How to Cite:
Dhole, M., & Topno, S. (2022). Change in climatic elements impact on agriculture: A case study on 24 PGS(S). *International Journal of Health Sciences*, *6*(S2), 5685–5705. https://doi.org/10.53730/ijhs.v6nS2.6446

Change in climatic elements impact on agriculture: A case study on 24 PGS(S)

Madhuchhanda Dhole
Research Scholar. R.K.D.F. University, Ranchi. Jharkhand
Corresponding author email: madhuchhandadhole@gmail.com

Dr. Sheetal Topno
Assistant Professor & HOD, Department of Geography, R.K.D.F. University, Ranchi. Jharkhand

***Abstract*---**The most essential physical factor in nature is climate. Changes in climate parameters are referred to as climate change (main parameters are temperature, rainfall, humidity and wind). It is a global and current issue that has become a well-known global calamity in recent years (IPCC, 2007). Climate change is a long-term process that has far-reaching consequences. From low to high latitude, the pace of change and the effect of that change differ. Low latitudinal places are impacted not just from an environmental standpoint, but also from a financial standpoint. Because the research location is in the tropical region of West Bengal, it is badly affected when the temperature rises over time. People's basic economy is agriculture in numerous locations, and agricultural productivity is influenced by climate factors. Agricultural productivity is influenced by climatic factors such as temperature, rainfall, and humidity. However, climate change has had an impact on lower latitudinal locations for numerous decades. Climate change is caused by the release of GHGs or Green House Gases (Gil Kim, 2009), urbanisation, and industrialisation, according to many sorts of studies. As a result, agricultural yield, area, and productivity have all dropped. In other words, agricultural land has been turned into a non-agricultural area. The distribution of built-up and barren land is greater than before. Agricultural systems (sowing, growing, and harvesting periods and patterns, for example), production quantity, and land use patterns have all been affected in this way. The major goal of a research paper should be to figure out what the main issue is and how to adopt a different approach to solve the problem using correct tactics. This does not imply that the aim has been abandoned. People should also be more aware of the environmental impact of Green House Gas emissions.

Keywords---agriculture, climatic element, effects, land use, pattern change, adaptation, precaution.

Introduction

The study area South 24 Parganas (24 PGS (S)) is the largest district of West Bengal (W.B.) and it is situated south-East portion of this state of India, the area is 9960 sq.km., lies between $22^0$12’13” N - $22^0$46’55” N latitude and $87^0$58’45” E – $88^0$22’10” E longitude or under the tropical region (Directorate of Census Operations West Bengal, 2011), shown in the Location Map, figure.1. The southern part is surrounded by the Bay of Bengal and the other parts are surrounded by the neighbour district (North 24 Parganas, Kolkata and separated from Howrah and East Midnapur by the river Hooghly) of it. According to the report of West Bengal State Action Plan on Climate Change (SAPCC) (2017-2020), the maximum part of the study area is situated under the Saline Coastal region (area of this region is 14.57 hectares, the soil of this part is alluvial, fine textured, saline soil, temperature range varies from 16°C - 34 °C, annual rainfall varies 150–170 cm) and a very little part of the north west portion of the study area is situated under the New Alluvial Zone (area of this region is 15.30 hectare, the soil of this part is Flat to rolling, Light to heavy, acidic to neutral (P^H 5.7) soil, temperature range varies from 15.6°C - 35 °C, annual rainfall varies 120–170 cm). It is an important agro-climatic zone among the six zones. The main crops of this region are rice, wheat, maize, jute, green gram, black gram, pigeon pea, lentil, rapeseed, mustard, groundnut, sesame, linseed and vegetables etc. (SAPCC, 2017). The total population of 24 PGS (S) was 6906689 in 2001 and 8161961 in 2011, (District handbook, 24 PGS (S), 2011). The growth rate is 18.17% in a decade.

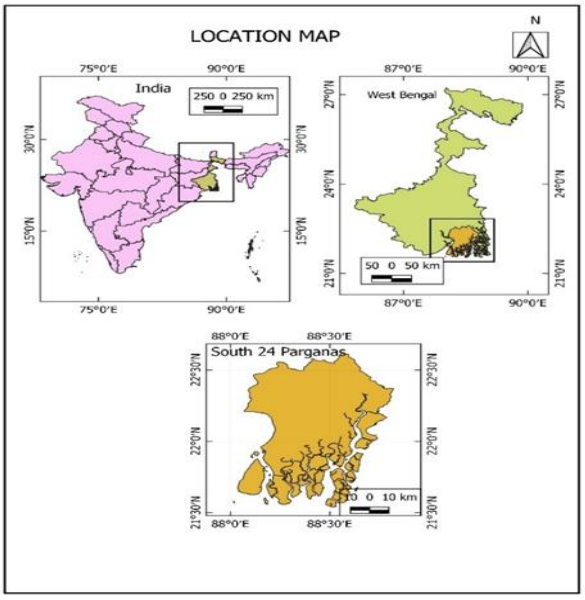

Figure.1 Location Map compiled by Dhole, M. (2021)

Climate change is referred to as positive and negative both in climatic conditions. But various reports from various organizations and research, moreover climatic hazards are indicating that it is referred to the increase of the temperature from a long time in the whole world, it is known as global warming (Finance & Development, 2008).

Global warming is the cause of climate change and it is responsible from two sides i.e., physical and another is anthropogenic activities, mainly emission of Green House Gases (GHGs) from urban centres (Gil Kim, 2009). The average temperature has been increasing day by day and it assumes that it will increase more 2.8^0C by this century (IPCC, 2007a). Other more international organizations like the Club of Rome Report-1972, World Meteorological Organisation (WMO), United Nations Environment Programme (UNEP) are announced in a different year in their report about the temperature increase and global warming due to the excessive emission of GHG in the atmosphere (Gil Kim, 2009).

Global warming has many impacts, it creates frequently climatic severe disasters and hazards, the rise of water level, temperature increase and fluctuation in precipitation, flood and drought etc. It changes the environment and ecosystem in the whole world (Zhai and Zhuang. 2009). According to the analysis of the Indian Meteorological Department (IMD), the mean, minimum and maximum temperature is increasing gradually after the analysis of 116 years of climatic data (1901- 2016). It is happening not only in this region but also in the whole of India (SAPCC, 2017).

Agriculture is directly dependent on climatic conditions. So, climatic change directly affects agriculture. To mitigate the impact of GHG and the effect of global warming various international environmental conferences are happening like Conference of the Parties (COP), United Nationals Framework Convention on Climate Change (UNFCCC), Intergovernmental Panel on Climate Change (IPCC), Kyoto Protocol etc. Now a days, to fight with the climate change agricultural adaptation is necessary. IPCC has emphasized that crop shifting and crop rotation should be necessary (Gil Kim, 2012).

Objectives

The objectives of this paper are

i. To find out the climatic elements are changing.
ii. To find out the climate change effects on the agricultural pattern.
iii. To find out the land use pattern is changing with agricultural production change.

Methodology and Materials

At first secondary data has been collected from the different sources i.e., i) agricultural data from the Evaluation wing Directorate of Agriculture, Govt. of West Bengal. ii) Climatic Data of Dumdum, www.ncdc.noaa.gov, iii) GHGs data from the State of the Global Climate 2020,

iv) Temperature difference data from World Meteorological Organization, v) Sea level change or rise data from Sea Level Change Initiative (SL_CCI), vi) satellite image and shapefile were downloaded from USGS and diva GIS site, vii) QGIS software has been used for preparing the maps, viii) MS Excel and SPSS software have been used for statistical data analysis. ix) Some literature review has been done. The steps of methodology have been shown in figure.2.

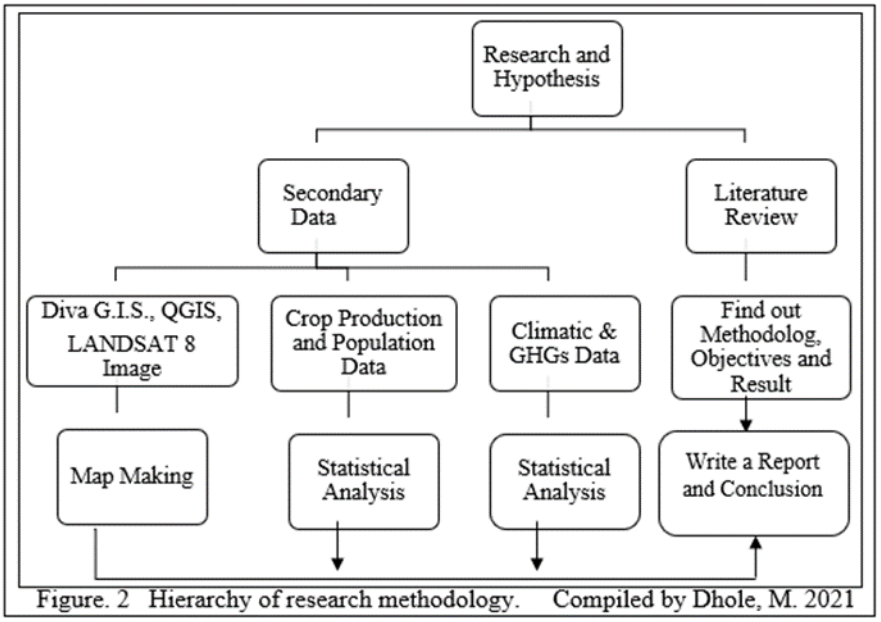

Figure. 2 Hierarchy of research methodology. Compiled by Dhole, M. 2021

Hypothesis

1. H_0: (Null Hypothesis) There is no relationship between increasing temperature with time. H_1: (Alternative Hypothesis) The temperature is changing with time.
2. H0: (Null Hypothesis) There is no relationship between climate change and crop production. H1: (Alternative Hypothesis) The climate change effect on crop production.
3. H_0: (Null Hypothesis) There is no relationship between land use pattern change and crop production. H_1: (Alternative Hypothesis) The land use pattern is changing with agricultural production.

Climate change and Agriculture

An increase in the ambient temperature is called climate change. Human activities are responsible directly for this, as a result, global warming eventuates from 1951- 2010 rapidly (IPCC, 2007). Even, report IPSS, 2007 also indicated that the global mean temperature will increase 3.7^0–4.8^0C in 2100, compare with the pre-industrial period. The main cause of climate change cum global warming is the result of the concentration of Green House Gases (GHGs) in the atmosphere (WG-I) (IPCC, 2007). GHGs are that gases which absorb and create obstructions to emit surface temperature from the earth and increase the earths' atmospheric

temperature. The GHGs are Water Vapour (H_2O), Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous oxide (N_2O), Hydrochlorofluorocarbons (HCFCs), Hydrofluorocarbons (HFCs) and Ozone (O_3) Halocarbons (SF_6) and Molecular Hydrogen (H_2) etc. (Greenhouse gases, World Meteorological Organization, 2021). The gradually increasing trend of various GHGs emission rates has been shown in table.1.

Table.1 Green House Gases

GHG\Year	1985	1990	1995	2000	2005	2010	2015	2019
CO_2 (PPM)	345.8	354.2	360.4	369.5	379.2	389	400.1	412.8
N_2O (PPB)	304.5	308.6	311.4	315.7	319.1	323.3	328.3	332.9
CH_4 (PPB)	1166	1724	1759	1783	1785	1809	1844	4885

Source: The State of the Global Climate 2020

The special report of IPCC, 2018 has been announced that the global warming of 1.5^0 C will impact (after the pre-industrial period) the atmosphere due to excessive emission of GHGs. Now, for reducing the temperature below 1.5^0C, it is needed a rapid reduction of GHGs emissions (IPCC, 2007). Agricultural fields, livestock, fertilizer production are responsible for the emission of GHGs.Indian main source of income is agriculture. But its two-third agricultural land is under rainfall region. The total agricultural system is dependent on monsoon rainwater. But vagaries of monsoon affect the agricultural system. Moreover, climate change regulates the irregularity of rainfall. Sometimes, it creates floods and drought due to over rain or insufficient rain. Moreover, temperature changes (Table.2, Figure.3) push up the effect (Climate Change & Agriculture in India, 2016).

Table.2 Distribution of Climatic Elements

Year	Precipitation (inch)	Average total Temperature ^{0} C
2008	10.12	26.21
2015	12.89	26.81
2019	18.04	26.24
Source: Climatic Data of Dumdum, www.ncdc.noaa.gov		

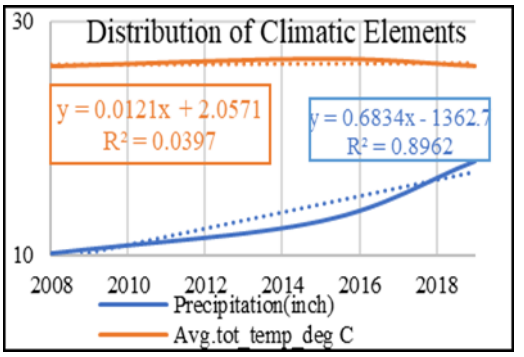

Figure.3 Climatic Element distribution of DumDum, nearest meteorological station of 24PGS(S)

Impact

The impact of climate change and global warming are two types- positive and negative. The positive impacts are- due to the concentration of carbon dioxide, Climate change effects on agriculture. It has changed the agricultural pattern and crop calendar. As a result, many serious issues have happened like lack of food security, childhood malnutrition, hunger etc. (Rosegrant, et al., 2015). Climate change impacts adversely on agriculture, as its production or yield rate is reduced in general (Rosegrant, et al., 2015). The increased rate of temperature also increases the rate of evaporation as evapotranspiration and soil moisture are reduced. So, the trees are absorbed insufficient moisture for living or growing or crop production. Perhaps, it can be said that the generally favorable conditions are affected (Rosegrant, et al., 2015).

An increase in temperature is suitable to spread out pests and various diseases. So, vegetation and animals are affected by them. Weeds spread out rapidly in this region and decrease the nutrition from the soil. So, sapling suffers from malnutrition and crop production decreases (Chatterjee, 2021). The production of boro (local rice type) rice has been reduced due to the lack of water. Jute is the crop of the tropical region. So, sufficient amounts of temperature (24^0-38^0 C) and water are needed for jute production. Because the fluctuation of rainfall and gradually increase of temperature may have an impact on jute yield. Furthermore, a rise in rainfall intensity in this location will likely eliminate alluvial silt deposition, reduce jute output. Seeds of high grade are deteriorating. Potato yields are dwindling due to rising winter temperatures (SAPCC, 2017).

As it is known that the potential impact of climate change of global warming is directly affected on environment and agriculture and land use patterns. There are two types of effects and they are classified as positive and negative. The main cause of this global warming is responsible for GHGs increase. Due to the temperature and carbon dioxide, a GHGs, increase the productivity of some crops, it is benefited for the high altitudinal and high latitudinal crop growth and development and the increased temperature is also beneficial for the people of polar region because excessive cold weather creates many problems for them in daily life, it saves cost used for protecting crop by heating from the harmfulness of cold, as the dry weather duration become long so that more various types of crops

and cultivation pattern can be practiced. As there are some positive spaces by searching within negative but the list of negative effects is long. As there are benefits in productivity for high latitudinal countries but it is for a certain period duration and for the other sectors of the world will be faced many problems like low productivity and production. Some sensitive crops are suffering the result of global warming. As the land surface increase that effect on soil moisture, increase soil erosion, increase mineralization process, effect on rainfall and water percolation in soil, directly and indirectly, affect the local ecosystem, increase the violence of various insects, weeds, pests and diseases that decrease the production and quality of crops (Gil Kim, 2009).

Result and Discussion

Here some agricultural data of different years have been taken to show the production pattern and their changes with time, for that the relevant data has been collected from Evaluation wing Directorate of Agriculture, Govt. of West Bengal 2008-'09, 2011-'12, 2015-'16, 2018-'19, the climatic data has been downloaded from various authentic climatic data sites (NOAA, W.M.O.) and land use related data has been collected from the Evaluation wing Directorate of Agriculture, Govt. of West Bengal. As agricultural production has been changing due to climatic elements (mainly temperature & rainfall) variation. In the same way, the land use pattern has been changing from agricultural land to non-agricultural land with time, from 2006-'07 to 2018-'19 along with some year gap, shown in the table.3. The conversion from non-agricultural land to agricultural land (positive change) in 2008-'09 (816.97 hectares) and 2015-'16 (2807 hectares) was not noteworthy, in the opposite the negative change in 2011-'12 and 2018-'19 was immense. The changing rate has been shown in figure.4. It is a huge loss in the crop production sector. According to data analysis, the fluctuation in the production of the crop is responsible for this conversion and the fluctuation of climatic elements is responsible in many ways.

Table. 3 Estimated Land use Statistics of 24 PGS(S), Area in Hectare

Year	Non-Agricultural	Agricultural land	Changes
2006-07	575867.00	372843.03	0
2008-09	575050.00	373660.00	816.97
2011-12	589414.00	359296.00	-14364
2015-16	586607.00	362103.00	2807
2018-19	590410	358300	-3803

Source: Evaluation wing Directorate of Agriculture, Govt. of West Bengal 2008-'09, 2011-'12, 2015-'16, 2018-'19.

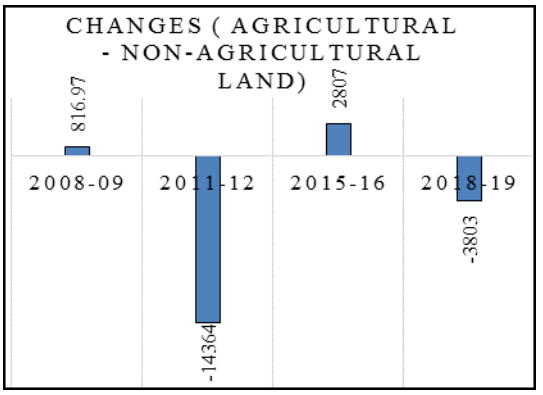

Figure.4 Land use changes from agricultural to non-agricultural land.

The climatic elements are changing at an excessive rate after industrial development due to the increasing rate of GHGs emissions (IPCC, 2007). The temperature changing pattern has been shown in table.4 and figure.5. The temperature changing curve has been become steep from 1850 to 2020 so that the temperature has been increasing at a very high rate and global warming is happening. In the table.5 and figure.6 the sea level heigh change has been shown. That has also gradually become steeped from Feb,1993 to Dec,2020. In this paper, the precipitation and average total temperature data of 2008, 2015 and 2019 are distributed in table.2 and with a trend line curve, the distribution is shown in figure.3. Temperature and rainfall have been increasing gradually with time, shown in both elements.

Table. 4 Temperature difference from pre-industrial condition in (0C) (1850-2020)

Year	WMO (^{0}C)	Year	WMO (^{0}C)	Year	WMO (^{0}C)
1850	-0.06	1910	-0.2	1970	0.25
1860	-0.03	1920	-0.2	1980	0.49
1870	0.03	1930	0.1	1990	0.66
1880	0.05	1940	0.37	2000	0.61
1890	-0.15	1950	0.07	2010	0.94
1900	0.12	1960	0.23	2020	1.21
Source: The State of the Global Climate 2020, World Meteorological Organisation					

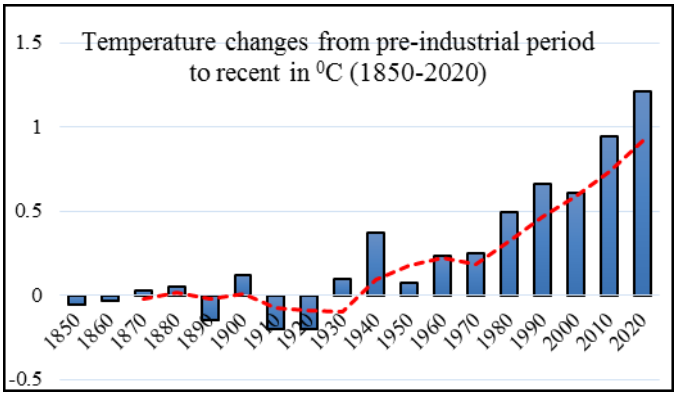

Figure.5 Temporal changes from pre-industrial

Rice is the main crop in this region. Also, wheat, maize, other cereals, pulses, oilseeds, jute, cotton, sugarcane and potato are produced in this region. The production area, yield rate and production amount have been shown in the table.6,7, 8. Agricultural data of some years are selected to show the area of production, production and yield rate accordingly in the above-mentioned table. An overall analysis is indicating that except rice, pulses and potato, the others crop production area and production amount have decreased from 2007-'08 to 2018-'19. But the yield rate has decreased for pulses, wheat and sugarcane. According to the report MANAGE, 1^0C temperature increase can reduce 4 – 5 million tonnes of wheat production. This report also has reported that an increase of temperature creates pests and various plant diseases related problems, moreover flood, drought and cyclone etc related climatic hazards reduce the production and yield rate. On the other hand, the yield rate has increased for maize, rice and potato. Other cereals, jute and cotton are produced in very small quantities. This is indicating that climate change is favourable for maize and sugarcane type C4 crops, that plants are produced 4 carbon compounds and grow up in a high temperature environment (InTeGrate, 2018), because they can survive in the warm climatic region.

Table. 5 Sea level change or rise (1993-2020)

Year	Height (mm)	Year	Height (mm)	Year	Height (mm)
Feb, 1993	1.38	Feb, 2003	27.8	Feb, 2013	62.09
Feb, 1994	5.87	Feb, 2004	29.1	Feb, 2014	62.73
Feb, 1995	10.64	Feb, 2005	34.64	Feb, 2015	70.99
Feb, 1996	8.87	Feb, 2006	35.88	Feb, 2016	78.57
Feb, 1997	7.42	Feb, 2007	37.12	Feb, 2017	76.93
Feb, 1998	14.46	Feb, 2008	40.17	Feb, 2018	81.83
Feb, 1999	13.18	Feb, 2009	44.26	Feb, 2019	88.21
Feb, 2000	18.11	Feb, 2010	47.47	Feb, 2020	90.45
Feb, 2001	21.05	Feb, 2011	45.29	Dec, 2020	96.07
Feb, 2002	24.54	Feb, 2012	55.28		

Source: Sea Level Change Initiative (SL_CCI)

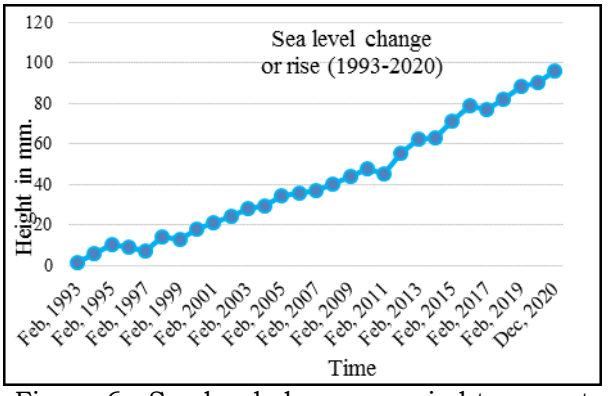

Figure.6 Sea level changes period to recent

Table.9 and figure.7, showing the cropping intensity (C.I.) [C.I.= (gross crop area/ net sown area) *100%] by the trend line, it is indicating a positive trend of crop production with time from 2011-'12 to 2018-'19. That is due to the nature of the crop. In this environmental condition, the causes of increasing the cropping intensity here are due to the gradual enlargement of the production area and the production of rice, pulses and potato. As, this area is situated in the tropical region and the temperature varies from 15.6^0 -35^0 C, mentioned before in this paper, these are the favourable situation for growing up these specific crops and need of food in this highly populated region the rice, pulses and potato as the main crop, these crops production have become more important. So that, the area and the production have increased gradually. To maintain and increase the fertility rate and to prevent crops from insects, various types of pesticides and fertilizer [Nitrogen(N), Phosphorous (P), Potassium (K)] have been used in the cultivable land which has been shown in table 10. In table 11, the total cultivable land, gross crop area and net cropped area have been shown for the year 2011-12, 2015-16 and 2018-19. Here it has been observed that the crop production areas are more than the net cropped area every year that means some areas are not used for cropped production. Rather the crop combination is active here. For that, the gross crop areas are gradually increasing and cropping intensity are increasing.

Table.6 Area in Hectares

Crops\Year	2007-08	2014-15	2018-19
Rice	392499	393943	404236
Wheat	2357	3868	1145
Maize	305	251	180
Others Cereals	17	0	0
Pulses	15165	30770	67168
Oilseeds	14408	14115	12605
Jute	667	527	349
Cotton	1600	615	360
Sugarcane	56	26	98
Potato	2798	1596	4441

Table. 7 Yield Rate in kg & motes/ hectare

Crops\Year	2007-08	2014-15	2018-19
Rice	2030	2586	2681
Wheat	2015	2941	1603
Maize	2079	2199	2217
Others Cereals	882	0	0
Pulses	696	777	460
Oilseeds	1138	1221	834
Jute	11.45	20.87	25.51
Cotton	1.67	2.56	4.67
Sugarcane	110421	93038	83752
Potato	17679	24445	27688

Table. 8 Production in Tonnes & Lakh motes

Crops\Year	2007-08	2014-15	2018-19
Rice	796765	1018732	1083847
Wheat	4749	11375	1835
Maize	634	552	399
Others Cereals	15	0	0
Pulses	10552	23921	30894
Oilseeds	16403	17233	10508
Jute	7636	10997	62922
Cotton	2672	1574	1753
Sugarcane	6184	2419	8208
Potato	49465	39015	122964

Table. 9 Crop Intensity

Year	Crop Intensity (%)
2011-12	150.21
2015-16	155.86
2018-19	168.46

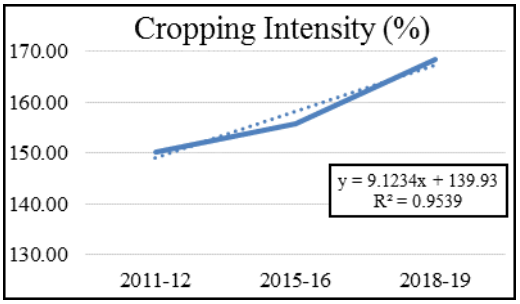

Figure. 7 Cropping Intensity

Table.10 Consumption of Fertilizer in 24 PGS (S), in Tonnes

Year	Nitrogen(N)	Phosphorous(P)	Potassium(K)	Total
2008-09	27566	14303	11977	53846
2011-12	30240	19616	8893	58749
2015-16	30262	19838	10793	60893
2018-19	26655	15960	7867	50482

Table. 11 Types of agricultural area in Hectares

Year	Cultivable area	Gross cropped area	Net cropped area
2011-12	378378	539713	359296
2015-16	376538	564381	362103
2018-19	371876	603595	358300

In table 3 and figure. 4 the agricultural land and non-agricultural land distribution changes have been shown of different years. The positive conversion from non-agricultural land to agricultural land are little in 2008-09 (816.97 hectares) and 2015-16 (2807 hectares) but the negative conversions are noteworthy, especially in 2011-12 session (14364 hectares) and comparatively less in 2018-19 (3803 hectares) and this change has been shown in figure. 4.

The total land use pattern of 24 PGS(S) of 2011 and 2021 has been enhanced in figure. 8. There are many changes in land use patterns have notable. The changes report Source: Evaluation wing Directorate of Agriculture, Govt. of West Bengal. 2008-'09, 2011-'12, 2015-'16, 2018-'19. (Applicable for table-6-11) has been highlighted in table 12 and shown in figure 9 by bar-graph. Rapidly increase of population, the land utilization has been changing with time. A small scenario has withdrawn in table 10 of land use change. The bank of river Hooghly, canal have occupied by cultural features, for that the area of these land has decreased than before. Trees are cut down and agricultural lands are converted for build-up. For that, both lands have decreased. Lack of interest in agriculture, irrigation

disorder, changing trend of interest in the non- agricultural economy, conversion of agricultural land for commercial purpose or making in build-up area, the agricultural lands are converting in plot and some has become current fallow land. Another very serious issues which is responsible for not production or loss in production are the fluctuation of rain in the current situation, frequent cyclones and conversion of agricultural land into a hatchery for fishing to the north eastern and southern part of 24 PGS(S). So, there are many wetlands seen in the north eastern part of the land use map in 2021 which did not exist at that level in the map of 2011. The settlement area has enlarged than before decades. All these pieces of information have been collected and decided based on data collected from the study area and figure. 8. There has another notable feature in table 11 i.e., the cultivable land has decreased gradually in comparison to the overall crop area.

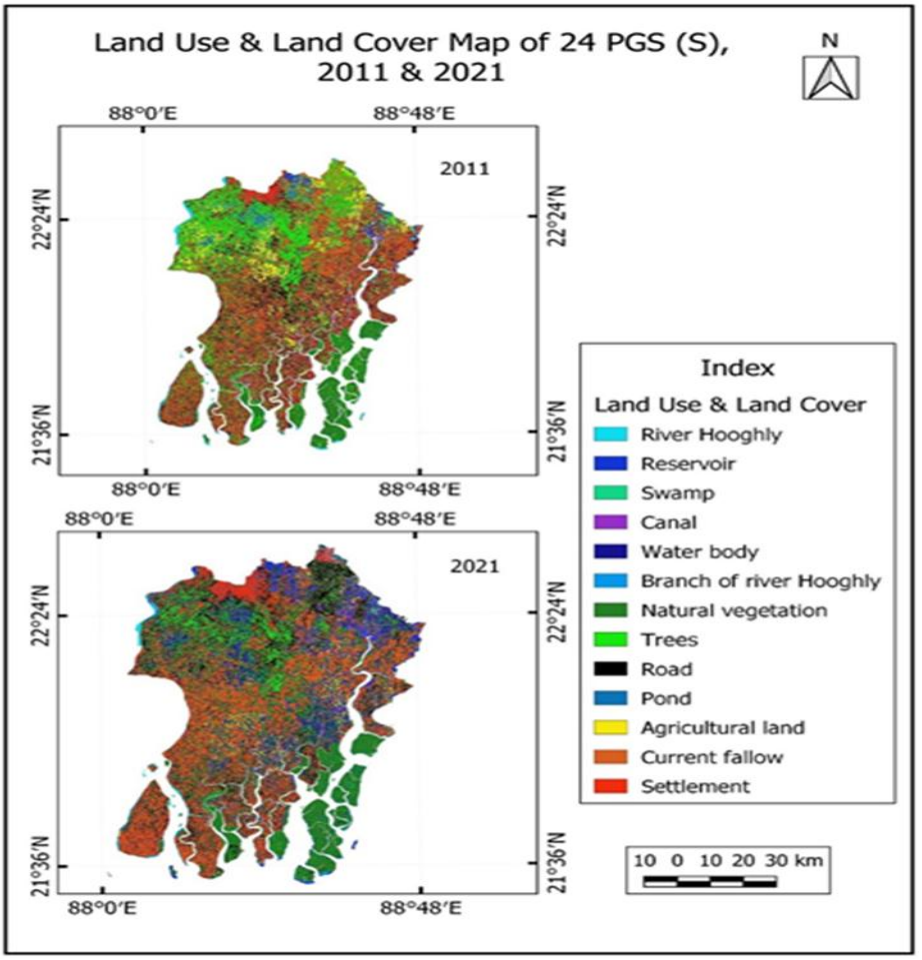

Figure. 8 Land use and Land Cover change of 24 PGS(S) between 2011 and 2021.

Prepared by Dhole, M. (2021). Source of Satellite Image: LANDSAT 5-TM & 8 OLI. USGS earth Explorer.

There have many facts behind that, though the crop area has been decreasing slowly, the partially agricultural area has been also increasing for some specific crops that are mentioned before and there have various causes behind them. A special cause for this incident is changing trend in the occupation of local people. Here, it has been tried to show the scenario with the comparison between 24 PGS(S) and West Bengal in table 13, 14. Table 13 sex-wise agricultural and non-agricultural labour data (1971-2001) of 24 PGS (S) in the rural sector has been represented the changes in economic activity from agriculture to non-agriculture and the data has indicated that the labour in both types of sex, the service sector has been changing and the trend is more vivid for female labour. The same feature has appeared in the service sector of West Bengal. From 1971- 2006, a decadal change has been showing that the economic activities have been changing from agricultural sector to manufacturing and service sector.

Table no. 12 Types of Land use change of 24 PGS(S), from 2021 to 2011.

Types land use	Change features (2021-2011)
River Hooghly	-52.6986
Reservoir	16.3098
Swamp	-3
Canal	-145.1286
Water body	578.2833
Branch of river Hooghly	36.4014
Natural vegetation	14.4396
Trees	-446.4612
Road	-13.0725
Pond	310.4226
Agricultural land	-258.4107
Current fallow	-224.4411
Settlement	163.1808

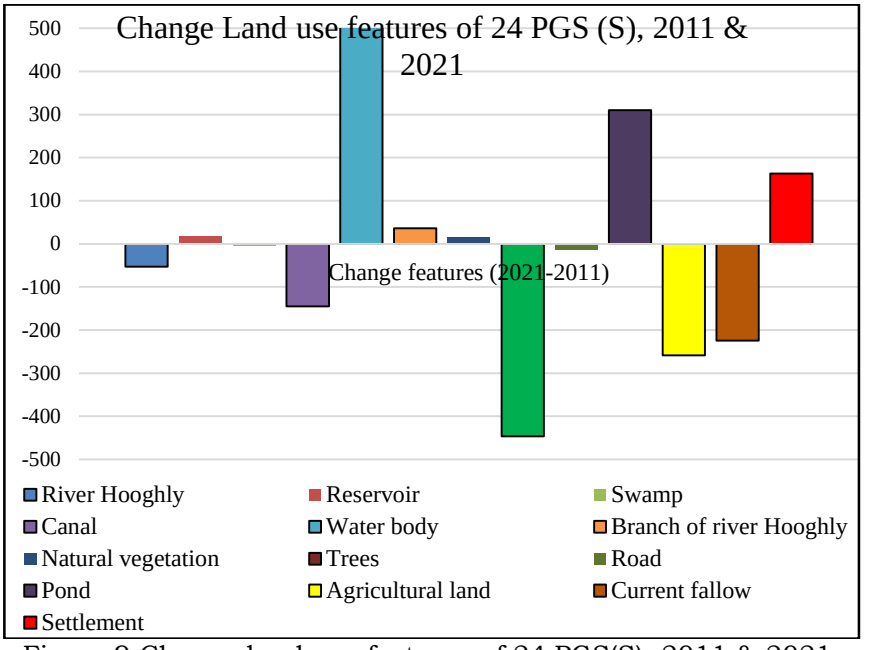

Figure.9 Change land use features of 24 PGS(S), 2011 & 2021.
Source: LANDSAT 5-TM & 8 OLI.
USGS earth Explorer and use of QGIS software.

Table.13 Percentage of Rural Agricultural Labour in 24 PGS(S)

Year\Types	Agricultural Labour		Non- Agricultural Labour	
	Male	Female	Male	Female
1971	41.81	40.71	20.03	39.37
1981	35.7	34.55	27.8	48.28
1991	33.71	27.35	33.54	36.75
2001	30.72	28.87	50.23	53.48
Source: West Bengal Development Report, 2010				

Table. 14 Changes in Sectoral Composition of NSDP (Net State Domestic Product)

Year	Sectors		
	Agriculture	Manufacturing	Services
1971	29.4	22.1	35.9
1981	25.9	19.9	42.3
1991	30.1	16.6	41.8
2006	20	17.2	50.2
Source: West Bengal Development Report, 2010			

Hypothesis test result

Test result-1

The null hypothesis is rejected and the alternative hypothesis is accepted because the result is significant in the Pearson correlation two-tail test. As the P-value is 0.037i.e., less than 0.05 so that the result is significant and it is proved that the temperature has been changing with time, which has been shown in figure.10.

Test result-2

The null hypothesis is rejected and the alternative hypothesis is accepted in the case of temperature change and total production, and temperature change and total yield rate because the result is significant in the Pearson correlation two-tail test. As the P-value is 0.008 and 0.000 i.e., less than 0.05 so that the result is significant and it is proved that the temperature change impacts crop production, which has been shown in figure.11.

Test result-3

The relationship between land use change and total production, and land use change and total yield rate are not significant. As the P value are 0.780 and 0.772 that means more than 0.05 percent the null hypothesis is accepted and the alternative hypothesis is rejected. So, it is proved here that there is no direct relationship between the land use change with the total production and total yield rate in this case, which has been shown in figure.12.

Test result-1 Correlations

		Year	Change Temperature
Year	Pearson Correlation	1	.998*
	Sig. (2-tailed)		.037
	N	3	3
Change _Temperature	Pearson Correlation	.998*	1
	Sig. (2-tailed)	.037	
	N	3	3

*. Correlation is significant at the 0.05 level (2-tailed).

Figure.10 Correlation between year and temperature change

Test result- 2 Correlations

		Total_ production	Change_ Temperature	Total_ Yield_ Rate
Total_ production	Pearson Correlation	1	1.000**	-1.000**
	Sig. (2-tailed)		.008	.008
	N	3	3	3
Change_ Temperature	Pearson Correlation	1.000**	1	-1.000**
	Sig. (2-tailed)	.008		.000

	N	3	3	3
Total_ Yield_ Rate	Pearson Correlation	-1.000**	-1.000**	1
	Sig. (2-tailed)	.008	.000	
	N	3	3	3

**. Correlation is significant at the 0.01 level (2-tailed).

Figure.11 Correlation among total production, climate change and total yield rate

Test result- 3 Correlations

		Land use Change	Total_ production	Total_ Yield_ Rate
Land use Change	Pearson Correlation	1	-.339	.351
	Sig. (2-tailed)		.780	.772
	N	3	3	3
Total_ production	Pearson Correlation	-.339	1	-1.000**
	Sig. (2-tailed)	.780		.008
	N	3	3	3
Total_ Yield_ Rate	Pearson Correlation	.351	-1.000**	1
	Sig. (2-tailed)	.772	.008	
	N	3	3	3

**. Correlation is significant at the 0.01 level (2-tailed).

Figure.12 Correlation among land use change, total production and total yield rate.

Mitigation of the effect of climate change on agriculture

As the climate is the most important controlling factor of agriculture, but climate change badly affects the production system. Though the economic system has changed still many peoples depend on agriculture. Moreover, agriculture is the basic requirement for the food supply. As much as, climate change still food production is necessary for people's basic needs, that crop production is necessary. So that, the agricultural scientist, researchers are searching for adaption and alternative ways to overcome this hazard. Some alternate ways have been found to mitigate the effect of climate change. They are-

i. Various local and central governmental programs like NMSA (National Mission For Sustainable Agriculture – it is an agricultural scheme where notices to enhance the productivity mainly in the rainfed area, to use water with efficiently, for management soil and conservation), PKVY (The Paramparagat Krishi Vikas Yojana- it is a farmer scheme for promoting organic matter in the country that will be applicable for a group of 50 farmers), should increase the skilled knowledge of poor and illiterate farmers. So that they can apply strategies to adopt and maintain the crop production rate.
ii. According to (CUESA, 2021) farmers should manage the irrigation system. Instead of ground water pumping by motor machine, they should use irrigation through the canal by conserving the rain water harvesting. In this way, we can reduce the emission of GHG (Green House Gases).

iii. There are many potentialities to boost up the production of the crop in this hazardous situation. For that several technologies can be comprehended against climate change. Even some comparatively safe fertilizers can be used as per the advice of the expert. Further shifting cultivation, alternative crops, high yield seeds can be used (Rosegrant, et al., 2015).
iv. A high rate of research is necessary to fight against and to adapt to the situation, as the new result of research may expand out the new ways for people to survive. Research can develop the production by using soil tests, field capacity, nutrient deficiencies, heat tolerance crops, carbon-nitrogen ratio level etc. (Rosegrant, et al., 2015).

Suggestion

Climate change has occupied the concentration of the whole world to it for its devastated and long-term result to the people. So, the intellectuals are worried about this. Many research works are going on and the scientist-Environmentalist have suggested many ways to fight against it and to take necessary steps for it.

i. It should be intervened in the agricultural system for the adaptation of the climate change. The integrated system is very suitable for that. In this way crop rotation help to follow up the fertility rate and help to get the adaptation system. It also improves the micro-level climatic condition by reducing the anomaly of the climatic element (World Resources Institute, 2021).
ii. As the trees can balance the Carbon-Oxygen ratio and control the climatic change, so it is needed more plantation in various types i.e., afforestation, reforestation by social forestry and agricultural forestry.
iii. People should be used the energy of non-renewable resources and stop using fossil fuel slowly (CUESA, 2021). This system should be started immediately around the world and the related policy of the international unions' society should be spread out in every country of the world. It is a ubiquitous object so we have to fight together.
iv. Government and non-government sectors should be taken the initiative of these immense activities. New governmental policies should be launched for the betterment of production. The provision of innovation methods can also be made skilled farmers adapt to complex situations and technologies (Rosegrant, et al., 2015).
v. Existing production and agricultural policies may have a limitation that can be developed and vigorous farmers may be facilitated by crop subsidy, agricultural loan subsidy and launch of various schemes (Chatterjee, 2021).
vi. Short-term crops should be cultivated instead of long-term crops (Chatterjee, 2021).
vii. An excessive amount of Carbon Di Oxide should be utilized properly by putting on other nutrients like Nitrogen and fertilizer to balance the additional Carbon Di Oxide (Chatterjee, 2021). Because, an increase of Carbon Di Oxide in the atmosphere increases the rate of photosynthesis (IPCC, 2007).
viii. Decrease the GHGs emission should be immediately (IPCC, 2007).

Limitation

There are some limitations in this research i.e.,

i. The data collection is a hassle in this situation from different government offices. Though data can be collected from websites in this day they are in general, not refer to a specific matter. A long periodic data is not available according to the requirements.
ii. Accurately the primary data collection is not an easy job, some respondents don't want to co-operate with the surveyor because of different socio-economic and some other difficulties. Though this is the part of the research still the researcher has to face some serious issues from the field.
iii. Another problem is the deficiency of collection of secondary data collection. Though secondary data are now available from the website but there are some limits for availability. To find out a precise result, accurate data analysis is very essential. So that some mouza level data were essential here but the district level data have been used for this research.
iv. Despite proper and reliable data, some biasness creates the analysis error and the researcher could not reach the right decision.
v. This paper has been prepared despite mouza level data, based on district-level which is a large area so that a thorough analysis has not been possible to do.
vi. Due to separate radiometry changes of two separate Landsat images LST05 TM and LST08 OLI, the resample correction has to be done along with images.

Conclusion

Climate change is a long-term incident. If the main cause of global warming, emission of GHGs, may stop immediately in the total world, still it may take at least 10 years to fall the effect of global warming (IPCC, 2007). Besides, the agricultural damage, it is increasing extreme climate phenomenon, that also be created damage crop along with other resources. As it is a whole world incident, no one can be stopped or changed the scenario from happening all these. Only we, the inhabitants can attempt to mitigate the emission of GHGs by using alternative production in daily life together and adaptation strategies application is very needed for the very agricultural sector (Ali, et al. 2017).

References

Ali, S., Liu, Y., Ishaq, M., Shah, T., Abdullah, Ilyas, A. & Ud Din, A., 2017, 24th May. Climate Change and Its Impact on the Yield of Major Food Crops: Evidence from Pakistan. *Food. PP. 2-19.* doi:10.3390/foods6060039. www.mdpi.com/journal/foods

C3 and C4 photosynthesis (2018) InTeGrate. 1st Jan, 2022. https://serc.carleton.edu/integrate/teaching_materials/food_supply/student_materials/1167

Chatterjee, A. (2021, 3rd Mar). Climate Change and Indian Agriculture. https://www.devalt.org/newsletter/nov03/of_5.htm

Climate Change and Agriculture in India (2016, January)

Climate change and its Impact on Agriculture - MANAGE https://www.manage.gov.in › CCA-EPDF
Climatic Data of Dumdum, www.ncdc.noaa.gov
CUESA (2021, 23rd September) https://cuesa.org
District Census Handbook, South Twenty Four Parganas, Village and Town Directory, Directorate of Census Operations West Bengal (2011). Census of India 2011. West Bengal. Series-20. Part- XII-A. https://censusindia.gov.in/2011census/dchb/DCHB_A/19/1917_PART_A_DCHB_SOUTH%20TWENTY%20FOUR%20PARGANAS.pdf
Finance & Development (2008, March). Global Warming and Agriculture.
Greenhouse gases, World Meteorological Organization. (2021). https://public.wmo.int/en/our- mandate/focus-areas/environment/greenhouse%20gases
IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Group I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
IPCC. 2007a. Climate Change 2007: The Physical Science Basis. Contribution of Work Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate. Cambridge, UK: Cambridge University Press.
Kim Chang-gil. 2009. "Strategies for Implementing Green Growth in Agricultural Sector." in Proceedings in Green Korea 2009 - Green Growth and Cooperation. National Research Council for Economics, Humanities and Social Science. Proceeding in green Korea. https://scholar.google.com/citations?user=QTYL6IsAAAAJ&hl=en
Kim, C. G., 2012, The Impact of Climate Change on the Agricultural Sector: Implications of the Agro- Industry for Low Carbon, Green Growth Strategy and Roadmap for the East Asian Region. United Nation. https://scholar.google.com/citations?user=QTYL6IsAAAAJ&hl=en
LANDSAT 5 TM & 8 OLI. USGS earth explorer. https://earthexplorer.usgs.gov/
OECD (2016, April) Agriculture and Climate Change: Towards Sustainable, Productive and Climate-Friendly Agricultural Systems.
Rosegrant, M. W., Perez, N., Pradesha, A. and Thomas, T. S., 2015, Sept. "The Economywide Impacts of Climate Change on Philippine Agriculture. Research Program on Climate Change and Food Security". *International Food Policy Research Institute*.
The State of the Global Climate 2020. https://public.wmo.int/en/our-mandate/climate/wmo-statement-state-of-global-climate.
West Bengal State Action Plan On Climate Change (2017–2020). Government of West Bengal.
World Resources Institute (2021, 10th March). http://www.environmentwb.gov.in/pdf/WBSAPCC_2017_20.pdf
Zhai, F., and J. Zhuang. (2009, Feb.). Agricultural Impact of Climate Change: A General Equilibrium Analysis with Special Reference to Southeast Asia. ADBI Working Paper 131. Tokyo: *Asian Development Bank Institute.* http://www.adbi.org/workingpaper/2009/02/23/2887.agricultural.impact.climate.change/

Abbreviations

A.D.O.- Agricultural Developmental Officer/ Office	K_2O – Potash
Al- Aluminium	Mg- Magnesium
BBGS- Budge Budge Generating Station	M.M.- Millimetre
BCCI- Bharat Coking Coal Limited	MCL- Mahanadi Coalfields Limited
B.D.O.- Block Developmental Officer/ Office	M.W.- Megawatt
C- Celsius	N- Nitrogen / North
Ca – Calcium	Na - Sodium
Cd - Cadmium	NOx - Nitrogen oxides
CESC- Calcutta Electric Supply Limited	O_2 – Oxygen
CO- Carbon Monoxide	P- Phosphorous
CO_2 - Carbon dioxide	P^H - Potential of Hydrogen
CT- Census Town	P_2O_5 - Phosphate
E- East	QGIS- Quantum Geographical Information
ECL - Eastern Coalfields Limited	S- South/ Sulphur
Fe- Ferrous	Ti- Titanium
G.P.O.-Gram Panchayat Office	Si - Silicon
HYV - High-yielding variety	SOx - Sulphur oxides
IADP - Intensive Agriculture District Programme	SPSS- Statistical Package for Social Science
K- Potassium	Sq. Km - Square Kilometre
KV- Kilo Volt	SPM - suspended particulate matter.