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"IMPACTS OF CLIMATE CHANGE ON AGRICULTURE SECTOR USING RS AND GIS"

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Abstract - *In the present study, an attempt was made to find the impact of climate on agriculture in relation to climatic parameters for Mysore taluk. To analyze the impact of climate on agriculture, weather parameters like Rainfall data, temperature data were used. NDVI analysis, MODIS TERRA data was used. Whereas, NCEP reanalysis, Relative Humidity, Soil Moisture, Solar radiation, water runoff were used. The findings of the study shows that the impact of climate change on agriculture from 1986 to 2016, the annual In case of minimum temperature, it shows decrease in trend, whereas, in case of maximum temperature, it shows increase in trend for annual and monsoon seasons respectively.*

The NDVI analysis for 2000-2016 indicated that there is increase in NDVI (positive trend) in case of annual, and decrease in NDVI (negative trend) during summer. In case of NCEP reanalysis, the annual average of Relative Humidity (RH), soil moisture and water runoff is negative trend. The solar radiation (Upward/Downward) for annual is positive trend. The crops area such as cereals, millet's, pulses, oil seeds, cotton and sericulture shows decreasing trend. Whereas, crop area for fruits, vegetables and sugarcane shows increasing trend (positive). C-MMACS,

GCM Model, the future prediction of rainfall and temperature shows increase in rainfall (positive trend) and decrease in temperature (negative trend) for the year 2020 and 2030 respectively for Mysore taluk.

***Key Words*: climate change. Rainfall, temperature, and NCEP reanalysis and MODIS data**

1. INTRODUCTION

Climate change and agriculture are interrelated to each another. Climate change affects agriculture in a number of ways, including through changes in average temperatures, rainfall and other parameters. The climate changes cause in pests and diseases in agricultural land due to lack of rain; changes in atmospheric such as carbon dioxide and ground-level ozone concentration.

Weather is an important factor in agricultural productivity, as well as both natural and soil properties. The effect of climate on agriculture is related to variability's in local climates rather than in global climate patterns. Weather refers to temperature and precipitation activity, whereas climate is the term for the averaging of atmospheric conditions over longer periods of time. Weather is depends on the air pressure, temperature and moisture differences between one place to another place. It is measured by assessing the patterns of variation in temperature, humidity, atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time.

1.1 Climate and Agriculture

Climate and agriculture are related to each other and as such climate change parameters influences the agricultural productivity. The effect of weather and climate on agriculture is related to variability in local weather and climates rather than global patterns. Weather and climate impacts agricultural sector in a following different ways such as:

1. Precipitation drives the water availability and determines the sowing period of time.
2. Temperature influences crop growth and duration. It also influences milk production in animals and spawning in fish
3. Temperature and relative humidity influences pest and diseases attack on crops, livestock and poultry.
4. Photosynthesis productivity is influenced by solar radiation.
5. Extreme events like high rainfall, floods, heat waves, cold waves, cyclone, hail, frost etc cause the enormous losses of standing crops, livestock and fisheries.
6. Runoff shows that how much water is drained of from land to the streams.
7. Soil moisture shows that how much soil is supply the moisture to the plants.

1.2 Climate Change

Climate change in India can be observed in the climate variables like temperature, precipitation and humidity. These are affecting the sectors like agriculture and rural

development. Many natural factors are responsible for the Climate change. Agriculture lands are being used for construction of houses due to urban sprawl. If there is decrease in the production of agriculture, the Indian economy and the food security both will be affected. The perusal of General Circulation Models (GCMs) on climate change indicate that rising levels of GHG are likely to increase the global average surface temperature by 1.5-4.5°C over the next 100 years.

2. OBJECTIVES

The objectives of the present study are as follows

1. To study the impact of climate change for Mysore taluk and estimate the climate change using multi-source remote sensing as well as observation data.
2. Analysis of agricultural scenario in Mysore taluk (using existing real time agriculture data).
3. Analysis of NDVI over the study area using satellite data (MODIS TERRA)
4. Development of Empirical relations of the climate change impacts on Agriculture
5. General Circulation Model for future Climate Prediction.

3. MATERIALS

The study is carried out by using data from various sources like Karnataka State Remote Sensing Application Centre (KSRSAC), Karnataka State Natural Disater Monitoring Centre (KSNDMC), NCEP/NCAR Reanalysis, India Water Portal and Giovanni MODIS TERRA Data for NDVI analysis etc. The local scale (station) data for Mysore taluk are being collected from the Statistical Department of GOK are used. Data from Agricultural economics review is also being used in the study.

3.1 Methodology for Agricultural Analysis

The flow chart of the detailed methodology followed in the current study has been represented in Fig 1. Data are collected from the KSNMDC and MODIS TERRA DATA from Giovanni website to Analysis the Rainfall and Temperature Data and NDVI Analysis to know about the Landuse classes and also the other climate parameters from NCEP/NCAR Reanalysis data for the study area by Open Grads Software.

The Agricultural analysis are carried out from the Data collected from DES Department for Mysore taluk and The GCM model has been Carried out for 2020 and 2030 to know about the Future scenario for the Climate changes in the study area and how it impacts on the Agriculture sectors by using Numerical Weather Prediction Model in GCM

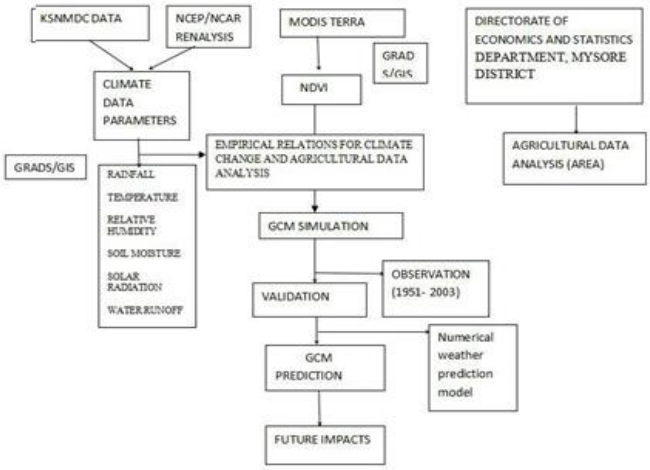

Fig -1: Flow chart shows the detailed Methodology

4 RESULTS AND DISCUSSION

4.1 Variations in Rainfall and Temperature

Variations in the rainfall and Temperature data are studied for the study area. The annual rainfall and minimum temperature data shows that there is decreasing (negative) in trend (chart-1, chart-2); the annual maximum temperature data shows that there is increasing (positive) in trend (chart-3) for study area. From this we observe that there is loss of rainfall for the Mysore Taluk.

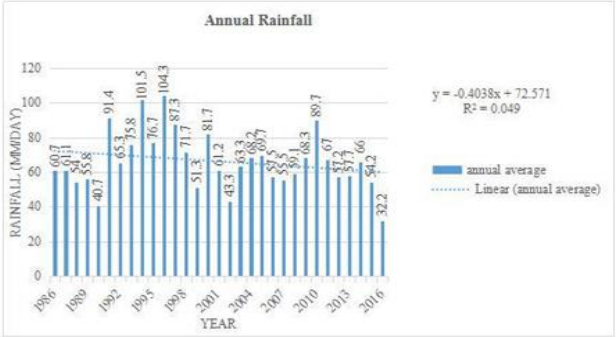

Chart-1 Annual average Rainfall trend for Mysore taluk from 1986-2016

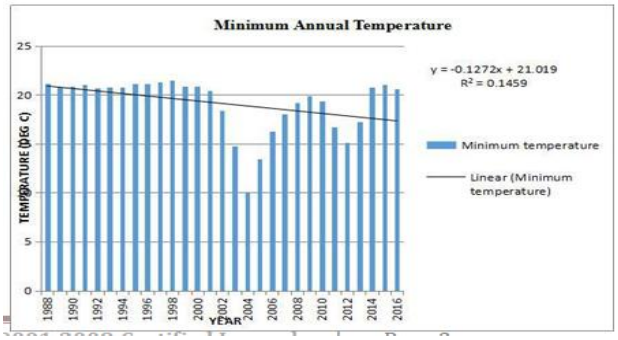

Chart-2 Annual average Minimum Temperature trend for Mysore taluk from 1986-2016

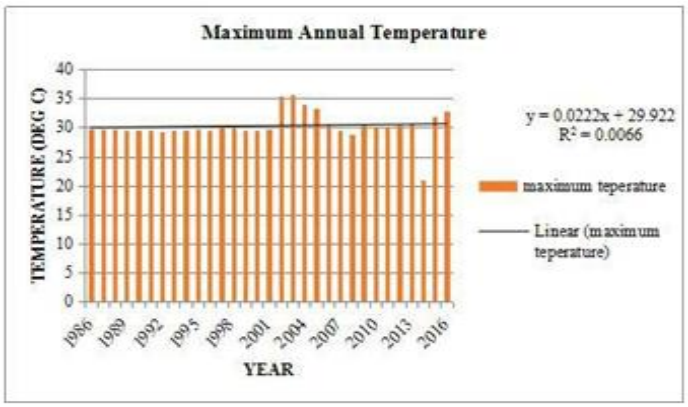

Chart- 3 Annual average Maximum Temperature trend for Mysore taluk from 1986-2016

4.2 Variations in NDVI or Vegetation Index in Mysore Taluk

The Annual averaged NDVI is analysed for 2000-2016 shows that there is a constant increase (positive) in trend (chart - 4). Currently, the general consensus on vegetation-temperature feedback is that an increase in vegetation promotes an increase in temperature particularly during summer. Nevertheless, there is still exists uncertainties regarding this conclusion because the dominant physical and ecological processes affecting vegetation are controlled by many other climatic factors.

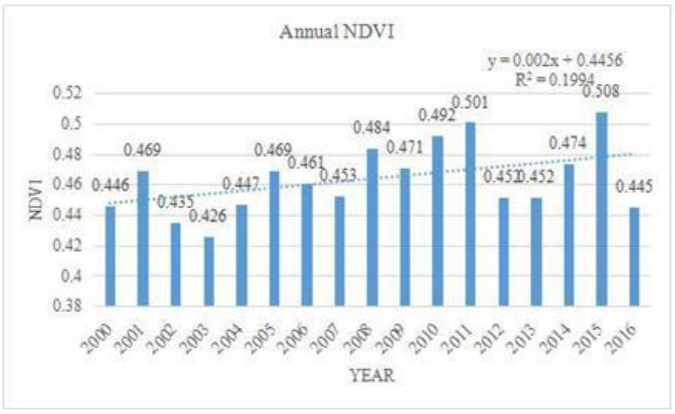

Chart-4 Annual average NDVI trend for Mysore taluk from 1986-2016

4.3 Variations in National Centers for Environmental Prediction (NCEP) reanalysis

NCEP Reanalysis data such as Relative Humidity, Runoff, Soil Moisture and Solar Radiation are taken in the Analysis for the Mysore taluk by using downscaling Techniques i.e., extracting the values for Mysore Taluk from the global data at the monthly scales by using Grads Software from the year of 2000-2016.

a) Relative Humidity (RH)

The Annual averaged Relative Humidity from 2000-2016 for Mysore Taluk is increasing (positive) in trend (chart-5). The Relative Humidity is a ratio of the actual amount of water vapor in the atmosphere compared to the saturation amount of water vapor. This shows that the relative Humidity will increases as temperatures decrease.

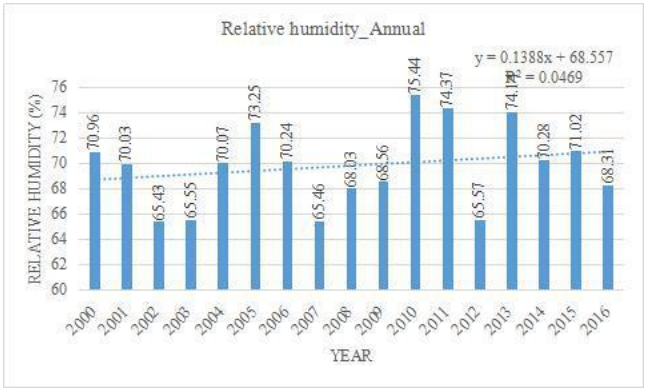

Chart – 5 Annual average Relative Humidity trend for Mysore Taluk from 1986-2016

b) Soil Moisture

The Annual averaged soil moisture from 2000-2016 for Mysore Taluk is increasing (positive) in trend (chart-6). Soil Moisture is a key variable in controlling the exchange of water and heat from energy between the land surface and the atmosphere through evaporation and plant transpiration and it is one of the important parameter for crop development.

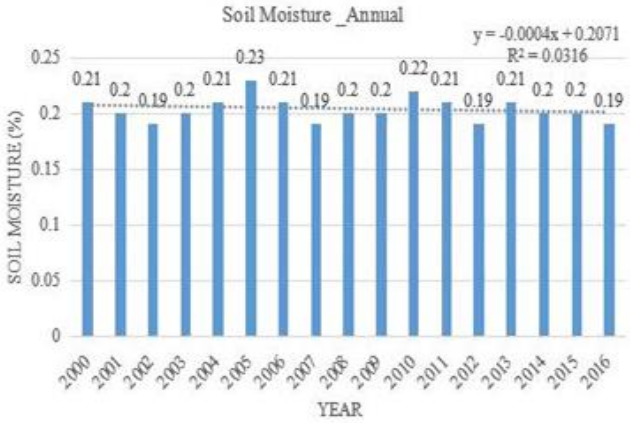

Chart- 6 Annual average Soil moisture trend for Mysore taluk from 1986-2016

c) Solar Radiations

The Annual averaged solar radiation from 2000-2016 for Mysore Taluk is increasing (positive) in trend (chart-7), and

(chart-8). Solar Radiation is an important parameter for the agriculture; Solar Radiation provides the light and heat for the plants development such as seed germination, Leaf expansion, flowering, growth of stem and roots, fruiting etc.

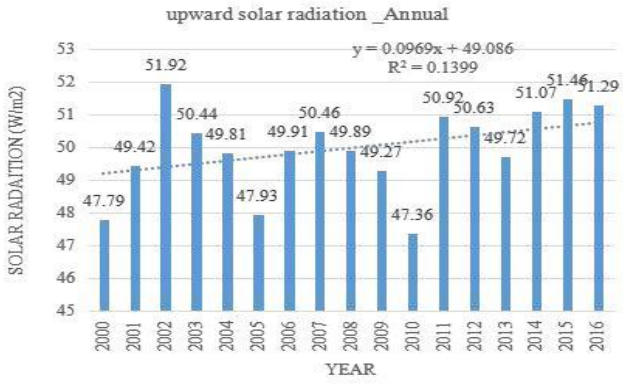

Chart- 7 Annual average upward solar radiation trend for Mysore taluk from 1986-2016

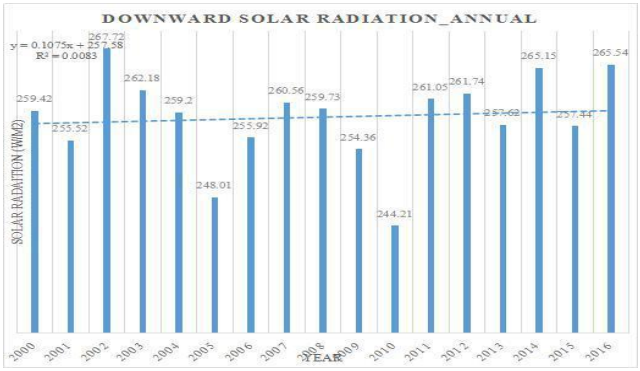

Chart- 8 Annual average downward solar radiation trend for Mysore taluk from 1986-2016

d) Water runoff

The Annual averaged water runoff trend is decreasing with a very low quantity (chart-9). This shows that as the rainfall increases, the amount of water that runs off increases.

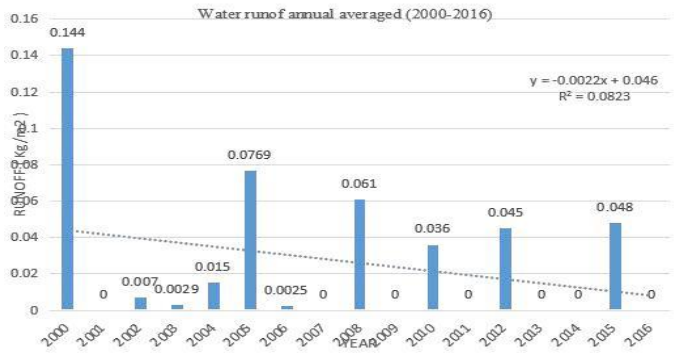

Chart- 9 Annual average water runoff trend for Mysore taluk from 1986-2016

4.4 Variations in Population and Agricultural Data Analysis

The results shows that there is an increase in the human population trend of Mysore Taluk (Chart-10) and as per the recent 2011 census, The livestock population of Mysore Taluk also shows an increasing trend from 1991 to 2001 (Chart-11) and the rate of the increase is around 0.74 % per Year.

The trend line shows a decreasing in the total area for cereals and minor millets, pulses, oilseeds, cotton and some of the vegetables crops, sugarcane and fruits crop area there is an increase in trend line (chart 12-16).

The area under Mulberry and cocoon production are decreasing in the trend for the year from 1986 to 2016 is shown in the (Chart-18) and the poultry population is also increasing in trend from 2000-2001 to 2007-2008 and again decrease in 2014-2015 is shown in the (Chart-19)

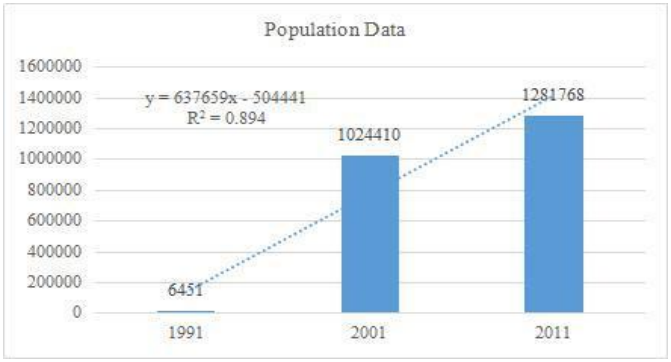

Chart-10 Population data trend for Mysore taluk from 1991/2001/2011 census

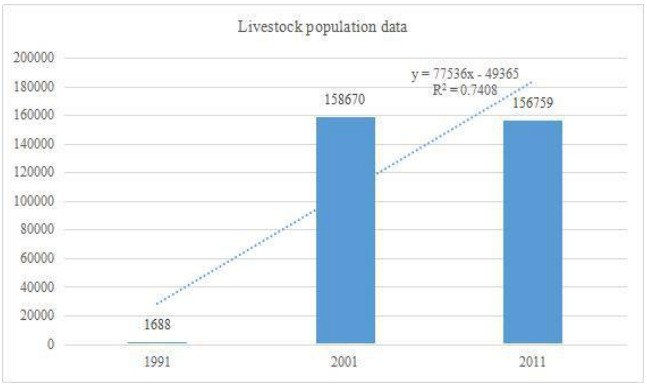

Chart- 11 livestock Population data trend for Mysore taluk from 1991/2001/2011 census

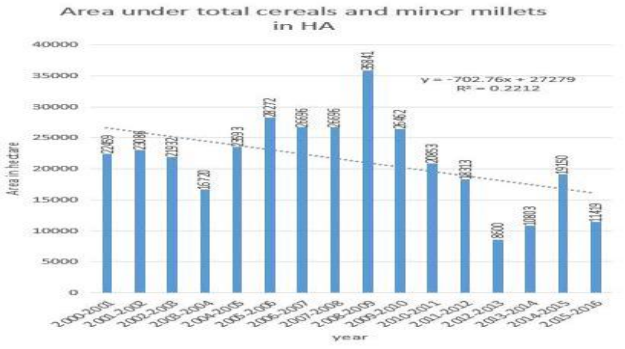

Chart-12 Population data trend for Mysore taluk from 1991/2001/2011 census

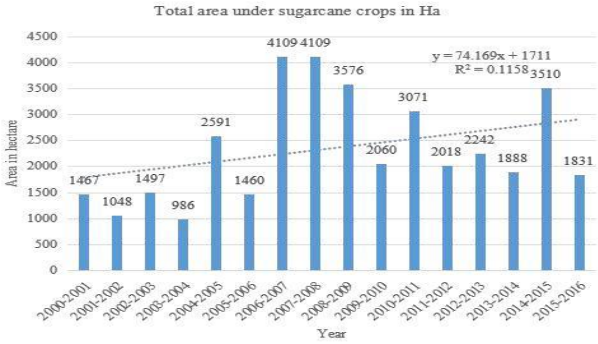

Chart- 16 Total Area under sugarcane in Ha for Mysore Taluk from 1986-2016

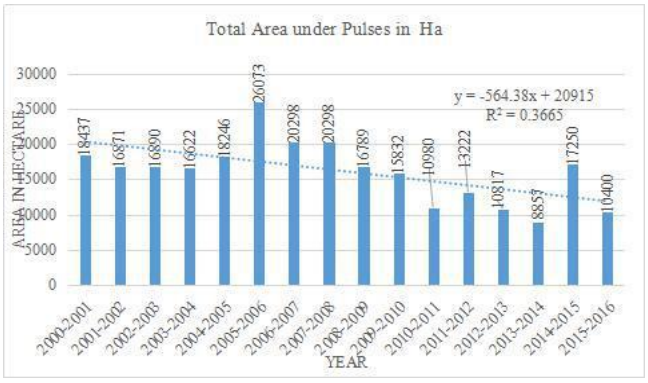

Chart- 13 Total Area under pulses in Ha for Mysore Taluk from 1986-2016

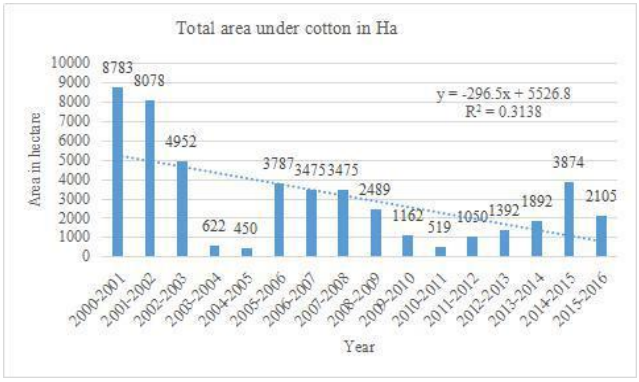

Chart- 17 Total Area under cotton in Ha for Mysore Taluk from 1986-2016

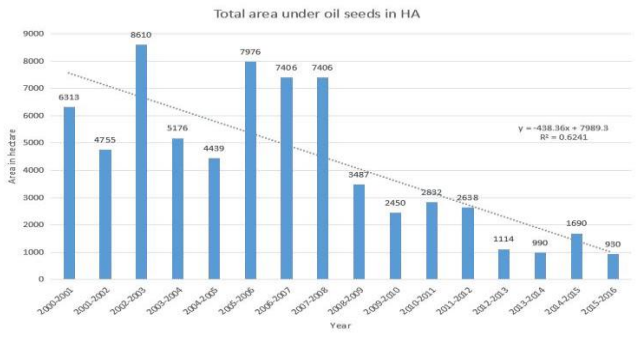

Chart- 14 Total Area under oilseeds in Ha for Mysore Taluk from 1986-2016

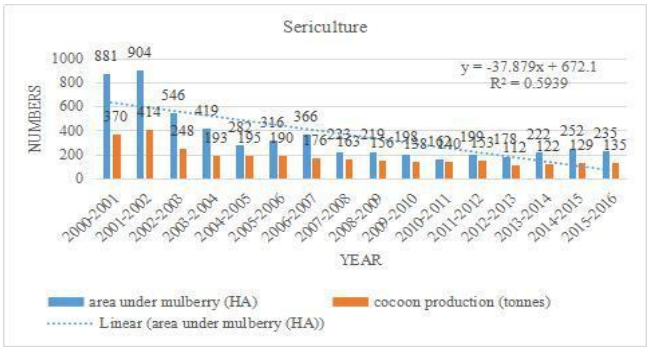

Chart- 18 Total Area under sericulture in Ha for Mysore Taluk from 1986-2016

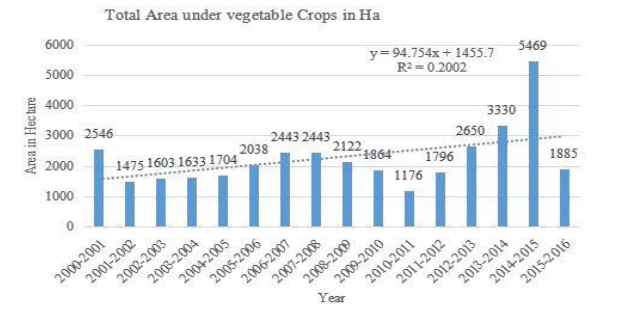

Chart- 15 Total Area under vegetable crops in Ha for Mysore Taluk from 1986-2016

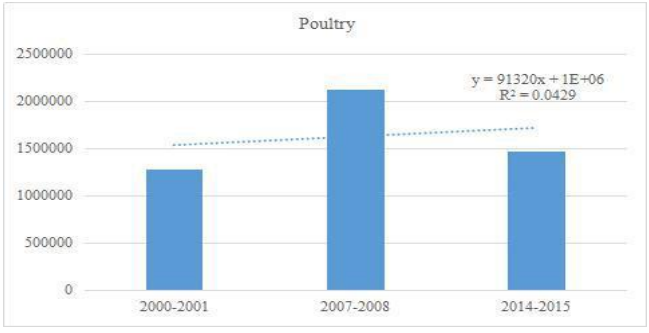

Chart-19 poultry population data for Mysore Taluk from 1986-2016

4.5 CLIMATE MODEL PREDICTION

There are two important parameters considered in the GCM model that is temperature and rainfall. Henceforth, for the future agricultural analysis, the GCM Climate Model predicted scenarios are used, followed in the present study also. The projected parameters of rainfall and temperature are considered to study the future impacts on agriculture, due to climate changes.

C-MMACS by using GCM model, GCM is capturing the climatogical rainfall mean over India. Apart from that the spatial distribution of monsoon rainfall is simulated by GCM and compared with IMD observation. The monsoon rainfall data of global scale to regional scale downscaling techniques by using Grads Software.

Monsoon rainfall from June to September, (mm/day), over India based on 1951-2003 data, (a) Observed data, (b) Simulated by GCM, (c) bias (mm/day) between observation and prediction and (d) percentage change for the period 2020-2030 with respect to 1951-2003 is shown in Fig. 1. Downscaling the rainfall data for Mysore Taluk with Latitude and Longitude details is shown Fig 2.

Table -1: The projected change in monthly Rainfall and Temperature data for the Mysore Taluk

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall	2020	0	0	33	42	55	75	91	95	79	96	55	4
	2030	0	0	31	41	54	72	89	93	74	92	50	4
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	2020	22.4224	24.53675	26.77675	27.83325	27.08475	24.71163	23.69967	23.845	24.16025	24.21762	23.0938	22.0308
	2030	22.43	24.555	26.79	27.87	27.14	24.76	23.9	23.856	24.19	24.27	23.0941	22.039

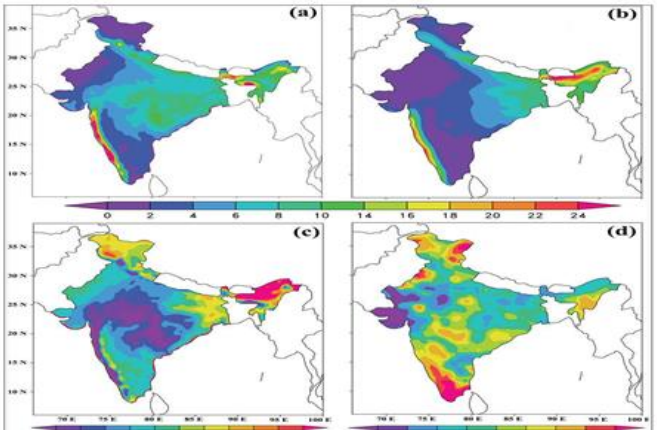

Fig-1 The comparison of observation data in (a), simulated data (b), and biased data (c) and finally projected data for 2020 and 2030 (d)

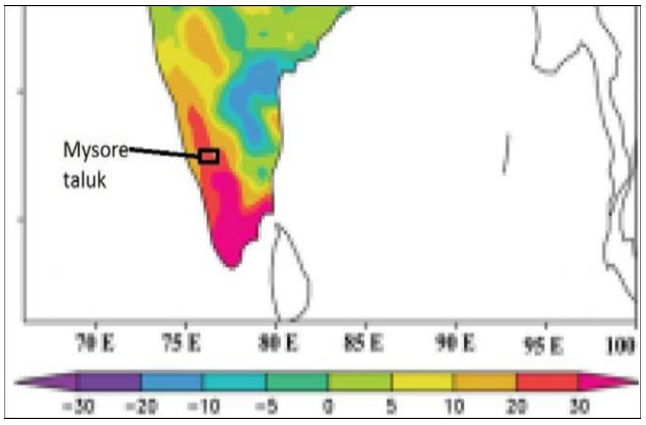

Fig-2 Downscaling the rainfall data for Mysore Taluk with Latitude and Longitude details

5. CONCLUSIONS

Climate change, the outcome of the "Global Warming" has now started showing its impacts worldwide. Climate is the primary determinant of agricultural productivity which directly impact on food production across the globe. Agriculture sector is the most sensitive sector to the climate changes because the climate of a region/country determines the nature and characteristics of vegetation and crops. Food production systems are extremely sensitive to climate changes like changes in temperature and precipitation, which may lead to outbreaks of pests and diseases.

Coping with the impact of climate change on agriculture will require careful management of resources like soil, water and biodiversity.

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