STUDY ON THE IMPACT OF METEOROLOGICAL PARAMETERS ON CROP PRODUCTION IN KARIMNAGAR DISTRICT, ANDHRA PRADESH, INDIA

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Abstract:

There is considerable evidence that climate change will result in changes of temperature and precipitation patterns. Crops are directly affected by the impacts of high temperatures, changed pattern of precipitation and also possibly increased frequency of extreme events such as drought and floods. The objectives of this study are to examine the effect of climatic variables on crop production in Karimnagar district of Andhra Pradesh, India. Climate response functions to crop productivity have been estimated using regression models, weather variables, fertilizers and labour inputs. The data sets are created for the period 1984 – 2009 for 57 mandals of the district. The impact on crop productivity has been estimated for four crops and the results indicate on an average 82% of variation. The contribution of agricultural productivity to the total Gross Domestic Product (GDP) is also calculated using Ordinary Least Square model. The results show the R^2 value varies from 0.22 to 0.54 and 0.72 to 0.78 without and with GDP respectively.

Keywords: Climatic variables, Multiple Regression, Gross Domestic Product, Ordinary Least Square model (OLS).

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1. Introduction

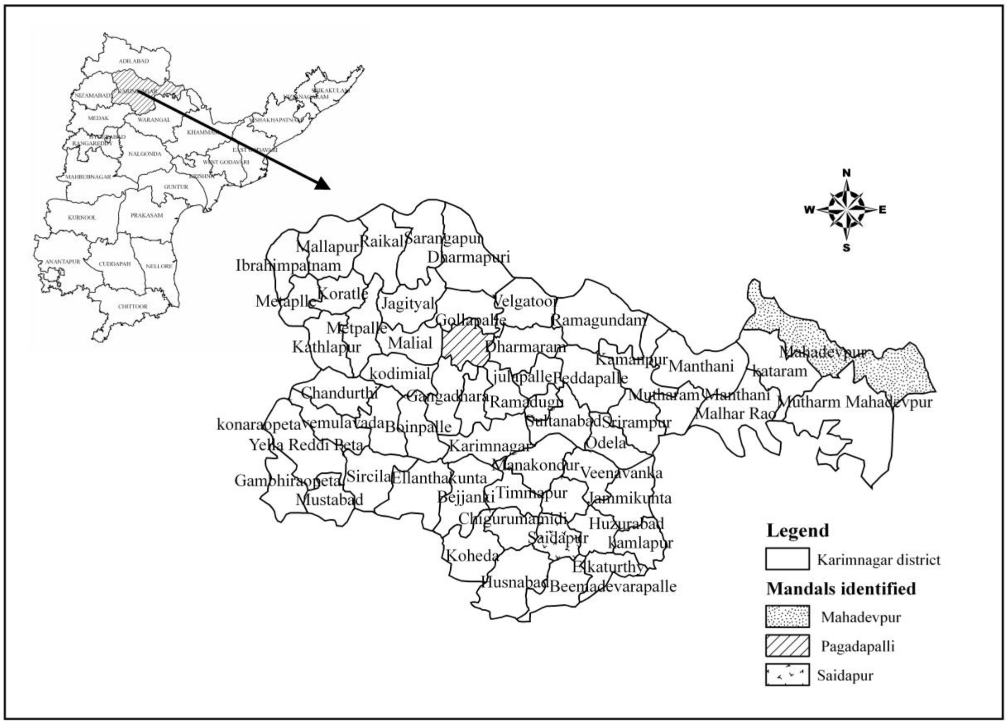
The increase in concentrations of atmospheric carbon dioxide (CO_2) and concurrent changes in temperature and precipitation patterns are expected to affect many aspects of human activities (IPCC 2007). Of all potential impacts of climate variability, those to the agricultural sector are amongst the most important. It has been estimated that long-term changes in temperatures and precipitation may have direct implications on agricultural productivity. Some studies have shown that due to the excess CO_2, some reduction in yields may be offset by carbon fertilization and increased precipitation. Easterling et al. (2007) have created a synthesis of 69 model-based results that demonstrates the relative impact of temperature and carbon fertilization on changes in cereal yield. Kumar and Parikh (2001), studied a range of equilibrium climate change scenarios which project a temperature rise of 2.5^{o}C to 4.9^oC for India, it is estimated that without considering the carbon dioxide fertilization effects yield losses for rice and wheat vary between 32 and 40%, and 41 and 52%, respectively and the GDP would drop by between 1.8 to 3.4% . As per the projected impacts of climate change on Indian agriculture, an increase of 1^{0}C in temperature may reduce yields of wheat, soybean, mustard, groundnut and much higher losses at higher temperatures (P.K.Agarwal et al, 2009). Increase of CO_2 to 500 ppm increases yields of rice, wheat, legumes and oilseeds by 10-20%. Productivity of most crops may decrease by 10-40% by 2100. In India with current food production of 230 million tons, the demand is expected to increase to greater than 276 million ton by 2021, this will have an impact on pricing of food (P.K.Agarwal et al, 2009). Due to the high sensitivity of the crops to the climate variations, it is important to understand the impact climate change will have on crop production. Changing hydrological characteristics, in relation to the onset, duration, and magnitude of the yearly monsoon, is expected to cause shifts in agro-ecological conditions. Many of the studies carried out in the country are state specific / region specific and the mitigation measures suggested are at a regional level. However, it may or may not be applicable at the block / mandal / local level in a particular region. In this context the present study aims to understand the trends of climatic parameters i.e. rainfall and temperature variations, their impact along with parameters like fertilizer input, human labour hour on crop yields at a local level and on the agricultural productivity.

2. Materials and Methods

2.1. Study Area

Karimnagar district is located on the North Eastern side of river Godavari in Andhra Pradesh, India. The district is situated between 17^{0}-50'-0" - 19^{o}-05'-00" Northern latitudes and 78^{o}-29'-0" - 80^{o}-22'-00" Eastern longitudes, and with an altitude of 1600meters above sea level and is divided into 57 mandals (figure 1). Each mandal is an administrative block and consists of an average of 25 to 30 villages. The district, in general experiences hot and dry climate throughout the year. The hottest month, May records a mean daily maximum temperature of 40^{0}-42^{0}C and a mean daily minimum of about 28^{0}C. December is the coldest with the mean maximum 28.4^{0} C and mean of minimum 13.2^{0}C. Rain gauges are installed in each of the mandal headquarters and the normal rainfall of the district is 966.2 mm. The cropped area in Andhra Pradesh is divided into seven zones based on the agro-climatic conditions. The classification for the agro-climatic zone, mainly concentrates on the range of rainfall received, type and topography of the soils. Karimnagar district falls under the agro-climatic region of "North Telangana Zone". The soil types are Chalkas, Red sandy soils, Dubbas, Deep Red loamy soils, Very deep B.C. Soils. The crops grown in this region includes Paddy, Sugarcane, Castor, Jowar, Maize, Sunflower, Groundnut, Turmeric, Pulses and Chillies.

Figure 1. Study area map of the district of Karimnagar showing the various mandals / blocks along with the mandals identified for the study.



2.2. Methodology

Meteorological, socio-economic and agricultural data for the district of Andhra Pradesh is used to understand the changes in the rainfall patterns and its impact on agriculture. The data was collected from Department of Economics and Statistics [DES] Government of Andhra Pradesh for a period 1984 – 2009 and analyzed both at the district and mandal level. The statistical analysis of rainfall, temperature and yield patterns was carried out using SYSTAT.7.0.1 to understand the interrelations between different parameters using the methods like Pearson Correlation, Multiple Regression analysis. The multiple linear regression analysis (for the bio-economic modelling) is done using the equation (1) to find out the overall impact of rainfall, temperature, human labour hour and fertilizer input on the crop yields.

Y=f (F, HL, AR, DFNR, MAXTEMP, MINTEMP) (1)

Y= Yield in kg/hectare

F= fertilizers in kg/hectare

HL=Human Labour hour per hectare

AR= Actual Rainfall (mm)

DFNR=%Deviation from normal Rainfall

MAXTEMP=Maximum Temperature in ^{0}C

MINTEMP=Minimum Temperature in ^{0}C

Various combinations of the above parameters were studied to understand the interdependency of each of these parameters and its impact on agricultural productivity. The analysis of agricultural productivity and prices was estimated by using the Ordinary Least Square model (OLS).

3. Results and Discussions

For the present study the rainfall and temperature data was collected for 25 year period and analysed both at district level and mandal level. The results are presented in two parts, namely at district level and at mandal level. The percent deviation of annual actual average rainfall from the normal is calculated for the district. It was found that during the years 1986-87, 1988-1990, 1995-1996, 2000-2001 and 2006-2007 there is positive deviation of actual average annual rainfall from the normal and the highest positive deviation was observed during the year 1988-1989 (41%). The highest negative deviation from normal was observed during the year 2004-2005 which is -42%. The rainfall analysis for the 25 year period was grouped into the seasonal data which is predominantly South West Monsoon (SWM) and North East Monsoon (NEM) for the district. The South West Monsoon (June to September) contributes over 80% of annual rainfall. Followed by SWM, the North East Monsoon (October to December) contributes 10% of annual rainfall. A study done by N.N. Srivastava et al (1995), on El-Nino's effect on SWM rainfall in AP for the period 1960-1989 and found that the SWM deviation from normal in the districts of AP was negative in only four years during that period. The overall trend observed is that of decreasing rainfall starting from around 600mm in 1984-85 to 400 mm in 2008-2009. In the present study there are 16 years during the period 1984-2009 for which SWM actual average rainfall is below its normal rainfall 790 mm i.e. four fold the previous 30years when compared with the previously conducted study.

An analysis of the rainfall data of more than 100 years over Maharashtra showed significant decreasing trends in monthly rainfall in many areas (districts) from the month of January (seven districts) to May(three districts) with maximum decrease in February (15 districts) (NCC Research Report, 2012). The changing patterns in rainfall may prove to be crucial in agricultural productivity in particular and the hydrological cycle in general.

As for NEM 20 years have shown that its actual average rainfall is below its normal 113 mm and the details are given in table 1.

Table.1 Months with actual average rainfall below its normal rainfall (mm) of Karimnagar district for period 1984-2009

Months	**No. of years below normal rainfall**	**Range of percent deviation from normal rainfall for deficit years(below normal)**	**Normal rainfall**
June	18	-64.9 to -1.6	151.22
July	18	-78.8 to -4.1	283.75
August	15	-74.5 to -6.2	235.85
September	12	-72.5 to -4.7	119.94
SWM	**16**	**-47.8 to -5.1**	**790.78**
October	16	-95.1 to -8.4	89.105
November	19	-100 to -35.2	18.61
December	23	-100 to -16.8	5.80
NEM	**20**	**-96.1 to -4.4**	**113.52**

The mandal wise data for rainfall was collected for 25 years for the 57 mandals in the district and analysed for the rainfall patterns at mandal level. The figure 2 shows the percent deviation of annual mean rainfall with reference to the normal for 57 mandals during the period 1984-2009.

Figure 2. Mandal wise percent deviation of average annual rainfall in mm from normal rainfall of Karimnagar district 1984-2009.

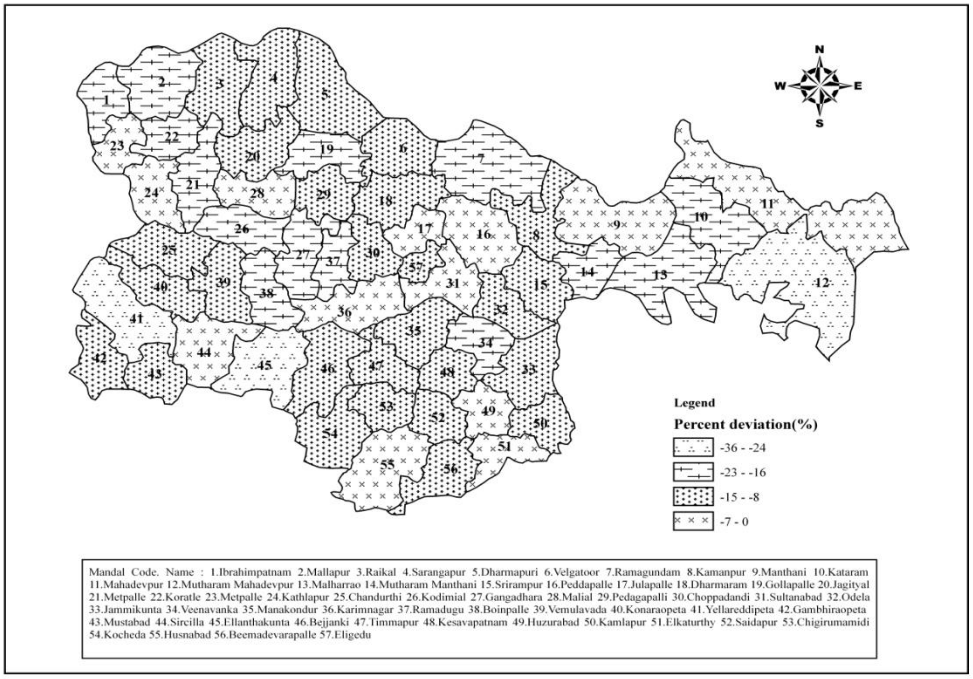
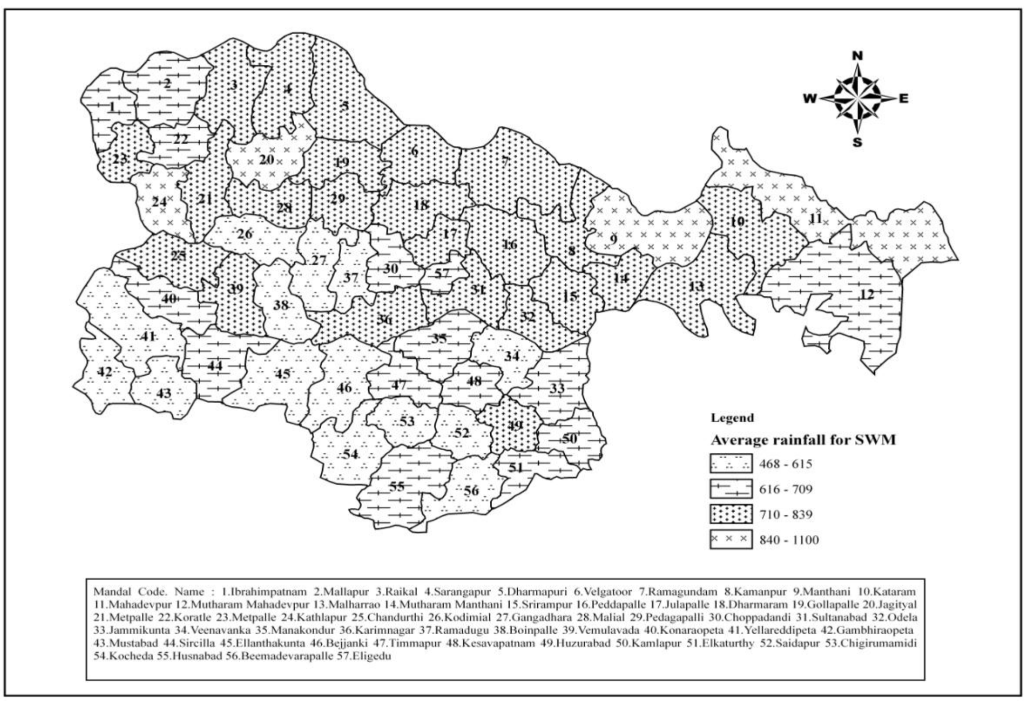
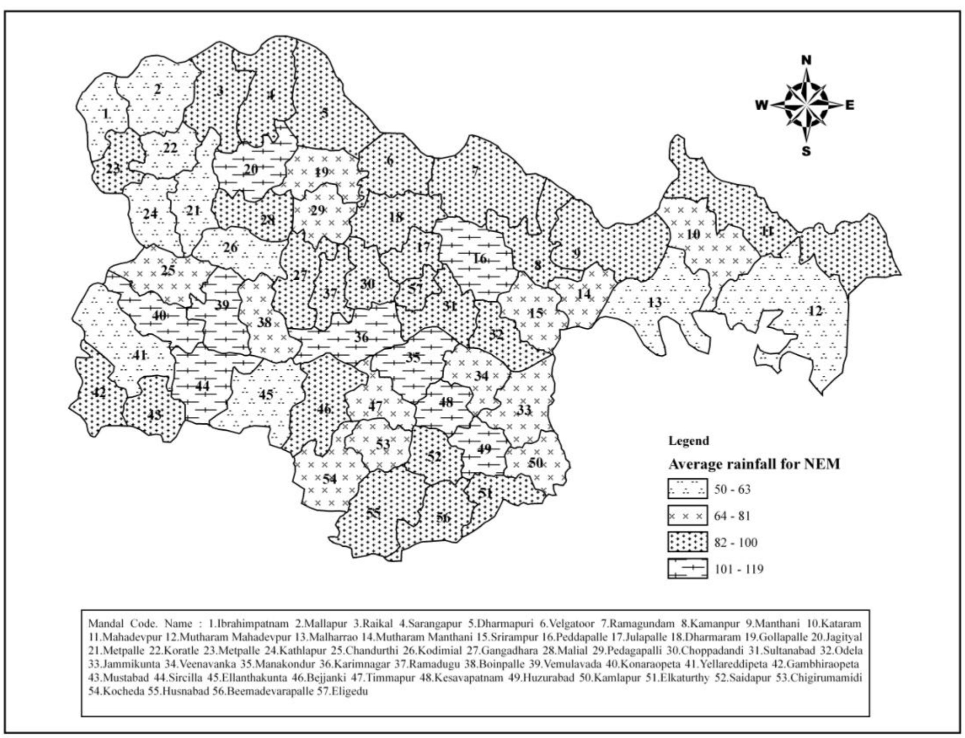


Figure 3(a). Mandal wise SWM actual average rainfall (mm) pattern of Karimnagar district 1984- 2009.



Spatial distribution of the average of seasonal rainfall over the district for all the 57 mandals for the SWM is shown in figure 3(a) and it is observed that rainfall pattern in the study period, the mandals along the north and north east boundary are receiving the highest rainfall and towards southwest there is decreasing pattern. The highest rainfall received by the mandals is in the range of 840-1100mm and whereas the least rainfall is in the range of 450-530 mm. That may be attributed to the topography of the area which is natural and the presence of river along the North boundary. Four mandals namely Mahadevpur, Jagityal, Manthani and Kathlapur are receiving the highest rainfall. Mustabad, Ellanthakunta, Saidapur, Chigurumamidi and Koheda have been receiving the lowest rainfall and all these mandals are geographically located towards the southern side of the district. A study by I.B. Abaje et al (2010), revealed that the decline in the annual rainfall is predominantly as a result of the substantial decline in July, September, and October rainfall, which are the critical months for agricultural production in the Kafanchan, Nigeria .

Figure 3(b). Mandal wise NEM actual average rainfall (mm) pattern of Karimnagar district 1984-2009.



Similar analysis of the NEM as shown in figure 3(b) shows that the mandals to the extreme west except Metpalle, Konaraopeta, and Gambhiraopeta are receiving the least rainfall. The mandals on the east- Malharrao and Mutharam Mahdevpur are also receiving least rainfall which is in the range of 50-60mm. The mandals which are centrally located Karimnagar, Peddapalle, Huzurabad, Manakondur, Kesavapatnam, Sircilla, Konaraopeta are consistently receiving highest rainfall which is in the range of 103-120 mm of rainfall.

Temperature measurements are recorded at two stations in Karimnagar and Jagityal mandals of the district. The study has revealed that the minimum and maximum temperatures are increasing during the months of June and July whereas the maximum temperatures are having a decreasing trend in the months of August to October. However November and December months have again shown an increasing trend. Correlation trends were computed using the SWM and NEM temperature data and it can be inferred that with the increase of the temperature, the rainfall in the region is decreasing (table 2).

Table.2 Correlation between the South West Monsoon and the North East Monsoon with reference to temperature

Seasons	Maximum Temperature	Minimum Temperature
South West Monsoon	-0.454	-0.294
North East Monsoon	0.146	-0.065

The detailed analysis of the climatic parameters (rainfall and temperature) shows complex changes which is expected to affect the crop productivity in the district. Hence an analysis of the crop productivity at district and mandal level has been carried out for the study period of 25 years. Four major crops of the district, Rice, Maize, Jowar and Groundnut were analysed and the results are presented below. The results indicate that Rice and Maize, annual productivity shows a decrease in the productivity for the period 1997-1998, 2004-2005 and 2007-2008 where as the pattern during 1990-1994 there is increasing for Maize while Rice is decreasing. These major decreases in productivity are due to decreased SWM rainfall in the same period as reported by the rainfall analysis. The Jowar annual productivity however shows an increasing trend till 2006 and later on a consistently decreasing trend is observed. The decrease in Jowar yields may not be attributed to SWM rainfall as in few years 1988-89, 1998-1999 the relation between yields and SWM is opposite. The yields of Groundnut are decreasing during the periods of 1997-1998, 2004-2005 and 2007-2008 which may be attributed to decrease in the SWM rainfall. However, other years have shown an increasing trend in the productivity.

Therefore it was clear that only rainfall cannot be an indicator for the changes in crop productivity. In order to further assess the impact of other parameters like fertilizers, human labour hour on agricultural production in addition to climatic variables of the Karimnagar district, multiple regression equation has been used. The multiple regression equation takes the form $y = b_1x_1 + b_2x_2 + ... + b_nx_n + c$. The regression values obtained from the 25years data for the four crops are presented in table 3.

Table 3. Regression values for the four crops for the period 1984-2009 at district level

Cases	Constant	Act_avg	Max_temp	Min_temp	Fertilizers	Human labour	Deviation	R^2
Coefficient values for Rice								
Case 1	77.28	0.476	86.337	41.175	16.497	0.024	###	0.435
Case 2	549.469	####	86.176	40.867	16.5	0.024	4.579	0.435
Case 3	301.993	0.46	86.129	37.145	16.21	####	####	0.435
Case 4	-4089.02	0.878	46.665	376.217	####	-0.221	###	0.243
Case 5	-7404.42	1.139	41.274	486.255	####	####	####	0.21
Coefficient values for Jowar								
Case 1	6527.769	-0.181	18.821	-245.485	-47.216	-0.102	####	0.168
Case 2	6357.634	####	18.751	-245.595	-47.198	-0.102	-1.761	0.168
Case 3	5976.785	-0.119	16.251	-228.297	-63.465	####	####	0.162
Case	6439.47	-0.24	22.799	-237.217	####	-0.22	####	0.14

4	6							7
Case 5	4353.392	-0.087	18.486	-165.334	####	####	####	0.099
Coefficient values for Maize								
Case 1	3462.987	0.925	-99.696	249.021	33.531	-0.6	###	0.595
Case 2	4366.76	###	-99.872	248.826	33.526	-0.6	8.913	0.595
Case 3	1534.282	1.115	-109.252	279.396	49.336	###	###	0.572
Case 4	-357.423	0.72	-28.956	425.314	###	-1.292	###	0.54
Case 5	-17934.2	1.165	83.154	960.098	###	###	###	0.313
Coefficient values for Groundnut								
Case 1	3281.444	1.884	-63.092	12.348	-137.456	0.603	###	0.191
Case 2	5110.051	###	-63.241	12.203	-137.443	0.603	18.192	0.191
Case 3	9818.925	1.884	-113.043	-187.989	-111.65	###	###	0.16
Case 4	3302.821	1.624	-69.403	-2.964	####	0.076	###	0.046
Case 5	4284.402	1.631	-76.729	-32.631	####	####	####	0.045
Act_Avg: Actual Average Rainfall; Max_temp:Maximum temperature; Min_temp: Minimum temperature								

The results indicate that the variables used in the study showed about 43.5% of variation in the productivity of rice, while the overall crop had a positive coefficient, implying that the variables of average rainfall, temperature (maximum and minimum) and fertilizers had positive impact on productivity. However in comparison between the average and percent deviation of rainfall more accurate results were obtained with the latter data set. The weather parameters actual rainfall and temperatures are showing a variation of only 21% on the rice productivity.

The results for Jowar indicate a 16.8% of variation in Jowar yield. However unlike rice, actual rainfall, mean minimum temperature, fertilizer use and human labour hour had a negative coefficient on the results of productivity while the mean maximum temperature is showing a positive impact on the Jowar yields. However the negative impact by the fertilizers may be due to the over application by farmers which could be theoretically incorrect. Similarly the actual average rainfall and temperatures were showing a variation of 9% only on the Jowar yields whereas the rainfall and minimum temperatures are showing negative coefficients implying that these values would affect the Jowar productivity negatively.

The results indicated that the weather parameters, fertilizers and human labour hour were showing a variation of 59.5% on the yields of Maize crop and except the maximum temperature all the other variables are showing positive impact on the yields. The variation shown by weather parameters on the maize yields is 31.3%.

The results for Groundnut indicate a 19.1% variation by the four variables while the maximum temperature and fertilizer are showing a negative impact on the yields. The negative impact by fertilizers on the yields may indicate that the farmers are over applying fertilizers possibly for more yields. Similar to the Rice crop the percent deviation is showing more positive impact on the yields than the actual rainfall. The variation showed by the weather parameters on the groundnut yields is only 4% and both temperatures affecting the yields negatively.

A similar study was done by Sushila Kaul (2007), with parameters of actual average rainfall, maximum and minimum temperatures, fertilizers input and human labour hour; their overall effect on the yields of the Rice and Jowar crops are calculated using multiple regression equations for the year 2000-01. The study reveals that excessive rains and extreme variation in temperature would affect the productivity of these crops adversely thereby affecting the incomes of farming families in a negative manner. H.Mongil et al (2010) carried out a study on vulnerability assessment of rain fed agriculture to climate change and variability in semi-arid parts of Tabora region in Tanzania in 2009. The results of meteorological data indicated for rainfall trends during the growing season from October to April showed that annual rainfall data in the study area had been in declining trends for the last 35 seasons from 1973-74 to 2007-08. Total rainfall during the seasons from 1973-74 to 2007-08 appeared to decrease at a non-significant rate.

The calculations at district level were at a large scale and may provide only a representative picture so analysis was attempted at the mandal level. However, as the district has 57 mandals the study was restricted to three mandals and was based on the coefficient of variation (CV) which was carried out using decadal and seasonal data. Two seasons Rabi and Kharif was considered during the analysis. The mandals of Pagadapalli, Saidapur and Mahadevpur have recorded the highest CV values and have been chosen for further analysis. The crop yields data was calculated based on the values the crop cutting and the averages of the dry yields of the surveyed villages are multiplied with the total area of the surveyed villages and later their ratio is taken to achieve the yields. A season wise analysis of the data for rice, for the three mandals was done and is presented in Table 4(a) to (c).

Table 4(a) Regression values for Rice in Karif and Rabi seasons of Pagadapalli mandal

	Pagadapalli mandal	**Coefficient values for Rice in Kharif Season**						
	Constant	**Rainfall**	**Max_tem**	**Min_tem**	**Fertilizers**	**Human labour**	**Deviation**	**R2**
1	2333.264	1.335	-73.723	62.046	3.147	-0.148	####	0.544
2	4019.958	####	-90.118	64.145	2.744	-0.137	12.254	0.546
3	1721.742	1.329	-88.617	106.003	2.54	####	####	0.534
4	-1335.088	1.398	-91.854	249.601	####	0.097	####	0.458
5	-1428.517	1.416	-80.843	242.113	####	####	####	0.452
	Pegadapalli mandal	**Coefficient values for Rice in Rabi Season**						
1	3431.932	0.792	-55.079	9.091	7.205	-0.322	####	0.709
2	4050.484	####	-62.276	18.038	4.552	-0.291	-2.582	0.696
3	2606.654	0.618	-81.036	77.164	7.416	####	####	0.658
4	7320.765	-0.699	-58.36	-105.385	####	-0.349	####	0.561
5	6547.338	-0.936	-86.679	-35.03	####	####	####	0.50

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Table 4(a) using the variables of actual rainfall temperatures, fertilizers and human labour hour shows a variation of 54.4% in the rice productivity for Kharif crop and 70.9% for the Rabi crop. The rainfall, minimum temperature and fertilizers are showing a positive impact whereas the maximum temperature and human labour hour are showing a negative impact on the yield. Comparatively the percent deviation is showing more positive impact than the actual rainfall for the Kharif crop while it was negative for the Rabi crop. The variation shown on the rice yields is 45.2% when only weather parameters for Kharif crop while it was 50.1% for the Rabi crop. However, it was negative for the two seasons as far as maximum temperatures are concerned. Similar analyses were carried out for Mahadevpur and Saidapur mandals for Karimnagar district and the results are given in tables 4(b) and (c) respectively.

Table 4(b) Regression values for Rice in Kharif and Rabi seasons of Mahadevpur mandal

	Mahadevpur mandal	**Coefficient values for Rice in Kharif Season**						
	Constant	**Rainfall**	**Max_tem**	**Min_tem**	**Fertilizers**	**Human labour**	**Deviation**	**R2**
1	4731.855	0.123	-111.848	47.26	0.303	-0.021	####	0.092
2	5006.754	####	-112.227	40.23	0.585	-0.3	0.589	0.09
3	4581.195	0.152	-112.658	53.505	0.032	####	####	0.091
4	4481.001	0.161	-112.042	57.389	####	-0.007	####	0.091
5	4542.483	0.157	-112.57	55.041	####	####	####	0.091
	Mahadevpur mandal	**Coefficient values for rice for Rabi Season**						
1	7516.829	0.014	-59.688	-143.647	-0.576	-0.251	####	0.278

2	7387.322	####	-55.426	-143.15	-0.614	-0.249	0.565	0.282
3	5685.44	-0.02	-74.671	-46.516	-1.551	####	####	0.163
4	7273.639	0.146	-57.275	-140.773	####	-0.261	####	0.276
5	4780.933	0.355	-69.389	-27.418	####	####	####	0.143

For the Rice productivity of Mahadevpur mandal a variation of 9.2% on the rice productivity for Kharif crop is seen while for the Rabi crop it is 27.8%. The rainfall, minimum temperature and fertilizers are showing a positive impact whereas the maximum temperature and human labour hour are showing a negative impact on the yield for the Kharif crop. Comparatively the percent deviation is showing more positive impact than the actual rainfall. The variation shown on the rice yields is 9.1% for Kharif and 14.3% for Rabi when only weather parameters are considered and maximum temperatures are showing a negative impact on the yields for both seasons.

Table 4(c) Regression values for Rice-Kharif and Rabi seasons of Saidapur mandal

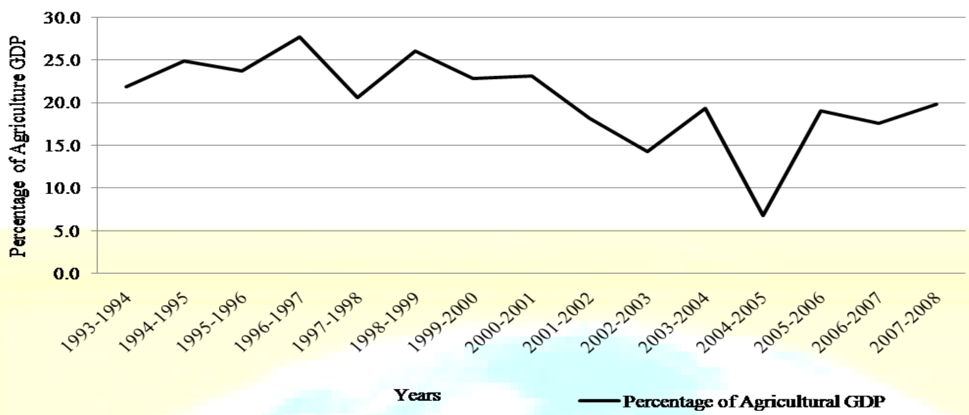
	Saidapur mandal	**Coefficient values for Rice-Kharif season**						
	Constant	**Rainfall**	**Max_tem**	**Min_tem**	**Fertilizers**	**Human labour**	**Deviation**	**R2**
1	3440.217	0.262	-1	-56.168	2.428	-0.173	####	0.11
2	3806.094	####	-8.339	-52.098	2.119	-0.171	0.873	0.103
3	2504.233	0.259	-21.713	10.384	1.378	####	####	0.092
4	1632.861	0.098	-33.772	77.06	####	-0.016	####	0.073

5	1608.672	0.108	-34.796	78.461	####	####	####	0.072
	Saidapur mandal	**Coefficient values for Rice-Rabi season**						
1	5050.987	0.431	-43.978	-61.868	2.377	-0.417	####	0.356
2	5259.975	####	-49.427	-47.891	1.303	-0.396	0.693	0.345
3	2844.419	0.342	-64.128	53.889	3.14	####	####	0.224
4	6360.985	-0.109	-42.636	-101.588	####	-0.448	####	0.325
5	4393.448	-0.397	-64.356	11.872	####	####	####	0.169

Variation of 11% is observed for the rice productivity for Kharif crop and 35.6% for Rabi crop. Except rainfall and fertilizers, the temperatures and human labour hour are showing a negative impact (the negative impact of maximum temperature is very less compared to above two mandals) on the yield. Comparatively the percent deviation is showing more positive impact than the actual rainfall. The variation shown on the rice yields is 7.2% when only weather parameters are considered and maximum temperatures are showing a negative impact on the yields.

To understand the loss in terms of the Agricultural Gross District Domestic Product (AGDDP) an analysis was attempted at the district level. The AGDDP was calculated for the period 1993-2008 to see its impact on the state GDP. The percent contribution of AGDDP to the total GDP in the state is given in figure 4.

Figure 4. Percentage of Agricultural GDP of Karimnagar district 1993-2007.



The connection of Agricultural GDDP with prices was carried out for 15 year period 1993 to 2008 to understand the impact of climatic factors. An analysis was performed using Ordinary Least Square Model (OLS) for the major crops and the two data sets (1) Prices, rainfall and production and (2) GDP, prices, rainfall and production, were used to estimate the significance of R^2 Values. The results presented in table 5 shows the R-square, Multiple-R, T-stat values for the Karimnagar district. A similar study by Preethi Laddha et al (2007) analysed the impact of weather on commodity prices and measured the degree of weather risk inherent on commodity prices and consequent linkages to inflation, exchange rates and GDP by using ordinary least square and co-integration models. The study shows that there is high impact of rainfall over production and prices. V.N.Reddy (1978), while critically examining the statistical procedures used in fitting various growth functions, emphasized that for proper assessment of the phenomenon goodness of fit as judged by R^2 and t values should be considered. Accuracy of the growth rates can be seen from standard error. Raymond Guiteras (2007), has also estimated the economic impact of climate change on Indian agriculture the effect of random year-to-year variation in weather on agricultural output using a 40-year district-level panel data set covering over 200 Indian districts was considered.

Table 5. Results of Ordinary Least Square model for Karimnagar district

District	Commo-dities	Obser va-tions	Prices, Index number, Annual rainfall			Prices, Index number, Annual rainfall , GDP		
			Multiple R	R Square	T-stat intercep t	Multiple R	R Squar e	T-stat interce pt
Karimnaga r	Rice	11	0.47	0.22	3.80	0.85	0.72	2.71
	Maize	10	0.48	0.23	2.43	0.88	0.78	1.81
	Jowar	9	0.74	0.54	8.65	0.88	0.78	-1.26
	Groundn ut	11	0.63	0.39	1.60	0.86	0.73	1.42

In the present study the regression values varied from 0.72 for Rice to 0.78 for Maize and Jowar. The present study concluded that is the negative results need to look into and address on priority and if the current trends continue climate change could significantly have an impact on the crop productivity. And hence it is recommended that agricultural planning and government policies in the district of Karimnagar should take into consideration the recent trends in the meteorological parameters.

4. Conclusions

The study was carried out in Karimnagar district of Andhra Pradesh, India. The entire district is classified under a single agro climatic zone – North Telangana Zone. In the study the analysis of the meteorological data viz. rainfall and temperature was carried out for a period of 25 years. An analysis of the South West Monsoon has shown that 16 years in the study period has recorded decreasing trends for rainfall. The mandals Mahadevpur, Jagityal, Manthani and Kathalpur are receiving the highest rainfall while the mandals Mustabad, Ellanthakunta, Saidapur, Chigurumamidi and Koheda are receiving the lowest rainfall during South West Monsoon. Similarly analysis of the North East Monsoon has shown that mandals to the extreme west and the mandals on the east Malharrao and Mutharam Mahadevpur are receiving least rainfall and the mandals Karimnagar, Peddapalle, Huzurabad, Manakondur, Kesavapatnam, Sircilla, Konaraopeta are consistently receiving the highest rainfall. Analysis of the impact of meteorological parameters on the four major crops in the district viz. rice, maize, jowar and groundnut has been carried out. The percent variation in crop productivity for rice was found to be 21%, jowar (9%), maize (31.3%) and groundnut (4%). Similar analysis was carried out for Pagadapalli, Mahadevpur and Saidapur mandals of the district for Kharif and Rabi seasons for rice crop. The results are positive in all the three mandals for Kharif season and positive in only Mahadevpur and Saidapur mandals in Rabi season when the meteorological parameters are considered along with the human labour and fertilizer data. AGGDP was carried out for the crops and the regression values varied from 0.72 for Rice to 0.78 for Maize and Jowar.

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