



The Relationship between Land Use/Land Cover and Climate Change: A Case Study of Murshidabad District, West Bengal, India

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Abstract: Climate change and land use/cover are intertwined. At different temporal and spatial scales, these changes have an impact on each other. The main cause of climate change is improper land use. Conversely, changes in climate have an impact on land cover and land usage. The current study focuses on the important relationships between changes in climate and land use/land cover. The author processes, evaluates, and represents gathered primary and secondary data. Over the previous 20 years, agricultural land fell from 76.33% to 66.35%, while the built-up area expanded from 22.12% to 32.76%. Due to the monsoon's fragility, it has been noted that the amount of fallow land is growing daily. In order to analyse, plan, and implement land use schemes to satisfy the growing demands for fundamental human needs and welfare, information about land use, land cover, and opportunities for their best use is crucial. Similarly, decision makers and conservation planners will be better able to manage land and climate if they are aware of the studies on both subjects.

Keywords: Land-use, Climate Change, Relationship.

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1 | INTRODUCTION:

In recent decades, land usage and climate change have become two of the world's most urgent problems. To comprehend these relationships and their long-term repercussions, much research is necessary. However, the causes and consequences of land-use activities and human-induced climate change have not received much independent research in the past. Stakeholders and researchers are aware that these are interconnected and have an impact on one another. This procedure requires interdisciplinary research, encompassing natural science and socioeconomic studies. "Land-use change" refers to the process through which human activity modifies the natural landscape. It makes reference to how land usage has altered the character of economic activity. Increases in the human population, deforestation, food types, and the need for fiber and energy are all caused by changes in land use. Climate change affects precipitation, global warming, and natural disasters such as storms, floods, and droughts. Deforestation and fast population increase are two ways that land use affects climate, while unpredictable high rainfall and rising temperatures are two ways that climate change affects land use. Climate change altered land usage, and land management strategies were put in place to mitigate the adverse consequences. For example, climate change affects agriculture productivity by altering land use. Driving force changes differ in both space and time. A key component of global adaptation that directly affects climate change is land-use change. Changes in land usage and climate have the greatest impact on developing nations. Due to a lack of several variables that exacerbate the catastrophic effects and the rise of vulnerable groups in communities, they are unable to avoid and respond to its affects. Natural catastrophes are influenced by changes in land use and climate. Despite having little money, resources, and technological capacity, poor countries have a significant impact on resilience and problem-solving, according to numerous studies.

2 | STUDY AREA

Murshidabad district, which is located between latitudes 23°43'30" and 24°50'20" North and longitudes 87°49'17" and 88°46'00" East, is the southernmost district in the Malda Division of West Bengal, India. It is 19 meters above mean sea level. The district is divided from the districts of Malda and Rajshahi (Bangladesh) by the Ganga and the Padma River, a Ganga distributary. Birbhum and Pakur (Jharkhand) lie on the western side of the district, while Burdwan and Nadia are on the southern side (Fig. 1).

The district is located in the Bengal Delta Plain's dormant deltaic region. The research area's principal river is Bhagirathi; other rivers include Jalangi, Bhairab, Sitalmari, Babla, and Mayurakhsi, among others. It is separated into two zones, "Rarh" and "Bagri," which are located on the eastern and western banks of the Bhagirathi River, respectively. The average annual rainfall in the district ranges from 989 mm to 1722 mm. The district has an average annual temperature of 30°C and rainfall of 1328 mm. The depth of the aquifer ranges from 26 to 70 meters. Rich, fertile clayey-loam, loam, loamy-sandy, etc. are among them.

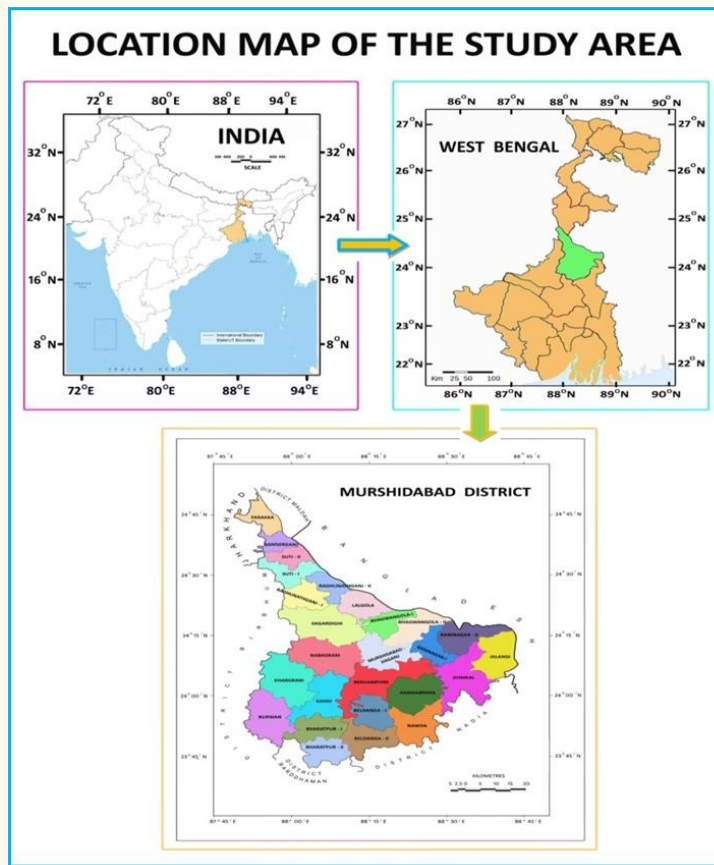


Fig. 1

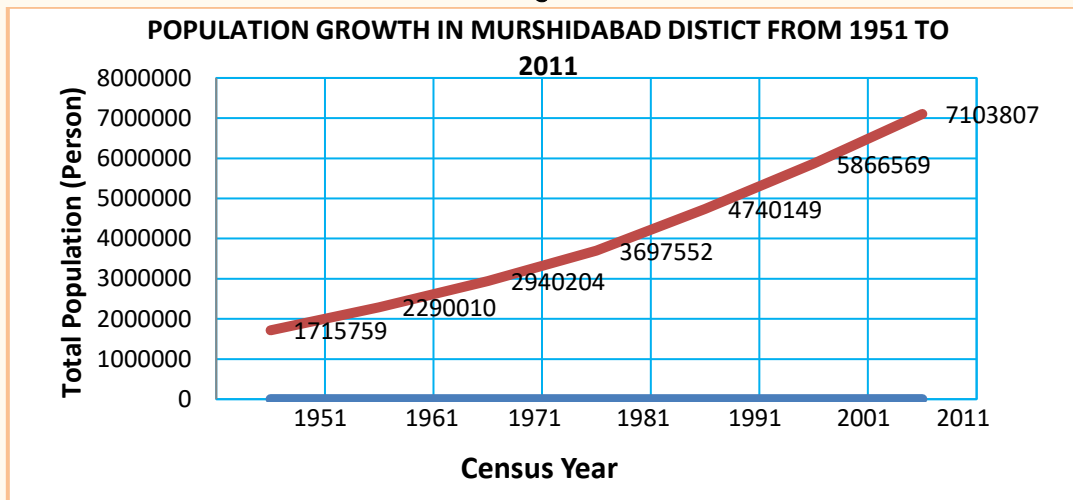


Fig. 2

As per 2011 census it has an area of 5324 sq. km with a total population of 7103807 persons (male- 3627564 and female- 3476243) and population density is 1334 persons/ Km². There are 27 Police Stations (P.S.), 7 statutory towns, 65 census towns and 2166 villages in the district. It has 5 Sub-divisions, viz. Jangipur, Lalbag, Damkol, Berhampore and Kandi. There are 26 Community Development (C.D.) Blocks in the district.

3 | AIMS AND OBJECTIVES

The main aims and objectives of the study are to evaluate the the relationship between land use/land cover and climate change in Murshidabad district.

1. To identify the climate change for last two decades (2000-01 to 2020-21).

2. To show the changes of land use pattern in the study area.
3. To analyze the effects of climate change in land use/land cover.
4. To examine the impact of land use/land cover change on climate.

4 | DATABASE AND METHODOLOGY

The data and other necessary information for the present study have been collected from secondary sources i. e. District Census Handbook, Census of India; District Statistical Handbook, Murshidabad; Meteorological Department, Govt. of India; Directorate of Agriculture, Govt. of W.B. Statistical and geographical research methods have been adopted to explain the relationship between land use/land cover and climate change in Murshidabad district. Apart from these a number of articles published in various National and International journals have also been consulted for the purpose. The published maps at District level has been used for preparing the base map for the present study. The suitable statistical and cartographic techniques have been applied for all the significant data to sow better result.

5 | LAND USE/LAND COVER

Census of India has classified land utilization in nine different categories, but the present study of landuse of Murshidabad district has been done on the basis of agriculture. Hence, the landuse categories have been studied in the following heads (Table 1):

Area under Forest: There are small areas of forest throughout the district. 770 hectare or 0.14% of total geographical area of the district is covered by forest. Forest is found in only few CD blocks i.e. Farakka, Samsanganj, Nabagram and Domkal. Segun, Sisu, Babla, Pitali, Tentul, Aswattha, Sal, Maua, Khend, Palas etc. trees are found in the forest of Murshidabad.

Area under non-agricultural uses: No crops can be sown and grown on this type of land. Settlement, roads, railways, communication (electric and telephone), temple, mosque, church, community halls and water bodies (ponds, tanks, canals, lakes and bed of streams etc.) are under this category. 117810 hectare or 22.12%, 129410 hectare or 24.30% and 174450 hectare or 32.76% areas out of total geographical area of Murshidabad district is non-agricultural uses in the year 2001-01, 2010-11 and 2020-21 respectively (Table-1).

Barren and uncultivable land: Barren lands are sorts of residual classes including different kinds of lands from Usar to Banjar which are practically barren and useless at the time of investigation. Soils are unproductive under barren land. It is due to excess use of fertilizer for a long period. Soil has no more energy or fertility to grow crops on this land. Sometimes, flood silting and deposition of sand into the field causes barren. 950 hectare or 0.18% of total geographical area is under this category in 2020-21. Barren land is found in few CD blocks like Beldanga-II, Nowda, Hariharpara, Kandi, Khargram, Burwan, Bharatpur-I, Bharatpur-II, Samsanganj, Suti-I, Sagardighi, Lalgola, Raninagare-I and Raninagar-II.

Permanent pasture and other grazing land: Permanent pasture and other grazing land i.e. all grazing lands which may be permanent land and village common pasture. Domestic animals are reared in each and every village for tilling lands, milk, meat, cow dung mainly for compost manure, skin and hides for shoes by the cobbler etc. Animals have to depend upon fodder. Fodder is available from hay, stalks of grain, maize, grass like rye, kherhi etc. Animals require green grass to graze in the open field and land. Government places, like river bank, tank bank, field, lake banks etc. have green grass, plants etc. These places are permanent pasture land. Some farmers grow rye, kherhi, jowar, bajraetc in some fields for fodder of animals. There are very small area (only 10 hectare area in 2020-21) as permanent pasture and other grazing land. It is scattered in different CD blocks.

Table No. 1

Classification of Land Utilisation Statistics in the district of Murshidabad from 2001-02 to 2020-21

(Area in thousand hectares)

Year	Reporting Area	Forest Area	Area under Non-agricultural use	Barren & unculturable land	Permanent pastures & other grazing land	Land under misc. tree groves not included in Net area sown	Culturable waste land	Fallow land other than current fallow	Current fallow	Net area sown
2001-02	532.5	0.77	117.81	1.75	0.18	1.39	0.78	0.50	0.87	406.45
2002-03	532.5	0.77	117.28	2.24	0.03	3.67	0.86	0.27	0.92	406.46
2003-04	532.5	0.77	120.80	2.03	0.04	2.00	0.82	0.40	1.82	403.82
2004-05	532.5	0.77	122.64	2.00	0.07	1.84	0.84	0.50	0.82	403.02
2005-06	532.5	0.77	124.25	1.98	0.08	0.84	0.85	0.39	0.49	402.85
2006-07	532.49	0.77	125.31	1.90	0.14	0.73	0.86	0.09	0.39	402.30
2007-08	532.5	0.77	127.84	2.00	0.01	1.95	0.82	0.01	0.33	398.77
2008-09	532.5	0.77	128.16	2.00	0.01	1.08	0.53	0.01	0.38	399.56
2009-10	532.5	0.77	129.41	1.96	0.01	1.19	1.02	0.16	0.51	397.47
2010-11	532.5	0.77	130.76	1.98	0.01	1.08	1.37	0.24	0.33	395.96
2011-12	532.5	0.77	130.94	1.68	0.01	1.16	1.53	0.20	0.94	395.27
2012-13	532.5	0.77	131.02	1.58	0.00	1.08	1.32	0.11	0.50	396.12
2013-14	532.5	0.77	131.34	1.52	0.00	1.13	0.81	0.11	0.84	395.98
2014-15	532.5	0.77	130.45	1.46	0.03	1.45	0.47	0.02	0.85	397.00
2015-16	532.5	0.77	129.45	1.38	0.06	1.77	0.27	0.02	0.86	397.92
2016-17	532.5	0.77	132.50	1.25	0.04	1.55	0.75	0.37	0.92	394.35
2017-18	532.5	0.77	140.83	1.17	0.05	1.06	0.66	0.10	0.94	386.92
2018-19	532.5	0.77	155.74	1.02	0.03	1.21	0.62	0.07	0.92	372.12
2019-20	532.5	0.77	169.20	0.98	0.02	1.18	0.53	0.05	1.02	358.75
2020-21	532.5	0.77	174.45	0.95	0.01	1.09	0.87	0.08	0.98	353.30

Source : Computed by the author with the help of data of Directorate of Agriculture (Evaluation), Govt. of W.B

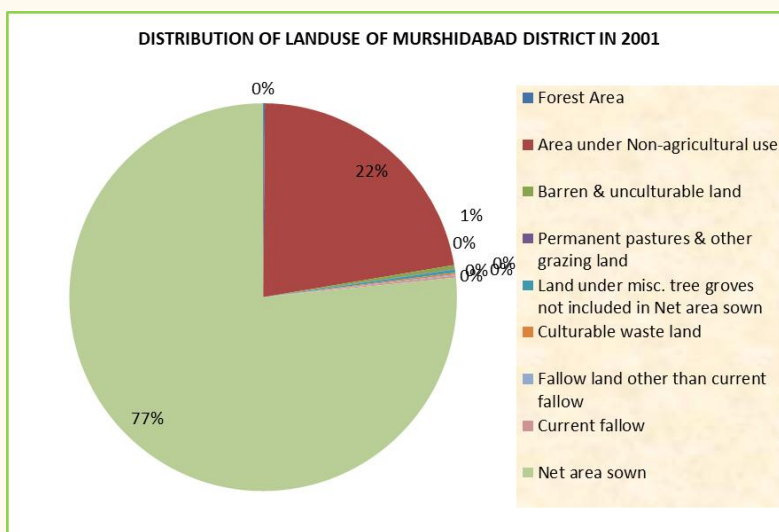


Fig. 3

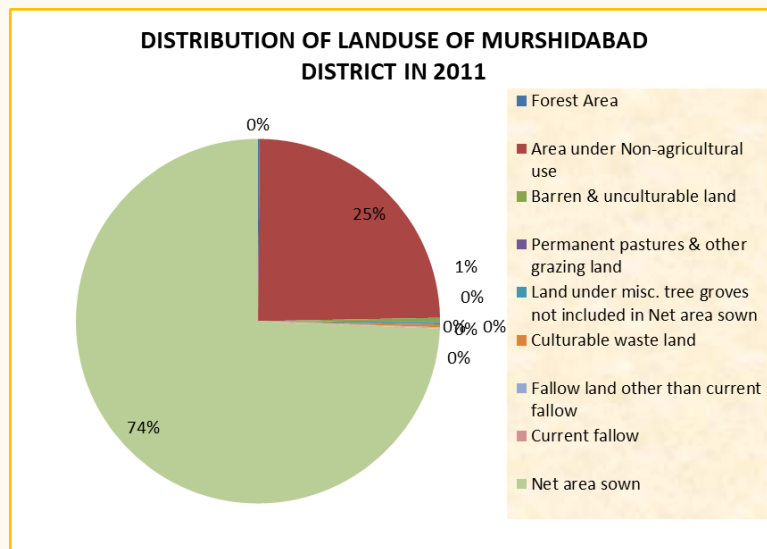


Fig. 4

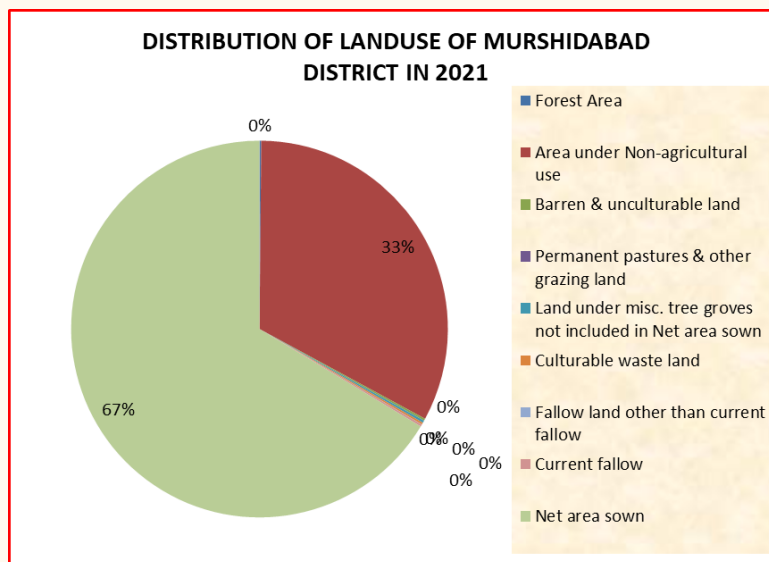


Fig. 5

Land under miscellaneous tree groves not included in Net area sown: Area under miscellaneous trees, crops and groves overcome all cultivable land which is not included in the net area sown but is put to some agricultural use other than seasonal cropping. In the ensuing discussion they are considered together. This is potential agricultural land that has not yet been farmed for a variety of reasons, but will be available for agricultural expansion. Total area under this category is 1090 hectare (0.20%) of total geographical area of Murshidabad district in 2020-21. Regional distribution under this land use category is below 2% in each CD blocks.

Cultivable waste land: Cultivable waste land denotes land considered by present judgments as cultivable but actually not cultivated during the current year and last five years or more in succession. So it is fallow land for more than five years. Cultivable waste land shows possibilities of the extension of arable and other uses of land, like pastures under careful field management. Only 870 hectare area is cultivable waste land in this district. It is 0.16% of total geographical land of the study area. It is found in the southern part of the district.

Fallow Land: Term fallow is applied to lands not under cultivation of the time of reporting, but which have been sown in the past. In different areas of the study region, the length of time that land is left fallow. This land use category consists of i) Current fallow land and ii) Other fallow land.

Current fallow land: Current fallow means the lands left unsown during the current agricultural year only to regain fertility and also that which remained uncultivated in the short term due to scanty of rainfall, litigated land under 144, water logging area, lack of seedlings, lack of capital, lack of time, lack of irrigation, the land owner moves away from his home or migrated etc. The next year it is cropped. With the improvement in the agricultural potential the percentage of fallow land decreases. Murshidabad district has a little proportion of current fallow land with average of 0.18% (980 hectare) of the total geographical area in 2020-21. Regional distribution under this land use category is below 1% in each CD blocks.

Other fallow land: Other fallow land means the lands left unsown for a period of not less than one year and not more than five years. In the study area has a very little proportion of other fallow land with only eight hectare land of the total geographical area.

Net Sown Area (NSA): NSA is the abbreviation of Net Sown Area. NSA is the area actually or net land under cultivation. This represents the total area sown with crops and orchards. Area which is sown more than once in the same year is counted only once. Out of total geographical land 397920 hectare (74.73%) area falls under net sown area. The percentage of net sown area sown in the Murshidabad district from CD block to CD block. But, southern part of the district has net sown area more than about 80% of total geographical land. In those CD blocks where have urban area and many census towns, have less net sown area. Farakka, Samserganj, Raghunathganj-II CD blocks have low net sown area (bellow 60%).

Climate Change

Weather is the combination of the current meteorological components, e.g. temperature, wind direction and speed, amount and type of precipitation, sun shine hours, etc. The weather is defining a short time period up to several days. The climate is describing the long term (min 30 years) and average weather conditions for a specific region. A climatic data is a measured parameter which helps to specify the climate of a specific location or region, such as precipitation, temperature, humidity, air (atmospheric) pressure, wind (speed & direction), visibility, clouds (type & cover), sunshine duration etc. Agriculture is highly dependent on climate mainly on temperature and rainfall. So change of climate has an important impact on agriculture of any region or country.

Table No. 2

SL No.	Year	Temperature (in °C)		Total Annual Rainfall (in mm.)
		Maximum	Minimum	
1	2001-02	39	7	1362
2	2002-03	41	9	1487
3	2003-04	43	7	1255
4	2004-05	43	9	1265
5	2005-06	44	11	1275
6	2006-07	40	8	1305
7	2007-08	41	8	1722
8	2008-09	40	10	1270
9	2009-10	42	9	1180
10	2010-11	43	8	989
11	2011-12	38	5	1526
12	2012-13	43	9	1001
13	2013-14	44	12	1144
14	2014-15	43	8	1175
15	2015-16	42	8	1673
16	2016-17	43	9	1046

17	2017-18	44	8	1187
18	2018-19	45	7	815
19	2019-20	44	8	1040
20	2020-21	43	6	1328

Source: Calculated by the author on the basis of different primary and secondary data.

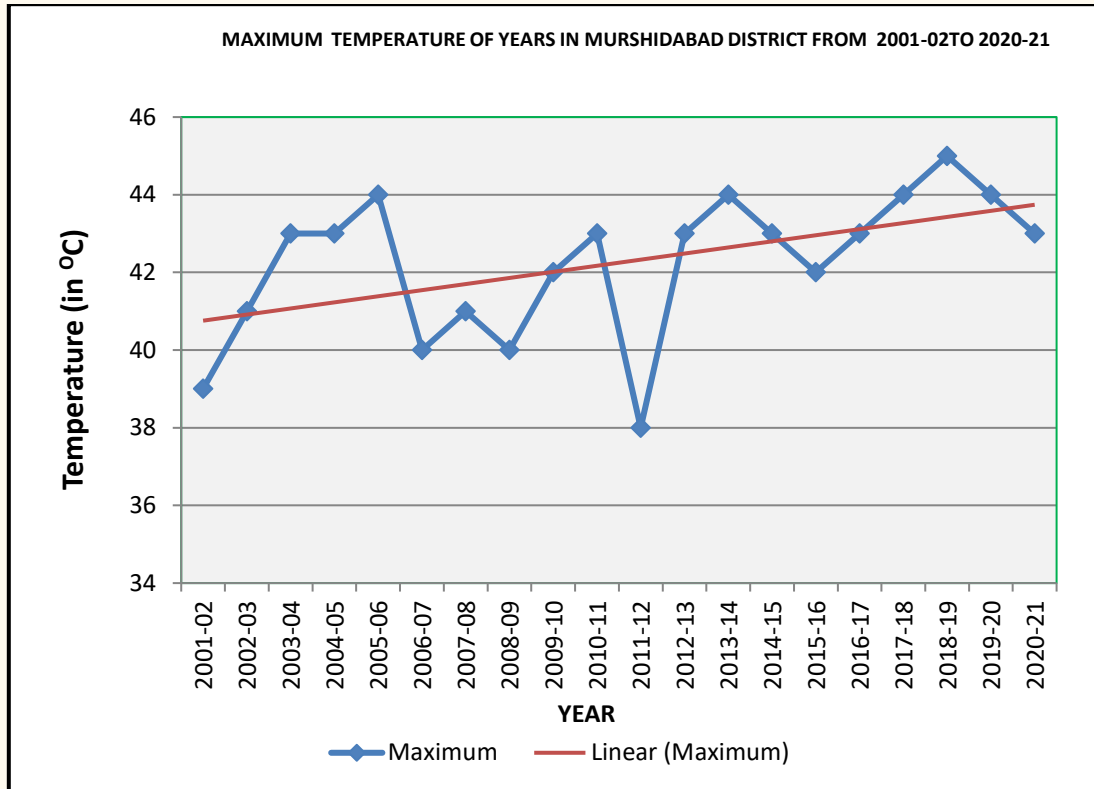


Fig. 6

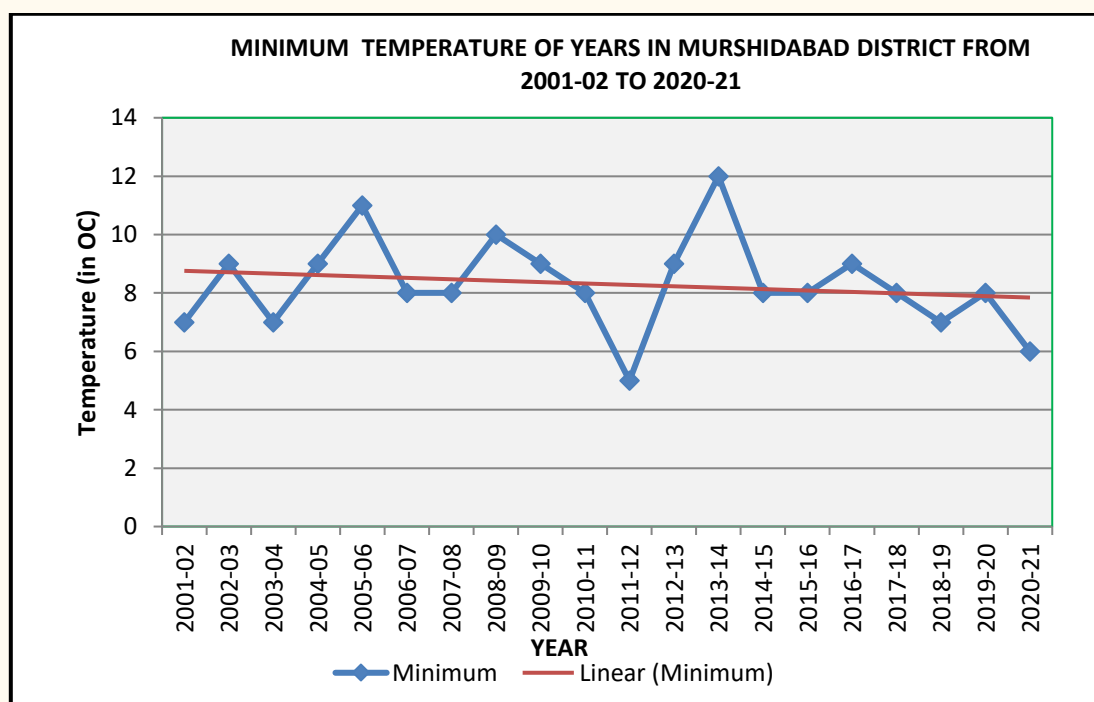


Fig. 7

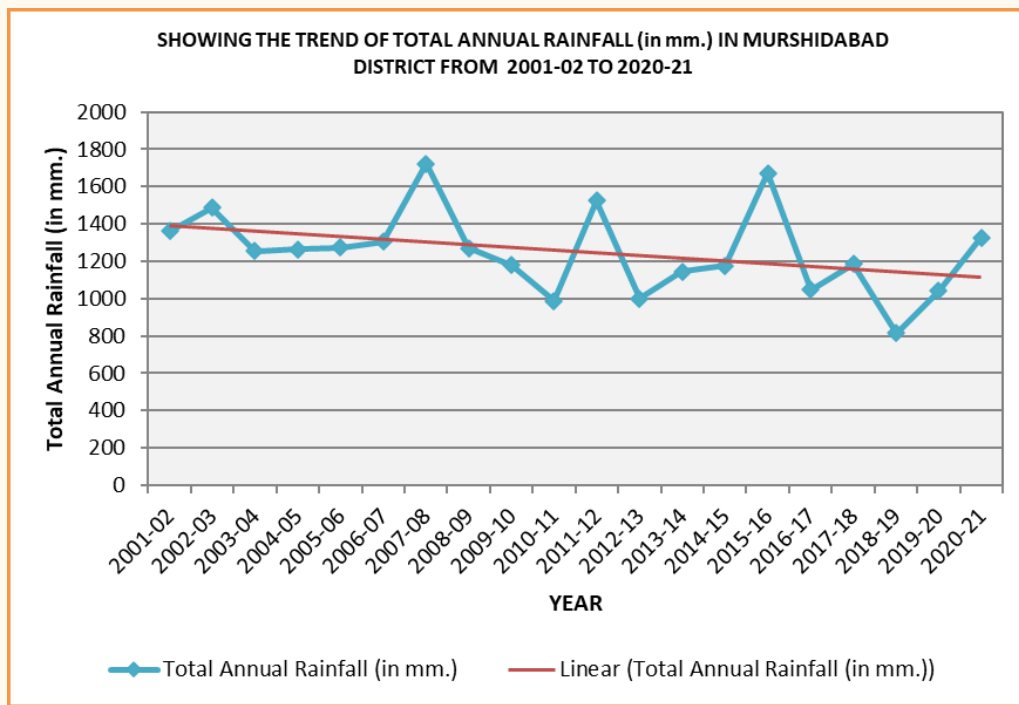


Fig. 8

Temperature: Temperature is an important parameter in determining the climatic condition of any region. The climatic condition determines the land use pattern, life style of people and the socio economic conditions of any region. The table no. 2 shows the maximum and minimum temperatures of the district in degree celsius during the past twenty years (2001-02 to 2020-2021). It is observed that maximum temperature is changed with a positive trend and minimum temperature is changed with a negative trend line. So the difference between maximum and minimum temperature during in year is gradually increased in the last two decades. It is proved that the climate is changed to an extreme climatic condition in the study area. It is very harmful for agriculture.

Rainfall: The District is characterized by uncertain and unequal distribution of rainfall throughout the year. The rainfall during the South-West monsoon season - June to September constitutes about 80 per cent of the annual rainfall. The district receives a mean annual rainfall varying from 989 mm. to 1722 mm. The average annual rainfall in the district is 1328 mm. In the present study rainfall data from 2001 to 2021 (twenty years) was collected from District statistical Handbook of different years (Table No. 2). It is observed from the fig. 8 that annual rainfall changes through a negative trend line. Rainfall is an important element for agriculture. So gradual decreasing of rainfall is very dangerous to agriculture.

Case studies on relationship between land use and climate change in Murshidabad District:

Climate change and improper land use are significant in Murshidabad district. Every year experience changes in temperature and precipitation faster than average. The land-use change key drivers of climatic factors are rainfall and temperature. The land cover of impermeable surfaces like concrete and the fast rate of urbanization are the main causes of the slight variation in surface temperature. Changes in land cover can affect surface radiation and thermal characteristics, which can change the humidity of an urban area. Summertime temperatures rise significantly, while wintertime temperatures fall. Table-2 (Fig. 6 & 7). It shows net sown area (NSA) decreased significantly over the past two decades and newly developed built-up areas are increased. In 2001-2002, area under Non-agricultural use, culturable waste land, fallow land and net sown area presided land use types with 22.12%, 0.15%, 0.25% and 76.33% respectively to total reporting area. In contrast, in the year 2020-2021, area under Non-agricultural use, culturable waste land and fallow land increases with 11% and 0.1% respectively. But, net sown area decreases about 12%.

Climate change effects on land use

Food security, terrestrial ecosystems, land degradation, and land use were all negatively impacted by climate change. In a similar vein, it plays a major role in the processes that lead to land degradation and changes in land use. Deforestation means land surface air temperature has increased from the growth of industries than the global land and ocean temperature. Increasing temperature and decreasing precipitation will increase summer and shorter winter. Stresses brought about by climate change include threats to livelihoods, biodiversity, infrastructure, food systems, human and ecosystem health, and biodiversity. The majority of the time, the contribution from growing deforestation and land degradation may even be less than the climate response to changes in land use and land cover. Current fallow land is increased due to vulnerability and decrease of rainfall in the study area. Temperature and fallow land are positively correlated to each other in the district of Murshidabad (Fig. 9). In the other hand annual rainfall and culturable waste land are negatively correlated to each other (Fig. 10).

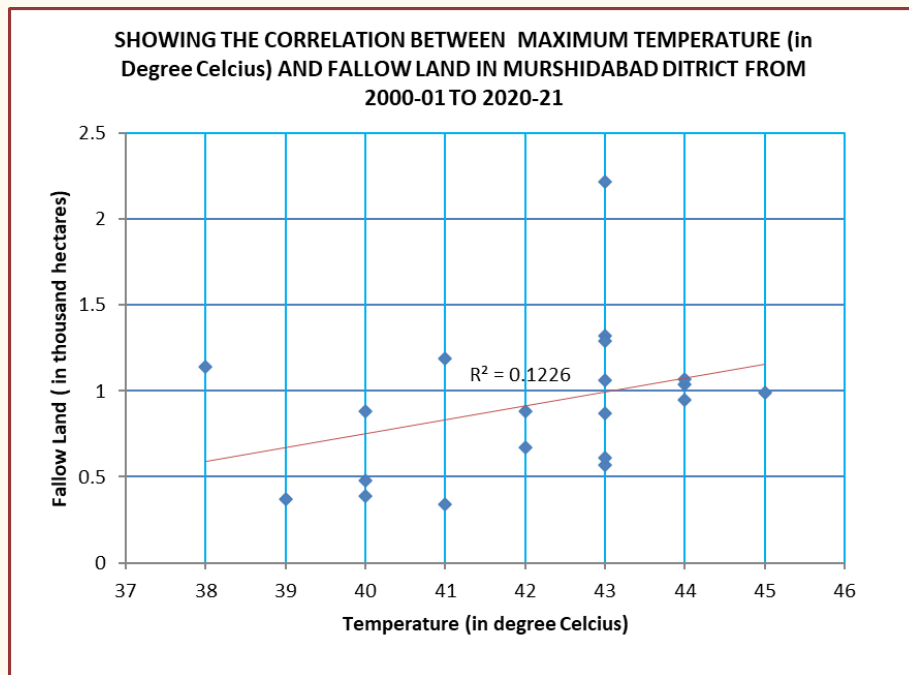


Fig. 9

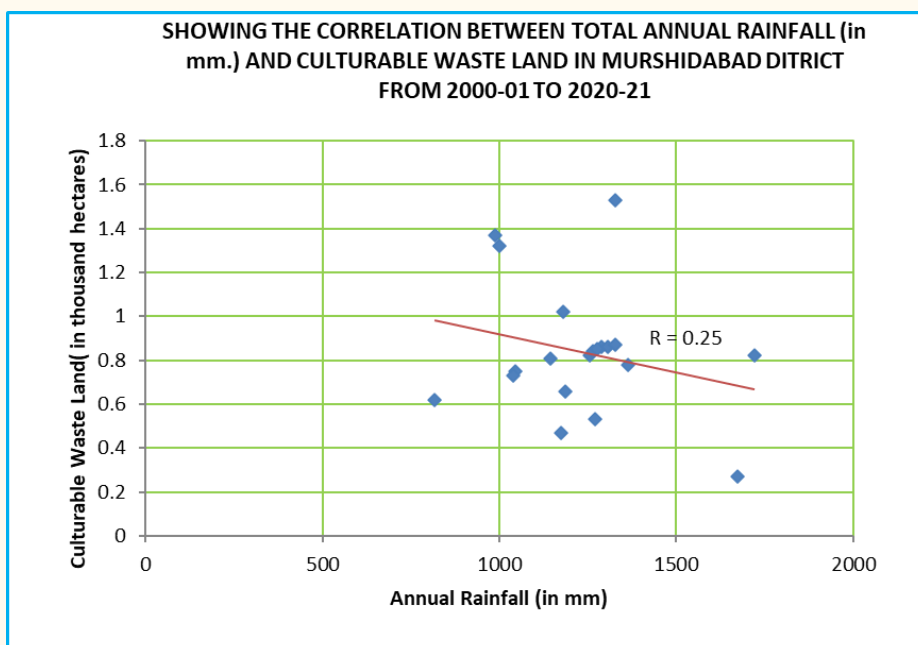


Fig. 10

Land-use effects on climate change

Land use and land-cover change impact weather and Climate. Although land cover changes are a centuries-long process, they are occurring more quickly now than in the past. Land-use change reflected in land cover change, the main component of Climate change, affects land-use decisions. Deforestation for agricultural purposes predominates, followed by other land-use types like developed industrial areas. Over the past three centuries, many developing nations have experienced a shift in their economies due to rising food and energy demands brought on by an expanding population that has resulted in increased cropland, deforestation, and urbanization. Landuse has changed in every nation in Asia, Africa, and Europe as a result of population and economic expansion. Land-use change has an impact on climate since the last few decades. At the local and regional levels, the precipitation cycle makes a major contribution. Climate change brings unpredictability of rainfall and extreme weather events, which will increase risk in the long term. Monthly maximum temperature is increased due to increasing of and built-up area and deforestation in the study area. Area under Non-agricultural use and maximum temperature are negatively correlated to each other in the district of Murshidabad (Fig. 11).

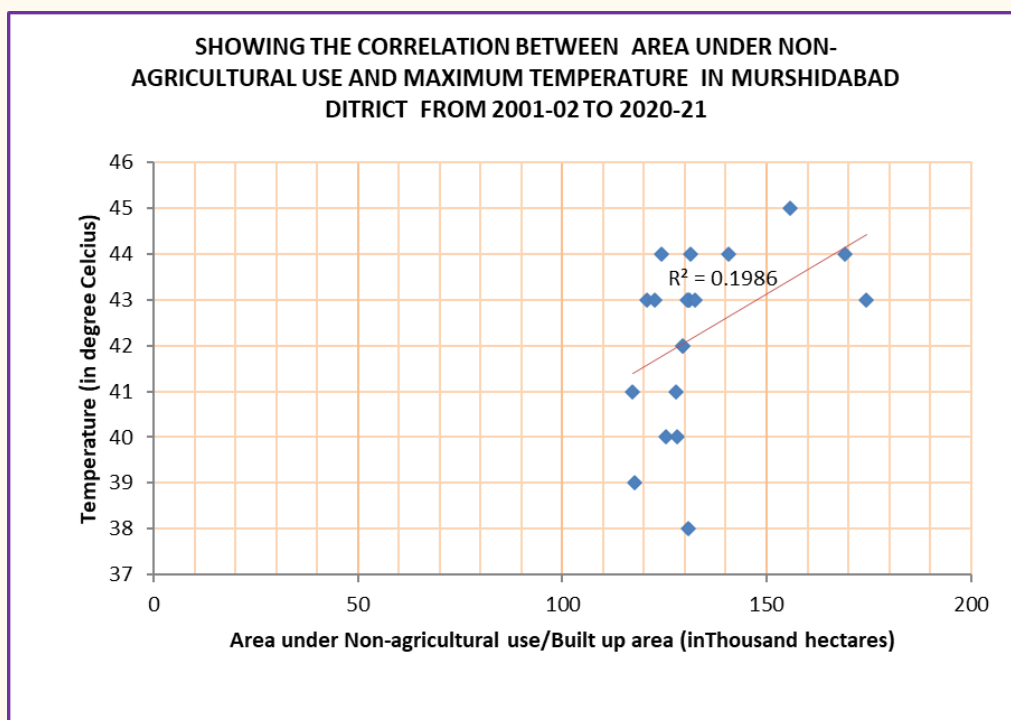


Fig. 11

6 | SUGGESTION

- Population policy should take to control exploration of population as early as possible.
- Vertical growth of build up area is needed to reduce the loss of agricultural land.
- Agro-forestry and social forestry policy should be taken to save environment.
- Changes in agriculture are necessary to adapt to climate change.

7 | CONCLUSION

The relationship shows that both influence each other. It finds land-use change with an increase in significant built-up areas and a gradual decrease in NSA. Over the past three decades, land use has changed at an unprecedented rate. Climate change is a change in temperature and rainfall over two decades and focuses on human influences like land use. One factor of land use and climate change is the human population. Increasing population and urbanization had impacted rapid change in land and climate. According to the research results, Murshidabad is vulnerable to both changes due to rapid

population growth, rainfall and temperature change, land covers, and land-use change. Numerous investigations are conducted at all scales, including local, regional, and global, in an effort to comprehend this intricate phenomenon. According to these studies, in order to address this situation, appropriate research and its implementation are required from all stakeholders.

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