Decadal Comparison of Rainfall Seasonality Index in Gujarat

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ABSTRACT

The study of seasonality index is important to know mean rainfall and its variability for the planning and management of agriculture and water resource systems, especially during dry climate periods. The present work contributes to understand the decadal variation of rainfall pattern in Gujarat state. Monthly rainfall data of Gujarat state was collected from India Meteorological Department (IMD) from eighty years. Here, first ten- ten years data are separated, then monthly and seasonal scale are developed. Mean rainfall and coefficient of rainfall are studied to get the pattern and variability in rainfall. The seasonality index which is the measure of absolute mean monthly rainfall from the overall monthly mean divided by the mean annual rainfall. This study will help to improve the planning and management pattern of rainfall for agriculture and water resource system in this region.

Keywords: Gujarat, Rainfall Pattern, Seasonality Index, Water Resource Systems.

1. INTRODUCTION

There is need to study the change in the spatial and temporal rainfall pattern in order to improve water planning and management of agriculture as well as water resource systems, especially during dry climate periods of a given region [1]. In past few decades, the study of rainfall characteristics has attracted attention; due to change in climate and extreme weather conditions [2]. Rainfall seasonality is a complex concept which incorporates a number of independent components [3].

[4] Studied the changes in rainfall pattern in Maharashtra. [5] Studied the seasonal rainfall variation for regions of India. Some studies like [6] studies the various rain events using the daily grid to find out regional trends in rain events over India, [7] they studied the characteristic and climatological features of daily rainfall over Andaman and Nicobar Islands and [8] study reveal rainfall in the part of north western Himalayas Kashmir and Deccan plateau in the south is increasing and part of Gangetic Plain and parts of Uttaranchal is decreasing. [11] They studied the frequency of rain events in India in terms of duration and intensity. [9] They analysed the impact of climate change on extreme rainfall events and flood risk in India. [10] They try to find out increasing and

decreasing trends in the frequency and the magnitude of extreme rain events. Therefore, in present paper, a study has been undertaken to understand the characteristics and climatological features of monthly and yearly rainfall over Gujarat state that will help to improve the planning and management pattern of rainfall for agriculture and water resource system of region.

2. STUDY AREA AND DATA COLLECTION

Gujarat is a state in the North-West coast of India and covers a geographical area of 196,204 square km. The population of Gujarat is 62,700,003 as per 2013 census. Gujarat State is having 23^0 N as latitude and 72^0 E as longitude. It is bounded by Arabian Sea on its western side. The state of Rajasthan lies north of it, while Madhya Pradesh and Maharashtra lie on the eastern sides of Gujarat. The UT of Daman, Diu, Dadra and Nagar Haveli lie to the south of Gujarat. Gujarat geographical location is such that it is subjected to different types of climatic features. The state receives rainfall mainly during the southwest monsoon season (June to September). The southern parts of the state receives rainfall of 760 to 1520 mm, northern part 510 to 1020 mm, while Saurashtra region receives less than 630 mm. Gujarat is having important rivers like Narmada, Tapi and Sabarmati etc..

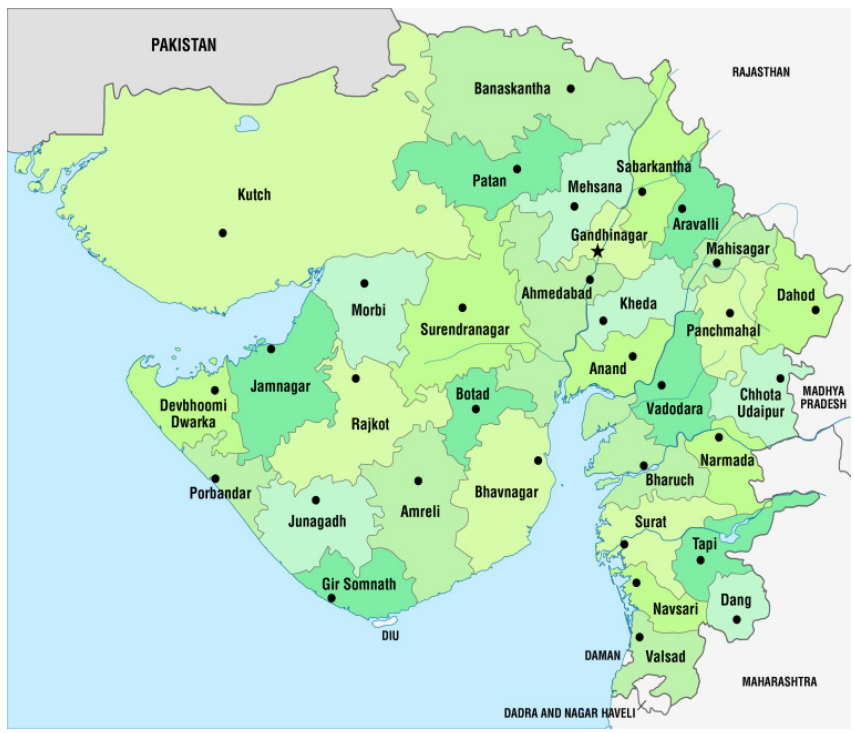

Figure 1: Gujarat map (source: en.wikipedia.org)

The necessary data were collected to understand the decadal variation of rainfall pattern in Gujarat state. Monthly rainfall data of Gujarat state was collected from 1930 to 2012 National Data Centre of India Meteorological Department (IMD), Pune.

3. METHODOLOGY

Seasonality Index helps in identifying the rainfall regimes based on the monthly distribution of rainfall. Seasonal contrasts can be define as, the Seasonality Index [12], which is a function of mean monthly and annual rainfall, is computed using the following formula: where Xn is the mean rainfall of month n and R is the mean annual rainfall.

$$SI = \frac{1}{R} \Sigma_{N=1}^{12} \left| Xn - \frac{R}{12} \right| \quad (1)$$

Theoretically, they can vary from zero (if all the months have equal rainfall) to 1.83 (if all the rainfall occurs in one month). Table 2 shows the different class limits of SI and representative rainfall regimes [12]. Though the method uses the distribution of rainfall for all the 12 months, the index as table shows identifies the seasonal pattern when the value is more than 0.6.

This study aims to find the changing pattern of rainfall over Gujarat in the district scale which may have an impact on increasing extreme rainfall events and floods or drought over Gujarat. The distribution of rainfall throughout the seasonal cycle is as important as the total annual amount of monthly or annual rainfall while evaluating its impact on hydrology, ecology, agriculture or in water use.

Table1: Seasonality Index (SI) classes and the associated different rainfall regime

Rainfall regime	Seasonality Index (SI)
Very equable	≤ 0.19
Equable but with a definite wetter season	0.20 -0.39
Rather seasonal with a short drier season	0.40 – 0.59
Seasonal	0.60 – 0.79
Markedly seasonal with a long drier season	0.80 – 0.99
Most rain in 3 months or less	1.00 -1.19
Extreme, almost all rain in 1- 2 months	≥ 1.20

The seasonal distribution of precipitation is the result of revolution of the earth resulting in the unequal heating of the earth's surface over the year and thus resulting in the atmospheric general circulation. The time and duration of the seasons of high precipitation at a place or watershed is most important for the planning and design of agriculture or water management. The distribution of rainfall through the season or year plays an important role in recharging the ground water. It is very important to identify the historical changes in the mean annual precipitation. But even in the absence of changes in annual total precipitation, changes in the seasonal receipt of precipitation greatly affect partitioning of water into runoff, evapotranspiration and infiltration and thus flood forecasting, stream discharge and ecosystem responses. The changing pattern of rainfall is also investigated by computing Seasonality Index of rainfall. The understanding of seasonality pattern of precipitation and also identifying changes in seasonality index is very useful for agricultural planning.

4. RESULTS

Figure 2 show the mean average rainfall (in mm) of Gujarat district in which Dangs, Narmada and Surat shows the maximum rainfall and Kutch, Banas Kantha and Patan shows the minimum rainfall.

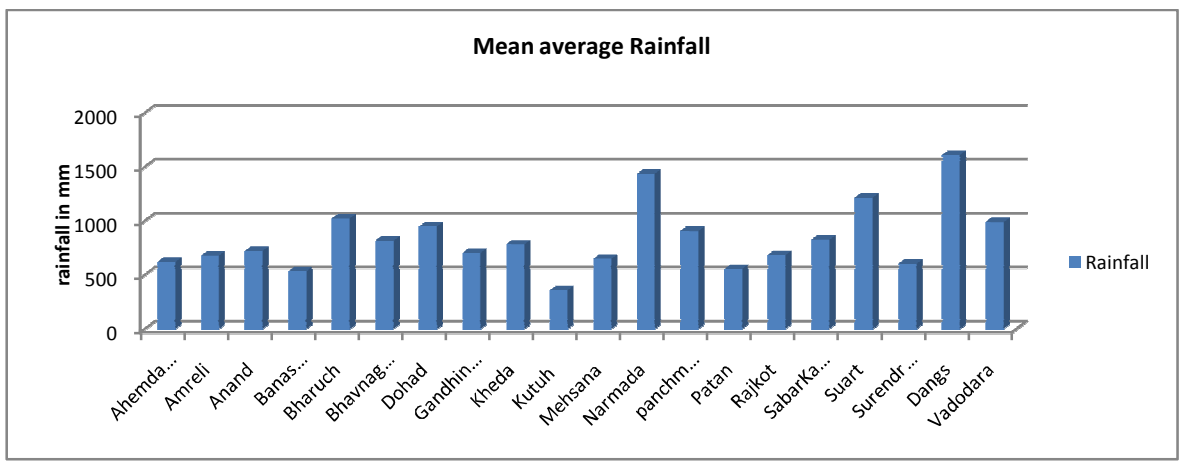

Figure 2: Mean Average Rainfall (in mm)

The seasonality index has been computed for 20 major districts of Gujarat from year 1932 to 2011 dividing it into eight decadal group showing 1932 to 1941, 1942 to 1951 and so on and calling them 1st decade, 2nd decade and so on. This will help to find out any changes in this region over the period. Table no 2 show the Seasonality Index of 20 district of Gujarat for 8 decade. Figure 2 gives the comparisons of Seasonality index between them in graphical form.

Table2: Seasonality Index (SI) of different district

District	1932-1941	1942-1951	1952-1961	1962-1971	1972-1981	1982-1991	1992-2001	2002-2011
Ahmedabad	0.464	0.3589	1.397	0.2739	0.2378	2.0456	0.1217	1.6307
Amreli	1.766	0.2934	1.3134	0.1541	0.2717	0.9361	0.8429	1.2659
Anand	0.385	0.3361	0.9486	0.5287	0.2381	1.8975	0.4034	2.841
Banas Kantha	0.509	0.2817	0.9694	1.9535	0.4753	1.9019	0.3921	2.2465
Bharuch	0.611	0.624	1.2246	0.0404	0.0895	0.7423	0.4084	0.9516
Bhavnagar	0.779	0.184	1.3422	0.461	0.3411	0.6187	0.801	1.73
Dohad	0.926	0.934	1.804	0.846	0.47	1.201	0.433	1.654
Gandhinagar	0.478	0.0048	1.326	0.968	0.421	1.497	0.379	1.542
Kheda	0.02	0.164	1.15	1.028	0.167	1.748	0.55	2.202
Kutch	1.415	1.152	2.336	0.911	0.497	2.886	0.849	2.684
Mehsana	0.497	0.109	1.475	1.103	0.563	1.668	0.149	2.206
Narmada	0.722	1.637	1.216	0.195	0.158	0.186	0.668	2.258
panchmahals	0.833	1.024	1.966	0.854	0.493	1.164	0.304	1.99
Patan	0.918	0.085	1.745	1.286	0.035	2.216	0.112	2.298
Rajkot	1.599	0.44	2.1	0.778	0.558	2.059	1	1.211
SabarKantha	0.133	0.74	1.427	1.364	0.089	1.571	0.275	0.821
Surat	1.3	0.223	0.043	0.629	0.998	0.818	0.323	3.887
Surendranagar	0.487	0.114	2.116	0.208	0.938	2.14	0.591	0.697
Dangs	0.216	0.651	0.179	0.524	0.548	0.072	0.18	3.416
Vadodara	0.009	0.64	1.315	0.825	0.059	1.23	0.26	0.318

From Table 1, lower the seasonality index value better the distribution of monthly RailFall throughout the year. And the maximum seasonality index value show that rainfall occur mostly in 1-2 months.

From figure 3, Ahmedabad, Anand and Banas Kantha the decade 6^{th} and 8^{th} have higher value of seasonality index than 1.5 that shows maximum rainfall occur in 1 month and same in 1^{st} decade of

Amreli. Kutch is having value higher than 1.5 in 3rd, 6th and 8th decade, Kheda in 6th and 8th decades, Dahod in 3rd and 8th decade in this region rainfall occurs in one month. Same condition in 3rd, 6th and 8th decades of Mehsana, Patan, Rajkot and 8th decade of Narmada and Panchmahals. From fourth graph Surat and Dangs is having high values in 8th decade.

The value below 0.15 was noted at 4th and 5th decade of Bharuch, 7th decade of Ahmedabad, 2nd decade of Gandhinagar, 1st decade of Kheda, 2nd decade of Mehsana, 1st and 5th decade of SabarKantha, 3rd decade of Surat and 6th decade of Dangs which indicate rainfall occur very equable during this period.

Seasonal rainfall occur were value lies between 0.6 to 0.79 and that was noted at 1st and 2nd decade of Bharuch, 6th decade of Bhavnagar, 1st and 7th decade of Narmada, 4th decade of Surat, 8th decade of Surendranagar and 2nd decade of Dangs and Vadodara. This implies that rainfall was evenly distributed in 4 months.

When seasonality index is low that indicates that the rainfall occur in shorter day season. When the value is high that indicates most of the rainfall occurs within few months. Thus, an increasing trend in seasonality index is thus an indication of alarming situation for the agriculture.

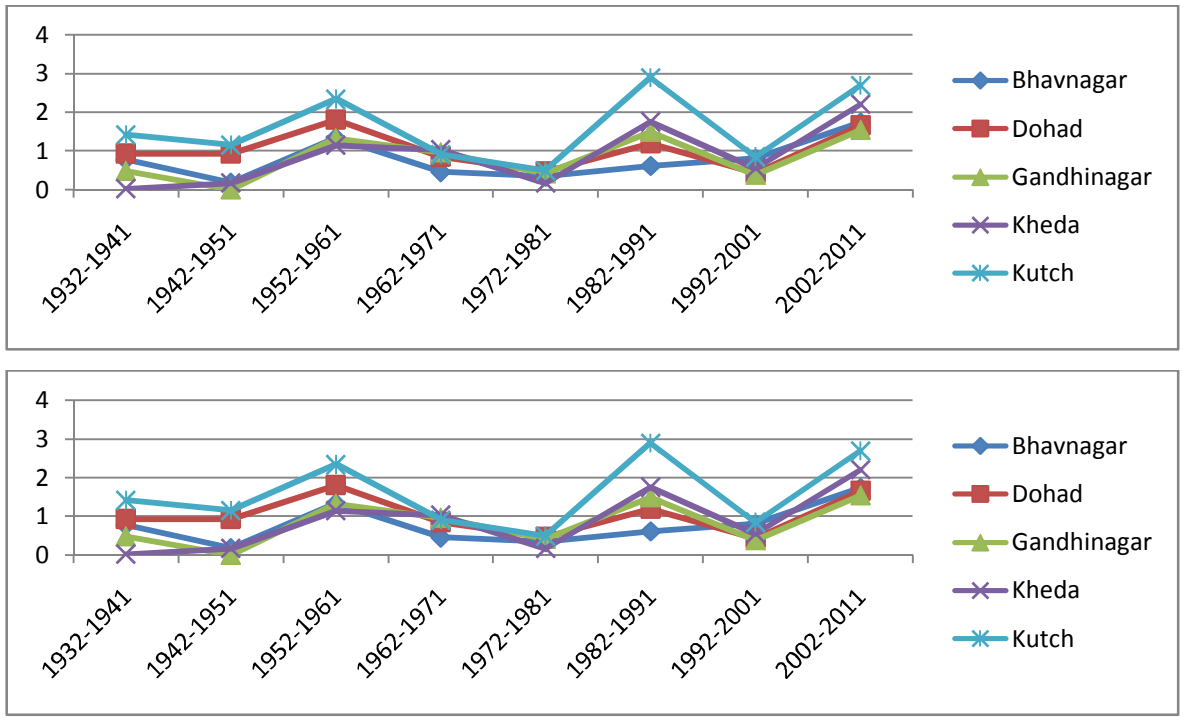

Figure 3: Seasonality Index (SI) of different district

5. CONCLUSION

From this analysis variability of rainfall and change in spatial and temporal pattern of seasonality index is observed. These changes play an important role from agricultural and hydrological point of view. At final 8th decade except Vadodara, Surendranagar, SabarKantha and Bharuch all the other district trend line is increasing that implies that shorter period of intense rainfall which is alarming situation for the agriculture.

Due to increasing in seasonality trends most rain fall occurs in one or two month and no rainfall in first five month of the year have resulted in increase in heating. This may result in lowering of ground water and insufficient soil moisture.

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