Geographical Analysis Of Climate Change Effects On Land Use & Land Cover: A Case Study Of Goa

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ABSTRACT

The interaction between climate, agriculture, and land use is a complex phenomenon, these are interlinked with each other, and climatic conditions are responsible for changing the shape of agriculture and land-use patterns of any country/region. Science has proven an increase in atmospheric concentrations of greenhouse gases namely, CO2, N2O, CH4, HFCs, PFCs Perfluorocarbons SF6, NF3 Nitrogen trifluoride. The Intergovernmental Panel on Climate Change (IPCC) anticipates that the build-up of atmospheric Green House Gases will cause a marginal temperature increase and changes in rainfall patternsare projected for large parts of the world. These changes can be noticed in productivity in the agricultural sector. Apart from these, agriculture also plays a vital role in shouldering future Green House Gases centration by changing land use from crops to forests, trees, energy use, paddy fields, grazing lands, and others. Finally, agriculture is controlled by both sides of climatic changes and production patterns.

Agriculture is a sensitive industry, study reveals that there is a shift in crops and land use patterns, the same is responsible for shifts in agricultural products also. The statistical data for the agricultural scenario in Goa revealed that agriculture is declining concerning the area as well as production, though agriculture is the backbone

of the State's economy, which provides a source of livelihood to the majority of Goan people.

The present paper discusses the trends, growth, and Impact of Global warming and climate change on agriculture in Goa. Information related to the area under different crops, the productivity of crop use of inputs, and the value of outputs were compiled from 2010 to 2018 from secondary sources. Therefore, the proposed study is intended to study the causes of the decline of agricultural products in Goa and proposed to suggest planning strategies to improve agricultural products and the income of the farmers of Goa.

Key Words: Climate, Agriculture, Land Use, Land cover, Green House Gases, Backbone.

INTRODUCTION:

All the concerned especially researchers, academicians, Non-Government Organisations, and planners opined that agriculture is a tendency to behave in a particular way, it is controlled by set factors especially geographical and non-geographical out of which geographical concerns climate change is more visible, this was stressed by researchers. The same researcher anticipates that agriculture is more affected at a larger scale than in recent times. The concept of climate change refers to changes in the average conditions of temperature, rainfall, and extreme weather conditions that impact agriculture. Further, the climatic impact is mainly associated with the increased number of flooding, excess weathering, soils holding moisture for a longer time, frequent occurrences of wildfires causing harm to human beings, and an increased population more than the economic threshold level. Scientists from NASA have observed the same situation on this earth; accordingly, many of the warmest years on record have happened in the past 20 years.

Climate can affect and be affected by changes in land coverand land use. Land uses are inherently coupled: changes in land-use practices can change the land cover, and land cover enables specific land uses. Changes in land use can occur in response to both human and climate drivers, as for non-geographical conditions like demand for new settlements which ultimately causes for permanent loss of natural and working lands. This is ultimately responsible for changes in weather patterns, temperature, and precipitation, these changes have the potential to influence Earth's climate by altering regional and global circulation patterns. The same changes are finally

responsible for land use cover and land-use changes, the change of land use is changed from time to time and region to region. Scientific devices i.e., satellite images have noticed these changes.

Undoubtedly is agriculture a more sensitive industry than many other industries in the world, more specifically traditional agricultural geography focuses on spatial patterns and changes in agricultural systems, based on economic geography and the other hand land use also. It is inevitable and time immemorial, as time has changed, modern agriculture has become more anthropo-concentric, where the environment plays a significant role. Man is using natural and cultural resources at an optimum level, concerned about sustainability, health, and the food system. Given modernization in agricultural pursuits, the concept of agriculture is changing year after year, presently agriculture has got status of Industry, its importance is spread across the world, and changes within the region with greater variability. Modern agricultural geography focuses especially on farms and farming types considering the region's physical, social and economic conditions. Agricultural geography has gained greater momentum, concerning the production of food, fiber, and fuel; economic, policy, and resource issues related to agriculture; and farm household and livelihood concerns.

At the outset, agriculture in Goa is losing its importance mainly to farming communities marching towards other activities. Agriculture in the study area is declining, and many institutions and researchers, and academicians writing with case studies, that many more factors are under agriculture are declining. The factors which control agriculture vary from region to region, but the factors that mainly determine agriculture in Goa are; natural, economic, social, political, and more.

REVIEW OF LITERATURE:

A review of literature is an essential part of any investigation as it not only gives an idea of the work completed in the past but also provides the basis for interpretation and discussion of the findings. The present study was intended to know the extent of knowledge, and the impact of climate change on land use patterns and agriculture.

Pawan Thapa (2019)accordingly land use and climate change are two major global issues, many researchers have established the correlation between these two but still, research is needed at the micro-level, there is a demand for finding relationships and impacts of these to know and analyze for the future. Therefore, the causes and consequences of anthropo-centric

climate changes and land-use activities have primarily been examined with case studies, However, land use and climate change are closely linked to affect each other. Landuse is one of thecritical factors for climate change andvice versa. Land use and climatechangeissues areopen for comprehensive research;however, there are constraints such as complicated processes, which involve both natural and human-inducedactivities.

Quentin P. Chiotti, and Tom Johnston (1995) quote 'Global environmental change is one of the most significant research and policy issues facing humankind. Although vast financial and human resources are being allocated to climate change research, there are numerous knowledge gaps between understanding climate variations and human responses, particularly in farm adaptation.

Israel Fierros-González, and Alejandro López-Feldman (2021) Global climate is changing rapidly, and it is not clear if agricultural producers in developing countries will be able to adapt fast enough to mitigate its negative effects. Farmers need willing to take the application measures and perceive saying the climate is changing enormously or it could change, accordingly farmers should contribute weight to this view to take action. In the last twenty years are so, the literature which examines farmers' views on climate has changed, this is ground reality also, but the same is not sufficient to claim.

Yohannes H (2016) Globally, climate change (CC) is the most serious environmental threat that adversely affects agricultural productivity. According to an inter-governmental panel on climate change (IPCC) report, climate change refers to any change in climate over time, due to natural variability or because of human activity. This climate change is mainly caused by greenhouse gas (GHGs) accumulation in the atmosphere, which results in an increased greenhouse effect. Agriculture and Climate change are positively correlated, and the same can be noticed at the regional and worldwide levels respectively. Perhaps this leads to an imbalance in population distribution and seeks more food production.

Dave S. Reay(2020) feels Land use is crucial in delivering enhanced carbon sequestration globally. Greenhouse gas emissions are a major source of food production. As pressure mounts for all nations to increase their levels of ambition under the Paris Climate Agreement, the pressure to radically reduce emissions from the agriculture sector and enhance carbon removal or separation in the land use of an area also increase in activity. This is clear from the drive for 'net zero' of unavoidable circumstances.

Goa, the smallest state in India, has a geographical area of 3702 square kilometers with a total population of 1,458,545 (2011).

Its geographical position is marked by 14°53‘54‖ North to 15°48‘00" North Latitude and 73°40‘33‖ East to 74°21‘13‖ East Longitude. Its immediate neighbors are the Arabian Sea (West), Karnataka (East), Maharashtra (Southeast), and Terekol river (North), its coastline is 105 kilometers, the east-west distance measures 60 kilometers, and the territory touches Belgaum and Karwar districts of Karnataka. Goa State, part of the west coast region of India, has many physical features like the neighboring states of Maharashtra and Karnataka. For administrative purposes, the state has been divided into two districts, namely, North Goa and South Goa. with twelve (12) talukas comprising 39l settlements. There are six talukas in the North and South Goa districts it is located in the Sahyadri mountain region, and due to its location extent experiences Orographic rainfall. (Fig. No: - 1).

The objectives of the Study:

1. To analyze the spatial variations in land use, size and area of holding, Cultivated area, and production, of different crops from 2001-2020

2. To trace out the influence of global warming on Goa’s agriculture

2. To identify the influence of global warming on agriculture and the changing land use pattern.

3. To suggest planning strategies to improve agricultural productivity in Goa.

Hypothesis:

The present investigation has formulated the following hypothesis. It is hypothesized.

1) The climate-controlling factors like precipitation and temperature influence the growth of agriculture in Goa.
2) The increased rainfall and temperature increase are responsible for reducing Goa's agricultural activities.

3) That global warming and land use are positively co-related.

Database:

The information related to the area under different crops, production, and other information was collected through the Directorate of Agriculture, Directorate of Statistics and Planning, the collected information has been compiled and put in the form of tables,and charts, and analyzed the same by using Gretl software used, trend analysis for further analysis, Satellite imagery used for this research consisting of cloud-free Landsat-5, Landsat-7, and Landsat-8 imagery obtained during the observed year. Based on the acquired Landsat imagery and collected reference training samples land cover maps for the years 2000 and 2020 were generated. Land cover maps were calculated based on the supervised satellite image classification algorithm. Satellite imagery was classified into six classes. The images have been classified using the Maximum Likelihood Classification Algorithm (MLC).

Methodology:

The researcher collected information from the Directorate of Agriculture, from 2001 to 2020, and applied simple statistical tools such as trend analysis by Gretl software, graphs and tables analyzed the tables and graphs thoroughly and tested the hypothesis.

Furthermore, for the calculation, the accuracy assessments of the land cover maps made by supervised satellite imagery classification validation samples were required. Accordingly established and common practice training and validation samples were collected at the same time and randomly divided into training (70% of all samples) and validation (30% of all samples) datasets. Samples were collected manually using the various available satellite data and historical maps (e.g., Google Earth Engine, Land Cover maps, etc.).The study site and acquired training and validation reference data for the years 2000 and 2020 are sown in the table.

Land-use effects on climate change

Humans have had to change the land cover for centuries, but recent change rates are higher than ever. Change in land cover reflects on land use changes also. The decision to land use affects climate change also. This is due to deforestation, bringing more land under agricultural activities, apart from bringing more area under construction, industrial areas. The impact of Land use and land-cover change (LULCC) is mainly due to the influence of weather and climate also, and it affects a larger scale also. LULCC study furnishes s required information to support further research of anthropogenic

activities on changes in the environment. The contribution of the precipitation cycle cannot be ignored, which is a more responsible attribute to changing the local and regional climate. Thus, climate change is ultimately responsible for unpredictable rainfall and extreme weather events, which leads to increase risks in the years to come.

Climate change effects on land use

Climate change adversely impacted terrestrial ecosystems, land degradation, and land use, and also play a significant role in land degradational processes. Ultimately this results in land use change abruptly. Deforestation is another important contributor which leads to an increase in the surface air temperature, the further temperature has increased tremendously from the rapid growth of industries, and it also leads to an increase in the global and ocean temperature. Similarly, increasing temperature and precipitation will increase warmer and shorter winters; these changes land-use patterns in many places. Climate change creates stresses on land, and risks to livelihoods, biodiversity, human and ecosystem health, infrastructure, and food systems. Given the increase in temperature is anticipated that the world is going to face higher risks, and even the areas which were not anticipated that they are not facing such problems will also face the same. It is undoubtedly the climate that is the root cause of changes in land use in general land-cover in particular, sometimes this maybe even more than deforestation and erosion i.e. land degradation.

Climate change scenario

Goa's mean annual temperature has increased by over 1°C since the beginning of the 20th century till date, much of it during the 1990-2018 period. The mean annual rainfall in Goa has increased by 68% over the period 1901-2015. The studies carried out by IMD and NIO indicate that increasing rainfall and its inter-annual rainfall variability have shown that there is an increase in the amount of rainfall that too since 1970. Whereas the mean annual rainfall in the state is concerned, the output recorded by rain gauges of the State is showing a trend of declining days of rainfall from moderate to high, this especially happened from the 2001-2015 period. But Goa witnessed very heavy rainfalls earlier.

Mean annual temperatures in Goa may increase by around 2°C in the 2030s compared to the 1901-1950 period, and further to by around 4°C by 2080s under high emission scenarios. Goa will start experiencing heat waves (>40C) beyond the 2040s, as maximum temperature increases by about 5°C towards the century's end

under high emission scenarios. Minimum temperatures are expected to rise even more by up to 8°C by the century end under the high emission scenarios.

Vulnerability to Climate Change:

In the context of Goa, communities living in low-lying areas, informal settlements like the slum population, people with disabilities, and those whoselivelihoods depend mainly on Kazan lands and low-lying ecosystems including riparian ecosystems are in particular the immediate and most vulnerable groups. Also, four coastal taluks of Bardez, Tiswadi, Mormugao, and Salcete, house about 80% of the population and are hubs of economic activity.

Observed Climate Change in Goa

It has been estimated that a warming of 2°C or even 1.5°C compared to the pre-industrial times is the threshold for dangerous climate change. As per IMD's (2019) analysis, the annual mean temperature during 1901-2018 showed an increasing trend of 0.6°C/100 years. Climate change and its impact in Goa is not been fully explored, however, researchers have explored some of the aspects of the observed climate change in Goa. The mean temperature trend in Goa is shown in Figure 2. It suggests that Goa is witnessing higher levels of temperature increase compared to the national average (IMD, 2013) as the mean temperature in Goa has increased by about 1°Cover the period 1901-2018.

Mean annual temperature (° C 1901-2018)

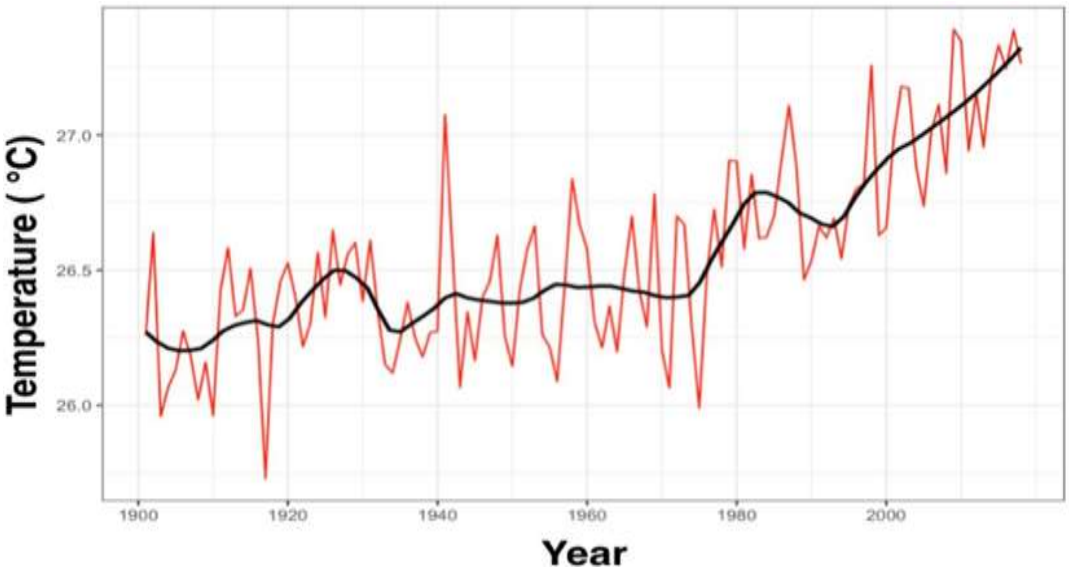


Fig. No: 2

The maximum and minimum temperatures of various stations including Panaji, Dabolim, and Margao stations wereanalyzed. The below figure based on Panjim is shown below. Station-based data also suggests a large temperature rise in Goa as analyzed from the gridded dataset

Similarly, the mean annual rainfall figures also exhibit that, there is an increase of about 68% over the last century. Statistical data about the rainfall of North Goa District support the same, whereas mean annual rainfall is found to have increased by 300 cm to 500 cm, which is an increase of 66% (Fig. No: 3)

Observed changes in mean annual rainfall in Goa (1901-2018)

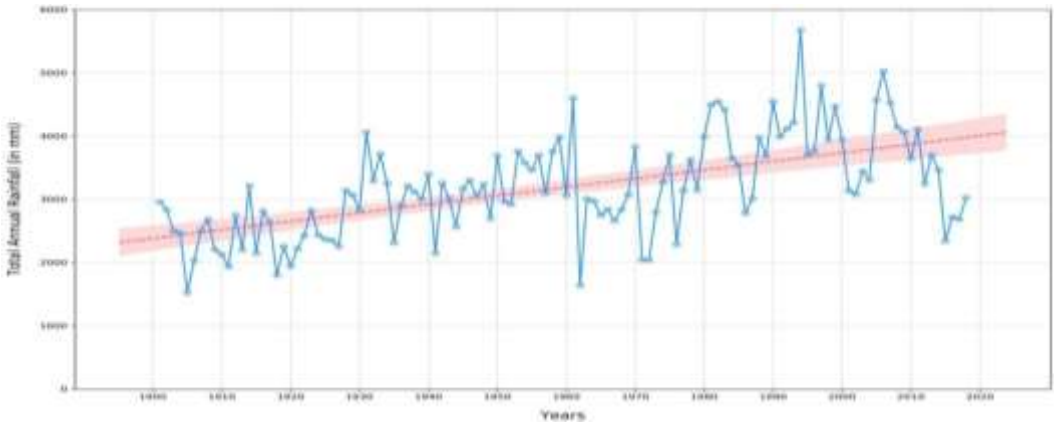


Fig. No: 3

Source: Goa State Action Plan on Climate Change (2019-20)

The researcher has made a humble attempt to know the impact of climate change on Agriculture concerningthe area, production, and yield of various crops from 2001 to 2020 in the study area, taking area as the main criterion with more than **4000** hectares of land for cultivation. though the period is insufficient to prove the impacts, this is a humble attempt to say that there is a climate impact in Goa (See table No: 1)

AREA UNDER DIFFERENT CROPS (Hectares)

Table No: 1

S. No	Year	Rice	Pulses	Cashew Nut	Coconut	Mango	Vegetables
1	2001-02	49382	9449	54060	25025	4140	7600
2	2002-03	50169	9368	54373	25068	4195	7600
3	2003-04	52801	9782	54668	25110	4179	7800
4	2004-05	52442	10326	54858	25160	4226	7800
5	2005-06	52177	10978	55021	25312	4339	8144
6	2006-07	52985	12058	55302	25468	4414	8213
7	2007-08	52191	11477	55612	25545	4494	5547

8	2008-09	49966	9855	55672	25608	4514	5703
9	2009-10	47104	7890	55732	25686	4650	5671
10	2010-11	46612	7550	55732	25718	4750	5880
11	2011-12	47237	9949	55737	25730	4760	6498
12	2012-13	45830	9949	55747	25712	4771	6646
13	2013-14	42820	8100	55936	25750	4819	7004
14	2014-15	41970	8538	56079	25786	4843	7188
15	2015-16	41344	7154	56609	25818	4884	7240
16	2016-17	40623	5887	56735	25913	4920	7379
17	2017-18	38520	5540	56248	26169	4969	7534
18	2018-19	36384	6203	56417	26381	5001	7625
19	2019-20	34698	4398	56476	26542	5034	7852
20	2020-21	32677	3840	56829	26629	5062	8030

Source: Department of Agriculture, Govt of Goa.

Production of Selected Crops (Tons)

Table No: 2

S. No	Year	Rice	Pulses	Cashew Nut	Coconut	Mango	Vegetables
1	2001-02	126523	8368	22976	125..12	17228	70457
2	2002-03	134767	7453	23109	122.02	17532	70467
3	2003-04	170661	9147	23233	122.22	17800	70467
4	2004-05	145181	9385	25556	123.52	18700	74725
5	2005-06	147253	11570	27070	125.34	27075	82580
6	2006-07	130279	16250	24380	126.68	19280	84290
7	2007-08	121670	11261	21942	127.57	18894	56027
8	2008-09	123303	10141	13165	128.18	17469	57603
9	2009-10	59267	10058	18456	127.69	11252	59620
10	2010-11	114994	9820	23138	128.88	9284	60472
11	2011-12	121753	8286	23240	129.28	8536	78201
12	2012-13	122824	8974	23804	122.72	9036	80511
13	2013-14	126511	8926	24332	128.15	8944	79920
14	2014-15	120505	8057	25011	127.77	8887	82001
15	2015-16	115068	6011	17549	129.35	5958	82594
16	2016-17	113227	5912	24396	132.16	9545	84823
17	2017-18	102997	4822	28012	131.63	9391	89363
18	2018-19	98854	6317	27588	132.75	9547	90440
19	2019-20	90375	3855	28630	167.03	11006	74582
20	2020-21	87341	3748	27366	164.67	10282	78387

Source: Department of Agriculture, Govt of Goa

AVERAGE YIELD (KGS/HECTARE)

Table No: 3

S. No	Year	Rice	Pulses	Cashew Nut	Coconut	Mango	Vegetables
1	2001-02	2562	886	425	4868	4189	9272
2	2002-03	2686	796	425	4868	4178	9272
3	2003-04	3232	935	425	4867	4259	9034
4	2004-05	2768	909	466	4909	4425	9580
5	2005-06	2822	1054	492	4952	6240	10140
6	2006-07	2459	1348	441	4974	4368	10253
7	2007-08	2331	981	395	4994	4204	10100
8	2008-09	2468	1029	236	5006	1674	10100
9	2009-10	2486	1035	336	5002	1745	10125
10	2010-11	2467	1057	415	5001	1954	10284
11	2011-12	2577	833	417	5014	1793	12034
12	2012-13	2680	902	427	4773	4771	12116
13	2013-14	2954	1102	435	4977	1856	11411
14	2014-15	2871	944	446	4955	1835	11408
15	2015-16	2783	840	310	5010	1220	11408
16	2016-17	2774	1004	430	5100	1940	11495
17	2017-18	2674	870	498	5030	1890	11861
18	2018-19	2717	1018	489	5032	1909	11861
19	2019-20	2605	877	507	6293	2186	9498
20	2020-21	2673	976	482	6184	2031	9762

Source: Department of Agriculture, Govt of Goa.

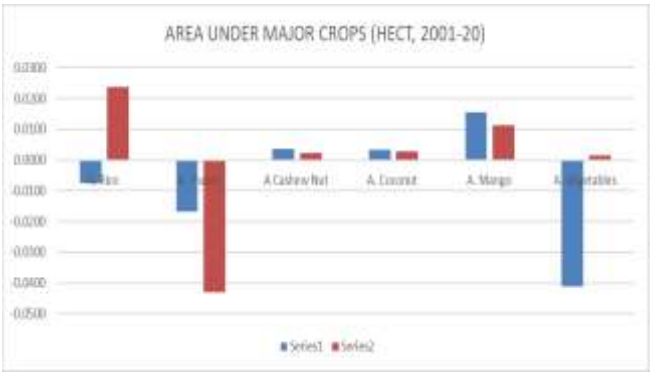
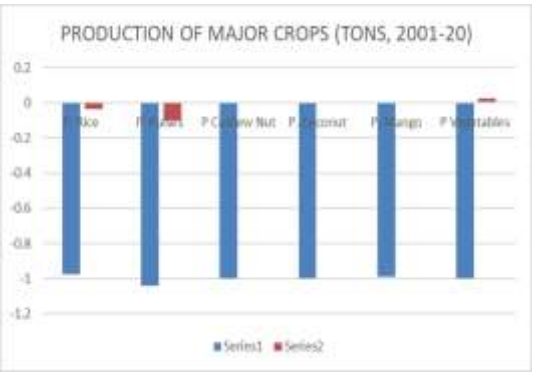


Fig. No: 4



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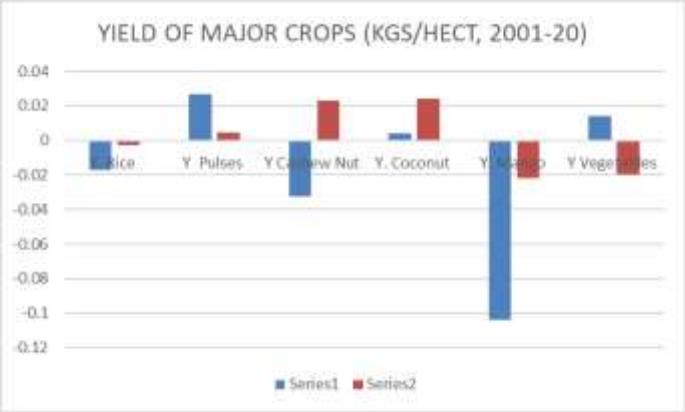


Fig. No: 6

The above statistics and figures indicate that there are no surprising things as for as area under crops, in the study region, is showing negative figures, it is due to many reasons, namely;

1. Conversion of Agricultural area into the non-agricultural area for construction purposes,
2. Farmers are showing the least interest in agricultural activities, according to them agriculture earns less income,
3. There is uncertainty in Monsoon arrival, even variations are noticed either increased/decreased number of rainy days,
4. Farmers work in the field the whole day, finding it difficult to work in the hot sun.
5. Agriculture in the study area provides job security problems, i.e., not certain, etc.

Apart from the above, many minor reasons also played the reduction of the area under crops declined (Fig No: 4).

Fig. No: 5 further indicates that the production of selected crops is showing a declining trend in the last 20 years from 2001 to 2020. There are specific reasons to say why agricultural production is declining. Is it mainly because of climate change? Farmers are finding difficulty with changing land use and land cover, and the study region is facing the problems of a shortage of laborers both male and female, even if they are available, they demand more wages, and fix their working hours between 9.00 am to 5.00 pm and in between they need lunch break also. And the morning they demand tea from the owner, so ultimately the production of major crops is declining.

It is interesting to see the fig no: 6, that out of the major crops, three crops' yields are increasing for the entire period from 2001 to 2020, these crops are pulses, coconut, and vegetables, whereas rice, cashew nuts, and mango yields are declining. Pulses, Coconut, and Ground nut yields are increasing, and Rice, Mango,

and Vegetable yields are declining. Experts, Academicians, Politicians, and Researchers are very much wondering how it is happening. Since the area under crops, and production of major crops statistics indicate a declining trend and how come yield is increasing?

Climate change is responsible for an increase in temperature, changes in rainfall patterns, extreme weather events, and reductions in the availability of water for agricultural activities may lead to reduced agricultural productivity. Climate change is already affecting agriculture with the declining area under crops, especially areas sown more than once, and gross cropped area(Table No:4), and a decline in food crop production.

LAND UTILIZATION PATTERN IN GOA (hectare, 2010-11 to 2019-20)											
S. No	Time	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Area under forest	125473	125473	125473	1,25,473	1,25,473	125473	125473	125473	125473	125473
2	Land not available for cultivation	37137	37137	37137	37,137	37,137	37137	37137	37137	37137	93675
3	Permanent pastures & Grazing Land	1305	1305	1305	1,305	1,305	1305	1305	1305	1305	1305
4	Land under Miscellaneous	580	580	580	580	580	580	580	580	580	580
5	Cultivable waste	65598	64796	64733	67,412	52,533	66509	66480	67487	68926	13408
6	Net area sown	131020	131822	131885	1,29,206	1,29,243	130109	130138	129131	127692	126672
7	The area is sown more than once	28896	32169	30620	28,646	28,459	26353	24583	22826	22156	19868
8	Gross cropped area	159916	163991	162505	1,57,852	1,57,702	156462	154721	151957	149948	146540

Source: Statistical Hand Books, (2010-2020), Govt Printing Press, Panjim.

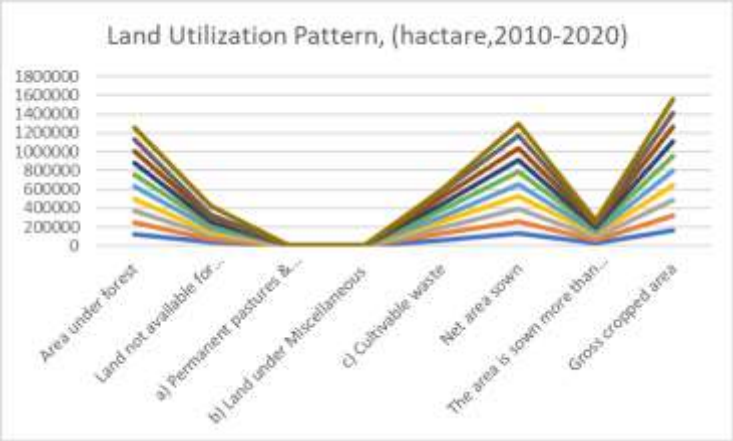


Fig. No: 7

The above table and figures indicate that the first four items like forest area, land not available for cultivation, permanent pasture lands, and land under miscellaneous are not shown any changes, not even one hectare of land either increased or decreased, this is very much doubtful.

But the other four items namely; Cultivable Waste, Net Area Sown, Area Sown More than Once, and Gros cropped areas showing, there is negative growth of the agricultural scenario in Goa. These all heads show that there is decline trend of agricultural activities in the study area within the last 10 years. The relationship shows that areas under crops, production, and yield influence each other. It finds land-use change with an increase in significant built-up areas and a gradual decrease in production, agriculture, and open areas. It has an unprecedented rate of land use changes over One decade. It can apply at the global or regional scale with a wide spectral range, high temporal resolution, low cost, and real-time. Land Cover implies the physical or natural state of the Earth's surface.

Training and validation reference data

Furthermore, the accuracy assessments of the land cover maps made by supervised satellite imagery classification validation samples were required for the calculation. Accordingly established and common practice training and validation samples were collected at the same time and randomly divided into training (70% of all samples) and validation (30% of all samples) datasets. Samples were collected manually using the various available satellite data and historical maps (e.g., Google Earth Engine, Land Cover maps, etc.). The study site and acquired training and validation reference data for the years 2000 and 2020 are sown in the table.

Several totals acquired reference data (R), training (t), and validation (v) samples per class and researched year.

Year	**2000**			**2020**		
Class	R	T	V	R	t	V
Water	65	46	20	54	38	16
Bare land	40	28	12	29	20	9
Urban	20	14	6	26	18	8
Forest	49	34	15	47	33	14
Agriculture	20	14	6	18	13	5
Wetland	26	18	8	12	8	4
Total	220	154	66	186	130	56

Source: Sanjay Gaikwad (2020) Unpublished UGC Project.

Accuracy Assessment:

LULC maps derived from the classification of images usually contain some sort of errors due to several factors that range from classification techniques to methods of satellite data capture. The accuracy of overall data is computed by dividing the total number of the correctly classified smallest units of a digital image (pixel) by the total number of reference pixels.

Accuracy assessment of the land cover maps from 2000 to 2020 (Overall accuracy – AO; figure of merit – FoM; omission – O; commission – C)

Year	**2000**			**2020**			
Class	FoM	O	C		FoM	O	C
Water	95	5	0		91.3	8.7	0
Bare land	85.7	0	14.3		60	30.8	18.2
Urban	80	20	0		66.7	11.1	27.3
Forest	100	0	0		93.8	6.3	0
Agriculture	100	0	0		60	0	40
Wetland	87.5	0	12.5		57.1	20	33.3
OA	96.5			87			

Source: Sanjay Gaikwad (2020) Unpublished UGC Project.

The Kappa stat supports the good quality of the classification of LULC. Classification data for the year 2000 gave the highest overall accuracy (96.5%) whereas forest and agriculture show the highest degree of agreement followed by other classes with < 85% accuracy. Classification of data for the year 2020 exhibits < 85% overall agreement. Also, the Landsat data used here is from July month of

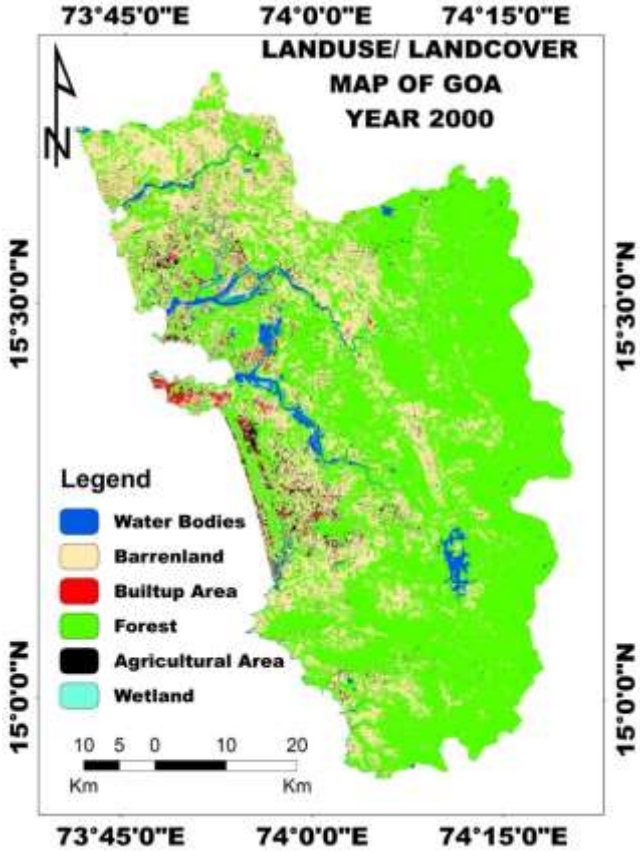
the respective year, since July month is the monsoon season in the State of Goa, it has also created errors while estimating wetland and water resources of the region. Due to seasonal variation, the estimation of forest and agriculture is varying.

The analysis predicts negative changes in the geographical coverage of forest and agricultural land.

Land Use Land Cover for years 2000 and 2020

Category	Legend	Area 2000 (Ha)	Area 2020 (Ha)
1	Water	10343.97	7745.49
2	Barren land	103548.78	116703.72
3	Built-up	4666.05	7554.87
4	Forest	238643.73	223519.95
5	Agriculture	10668.06	6953.13
6	Wetland	1095.57	6578.73

Source: Sanjay Gaikwad (2020) Unpublished UGC Project.



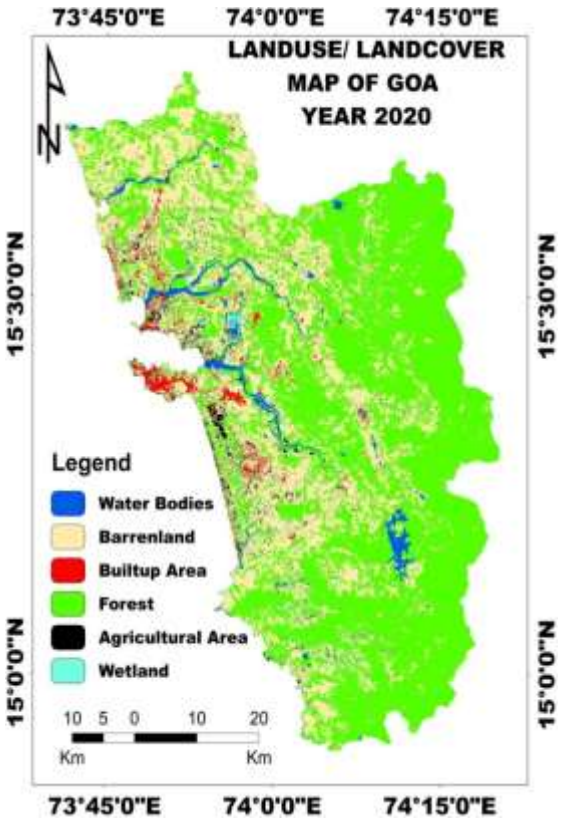


Fig. No 8 **Fig. No 9**

OBSERVATIONS

- ✓ Farmers across Goa are experiencing this firsthand. They are not unaware that due to climate changetemperature is rising, heavy downpours across the State, and sometimes storms are also experienced, with droughts.
- ✓ Major cereal crops like Rice, and commercial crops; Sugar Cane fails i.e., the area under crops declined, due to these extreme weather conditions, this is not because of farmers' attitudes but also the prevailing conditions of climate change.
- ✓ Forest areas have to make way for agricultural land. In the study region, most of the forest area is declining either due conversion of agricultural land into non-agricultural land or the mining industry also playing role in changing land use change and land cover.
- ✓ Due to the topography of the State changes in the use of land and its cover greatly affect watershed runoff, and rapid erosion of topsoil is noticed.
- ✓ Due to changing climate and land use land cover there is degradation and landscape and more loss of biodiversity, and deposition of sediments along the mining areas.
- ✓ The construction works also destroy the existing ecosystem balance, hydrology, and fisheries.

Conclusion

The present study is a humble attempt to examine the impact of climate change and its impact on land use land cover at the global and regional levels. In this regard, many researchers, academicians, scientists, NGO's and others worked hard to know the impact of climate change on various economic activities, especially agriculture. The outcome of the studies suggested still proper study is needed and its implementations are needed to help every corner of worldwide, mostly stakeholders, the situation that arises due to climate change should be addressed effectively. Future planning is very essential to adopt certain measures and mitigation is context-specific, including the capabilities of adaptation of communities and regions. According to climate change, the land capability is also changing, this is witnessed in the study area, even on land under cultivation, the production of different crops declined but the yield increased, it is due to adaptation technology by way of increasing the use of fertilizers, pesticides, etc.

Further studies are needed to enhance the impact of climate change on land use land cover, and simple modes should be

developed, and the same will help give initial estimates of climate change on land use land cover.

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