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Research Paper

Long-term variability in climate of North Karnataka, India

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ABSTRACT : Climate change refers to any change in climate due to natural variability or as a result of human activity over time. Indian economy is mainly depends on agriculture, since agriculture is one of the main source of livelihood of about 58 per cent of the population in the country. Climate and agriculture are mutually linked together. For achieving the objectives of the study secondary data was used. The secondary data pertaining to rainfall and temperature for assessing variability of climate in the study area (north Karnataka) were collected. The temporal impact of the identified climate variables was studied by subjecting the time series data to the process of time series analysis. In North Karnataka rainfall was showing decreasing trend (in Vijayapura, Bellary, Bidar, Kalaburagi and Raichur) and temperature was showing increasing trend. This was mainly due to human activities which lead to emission of greenhouse gasses (GHGs) resulting in increase of earth temperature.

KEY WORDS : Climate, Rainfall, Temperature, GHGs, Climate change

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INTRODUCTION :

Climate change refers to any change in climate due to natural variability or as a result of human activity over time (Anonymous, 2001). Indian economy is mainly dependent on agriculture, since agriculture is one of the main source for livelihood of about 58 per cent of the population in the country. Climate and agriculture are mutually linked together. Climate change affects agriculture in many ways, including changes in average temperatures, rainfall, climate extremes, changes in pests and diseases; changes in atmospheric carbon dioxide and ground-level ozone concentrations etc. Climate change also have an economic impact on agriculture, including variations in farm profitability, prices, supply, demand and trade. Impact of climate change are more diversified and need to be understood, so as to workout appropriate strategies to mitigate the ill-effects of climate change is necessary. In this context, the present study aims to study the suggestions expressed by sample farmers to mitigate the ill effects of climate variability.

In India, agriculture is strongly affected by two hydro-meteorological disasters, namely drought and flood. Indian agriculture is mainly dependent on monsoon as a source of water in India. About 68-70 per cent of total sown area in India is vulnerable to drought condition. The failure of the monsoons in the some parts of India resulted in water shortage and below-average crop yields.

This is particularly true in major drought-prone areas such as southern and eastern Maharashtra, northern Karnataka, Andhra Pradesh, Orissa, Gujarat, and Rajasthan. The droughts have periodically led to major Indian famines in the past. It includes the Bengal famine (1770), in which around five million died from starvation and illnesses, in 1876–1877, the famine in which over five million people were died and in 1899 famine, over 4.5 million people died. Hence, this is posing an increasing threat to the agriculture sector and food security of the country, with rising stress on rural livelihoods and resources like land, soil, water and forests. Farmers and land labourers in rural areas of India have started migrating seasonally, either temporarily or permanently to urban areas in search of livelihoods to cope with this stress.

As a result of this, drought is considered as one of the severe menace to agriculture among all weather related crises. The impact of drought varies from place to place depending upon normal climatic condition, available water resources, agricultural practices and the various socio-economic activities of the region (Anonymous, 2012).

In the three consecutive years, Karnataka experienced a severe drought (2001-02, 2002-03 and 2003-04) and 159 taluks were listed as drought affected. The state received 23 per cent of less rainfall during these periods (Nagaratna and Sridhar, 2009). The agricultural production decreased to 64 lakh tonnes against the target of 104.05 lakh tonnes and the availability of crop residues for livestock was comparatively low (Anonymous, 2003). The intense drought pashed most of the farmers in the state to the precarious situation and resulted in migration to the nearby towns and cities.

MATERIALS AND METHODS :

For achieving the objectives of the study, only secondary data was used pertaining to rainfall and temperature for assessing variability of climate in the study area (North Karnataka) were collected and compiled from different sources *viz*., Indian Meteorological Department (IMD), Pune, India and Directorate of Economics and Statistics (DES), Government of Karnataka. Rainfall data for a period of about 33 years and monthly temperature data for 17 years, were collected and utilized in assessing the magnitude and extent of climate variability trend for the selected districts of North Karnataka. The temporal impact of the identified climate variables was studied by subjecting the time series data to the process of time series analysis. With regard to the rainfall aspect, the seasonal rainfall distributions for selected districts of North Karnataka and for the temperature aspect of climate change such as season-wise average maximum and minimum temperatures were calculated using tabular analysis.

RESULTS AND DATA ANALYSIS :

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Long term variability in climate of North Karnataka:

Rainfall pattern in north-Karnataka is discussed under the following sub head.

Rainfall pattern in north-Karnataka:

The pattern of rainfall trend was analyzed and rainfall in North Karnataka showed slight increasing trend but with, lot of variations from the year 1983-84 to 2014-15 (Table 1). It does not mean that, the region did experience more number of wet years. Some of the districts in North Karnataka namely Vijayapura, Bagalkote and Koppal had experienced the drought years while in some places of North Karnataka, the rainfall was more than the normal (Uttara Kannada). Hence, on an average the rainfall pattern showed an increasing trend in North Karnataka. Further, under the circumstance the rainfall pattern in study area also indicated the cyclical movement (Between wet and dry years) with irregular cycles. From the results it was inferred that each cyclical movement was repeated after an interval of 6 to 7 year.

The seasonal indices of monthly rainfall (1983-84 to 2014-15) indicated that, there was no rainfall during the months of January and February (Table 2). Thus, the rainfall in the study area started to recover from March month and goes on increasing, the highest rainfall was observed in July month and later on it showed decreasing pattern. The June month southwest monsoon winds were considered to be the significant in bringing 80 per cent of this type of rainfall pattern in many parts of the Karnataka. Remaining 20 per cent of the annual rainfall was received in the later winter season (January to February), in the hot summer season (March and May) and in the post-monsoon season (KSDMA). Thus, in the

study area the irregular rainfall variation was observed. The highest variation in rainfall was observed in 1988 (0.56) and the lowest variation was during 1985 (0.51). These results were in line with results obtained by Anonymous (2013). This type of variation in the rainfall in the North Karnataka as well as in the country as a whole could be attributed to the irregular performance of monsoon in India which was greatly influenced by the deforestation would brought down precipitation and increased the temperature which leads to drying of perennial water bodies like rivers and lakes. Hence, it had resulted in to drought in one region and flood in another region.

Driest and wettest years of North Karnataka during the period from 1983 to 2015 :

Driest and wettest years of North Karnataka during the study period were documented in Table 3. In case of Bagalkote, Vijayapura, Gadag, Kalaburagi and Koppal districts, year 2003 was the driest year whereas in

Table 1: Trend and cyclical indices of rainfall in North Karnataka

Year	Average annual rainfall (mm)	Irregular indices	Cyclical indices
1983	796.5	-	-
1984	640.4	0.5331	97.0824
1985	532.6	0.5116	93.6312
1986	605.6	0.5300	94.9072
1987	708.1	0.5382	99.9778
1988	792.4	0.5572	100.5651
1989	633.7	0.5089	101.2739
1990	749.6	0.5469	100.4516
1991	741.1	05343	102.3973
1992	739.1	0.5360	101.9840
1993	725.0	0.5371	101.0578
1994	688.3	0.5353	99.4320
1995	649.7	0.5225	99.6286
1996	736.6	0.5466	99.8810
1997	702.2	0.5242	102.3247
1998	790.0	0.5525	101.3167
1999	679.7	0.5220	101.4820
2000	711.5	0.5513	97.7692
2001	589.0	0.5294	94.4707
2002	527.3	0.5296	90.0290
2003	505.2	0.5157	90.6981
2004	620.1	0.5333	95.7975
2005	785.6	0.5536	100.9160
2006	751.3	0.5233	105.0725
2007	866.7	0.5540	104.2524
2008	735.0	0.5206	104.7811
2009	784.3	0.5382	103.7508
2010	795.3	0.5377	104.3504
2011	771.5	0.5320	104.3412
2012	783.7	0.5309	104.3200
2013	792.0	0.5432	105.2600
2014	930.2	0.5697	101.0756
2015	642.9	0.4993	100.4822

Table 2: Seasonal indices of rainfall in North Karnataka (1983-2015)

Months	Seasonal indices
January	2.6526
February	2.5315
March	26.3040
April	26.5900
May	66.3843
June	223.2108
July	236.7865
August	235.6248
September	205.8456
October	134.5408
November	33.0923
December	6.4368

Dharwad and Haveri, 2001 was the driest year. In Belagavi and Uttara Kannada districts, 1985 and 2015 were the driest years. Thus, the driest years influence in these district under respective years lead to decline in different crop yields and livestock production. As a result farm employment also declined which associated with decreased income of farmers which were the most immediate economic impacts of drought years. Contrarily, wettest year was 1998 in case of Bagalokot, Vijayapura, Raichur and Koppal while 1996 and 1995 were the wettest years in case of Bellary and Bidar, respectively. Under these years of good monsoons, farmers in the respective districts were tend to undertake the production of high-

Table 3 : Driest and wettest years during the period 1983-2015 in North Karnataka

Sr. No.	District	Driest year	Rainfall (mm)	Wettest year	Rainfall (mm)	Range
1.	Belagavi	1985	536.4	2005	1,366.0	829.60
2.	Bagalkote	2003	242.0	1998	876.0	634.00
3.	Vijayapura	2003	315.0	1998	908.0	593.00
4.	Dharwad	2001	413.0	2014	980.0	567.00
5.	Gadag	2003	347.0	2007 and 2008	822.0	475.00
6.	Haveri	2001	508.0	2014	1094.0	586.00
7.	Uttara Kannada	2015	2,043.0	2003	3,965.0	1922.00
8.	Bellary	1995	324.0	1996	799.0	475.00
9.	Bidar	2015	562.0	1995	1,308.0	746.00
10.	Kalaburagi	2003	471.0	1983	1,425.9	954.90
11.	Raichur	2011	358.0	1998	921.0	563.00
12.	Koppal	2003	328.0	1998	751.0	423.00
13.	North-Karnataka	2003	505.2	2014	930.23	425.03

Table 4: Season-wise average maximum and minimum temperatures (degrees centigrade) of North Karnataka (1999-2000 to 2014-15)

Sr. No.	Districts	Winter Dec.- Feb.		Summer March-May		Monsoon June-Sept.		Post-monsoon Oct.-Nov.	
		Avg. max. temp.	Avg. min. temp.	Avg. max. temp.	Avg.min. temp.	Avg. max. temp.	Avg. min. temp.	Avg. max. temp.	Avg.min. temp.
1.	Belagavi	31.96	15.75	36.93	21.29	29.97	21.22	31.48	19.33
2.	Bagalkote	30.79	16.31	36.59	21.69	30.22	21.23	30.29	19.20
3.	Vijayapura	32.62	17.36	37.80	23.44	31.57	22.24	30.81	18.06
4.	Dharwad	30.48	14.88	35.67	20.63	28.04	20.68	29.70	17.99
5.	Gadag	30.93	15.56	37.33	22.36	30.33	21.36	30.19	19.11
6.	Haveri	31.78	17.84	35.67	22.41	28.17	21.93	30.12	20.71
7.	Uttara Kannada	31.35	17.83	33.57	22.69	27.97	22.58	30.28	20.40
8.	Bellary	31.79	18.78	35.80	22.91	30.50	21.83	30.17	19.71
9.	Bidar	31.29	16.08	38.82	23.38	31.17	22.45	30.45	19.02
10.	Kalaburagi	31.88	16.69	39.93	24.12	31.45	23.02	31.05	21.28
11.	Raichur	31.95	17.72	38.47	24.28	32.74	23.56	31.58	20.69
12.	Koppal	30.82	16.07	36.79	21.98	30.24	20.86	30.10	18.84

income crops like paddy, cotton, soybean, pulses, maize, chilli and wheat from low-income crops like coarse cereals cultivation were limited to the marginal lands. On the account of this, greater amount of particular crop area coverage lead to over production of such crops lead to glut in the market prices of such crops which had further mounted the pressure on farmers due to non-availability of storage facilities. Hence, in general, the management of dry and wet year bottle neck need to be understood by farmers as well as line departments for their effective management.

In north Karnataka droughts (dry years) becoming more common compare to wet years. The northern regions of Karnataka comes under arid and semi-arid regions, so more number of worst droughts the state has seen in the last 33 years. As said by Srinivas Reddy, Director of Karnataka State National Disaster Monitoring Cell (KSNDMC) even some of the rain rich parts of the state have been declared drought-hit regions. The perpetual aberrations situation observed with the climate rythem in North Karnataka has created a shift from agricultural activities to non-agricultural activities among the farming community. Hence, rural youth every day move out of their native villages to adjoining peri-urban areas in search of employment opportunities.

Season-wise average maximum and minimum temperatures (degrees centigrade) for the districts of North Karnataka:

In summer, the average maximum temperature recorded during the period from 1999-2000 to 2014-15 was more in case of Kalburagi district followed by Bidar, Raichur, Vijayapura, Gadag, Belgavi, Koppal and Bagalkote districts and least temperature was observed in Uttara Kannada district (Table 4). Under the well-marked reason for the maximum summer temperature was observed in case of Kalaburagi followed by Bidar, Raichur and Vijayapura. The reason for maximum summer temperature in these three districts could be attributed to the existance in Northern Dry Zone of the state where the amount of rainfall received was least. The main reason for receiving least amount of rainfall could be attributed to the existence of negative correlation between temperature and rainfall. Hence, these three districts in the state experience the more temperature and less rainfall. Further, the average maximum temperature during post-monsoon season was more in case of Raichur district followed by part of Belagavi, Kalaburagi, Vijayapura and Bidar districts and in contrast to the average maximum temperature which was least during post monsoon in case of Dharwad district followed by Haveri, Bellary and Gadag districts. Thus, the hypothesis accepted as long term variation in temperature in North-Karnataka (Reddy, 2009).

Conclusion:

In North Karnataka rainfall was showing decreasing trend (in Vijayapura, Bellary, Bidar, Kalaburagi and Raichur) and temperature was showing increasing trend. This was mainly due to human activities which lead to emission of greenhouse gasses (GHGs) resulting in an increase of earth temperature. There is a need to switch over from fossil fuel based power generation for reduction of emissions of GHGs to alternative sources of renewable energy like solar, wind, nuclear etc. Along with this some programmes like National Solar Mission, National Mission for Enhanced Energy Efficiency in Industry, National Water Mission and National Mission for Green India etc. must be implemented and evaluated strictly. In order to negate/mitigate the impact of climate change in the study area especially the impact of drought or heat stress on majority crops cultivated in rain fed conditions, the suitable varieties need to be familiarize and introduced. Some of the important drought /heat resistance varieties suited to region are Vikash, Vijay and Pusa 362 (chickpea), TAG-24 and Girnaril (groundnut), K-8962 and PBW-527(wheat), DHM-121 (maize), CSH-19R and CHS15R (sorghum), ICPL332WR and Hanuma (pigeonpea), NRC-7 and JS-7 (soybean), HHB-67(pearl millet).

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