IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

CHANGES IN RAINFALL PATTERN IN HAVERI DISTRICT: A GEOGRAPHICAL STUDY

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: ABSTRACT:

Rainfall is one the important climatic factor, which varies from year to year. To know the extent of variation in the rainfall pattern in the study area, time series yearly rainfall data were used for a period of 23 years *i.e.* from 1990 to 2012 and the data were collected from the different rainfall stations in Haveri district. The annual rainfall (mm) and the deviation from the mean were computed and are presented in the Table 4. 1. Increasing and decreasing mean annual rainfall were found in the results. It indicated that rainfall was not uniform over the years. The mean rainfall for 23 years was 485 mm.

Introduction :

In every economy which depends on the agriculture, rainfall is very crucial for the economic development. In no area the rainfall is uniform over the years. In order to study the impact of changes in rainfall pattern on cropping pattern of the district, 10years time series data on actual rainfall and area, production and productivity of Paddy, Maize and Groundnut were used. The data on area, production and productivity of Paddy, Maize and Groundnut were collected from the District Statistical Office in Haveri and rainfall data was collected from the different rainfall stations in the district.

Climate change refers to statistical variations in properties of the climate system such as changes in global temperatures; precipitation etc, due to natural or human drivers over a long period of time. Climate change could drastically alter the distribution and quality of natural resources there by adversely affecting livelihood security of people. Observations of Inter governmental panel on climate change (IPCC) indicate adverse impact of climate change due to rising temperatures and extreme weather events on food production system could impact agricultural growth. Climatic fluctuations could adversely affect agricultural sustainability resulting in unforeseen situational shortages which could also impact other economical sector.

Agriculture mainly depends on the rainfall performance, although there are other factors such as high cost of production, poor market prices, reduced farm land prices, reduced farm land sizes due to population, which contributed to the decrease in the agricultural productivity. But, changes in rainfall pattern plays the key role in the agricultural performance. Changes in rainfall patterns alter farming activities with overall negative effects on the final yields.

The district enjoys sub-tropical climate with temperature ranging in between 18 and 40^0C. The rainfall varies in the district from 1110 mm in West (Hanagal) to less than 671 mm in East (Ranebennur). October is the wettest month with normal monthly rainfall in all hydro

meteorological stations recorded in excess of 80 mm. During the year 2011, the annual rainfall in all the taluks was normal except in Shiggoan taluk where it received deficit rainfall and Hanagal taluk received excess rainfall.

In order to study the impact of changes in rainfall pattern on cropping pattern of the district, 10years time series data on actual rainfall and area, production and productivity of Paddy, Maize and Groundnut were used. The data on area, production and productivity of Paddy, Mai

ze and Groundnut were collected from the District Statistical Office in Haveri and rainfall data was collected from the different rainfall stations in the district.

In this context, the present study with the following specific objectives was an attempt to analyse the rainfall changes in Haveri district and impact of these rainfall changes on Agriculture in the district. This will throw light on the adaptation (coping) measures farmers need to follow during times of changing rainfall in order to improve their crop production. The study will help to develop agricultural adaptation and mitigation strategies in the face of climate change as an integral part of agricultural development and food security policy.

Objectives :

1. To analyses the changes in rainfall pattern in Haveri District.
2. The variation in the rainfall over the years in the study area.

Hypotheses :

1. The rainfall pattern in Haveri district has changed over the years.

Methodology :

Scientific study of any problem requires a systematic investigation using appropriate method and procedures in order to arrive at a reliable unbiased and practical conclusion. Beginning with a general description of the study area, the data base and the analytical tools and techniques used in the present study are discussed in this chapter. This chapter is arranged under the following headings,

1. Description of the study area
2. Sampling procedure
3. Nature and sources of data
4. Analytical framework

Study area :

Haveri district popularly known for Byadgi Chilli variety and Chilli market in South East Asia is almost in the center of Karnataka. Geographically the district is situated between North latitude 14^0 28′ to 14^0 39′ and East longitude 75^0 01′ to 75^0 38′. Haveri is one of the newly formed districts of Karnataka, a decade ago on 15^{th} august 1997. The district is located in Northern-semi-rainfed and Malnadu zone. The district is bounded on the North by Dharwad and Gadag districts, on the East by Bellary district, on the West by Uttarkannada district and on the South by Davanegere and Shimoga districts. Dharma, Kumadwati, Varada and Tunga Bhadra are the four rivers flowing in the district. The general information about the district is given in the Table 3.1. The study area is depicted in Fig. 1.

The study has been conducted in seven taluks of Haveri district of Karnataka, namely Haveri, Byadgi, Hanagal, Hirekerur, Ranebennur, Savanur, and Shiggoan.

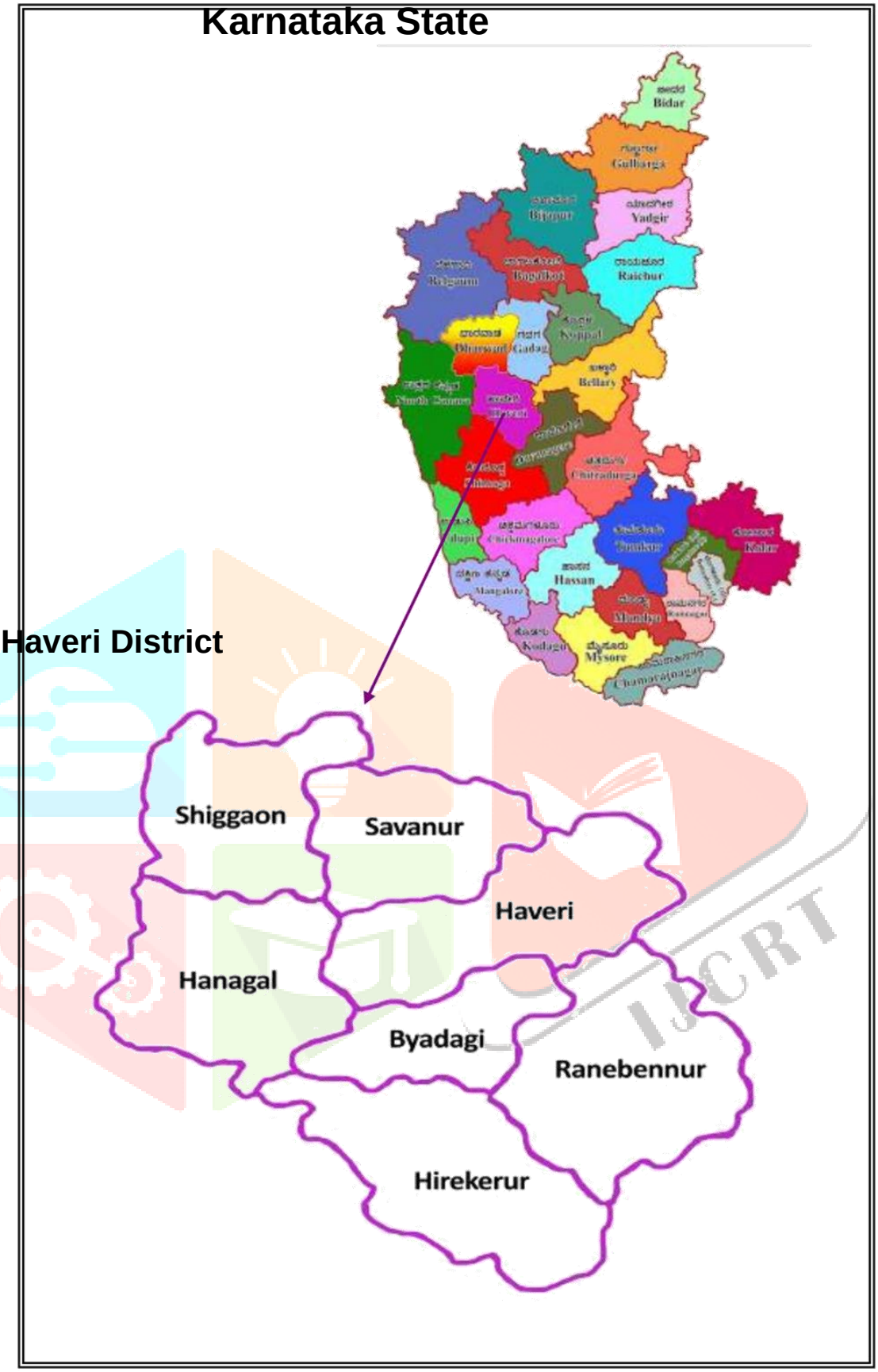

Fig. 1: Haveri district map

Climate and Rainfall :

The district enjoys sub-tropical climate with temperature ranging in between 18 and 40^0C. The rainfall varies in the district from 1110 mm in West (Hanagal) to less than 671 mm in East (Ranebennur). October is the wettest month with normal monthly rainfall in all hydro meteorological stations recorded in excess of 80 mm. During the year 2011, the annual rainfall in all the taluks was normal except in Shiggoan taluk where it received deficit rainfall and Hanagal taluk received excess rainfall.

Soils :

Haveri district is characterized by different types of soil like Red sandy soil, Medium black soil, Deep black soil, Red loamy soil and Lateritic soil. Presence of this kind of soils helps for cultivation of Paddy, Maize, Jowar, Ragi, Oilseeds and Pulses in the district.

Land use pattern :

Land use pattern in the Haveri district (2011-12) is presented in the Table 3.3. It can be observed that net area sown accounted for 75 per cent of the total geographical area, of which Haveri taluk occupies the first position followed by Ranebennur taluk. Around 10 per cent of area is forest land. Land put to non-agricultural uses occupied a share of 7 per cent of total geographical area. The area fallow land is 3 per cent, other. Barren land occupied area of about 1 per cent and permanent pastures formed 2 per cent of the total geographical area. The area under arable land but not available for cultivation accounts for about 1 per cent of the total geographical area in the district. Area sown more than once accounted for 10 per cent of total geographical area and trees and groves occupied 2 per cent of the total geographical area.

Cropping pattern :

The area under the major crops in Haveri district (2011-12) is presented in the Table 3.4. It can be observed from the Table that Maize is the major cereal crop in the district occupied an area of 51.47 per cent of the total cropped area with the highest area in Haveri taluk, followed by Hirekerur taluk. Paddy is the second major cereal crop which occupied an area of 18. 40 per cent of the total cropped area with the highest area in Hanagal taluk followed by Shiggoan taluk. Similarly Jowar and Ragi occupied 11.20 and 0.22 per cent of the total cropped area. Pulses occupied 4. 9 per cent of the total cropped area, oilseeds occupied 11.16 per cent of the total cropped area and sugarcane occupied 2 per cent of the total cropped area in the district.

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Table 1
List of selected rainfall stations in the district

Sl. No.	Name of the Taluks	Rainfall stations name
1	Shiggaon	Shiggaon
		Bankapur
		Tadasa
		Dundasi
2	Savanur	Savanur
		Hattimattur
		Kunimellahalli
3	Ranebennur	Ranebennur
		Asundi
		Kuppelur
		Hanamanamatti
		Medleri
4	Byadgi	Byadgi
		Hedigonda
		Kaginele
5	Haveri	Haveri
		Devihosur
		Hosaritti
6	Hanagal	Hanagal
		Bommanahalli
		Havanagi
		Sammasagi
		Naganur
		Adur
		Tilavalli
7	Hirekerur	Hirekerur
		Rattihalli
		Hamsabavi
		Madagamasur
		Masur

Year wise annual rainfall and deviation from the mean in the district :

During 1990, the annual rainfall was 311.78 mm and the deviation from the mean was -35 per cent, it indicated that the annual rainfall was less than the normal rainfall. But during 1991, the annual rainfall increased to 576.8 from 311.78 mm and the deviation from the mean was 18 per cent, a positive deviation was observed in the year 1991. In the year 1992, the annual rainfall was 952. 4mm which was more than the year 1991 and deviation from the mean was 92 per cent, in 1992 the annual rainfall was much more than the mean rainfall. Again in the year 1993, the annual rainfall was decreased to 517.4 mm and deviation from the mean was 6 per cent.

The comparison between the year 1993 and 1994 showed that the annual rainfall during the year 1994 was increased to 561.5 from 517.4 mm and the deviation from the mean was 15 per cent. But in the year 1995, decreasing pattern of rainfall was observed and the annual rainfall in 1995 was 335. 6 mm and the deviation from the mean was -30 per cent.

In 1996 and 1997 the annual rainfall increased to 462.9 and 533.8 mm with a deviation of -4 and 10 per cent respectively. But again decreasing pattern of annual rainfall was observed in the year 1998 and 1999 *i.e.,* 409.2 and 400 mm and deviations from the mean were -15 and -17 per cent, respectively.

In the year 2000, there was a slight increase in the annual rainfall compared to the years 1998 and 1999, the annual rainfall during 2000 was 451.7 mm and the deviation from the mean was - 6 per cent, the deviation was also less for the year 2000 compared to the year 1998 and 1999.

There was a huge decrease in the annual rainfall during 2001, the rainfall was only 300.5 mm and deviation from the mean was -38 per cent. It indicated that the rainfall was much lesser than the normal rainfall during 2001. There was a slight increase in the annual rainfall during 2002 and 2003, the annual rainfall during these years were 335.5 and 322.1 mm and the deviation from the mean were -30 and -33 per cent. In the year 2004, 360 mm annual rainfall was observed and deviation from the mean was -25 per cent.

The annual rainfall during 2005 was 493.8 mm and deviation from the mean was 1 per cent. It indicated that rainfall during 2005 was more than the normal rainfall so that it showed a positive deviation from the mean, but in the year 2006 the deviation from the mean was negative which showed annual rainfall of 390.4 mm and the deviation was -19 per cent.

In the year 2007, the rainfall received was above mean rainfall and annual rainfall during that year was 560.6 mm and the deviation from the mean was 15 per cent. The annual rainfall decreased during the year 2008 and the rainfall was 457.8 mm with deviation of - 5 per cent.

Table 2
Year wise annual rainfall (mm) and deviation from the mean in Haveri district (1990-2012)

Years	Annual rainfall (mm)	Deviation from the mean (%)
1990	311.7	-35
1991	576.8	18
1992	952.4	96
1993	517.4	6
1994	561.5	15
1995	335.6	-30
1996	462.9	-4
1997	533.8	10
1998	409.2	-15
1999	400.0	-17
2000	451.7	-6
2001	300.5	-38
2002	335.5	-30
2003	322.1	-33
2004	360.0	-25
2005	493.8	1
2006	390.4	-19
2007	560.6	15
2008	457.8	-5
2009	568.8	17
2010	611.9	26
2011	425.3	-12
2012	816.8	68
Mean	**485.0**	
CV (%)	**32**	

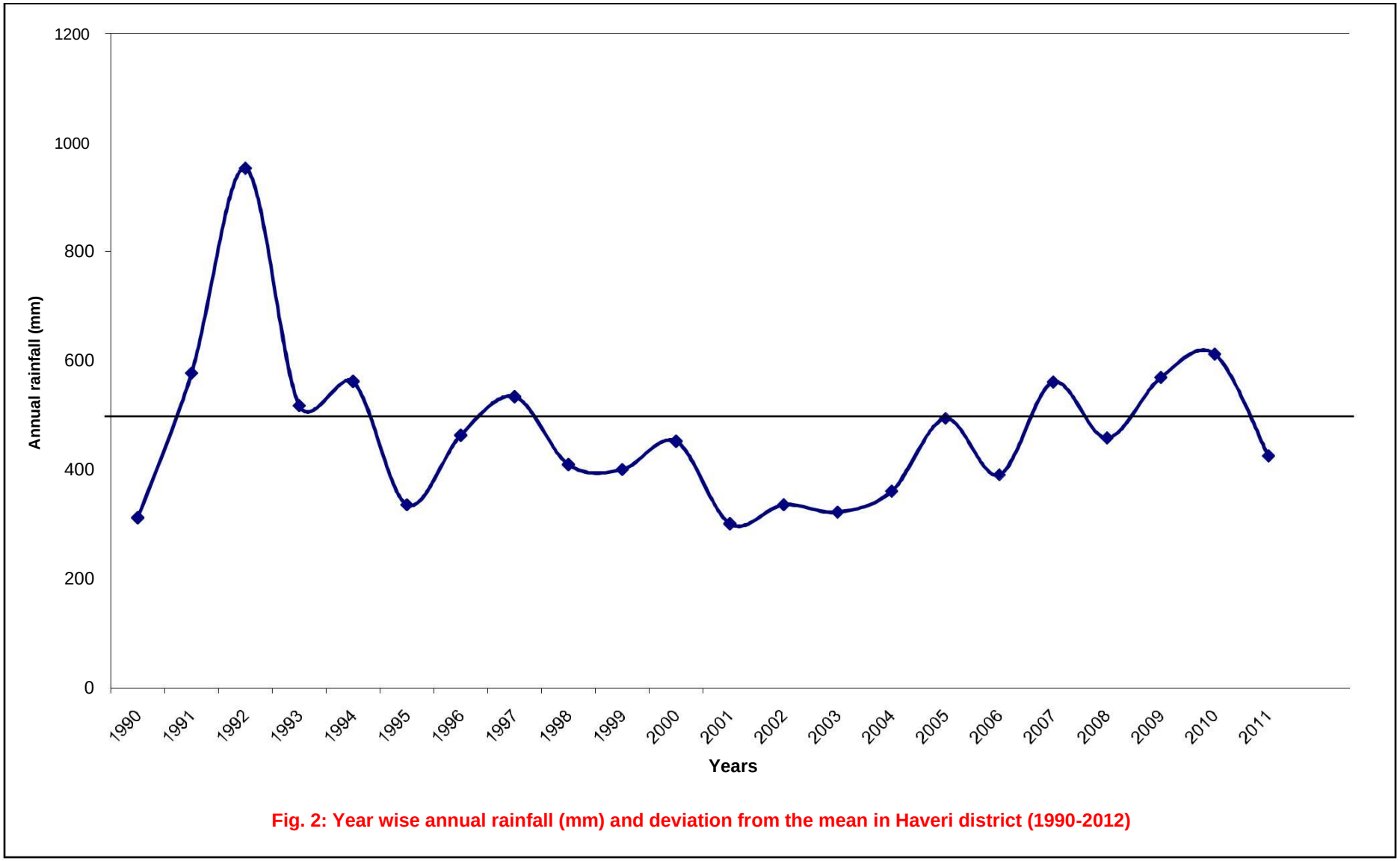

Fig. 2: Year wise annual rainfall (mm) and deviation from the mean in Haveri district (1990-2012)

There was increase in the annual rainfall during 2009 with 568.8 mm and deviation from the mean was 17 per cent. Again in the year 2010, also mean rainfall was increased with positive deviation of 26 per cent and rainfall was 611.9 mm.

In the year 2011, the annual rainfall had showed a negative deviation of -12 per cent and the annual rainfall was 425.3 mm. During the year 2012, the annual rainfall was increased to 816. 8 mm with a positive deviation of 68 per cent, it indicated that rainfall was more than the normal rainfall.

Thus, the overall rainfall pattern showed a variation in the annual rainfall from year to year which indicated that the rainfall was not uniform over the years. The annual rainfall was highest during the year 1992 (952.8 mm) with a positive deviation of 96 per cent from the mean and lowest annual rainfall was observed during the year 2001 (300.5 mm) with a negative deviation of 38 per cent from the mean.

Rainfall variations in Haveri district (1990-2012) :

Based on the rainfall deviations observed from the mean rainfall in the Table 4.1, frequency tables were constructed. The rainfall deviations were found to be both positive and negative. Based on the magnitude of these deviations, frequency tables with classes corresponding to less than 10, 10 to 20, 20 to 30, 30 to 40, 40 to 50 and 50 per cent and above for both positive and negative deviations were constructed and also number of years under these deviations was also worked out and presented in the Table 4.2. The table indicated all those years in which rainfall was surplus /deficit and the extent of surplus /deficit rainfall in percentage for the study area during the period.

During the years 1992 and 2012, the positive deviation of 50 per cent and above was found. It indicated that the rainfall was surplus during those years, for positive deviation of 40 to 50 per cent none of the years were found. In the positive deviation of 30 to 40 per cent also none of the years were found. The year 2010 fall under the positive deviation of 20 to 30 per cent. In the positive deviation of 10 to 20 per cent most of the years were found they were 1991, 1994, 1997, 2007 and 2009. For the positive deviation of less than 10 per cent two years were found those years were 1993 and 2003.

For the negative deviations, the years 1996, 2000 and 2008 were found in less than 10 per cent deviation, 1998, 1999, 2006 and 2011 were found under the deviation of 10 to 20 per cent. The deviation of 20 to 30 per cent was observed in the years 1995, 2002and 2004. In the years 1990, 2001 and 2003 the highest deviation of 30 to 40 per cent was observed. For the deviation of 40 to 50 per cent and 50 per cent above none of the years were found, based on these frequencies driest and wettest years were classified and presented in the Table 4. 3.

4.1.3 Dry and Wet years during the period 1990-2012 in Haveri district

Based on the different frequencies found for the deviation from mean annual rainfall the dry and wet years were classified and are presented in the Table 4. 3. Those years for which the deviation of the annual rainfall from the mean was negative and were classified as dry years and those years for which the deviation was positive were classified as wet years.

The driest years found during the study period were 1990 (311.78 mm), 1995 (335.6 mm), 1996 (462.9 mm), 1998 (409.2 mm), 1999 (400 mm), 2000 (451.7 mm), 2001 (300.5 mm), 2002 (335.5 mm), 2003 (322.1 mm), 2004 (360 mm), 2006 (390.4 mm), 2008 (457.8 mm) and 2011 (425.3 mm) in which the deviation from the mean were negative. Among all the dry years during 2001, the average mean annual rainfall was only 300.5 mm resulting in a substantial negative

deviation of -38 per cent followed by the year 1990 with a negative deviation of -35 per cent with average annual rainfall of 311 78 mm.

On the other hand, the relatively wet years found during the study period were 1991 (576.8 mm), 1992, (952.4 mm), 1993 (517.4 mm), 1994 (561.5 mm), 1997 (533.8 mm), 2005 (493.8 mm), 2007 (560.6 mm), 2009 (568.8 mm), 2010 (611.9 mm) and 2012 (816.8 mm) in which the deviation from the mean were positive. Among the all wettest years, the year 1992 was having highest mean annual rainfall of 952. 4mm with a deviation of 96 per cent followed by the year 2012 with a deviation of 68 per cent (mean annual rainfall (816.8 mm). The negative rainfall deviation from the mean was minimum during the years 1996 (-4%), 2000 (-6%) and 2008 (-5%). The minimum positive deviation from the mean was during the years 1993 (+6), 1997 (+10) and 2005 (+1).

Table 3
Rainfall variations in Haveri district (1990-2012)

	Rainfall deviation (%)	Years	Frequency
Positive deviations	50% and above	1992,2012	2
	40 - 50 %	-	-
	30 - 40%	-	-
	20 - 30 %	2010	1
	10 - 20 %	1991,1994,1997,2007,2009	5
	<10%	1993,2005	2
Negative deviations	<10%	1996,2000,2008	3
	10-20%	1998,1999,2006,2011	4
	20-30%	1995, 2002, 2004	3
	30 -40%	1990, 2001,2003	3
	40-50%	-	-
	50% and above		-

Table 4
Dry and Wet years during the period 1990 -2012 in Haveri district

Sl. No.	Dry years	Rainfall (mm)	Wet Years	Rainfall (mm)
1	1990	311.78	1991	576.8
2	1995	335.6	1992	952.4
3	1996	462.9	1993	517.4
4	1998	409.2	1994	561.5
5	1999	400	1997	533.8
6	2000	451.7	2005	493.8
7	2001	300.5	2007	560.6
8	2002	335.5	2009	568.8
9	2003	322.1	2010	611.9
10	2004	360	2012	816.8
11	2006	390.4		
12	2008	457.8		
13	2011	425.3		

Conclusion :

The results of the investigation presented in this paper is the changes in rainfall pattern in Haveri district. The annual rainfall in Haveri district for a period of 23 years (1990 to 2012) and their deviation from the mean rainfall, surplus and deficit rainfall years are presented in the Tables 4.1 to 4.2.

The mean annual rainfall for 23 years for Haveri district was 485 mm. The years of 1990, 2001 and 2003 were found to be the driest years during the study period there by accounting for 13.04 per cent of the total number of years. The norm followed for the consideration as dry years was, during those years the deviation from the mean rainfall was negative and also the deviation was more than 30 per cent.

The year 2001 was observed to be the driest year during the entire study period. This is because of the mean annual rainfall during 2001 was only 300.5 mm and deviation from the mean was also -38 per cent. This highest negative deviation from the mean made it as a driest year followed by the year 1990 with a negative deviation of 35 per cent. The mean annual rainfall during 1990 was 311.78mm.

The years 1992 and 2012 were considered as a wettest years during the study period. The deviation from the mean in those years was positive and also that was more than the 50 per cent thus accounting for 8.69 per cent of the total period under consideration.

The year 1992 with an average mean rainfall of 952.4 mm resulting in a whopping positive deviation of + 98 per cent was reported as the wettest year followed by the year 2012 with a mean annual rainfall of 816.8 mm and deviation from the mean was + 68 per cent.

The years 1996 and 2005 were considered as the minimum negative and positive deviation years during entire study period because the deviation from the mean during 1996 was -4 per cent hence it was minimum negative deviation year. During 2005 the deviation from the mean was + 1 per cent leads it as a minimum positive deviation year in the study period. Similar result was reported by Deepa (2011).

The hypothesis that rainfall pattern had changed over the years in the study area holds true.

Summary And Policy Implications :

The climate change is being modified at a faster rate due to mushrooming of industries and exploding human population and it is one of the main determinants of agricultural production. The climate change is "any change in climate over time that is attributed directly or indirectly to human activity that alters the composition of global atmosphere in addition to natural climate variability observed over comparable time periods" (IPCC, 2007).

Globally 80 per cent of the agricultural land is rain fed which generates 65 to 70 per cent staple foods but 70 per cent of the population inhibiting in these areas are poor due to low and variable productivity.

India ranks first among the rain fed agricultural countries of the world in terms of both extent and value of the produce. Rain fed agriculture is practiced in two thirds of the total cropped area of 162 million hectares (66 %).The rain fed agriculture supports 40 per cent of the national food basket. The importance of rain fed agriculture is obvious from the fact that 55 per cent of rice, 91 per cent of coarse grains, 90 per cent of pulses, 85 per cent of oilseeds and 65 per cent of cotton are grown in rain fed areas. These areas receive an annual rainfall between 400 mm to 1000mm which is unevenly distributed, highly uncertain and erratic. In certain areas, the total annual rainfall does not exceed 500
mm. As a result of low and erratic rainfall a significant fall in the food production is often noticed (Ashalatha *et al.*, 2012).

Agriculture is likely to worst hit by climate change arising from rising GHS concentrations in the atmosphere. The Southwest monsoon, which accounts for nearly 75 per cent of India's rainfall, is critical for agriculture. Climate change is likely to intensify the variability of summer monsoon dynamics, leading to a rise in extreme events such as increased precipitation and heightened flood risks in some parts of the country and reduced rainfall and prolonged drought in other areas. Crop yields will decline, food prices will increase and consumption will fall leading to increased poverty, hunger and malnutrition.

The change in climatic conditions particularly the rainfall pattern has a great impact on the cropping pattern of any country. It was proved that changes in the climatic conditions such as un-expected rains, delayed monsoons and heavy downpours adversely affect the area under cultivation, production and productivity of important crops such as paddy, Groundnut, Wheat,

and Maize. It will lead to food insecurity. This is the general situation existing in India and the situation in Karnataka is not different. These changing rainfall patterns need to be studied in detail.

Hence, the present study was undertaken taking into consideration the pressing problems exiting in agriculture economy due to fluctuations in rainfall patterns and change in the cropping pattern with special reference to Haveri district of Karnataka state.

FINDINGS :

The main findings of the study are as follows

Variation in the rainfall pattern in Haveri district

The years 1990, 2001 and 2003 were found to be driest years and the years 1992 and 2012 were found to be wettest years.

The year 1992 received a maximum rainfall of 952.4mm and proved to be the wettest year for the district. The year 2001 received lowest quantum of rainfall of 300.5mm and became the driest year during the study period for the district. The minimum positive and negative deviation years found were 2005(+1) and 1996(-4).

Based on the findings of the study, following policy implications are drawn

1. The analysis of rainfall data over a long period of 23 years has shown wide fluctuations in rainfall from year to year. Predicted impacts need to be introduced into development planning in the future including land use planning.
2. The changes in rainfall pattern has led to changes in cropping pattern in the district. Suitable cropping patterns for different rainfall situations have to be identified through research and recommended to the farmers.
3. The rainfall variations have impacted the area, production and productivity of major crops in the district. Research efforts to evolve drought resistant, short duration and high yielding varieties of these crops need to be strengthened.
4. Farmers are adopting changing cropping pattern and intercropping or mixed cropping as major coping strategies for rainfall variations. Along with those farmers need to be educated about the other coping mechanisms like farm ponds, watershed management and other dry land farming practices.

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