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Awareness on Impact of Climate Change in Agriculture, A Study of Chidambaram Agricultural Area by Using Educational Global Climate Model Software

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Abstract: ***In Tamilnadu over 60 per cent of the employment is dependent on agriculture, a sector which is highly sensitive to climate variability. Climate and Agriculture are interrelated processes; both take place on a global scale [1 & 2]. Global warming is projected to have significant impact on conditions affecting agriculture, including temperature, precipitation and glacial runoff. Rising Carbon Dioxide levels would also have effects both detrimental and beneficial, on crop yields. The overall effect of Climate Change on agriculture will depend on the balance of these effects by the authority of the Intergovernmental panel on climate change (IPCC). This study aims to examine the impact of climate variables on agriculture and bring out the awareness of the farmers who are quitting from their agricultural activities due to this correspondence of ill effects and helps to sustain their life of human beings for present and future generations too [3].***

Keywords: Climate Change, National Atmospheric Research Laboratory, Crop Yield, Climate Variable, Educational Global Climate Modelling.

1. Introduction

The climate is one of the main determinants of agricultural production. There is significant apprehension about the effects of climate change and its variability in agricultural production throughout the world. The Climate change is any change in climate over time that is attributed directly or indirectly to human activity which alters the composition of the global atmosphere. In addition to natural climate variability observed over comparable time periods (IPCC, 2007). Since climatic factors serve as direct inputs to agriculture, any change in climatic factors is bound to have a significant impact on crop yields and production. Of course the industrial revolution in the western countries was rapidly utilized the fossil fuels, on the other side the natural buffering system for climate change, forests were destroyed indiscriminately for want of fuel, fodder and timbers in the developing countries. These factors were intensified by the human activities in the past 250 years, which had tremendous impact on the climate system [13]. According to the IPCC the greenhouse gas emission could cause the mean global temperature to rise by another 1.4^{o} C to 5.8^{o} C. Already the symptoms of climate change were observed at a faster rate in the arctic and under arctic regions through melting of the frozen ice which have the danger of submergence of the coastal zones. In the case of the inland water source, there is tremendous change in both surfaces as well as ground water due to erratic rainfall and occurrence of frequent droughts [3 & 4]. Anthropogenic activities are the main reasons for Climate Change. Industries, transportation, generation of power are the main reasons for the increase in temperature. Agriculture, forestry and fisheries are sensitive to Climate Change impacts on the one hand, and are also contributing to emission on the other. Agriculture accounts for 13.5 percent of global greenhouse gas emissions from fertilized soils, biomass burning, rice production as well as manure and fertilizer production [5]. According to Intergovernmental Panel [6] on Climate Change (IPCC) mitigation is defined as an anthropogenic intervention to reduce the sources or enhance of the Greenhouse Gases" [7]. On other hand climate adaptation refers to the ability of a system to adjust to Climate Change, including climate variability and extremes, to moderate potential damages, to take advantage of opportunities or to cope with the consequences [8]. To meet the challenges posed by Climate Change on the agricultural system, Indian Council of Agricultural Research (ICAR) has accorded high priority in understanding the impact of Climate Change and developing adaptation and mitigation strategies through its network research program, National Project on Climate Change (NPCC). Its main objectives are to identify the region experiencing extreme Climate Changes, developing methodologies for assessing the impact of Climate Change on agricultural productivity and suggesting suitable intervention for reducing the impact of Climate Change. Climate change may exacerbate the impacts and thus limit agricultural production. Notwithstanding the challenges in the agriculture sector, animal Husbandry, including fisheries sector, which together account for a quarter of total agriculture and allied activities GSDP, provides opportunities for livelihood diversification in this sector. Any impact on agriculture and allied sectors will exert cascading effect on secondary and tertiary sectors. At present, though there is no systematic study to assess the direct and indirect effects of climate change on agriculture and allied sectors, this sectoral plan will enable the State to assess the vulnerability of the State to climate risks, prioritization of research and development issues and effective decision making to reduce risks through adaptation [9].

2. Study Area

Tamilnadu is a state of the Indian sub - continent was chosen as the study area. Tamilnadu lies between 7°91N to 13°65N latitude and 76°17E to 80°82E longitude (Fig. 1). Tamil Nadu is situated in the southernmost part of the Indian peninsula. Agriculture, a predominant sector, contributes to about 10 percent of the state's Gross Domestic Product (GDP) and provides employment for about 60 percent of the rural work force. Currently, the gross cropped area is 6.3 million hectares, accounting for nearly 50 per cent of the total geographical area of the state [3]. Food crops account for 70 per cent of the gross cropped area, of which nearly half is under rice (Government of Tamil Nadu, 2010) [3 & 9].

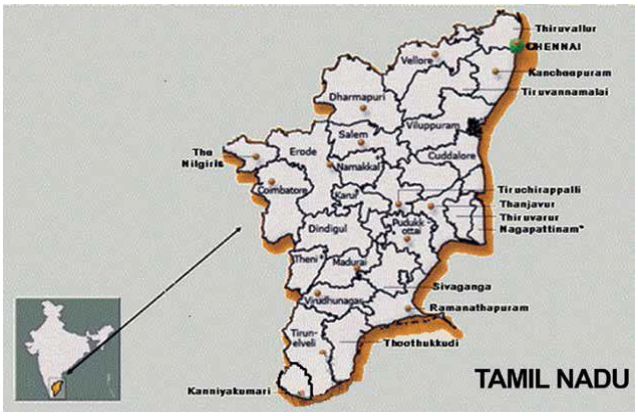


Figure 1: Location of the study area

3. Methodology

3.1 Temperature Projections

3.1.1 Maximum temperature

The maximum temperature over Tamil Nadu is projected to increase by 1.1^{0}C, in the years 2040 respectively, with reference to the baseline 1970-2000. District wise changes indicate a general maximum increase of about 1.3℃ over the North western districts of Nilgiris , Coimbatore, Tiruppur and western parts of Dindigul District . The minimum increase of about 0.7℃ is seen along the eastern parts of coastal districts, particularly over Kanyakumari, Nagapattinam, Tirunelvelli and Ramanathapuram [9].

3.1.2 Minimum temperature

Projection of minimum temperature over Tamil Nadu as a whole for 2040 with reference to baseline 1970-2000 are likely to increase by 1.10℃ respectively. District wise changes indicate generally lesser changes over the western parts and close to the coast . A general rise in temperature is seen ranging from 1˚ to 1.50℃ for the period 2010 to 2040 The southern districts Kanyakumari and Tirunelvelli show minimum increase, while the central interior districts Karur, Tiruppur, and Namakkal show the maximum increase in the minimum Temperature (Fig. 2) [9].

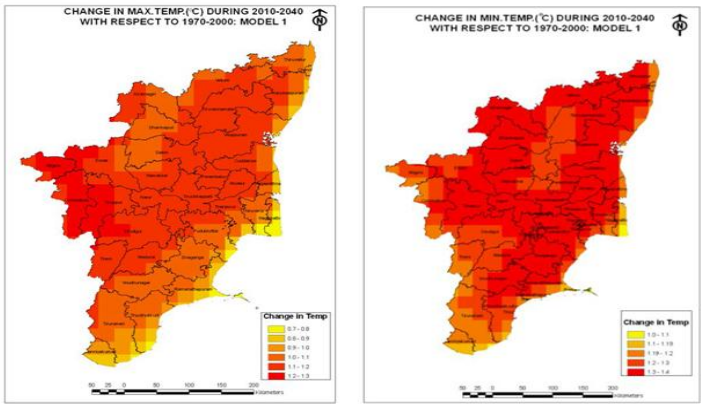
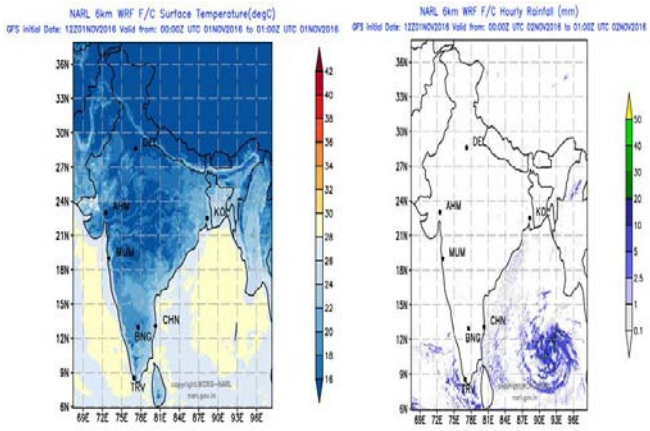


Figure 2: Change in maximum and minimum temperature (℃) projections of 2040

Various meteorological data were collected and analyzed for better understanding of the effect of meteorological parameters on climate change & finally on crop yield (Fig. 3, 4, 5 & 6).



http://forecast.narl.gov.in/weather/pdf/new/20161101/meteograms.html

Figure 3: Surface temperature & Rainfall data

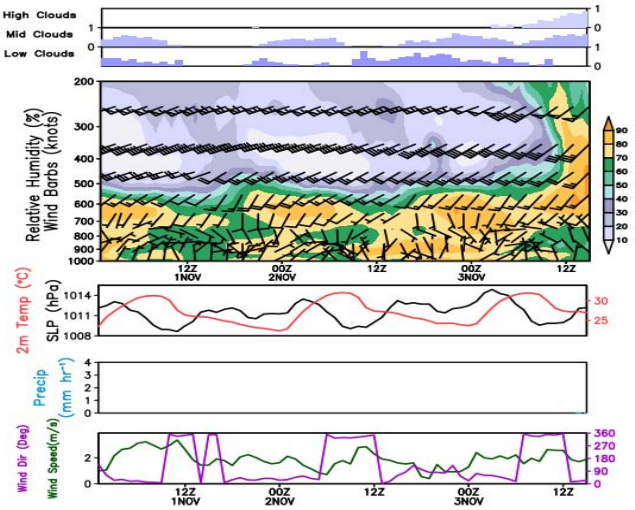


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Figure 4: Meteograms

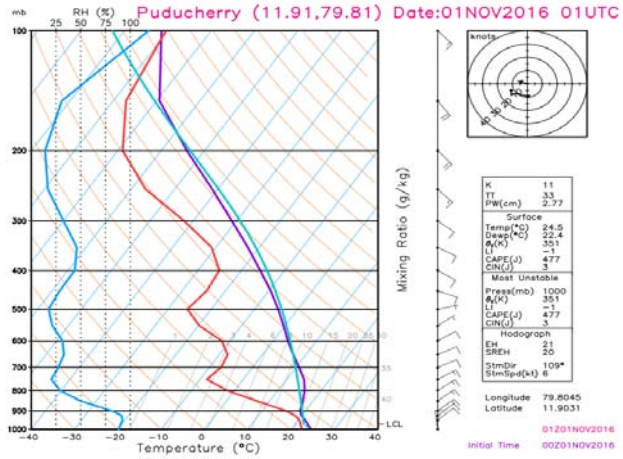

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Figure 5: Tephigrams for Pondicherry

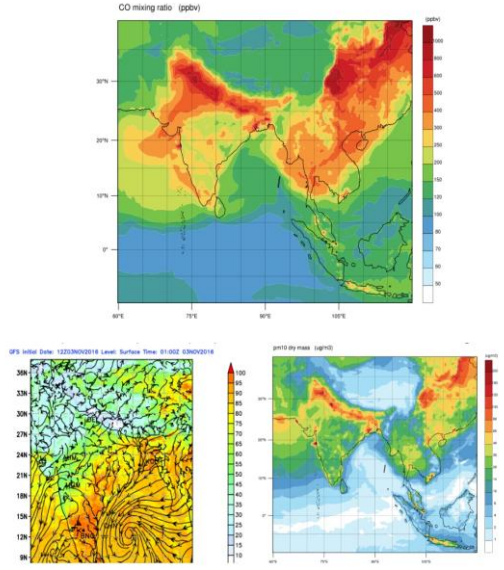

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Figure 6: Mixing rate of CO, RH & PM10 analysis

Following instruments were utilized during the weather data analysis (Fig. 7).

Figure 7: Various instruments of analysis and location of station

Table 1: Analyzed weather data show the significant change

Year: 2012	*Temperature (˚C)*		*Wind velocity*	*Rainfall*
Month	Maximum	Minimum		
JAN	29.3	21.0	3.0	011.7
FEB	30.5	21.3	3.4	000.0
MAR	33.4	23.3	3.5	010.0
APR	34.9	26.1	4.0	006.4
MAY	38.3	27.4	8.6	002.8
JUN	37.9	27.3	9.5	000.6
JULY	35.7	25.7	6.3	078.0
AUG	35.2	25.3	6.4	079.4
SEP	34.9	24.9	5.8	113.3
OCT	31.0	24.0	3.9	640.2
NOV	30.4	23.1	4.5	098.4
DEC	29.2	22.3	5.0	045.5
Total	400.7	291.7	63.9	1086.3
Mean	33.3	24.3	5.3	-
2013				
JAN	33.4	23.6	4.5	004.2
FEB	30.4	21.8	4.1	060.1
MAR	32.4	22.4	3.5	030.6
APR	35.8	25.6	4.7	000.0
MAY	38.2	27.0	6.5	043.8
JUN	36.1	26.5	7.3	021.4
JULY	35.6	25.8	6.6	042.8
AUG	33.7	24.3	5.2	201.6
SEP	33.0	24.4	4.7	144.9
OCT	32.9	24.5	3.3	120.4
NOV	29.1	22.9	3.9	298.9
DEC	28.0	21.1	4.0	222.8
Total	398.6	298.9	58.3	1188.5
Mean	33.2	24.1	4.8	-
2014				
JAN	28.4	20.9	4.4	007.2
FEB	29.6	20.3	2.7	025.8
MAR	31.6	21.9	2.9	000.0
APR	34.9	24.5	3.4	000.0
MAY	33.8	25.8	5.0	183.2
JUN	37.2	26.8	5.8	067.2
JUL	35.3	25.6	6.3	092.4
AUG	33.9	24.8	4.7	171.0
SEP	34.1	24.7	4.0	034.5
OCT	31.6	24.1	2.5	528.9
NOV	28.9	23.1	3.5	341.8
DEC	28.0	22.6	04.8	227.9
TOTAL	387.3	285.1	50	1679.7
MEAN	32.2	237	4.1	-
2015				
JAN	28.7	21.2	2.5	022.8
FEB	29.6	20.8	2.5	000.0
MAR	32.3	22.9	1.9	000.0
APR	34.1	24.8	2.8	067.5
MAY	33.9	26.2	4.3	100.8
JUN	34.9	25.5	5.1	073.2
JUL	36.7	27.5	4.5	107.6
AUG	35.1	25.6	3.5	125.0
SEP	35.0	24.6	4.6	028.6
OCT	32.8	24.1	3.0	118.0
NOV	29.1	23.5	3.9	950.0
DEC	29.2	23.2	3.1	459.0
Total	391.4	289.9	41.7	2025.5
Mean	32.6	24.1	3.4	-
2016				
JAN	29.8	21.2	2.9	007.0

FEB	31.5	22.0	2.4	000.0
MAR	33.8	23.3	3.0	000.0
APR	36.5	26.1	4.7	000.0
MAY	36.1	26.4	5.0	124.8
JUN	35.1	25.8	5.1	055.0
JUL	35.3	25.4	4.5	041.8
AUG	35.8	24.8	5.1	167.2
SEP	34.3	24.9	5.8	086.6
OCT	34.2	25.2	2.5	052.5

3.2 Comparative studies by Educational global climate modeling software (EdGCM)

EdGCM is an integrated software suite designed to simplify the process of setting up, running, analyzing and reporting on global climate model simulations. Various results are shown below (Fig. 8, 9 & 10) [11].

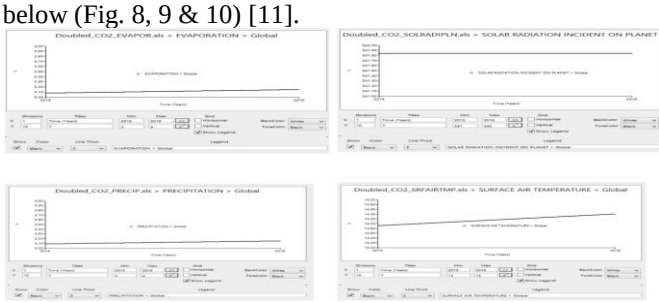

Figure 8: Co_2 emissions during 2015- 2016 concerning with various other parameters

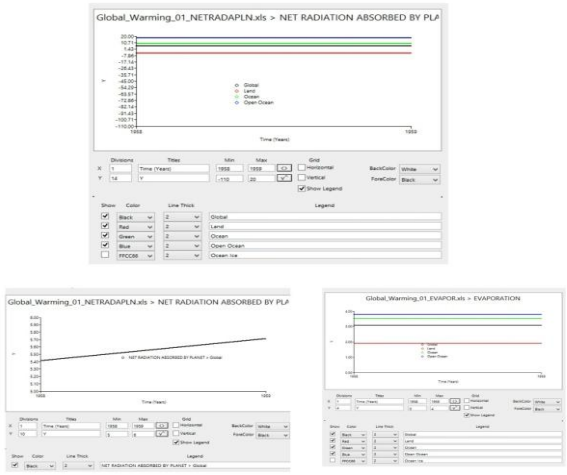

Figure 9: Global warming during 1958-1959

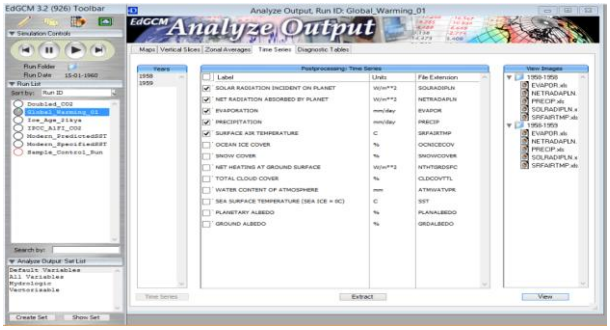

Figure 10: Software output sight

3.3 Impact on crop production

Tamil Nadu is one of the most urbanized and industrialized states in India and only 22 percent of its income comes from the agriculture and allied sectors, and the share is indicating a declining trend over the years. The sector, which grew at 15.28 per cent during 2006-'07 declined to -4.46 per cent in 2007-'08 due to the crop damages caused by natural calamities. However, still about 40 per cent of the state population is dependent on this sector for livelihood. Hence the growth in agriculture is important not only to ensure food security, but also for higher living standards as well. In addition to the frequent and recurrent hydro meteorological events such as droughts, extreme rainfall events and cyclones impacting agriculture in the state, the growth of the sector is constrained by a number of other factors such as reduced availability of water and declining crop area which has declined from 33% of available land area in 2000-01 to 31% of total land area in 2010-11. Further, small land holdings, deterioration in soil health due to depletion of topsoil & decline in organic content, decrease in cropping intensity and shortage of labour force besides reluctance to work on the farms and poor adoption of crop management practices etc. adds to the existing pressure on agriculture. In the last decade between 2001-02 and 2010-11, the net sown area was at its peak during 2001-02 in Tamilnadu, but due to the extreme drought in 2002-2003, the net sown area as well as the total production dipped significantly. Since then the net sown area has not recovered. However, with the increase in area under assured irrigation from 54% of gross sown area in 2001-02 to 58% in 2010-11, the production of cereals, pulses, oil seeds etc. are on the path of recovery and productivity of a majority of the crops are on the rise except for a nominal decline in rice and pulses. In 2011-12, the total irrigated area was 2912 '000 ha of which 56% was irrigated by ground water and the rest by canals, tanks and other modes of irrigation. In case of rice, 93 percent of the gross sown area is irrigated. Six percent of the gross sown area under pulses is irrigated. In the case of oil seeds, 38 percent of the gross sown area is irrigated. Tamilnadu is the highest producer of oilseeds in the country [9 & 12].

Table 2: Change in crop yields during past decade due to climate change

*CROP VARITIES**	*2001-2002 (kg/ha)*	*2010-2011 (kg/ha)*	*Net change (%)*
Rice	3196	3039	-4.9
Cholum	866	1014	+17.1
Cumbu	1223	1564	+27.9
Ragi	1883	2262	+20.1
Maize	1950	2468	+26.6
Ground nut	1885	2323	+23.2
Pulses	395	386	-2.5

* www.environment.tn.nic.in/doc/pdf/Chapter 5.pdf

4. Results & Discussion

In order to achieve the objective of this work and to develop a monitoring based meteorological model for maximum crop yield, several important issues are essential and has to be taken into consideration, to provide satisfactory results like, proper planning and study of the region of interest, meteorological data collection and processing etc. The study found that increase in temperature by about 2℃ will reduce potential grain yields in most places. Region with higher potential productivity, such as northern India were relatively less impacted by Climate Change than areas with lower

potential. Climate Change will also lead to boundary change in areas suitable for growing certain crops. Reduction in yields as a result of Climate Change is predicted to be more pronounced for rain fed crops as opposed to irrigated crops because of no coping mechanism for rainfall variability. The difference in yield is influenced by baseline climate. In subtropical environment the decrease in potential wheat yield range from 1.5 to 5.8 percent, while in tropical regions the decrease is relatively higher, suggesting that warmer regions can expect greater crop [3].

5. Conclusion

Climate Change and agriculture are inseparably linked globally, both affecting and influencing each other. Climate Change influences the crop yield and quality, fertility status of soil and may pose a serious threat to food and nutritional security. The challenge for Indian agriculture is to adopt to potential changes in temperature and precipitation and to extreme events without compromising productivity and food security. The consequences of these changes may result in a need to adopt existing regulation with respect to environmental policy goals. Though the efforts are going on to develop strategies to mitigate the negative impact of Climate Change and research in new directions are being carried out, more emphasis is required to make sufficient investments to support Climate Change adaptation and mitigation policies, technology development and dissemination of information. Making possible of interlinking rivers from northern to the southern India region to solve the problems of drought. Moreover the above impacts concluded and resulted that farmers decided to go for suicide. These issues should be controlled and made possible to form a green earth. Now, after taking all the probable reasons under consideration of the above study, a conclusion has been arrived that the greenhouse effect and global warming could be the most appropriate reason of climate change, which is accelerated due to anthropogenic activities.

6. Future Scope

In order to improve the understanding of all the meteorological parameters effect on crop yield, individual parameters can be monitored and analyzed. Water and nutrition management also could be undertaken to study, for better understanding of the growth pattern of crops.

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