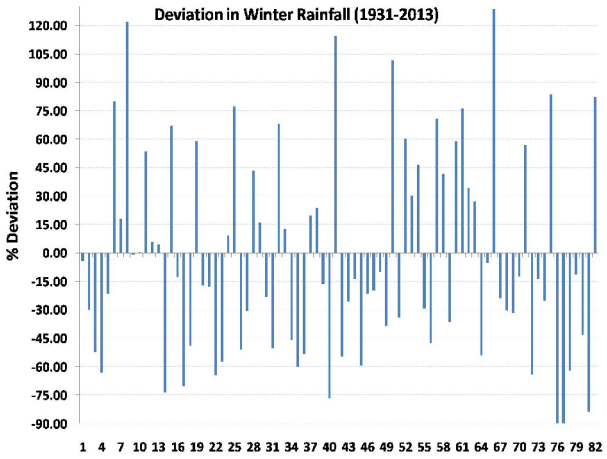
"Normal" precipitation (rainfall) is an average of the precipitation values over a 30-year period. Precipitation may very often be either well above or well below the seasonal average or "normal." To understand the epochal behavior of rainfall series for different months, we have also calculated 30-year running means of each of the months. The normal rainfall season wise and annual are shown in Figure 1.



The figure clearly indicates that the normal rainfalls of year of all the seasons are varying temporally. However there is slight increase the normal rainfall of different seasons as well as annual one as indicated by the regression line. In order to understand the variation in normal rainfall with an annual rainfall for particular year, percentage deviations of annual and seasonal rainfall data were calculated and presented in figures 2 (a-e). These help in understanding the rise and fall of the normal rainfall during respective year. The percentage deviation for normal were found to be around ± 65%. (Fugure 2a) which is quite low as compared to seasonal % deviation of the all the four seasons. The maximum percentage deviation were observed for post monsoon season (+ 190 to -100) indicating that wide variability or uncertainty of amount of rainfall during post monsoon. These observations necessities for the proper planning in relasing of water in canal for rabi crop of the region.



(a)



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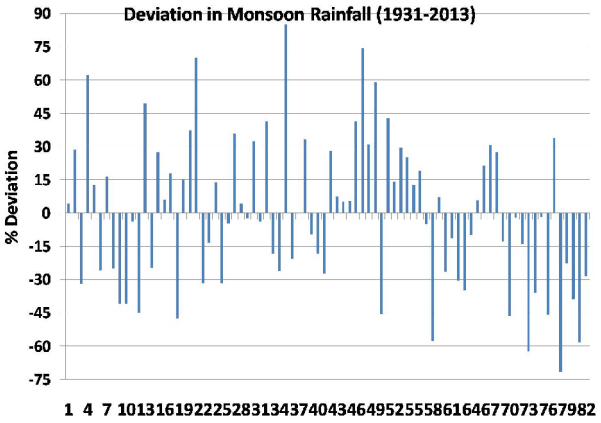

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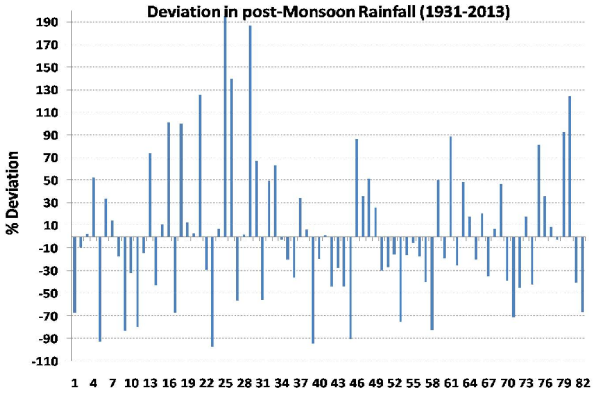

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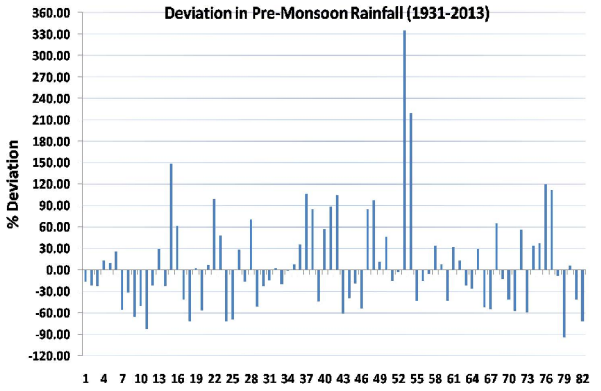
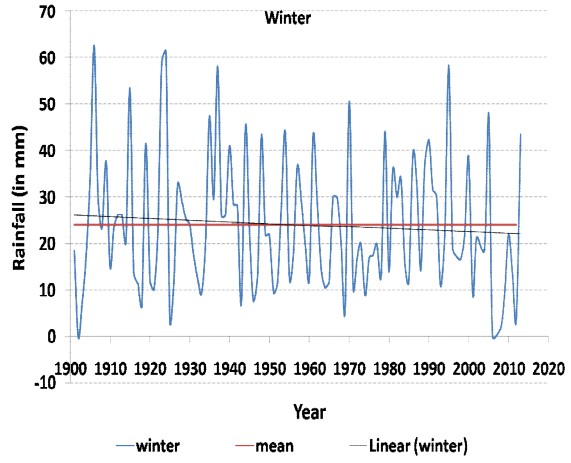


(e)

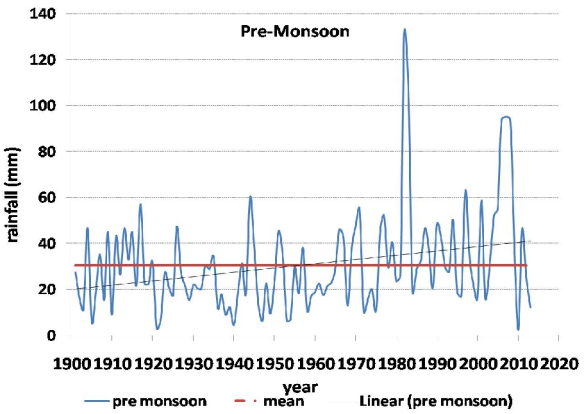
Figure 2(a-e): % deviation from normal rainfall

C. Seasonal variation in rainfall

The season variation in temporal trned in of rainfall was analyzed by plotting the seasonal time series of rainfall data along with their mean and regression lines which shown in Figure 3(a-d). The figures show that there is a decrease in only winter rainfall (Figure 3a) and for rest of all the three seasons there are increments in rainfall over the studied period (figure 3b-3d). The increase is highest for premonsoon followed by monsoon and post monsoon. The temporal variations during all the seasons are highly noisy with numbers of crests and troughs above and below the mean rainfall over the studied period in the respective seasons.



(a)



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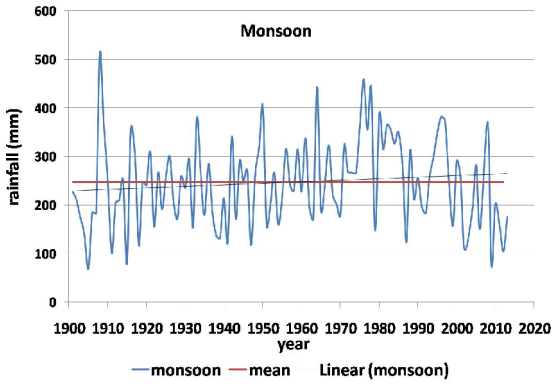

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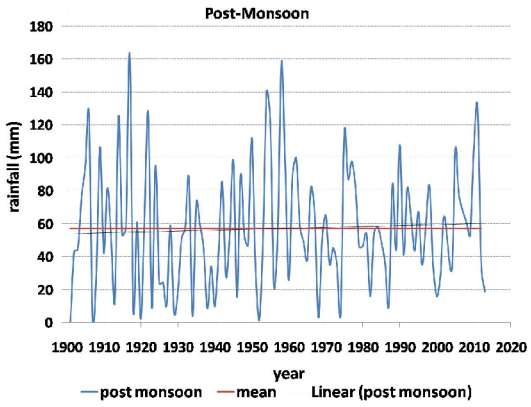

(d)

Figure 3 (a-d): Seasonal variation in temporal trend in rainfall data

For winter season crests and troughs are of equal amplitude and uniformly distributed over the study period. Incase of premonsoon crests are large than troughs in their amplitude and more frequent at the end time series (after 1980). This may be because of increased number cyclonic or orographic storms due to changed mean temperature followed by climatic changes. Monsoon seasons have crest and trough with smaller amplitude relative to its mean. All these observations quite agree with findings of Kumar et al. [9]

D. Decadal rainfall pattern and Deviations

It is well known that Indian annual rainfall displays multi-decadal variations in which there is a clustering of wet or dry anomalies. Thus decadal analysis of deficient and excess rainfall was carried out and the results are presented in Table 2.

Table 2: Decadal frequency of deficient and excess rainfall

Decade	Decadal Mean %departure from normal	Freq. of Deficient year	Freq. of Excess year
1931-40	-8.07	3	1
1941-50	11.42	3	5
1951-60	4.54	2	2
1961-70	4.33	3	3
1971-80	16.42	0	5
1981-90	3.90	2	2
1991-00	-5.33	2	2
2001-10	-22.51	6	0

The deficient or excess annual years are defined for those years where annual rainfall percentage departures from the mean rainfall percentage are less or more than the ± 20 % mean normal rainfall of the decade. During the study period (1930–2010), there were 21 years which were recorded annual rainfalls below average whereas 20 years the annual rainfall were observed to higher to excess of decadal mean normal rainfall. Thus, frequencies of normal rainfall and anomalous rainfall are almost equal and among

the anomalous rainfall year excess and deficient rainfall occurred with same frequencies. The alternating sequence of multi-decadal periods having frequent droughts and flood years are clearly noticed in Table 2. We can delineate 1931-1940 and 2001-2010 as dry period, 1941-50 and 1971-1980 as wet period, 1951-1970 and 1981-2000 have the same frequency of deficient and excess year of rainfall. As such 2001-2010 is considered to be the worst decade of deficient rainfall and 1971-1980 is the decade of most excess rainfall during the study period.

V. CONCLUSION

Long term (1900-2013) trends of monsoon rainfall for the Fetehabad district have been studied both annual and seasonal scale separately. The average annual normal rainfall over the Fatehabad from 1901 to 2013 is 360.62 mm with a standard deviation of 105.33 mm. It is found that the monsoon rainfall is without any strong trend in nature over the study period. However, it was also observed that there is a great seasonal variation in rainfall trend. The percentage deviations of season rainfall were found to be more for dry periods (post monsoon and premonsoon) than monsoon season. The trend analysis shows that except in winter overall trends show an increment in rainfall. The decadal percentage deviation analysis also did not show any cycling pattern in decade of rainfall excess and deficient years indicating the rainfall variation in the region is extremely complex function of various meteorological parameters. It can be suggested that the incorporation of spatial variability (multiple rain gauge stations along with other parameters) may help to understand any significant pattern in historical rainfall data of the region.

VI. REFERENCES

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