LAND USE TRANSFORMATION AND SOCIO-ECONOMIC CHANGES IN RURAL AREAS OF HUGLI DISTRICT

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By

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CERTIFICATE FROM THE SUPERVISOR

This is to certify that the thesis entitled "**Land Use Transformation and Socio-Economic Changes in Rural Areas of Hugli District**" Submitted by Smt. Nirupama Bairagi who got her name registered on 11/05/2015 for the award of Ph.D. (Science) Degree of Jadavpur University, is absolutely based upon her own work under the supervision of Dr. Kaniska Sarkar and that neither this thesis nor any part of it has been submitted for either any degree/ diploma or any other academic award anywhere before.

Kaniska Sarkar.

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PREFACE

Land is a dynamic concept that changes over space and time. The study of changing land use patterns is important in geographical study. Land use and Land cover an important fundamental element, which is considered in the planning and development of a region. Hugli district in West Bengal is unique in distinct respects. This part of the country has experienced with first European settlement way back in the 15th century. The proximity to the State capital and well connected by railways, roads and water transportation, have helped the area to reap the blessings of contemporary development at a quicker speed than most of the districts of the State. Along the bank of river Hooghly, the district is economically better off both in terms of agriculture and industry. The present work is a comprehensive and humble attempt to shape the volume, **Land Use Transformation and Socio-Economic Changes in Rural Areas of Hugli District** based on details of making an investigation on the past and present land use pattern and their socio-economic changes through space-time analysis.

The Hugli district has a diverse landscape comprising urban areas, agricultural fields, forests, water bodies, and industrial zones. The period from 1991 to 2021 witnessed a transformation in land use dynamics. The expansion of urban areas and industrial zones has resulted in the conversion of agricultural lands and natural vegetation. Agricultural land has experienced significant changes, indicating the growth of agricultural activities. Settlement areas have expanded over time, reflecting urbanisation and the development of residential, commercial, and industrial sectors. The whole thesis is summed up into seven chapters of which the first two chapters provide structure and background of the study area. The last five chapters are very much important as those are the outcome of a deep investigation that critically layout of spatio-temporal changes of land use and socio-economic aspects of the study region during the study periods.

Attempts have been made to find ways to develop the area holistically by solving the problems created in the socio-economic field along with the changes of land use transformation. Geographical techniques, interpretation and analysis will be cultured to show a new way to build up a new policy for development.

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During the research work, I have had many opportunities to discuss the results of the research with numerous friends' geography fraternity. In this regard, I show appreciation and request the readers to point out the mistakes found in this dissertation besides giving suggestions for further modification of this type of work in the next time.

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Nirupama Bairagi

Nirupama Bairagi

Dedicated to

My respected father, Sri Sudhir Bairagi

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

LIST OF MODELS

ACRONYM

SLM - Sustainable land management

SHG - Self Help Group

NGO – Non-Government Organization

LULC – Land use Land cover

CR – Completion Rates

GIS - Geographic information system

NLEP - National Leprosy Elimination Programme

SWID – State water investigation Directorate

WRDD – Water Resource Development Directorate

STW – Shallow Tube Wells

DTW – Deep tube Wells

NREP- National Rural Employment Programme

RLEGP – Rural Landless Employment Guarantee Programme

HYV – High-yielding varieties

SMP – Seed Multiplication Programme

FFDA – Fish farmer Development Agency

CADP – Command Area Development Programme

DVC – Damoder Valley Corporation

CI – Cropping Intensity

WBSEB – West Bengal State Electricity Board

FYM – Farm Yard Manure

CDAP – Comprehensive District Agricultural Plan

ULB – Urban Local Bodies.

ATM – Automated teller machine

MGNREGA – Mahatma Gandhi National Rural Employment Guarantee Act

PMAY – Pradhan Mantri Awaas yojona

SGSY- Swarna – Jayanti Gram Swarojgar – yojana.

PHE – Public Health and Engineering

PMKSY – Pradhan Mantri Krishi Sinchayee Yojana

BKSY- Bangla Krishi Sech Yojana

SWM- Solid Waste Management

LWM – Liquid Waste Management

GWM- Grey Water Management

BWM – Black Water Management

NRHM – National Health Rural Mission

CHC – Community Health Centre

PHC – Primary Healthcare Centre

AWWs – Anganwadi workers

ASHA – Accredited Social Health Activist

NSAP- (National Social Assistance Programme)

PMKVY- (Pradhan Mantri Koushal Vikas Yojona)

ATMA – District Agriculture department

SHM – Soil Health Management

WRC – Water Resource Conservation

NTFP- Non-timber forest products

HDTW- High density tube-well

MDTW- Medium density tube-well

LDTW - Low density tube well

SDW- Shallow deep tube well

RLI- River lifts irrigation

NHM – National Horticulture Mission

HYV – High Yielding Variety

ABSTRACT

Land Use Transformation and Socio-Economic Changes in Rural Areas of Hugli District

Land use of an area depends upon the anthropogenic activities on the land which is very much important to formulate developmental planning of that particular area. Land use planning is an activity for finding technically, ecologically, economically and socially sound infrastructure of land (Jurgens, 1994). The need for such planning is to get optimum use of available land resources both in terms of agricultural and ecological purposes. It becomes essential, especially after the gigantic enhancement of population pressure all over the country. To assess the scenario of present-day agriculture in an area, the socioeconomic condition of that particular area can't be ignored.

The consequence of this study is inconceivable in the most recent 30 years. There is an extreme transformation in the developmental range and for the expanding developed region; the agricultural area and normal vegetation scope are managed. Due to over-populace injunctive approval of victuals builds; the settlement scope hampers the farming region. So, the extravagant weight in a specific area misfortune the richness of the area quickly. The primary point of this study is to investigate the spatial-fleeting land use/land spread changes in 30 years in the rural areas of Hugli district.

In an interpretative sense land use is the surface utilization of all developed and vacant land in a specific time. Land use is the application of human controls upon land in a systematic manner. This study encompasses the survey and analysis of socio-economic structure which was affected by changing land diversification. In the context of fast-growing urbanization, necessity of the work assessment of ecological and environmental condition of this area is taken into consideration as an important part of the research. The study involves an evaluation of the feasible impacts of the physical setting and related socio-political and economic instability and assessment of the effects of the changing environment.

The main objectives of this study are, to assess the C.D block-wise land use pattern and its temporal changes from 1991 to 2021, study the Socio-Economic Status of the study area, identify the socio-economic problems created by transforming land use pattern of the study

area and try to indicate the major reasons behind the changes in land use patterns and suggest measures to attain desirable land use patterns of the study area.

Hugli district is characterized by a diverse landscape comprising urban areas, agricultural fields, water bodies, and industrial zones. The span from 1991 to 2021 witnessed a transformation in rural areas of Hugli district's land use dynamics. The study will be highly effective in assessing the present status to draw a perfect planning map for land use in the future. It is necessary to diversify the predominating agricultural rural economy to planned developed secondary and tertiary industries which is demanded of local people.

The total study has been divided into three phases: the first phase includes the formulation of the research problem and selection of the study area, an extensive literature survey and finding research gap, selection of the aims and objectives of the study and framing of the chapters. Data collection was done in the second phase of the study. The entire exercise in getting the theme materialized from both primary and secondary sources should be taken into account. For collecting the primary data, a field survey was carried out in the study area through a questionnaire survey, in-depth interview, and observation method and a pilot survey was conducted before the final data collection process to test the validity and reliability of the questionnaire. A total of 400 respondents (n = 400) from 12 sample villages have been selected to study the socio-economic condition of the villagers, and perceived causes of their local land use transformation. The questionnaire consisted of mixed types of questions such as open and closed questions and binary questions (Yes/ No). The study area of Hugli District consists of four sub-divisions. The study only focuses on rural areas of this district. The total number of rural households in this area is 7697. The study involved the technique of multistage random sampling. In the first stage, the entire district has been administratively divided into 18 C.D Blocks and a total of 12 sample villages have been randomly chosen from all the C.D Blocks in the study area. The sample size of the study has been ceiled to 400 (Krejcie & Morgan, 1970). In the next stage, stratified proportional sampling was applied. Considering the unequal distribution of households in each selected village, the sample size has also been distributed as per the proportion of households in each village out of the total number of households in all the selected sample villages in the study area.

The individual household was selected purposively by the researcher to study the socioeconomic condition of the villagers. The secondary information and data namely,

topographical map, land use map, block map, police station map, data on area, population, etc. are planned to be procured from different sources both from commercial as well as government institutions. C.D block-wise land use transformation analysed by using Acquisition of Landsat Data (1991-2021). For preparation of the GIS database satellite remote sensing data of Landsat TM, ETM, and OLI (Spatial resolution 30 m) have been collected from the USGS Earth Explorer website. Indian Topographical sheets (1984, Scale 1:50, 000) have also been used. For the analysis, collected Topographical sheets were Georeferenced using several ground control points manually using ground control points (GCPs) collected through GPS surveys and projected with UTM (Northern Hemisphere, Zone 45; Datum WGS 84). Evaluation of spatio-temporal dynamics of land use has been done by using a set of Landsat images from four different years (1991, 2001, 2011, and 2021).

This third phase of the work is mainly based on the analysis of the data collected from primary and secondary sources. Computer based cartographic and statistical method and techniques are considered to be applied to draw the maps and diagrams leading to determination of the environmental status and land potentiality of the studied area. Percentages, average, composite index score using statistical techniques, LULC prepared by supervised method (maximum likelihood classification), GIS techniques used for Accuracy Assessment by Kappa coefficient and pie, bar diagrams, graphs, etc. are applied in this study as cartographic techniques.

The analysis of research work focuses on the decadal change in land use transformation and socio-economic changes in rural areas of Hugli district. It is observed that the district presents an almost homogeneous landscape. From the census data analysis, it is clear that land use pattern of the Hugli district is dominated by net sown area. Satellite data depicts that agricultural land has gradually decreased. Sometimes, Agricultural land is transformed into settlements by migrated people in villages from neighboring countries. They occupy agricultural land from farmers in very cheap rate (Mollarber Village). Depletion of ground water table is a serious problem to supply of water for drinking and any agricultural production. Due to the lack of irrigation in agriculture, the type of crop cultivation has changed. The scarcity of drinking water is a serious problem for rural people. There is no proper solid and liquid waste management plan in the nearby municipality (Dankuni) of Chanditala-I and Chaditala –II and Serampore-Uttarpara C.D Block which is harming the

farming in the panchayat area, the villagers have stopped farming and are making living by doing small-scale, small-scale factories in the vicinity for low wages. Inadequate medical facilities in rural areas, lack of secondary schools in rural areas, roads impassable during monsoons, and lack of night vehicles inside the village at night are common problems in the district. The expansion of urban areas and industrial zones has resulted in the conversion of agricultural lands and natural vegetation in the study area. Agricultural land has experienced significant changes, indicating the growth of agricultural activities. Settlement areas have expanded over time, reflecting urbanization and the development of residential, commercial, and industrial sectors.

With a view to thoroughly studying the whole matter, the entire thesis has been divided into seven chapters. The first chapter is the introductory chapter of this study. introduces the study area, Hugli district within the jurisdiction of Bardhaman Division, West Bengal. Hugli district is situated between 23° 01' 20" North (Guptipara Char on the Bhagirathi River) and 22° 39' 32" North latitude (Right bank of the Rupnarayan River) and between 88° 30' 20" East longitude. The chapters contain research problem, objectives, methodology, research Gap, justification for the selection of the study area, limitation of the study, and a review of previous literature with a brief account of the historical background of the study area.

Chapter two describes both physical and socio-economic aspects of the study area. Geologically, the area is located in the stable shelf area of the western flank of the Bengal Basin and is entirely covered by alluvial formation. Sand is common in the river beds. Hugli district is made up of two geomorphologic units, a high old deltaic plain to the west (Arambagh subdivision) and the rest a dead delta (chinsurh, Chandannagar and Serampore subdivision). The river Darakeswar forms the dividing line between the two. The types of soil constituted this district viz. Gangetic Alluvial soil Vindhyan Alluvial soil and red soil. Sub-tropical humid climate prevails in this district. The average minimum temperature varies from 15℃ - 20℃ and maximum temperature varies from 28℃ - 35℃. The average annual rainfall of the district varies from 1200mm to 1700m. The district is rich in natural drainage lines. The total length of the drainage in Hugli district is 461. 83k.m. Damodar, Dwarakeswar, Hooghly, Mundeswari and Saraswati are the main rivers of Hugli district. The others tributaries are Sankari, Ghea, Kunti, Dankuni–khal and Baidyabati khal etc. There are no forests in the district, but patches of scrub jungle occur in Thana Goghat.

Another part of the study analyses the socio-economic setup of the study area because population and other aspects like literacy, Health Status, occupation structure, Drinking Water, Electricity, Transport and communication, etc. are significant social determinants. The population of the study area has rapidly increased from 1991 to 2011. The increasing number of urban populations depicts the conversion of Land from agricultural use to settlement. No. of Schools, Health centers, Post offices, Length of Road and Power Stations also be considered which are increasing gradually and change the cultural landscape of the study area.

From the census data analysis in Chapter three, it is clear that land use pattern of the Hugli district is dominated by net sown area. More than 95% of land belongs to small and marginal farmers and the average size of land holdings ranges from 0.66 ha. Cropping intensity is very high in this area. Out of the total area under cultivation 57% area is covered by irrigation. The main source of irrigation is groundwater. Irrigation intensity is very high in chinditala-I, Chinsurh-Mogra, Polba-Dadpur, and very low in Goghat-I and Chanditala-II.

Fourth chapter analyses land use change detection of Hugli district and C. D block-wise land use transformation with the help of change matrix statistics. From the Satellite data analysis, it is clear that Agricultural land has experienced significant changes, indicating the growth of agricultural activities. Settlement areas have expanded over time, reflecting urbanization and the development of residential, commercial, and industrial sectors. Water body areas have generally shown an increase, possibly due to the construction of reservoirs, Fish Pond and conservation efforts. Barren land remains stable. Major amount of conversion of Barren land to cropland in Arambag and Dhaniakhali highlights the agricultural development and utilization of unproductive land. Transformation of vegetation to aquaculture has been observed in Balagarh.

Fifth chapter focuses on socio-economic condition of households based on a field survey. The present chapter also attempts to explain and highlight land use pattern of sample villages and its spatio-temporal changes. In this chapter socio-economic scenario have been highlighted through primary data and land use pattern of the sample villages have been discussed through census data of 1991, 2001 and 2011. Most of the respondents used their land for plantation purposes followed by bastu, agricultural land, waste land, fallow land and fishing land. Majority of cultivators used their agricultural land as a double

cropping pattern. In some villages, farmland has been converted into nurseries, farm houses and settlements. There are several problems with socioeconomic development, such as scarcity of drinking water, inadequate medical facilities etc.

Sixth chapter is a critical one and major strength of this enquiry. This chapter emphasizes the impact of land use transformation and its impact on socio-economic condition of the villagers. These chapters also focus on the spatio-temporal variation and level of socio-economic development in the rural areas of Hugli district. The result depicts that Balagarh and Chinsurah-Magra are the least developed C.D. Block. On the other hand, Chanditala-I, Chanditala-II, and Singur have outstanding social and economic outcomes. Higher education options are being restricted due to the small number of high schools in Balagarh, Goghat I, and Khanakul-I. A case study of two sample villages has also been conducted to study the land use transformation and related socio-economic changes in the study area.

Seventh Chapter includes a discussion on various kinds of problems relating to the transformation of land and related socio-economic issues. The main problems which hinder development of farming in this district are small land holdings. The average size of land holdings is 0.63 hectares. Small cultivable land in some villages, not profitable for crop cultivation, is being sold by marginal farmers at a low price to the migrated people from neighboring countries and others for construction purposes. Besides irrigation problems also affect the production of crops. Problem arising in the Fishery and Livestock sector, supply is inadequate to meet demand. The Study area also suffered from inadequate health facility, Drinking water problems, Poverty and unemployment. Remedial measures for proper utilization of land for agricultural growth, Mixed Agriculture, Agro-based industry and Proper implementation of the various developmental schemes at the grassroots level for overall development. This chapter also presents a suggestive way of sustainable land use planning and community development program of the study. Finally, the Conclusion has been drawn by summing up the distinctive characteristic outlines of all the chapters and highlighting the summary of the study.

Land use is related to the conservation of landforms, one major use to another general use (Nanabati, M.B.1957). The concept of land use, therefore, revolves round the man's accomplishment in conversion of land, major use to other general use. Each stage of such change may involve any problem to pave the path for attaining equilibrium in the use of land (Sing. R.P., 1967). the emerging scenario in agricultural land use transformation in

Hugli district needs proper attention from policymakers and researchers. A holistic approach is required to incorporate a plan of agricultural land and allied sectors by removing the Socio-economic problem, to achieve the goal in the district.

Nirupama Bairagi

Chapter 1
Introduction

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1.1 Introduction

Land use of an area depends upon the anthropogenic[1] activities on the land which is imperative to formulate developmental planning of that particular area. Land use planning is an activity for finding technically, ecologically[2], economically, and socially sound infrastructure of land (Jurgens, 1994). The need for such planning is to get optimum use of available land resources for agricultural and ecological purposes. It has become indispensable, especially after the gigantic enhancement of population pressure all over the country. To assess the scenario of the present-day agriculture of an area, the socio-economic condition of that particular area can't be ignored.

Land use also pertained to the conservation of landforms, from one major use to another general use (Nanabati, M.B. 1957). Land that has once been withdrawn from agricultural use seldom returns to the farmers, and if it does, it will only be after a long intermission (Stapledon, R.G. 1940). A land utilization project aims at striking between added mouths and land use capacity. The concept of land use, therefore, revolves around man's accomplishment in the conversion of land, major use to other widespread use. Each stage of such change may involve some problem to pave the path for attaining equilibrium in the use of land (Sing. R.P. 1967).

The potential of land use Planning depends upon the geomorphologic nature of soil quality, drainage, climate, vegetation, and other ecological and environmental qualities. Systemic assessment of such parameters is the prerequisite condition for good planning. The growth of industry, commerce, and agriculture has not completely obliterated the traditional ways of life in modern societies. Spatial variations of socio-economic aspects exist with the variations in science and technology.

Hugli district in West Bengal is unique in distinct respects. This part of the country has experienced with first European settlement way back in the 15th century. The proximity to

[1] (Chiefly of environmental pollution and pollutants) originating in human activity.

[2] The branch of Biology deals with the relations and interactions between organisms and their environment, including other organisms. Also called human ecology. The branch of sociology is concerned with the spacing and interdependence of people and institutions.

the State capital and well connected by railways, roads, and water transportation, have helped the area to reap the blessings of contemporary development at a quicker speed than most of the districts of the State. Along the bank of river Hooghly, the district is economically better off both in terms of agriculture and industry. It is among the very few districts in West Bengal that successfully assumed the strategy of green revolution, especially concerning rice and potato cultivation. The river belt of Hooghly is heavily industrialized. During the British era, the district witnessed the establishment of jute mills along the Hooghly River, marking the beginning of the industrial revolution. Since the birth of time, education has also had a deep foundation.

Although this region made progress in agriculture, some problems may arise, physically and culturally, which will cause agricultural restrictions in this region. The average size of land holdings, modern implements, and machinery cannot be used. For the meager benefit from agriculture, the adults are migrating to the neighboring districts, searching for other jobs to be financially sound. A consequence of the crisis of agricultural workers can be seen. They are less keen to make their children pursue higher education and deploy them to agricultural work after an elementary level of education. To illustrate how the land use pattern in this area's rural-urban continuum evolves dynamically in response to the surrounding environment, which requires further study. The study attempts to illustrate the socioeconomic issues associated with the developing rural-urban continuum of Hugli. To analyze the district's current state of development and make recommendations for the best methods to utilize the available land.

1.2 Historical Background

Regarding the origin of the name of Hugli district the most popular view is that the district of Hugli, which is situated on the western bank of Hooghly River, got its name after Hooghly River. According to another view, the district derived its name from "Hogla", a tall reed that grows along the banks of the river and marshy lowland. The third view proclaims foreign origin in the name of Hugli district because many foreign traders such as Portuguese, Dutch, French, and British invaded and settled in the region in the historical past. The Portuguese settled in Hugli about or immediately after 1575. Hugli at that time was a petty village with only several straw huts and bamboo stockades in which the visiting Portuguese ships used to sell their cargo of salt from Hijli and which they used to evacuate when the sale was over. A storehouse of salt or any other commodity is called ‘Gola’ in Bengali and this word being

mispronounced by Portuguese became O-Golim. The Bengalis turned O-goli into Hugli (Banerjee, 1972).

The European Settlement in Hugli District

The Portuguese were the first to arrive in Bengal and the district of Hugli was one of the main centers of their mercantile activities. In 1535 Diego Rebello, the first Portuguese reached Satgaon through Hooghly River way. In 1536 they procured a permit from Sultan Mahmud Shah to trade in this area of Bengal. With the boon of Hooghly River port, this region turned into one of the major commercial hubs of Bengal within a very short period. In the years 1579-80, the emperor of Bengal, Akbar permitted the Portuguese traders to develop a city within the Bengal province. In 1588 Ralph Fitch, an English merchant, found Hugli in the sole possession of the Portuguese. During this span, many schools and churches (like Bandel church) were set up. They had chosen Hugli and the district became the first European settlement in Bengal. In 1632 Hugli, the great centre of Portuguese activity in Bengal gave away to the imperial army of Shah Jahan. Virtual monopolists in the first two decades of the 17th century, the second half of the century saw the passing of their trade to the Dutch and the English, and they were reduced to poor industrious, and numerous communities.

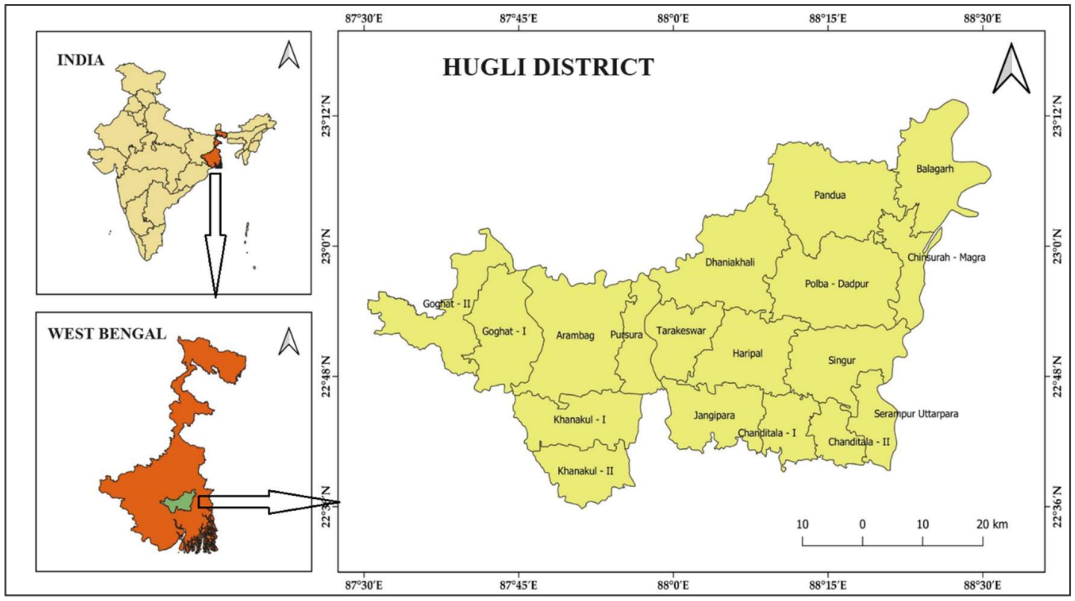
The next European nation to settle in Bengal was the Dutch. The Dutch were called the Olandaz from Holland. They also entered the region through the imperial port of Bengal, Satgaon, probably in 1615, and settled in Chinsura. During the reign of Aurangzeb, the Dutch in Bengal were regulated by a Farman granted by that Emperor in 1662. During the reign of Sirajuddaula, they appeared to have been the most favored European nation. However, the competition with the English Merchants district resulted in the loss of ground for the Dutches. This had made the Dutches hostile towards English traders. In 1781, with the outbreak of war with Holland, Chinsura was occupied by the British. By 1827 the Dutch of Chinsura had fallen on evil days, and they disappeared shortly after.

The English: The first Englishman to visit Bengal was Ralph Fitch, who came to Huglu about 1588. In December 1600 the East India Company was incorporated by the royal charter. Finally English took over Hugli in 1757. Chandannagore was captured in March 1757.

Among **other European powers** that set foot on Hugli were the **Dutch, Danish, French, Belgians, and Germans.** With the boon of the Hugli River port, this region turned into one of the major mercantile hubs of Bengal within a split-second time. Chandannagar was under the French from 1696 till 1950. Similarly, the Danish settled in Serampore, Chinsurah, and Serampore were under the Dutch and Danes respectively for a long period. All of the European

settlements attempted to establish their supremacy in the region. The British ultimately became the mightiest. After the battle of Plassey, Mirkashim by an agreement handed over the Zamindary areas of Burdwan, Midnapur, and Chittagong to the British in the year 1760. The British initiated their own rule to administer those areas according to their system. For administrative purposes in 1795, the district of Burdwan was divided into two parts, the Northern division being called Burdwan and the Southern division Hugli. Interestingly, ever since the "Buxar War" this region was under direct British rule until India's independence in 1947. After independence, this district merged into the State of West Bengal (Banerjee, 1972, Census 2001).

Figure 1.1: Location of the study area



Source: Prepared by researcher with the base map given in Census of India (2011). District census handbook: Hugli. Village and town-wise primary census abstract.

1.3 The Study Area

The study area of the is the Hugli district within the jurisdiction of Bardhaman Division, West Bengal. Hugli district is situated between 23° 01' 20" North (Guptipara Char on the Bhagirathi River) and 22° 39' 32" North latitude (Right bank of the Rupnarayan River) and between 88° 30' 20" East (Bhabanipur Char on the Bhagirathi River) and 87° 30' 15" East longitude (Tirol village of the Goghat P.S.). The frontier of the Hugli district is covered by the Hooghly River (Sharing with Nadia in the East and 24 parganas in the South – East) in the East, Bardhaman in the North, Howrah in South, Paschim Medinipore in the West, and Bankura in the North-

West. The district contains 4 sub-divisions, namely Hugli-Sadar, Chandannagar, Serampore, and Arambagh with 18 C.D. blocks. The expanse of the district as furnished by the survey of India is 3149 sq. km.

Table 1.1: Administrative set up of Hugli District

Sub-Division	C.D. Block	Area (sq. km.)	Population (person)
Hugli Sadar	Mogra-Chuchura	81.86	244383
	Polba-Dadpur	285.69	263555
	Dhaniakhali	275.68	320534
	Pandua	276.43	316197
	Balagarh	202.15	228998
Chandannagar	Singur	164.85	276413
	Haripal	184.40	261073
	Tarakeswar	119.93	179148
Serampore	Jangipara	164.23	221578
	Chanditala-I	93.45	179825
	Chanditala-II	70.34	158396
	Serampore-Uttarpara	44.80	152266
Arambagh	Goghat-I	186.32	140030
	Goghat-II	190.03	160585
	Arambagh	117.20	285207
	Khanakul-I	171.92	254434
	Khanakul-II	121.78	184734
	Pursurah	100.42	173437

Source: Census of India, 2011

1.4 Statement of Research Problem

The United Nations defines sustainable land management (SLM) as “the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions”. The demand for land changes due to the changing needs of the society. As socio-economic circumstances change, land use keeps on changing. Hugli district is characterized by a diverse landscape comprising urban areas, agricultural fields, woodlands, water bodies, and industrial zones. The span from 1991 to 2021 witnessed a transformation in rural areas of Hugli district's Land use dynamics. The expansion of urban areas and industrial zones has led to the conversion of agricultural lands and vegetation. Agricultural land has experienced significant changes indicating the growth of agricultural pursuits. Settlement areas have expanded over time, reflecting the development of residential, commercial, and industrial sectors which is detrimental to future food security

and environmental quality. Hugli district shares only 3.55% of the geographical area of the state whereas it shares 6.29 % of the state population (Census of India, 2001-2011). The consequence of this is most conceivable as observed in the last 30 years. There is an extreme transformation in the development range and for the expanding developed region; the agricultural area and natural vegetation are to be compromised. Due to over-populace injunctive approval of myriad builds; the settlement scope hampers the farming region. So, the extravagant weight in a specific area is rapidly reducing the richness of the region. The principal point of this study is to probe the spatial-fleeting land use/land spread changes in 30 years in the Hugli District.

1.5 Objectives of the Present Study

In an interpretative sense land use is the surface utilization of all developed and vacant land in a specific time. Land use is the application of human controls upon land in a systematic manner. This study encompasses the survey and analysis of socio-economic structure which was affected by changing land diversification. In the context of fast-growing urbanization, the necessity of the work assessment of the ecological and environmental condition of this area is taken into consideration as an important part of research. The study involves an evaluation of the feasible impacts of the physical setting and related socio-political and economic instability and an assessment of the effects of the changing environment. However, the objective may be categorized as follows:

1. To assess the C.D. Block wise Land use pattern and its temporal changes from 1991 to 2021.
2. To study the Socio-Economic Status of the study area.
3. To identify the socio-economic problems created by transforming the land use pattern of the study area.
4. To indicate the major reasons behind changing land use patterns of the study area.
5. To suggest measures to achieve desirable land use pattern of the Hugli District.

1.6 Literature Review

Studies on the Land use Pattern are not a present-day matter. In the prehistoric period, the peoples began to utilize land mainly for agricultural and domestic purposes. The literature related to land use studies may be divided into two categories – 1) The study with old

techniques and 2) The work with the help of contemporary techniques and concepts. A good number of studies have been carried out to study the land use characteristics.

King (1910) observed the activities of the farmers on the land in terms of their agricultural activities. Stamp (1950) for the first time initiated 'World Land Use Survey. Following him several survey works were carried out in different countries. Mc Cormack (1971), Sarfalvyet (1967), Stamp (1961), Van Liera (1965), Yahia (1971) Rey (1968) White (1997), Almer (1999), described different methodologies for the survey and planning of Land use pattern. Vink (1970) discussed the involvement of human beings with elements responsible for altering the land use pattern in a specific area. In a discussion of land use especially in the aspect of agriculture, Vink (1975) categorized the pattern of land usage mainly from rural, urban, and industrial points of view. Grice (1971) emphasized the significance of drainage system in illustration of a Land Use Pattern. Staver (1994) discussed land resource management through the spectacle of forest conservation. Lorry (1968) proposed a model structure for optimum land use. Bakema (1994), Blume (1998) stressed the sustainability of planning a land use pattern. Sociological interaction in the land use pattern was narrated by Soloni and Rossi (1992), and Tan Kim Young (1993).

The studies on general land use and agricultural land use/land cover and their changes have been completed by many researchers in different parts of the world. The related research work is grouped under the international, national and state level categories. A brief account of review works is given here.

Foreign publications

Valkenburg S. Van (1950) worked as the chairman of the World Land Use Survey Commission and he put forward the concept of the World Land Use Survey. This commission had constructed the world land use maps of 1:1000, 000 for regional development planning by employing the pilot survey and aerial photographs. They classified the world into nine categories. These were settlements and associated non-agricultural lands (dark and light red), horticulture (deep purple), tree and other perennial crops (light purple), cropland (brown), improved permanent pasture (yellow), unimproved grazing land (orange and yellow), woodlands (different shades of green), swamps and marshes (blue) and unproductive land categories (gray).

Uyanga, J. (1978) conducted a study of the correlation between agricultural inputs, Land use, and productivity and population change in South Australia from 1961 to 1971. He concluded that there is a correlation between relative productivity and farm depopulation.

Davidson, D. A. and ET. al. (1986) studied the land resource information system to produce soil and land evaluation maps for Scottish land use planning and management. A variety of different sources such as published maps, air photos, satellite imagery, field data, census and statistical sources were used to form a land resource information system.

Nguyen-Huu–chiem (1994) brought out a paper on former and present cropping patterns in the Mekongdelta. He studied the agricultural land use and cropping pattern with landforms, water conditions, soil and traditional methodology of rice cultivation.

Yukio Himiyama (2001) conducted a study on "Land use and cover change studies in Japan – an interim review and proposals" to prepare Land Use transformation System (LUIS). He discussed the trend and major achievements of land use and covered change studies in Japan and put forward priority themes and direction in land use change for future study. Such LUIS has been applied to ecology, climatology, agronomy geography and regional planning.

Kuhlman, Tom (2003) endeavored to find out agricultural land use changes in Netherland. He prepared a special model to demarcate the changes in agricultural land use.

Mohamed Ait Belaid (2003) researched "Urban rural land use change detection and analysis using GIS and Remote Sensing technologies" to investigate the effects of urbanization on agricultural lands of Baharin. Multi-date Composite image methods, image comparison methods, spatial analysis methods were adopted. He concluded that climatic factors, a decrease of ground water table, rural settlements and growth of urbanization are accountable for the declining agricultural land.

Aylward Bruce (2006) has carried out his research on Growth, Urbanization and Land Use Change and its repercussions on Agriculture and Irrigation. He examines how growth impacts irrigated agriculture and pinpoints the social, economic and environmental issues arising. The primary focus of the paper is to comprehend the risk to irrigated agriculture and the irrigation districts that serve irrigators. He emphasized the current conditions and future trends in irrigated agriculture in the upper river basin – where population growth, urbanization and land use change are having a great impact on the demand for irrigation water – and therefore also a significant impact on the potential supply of irrigation water rights to meet new, non-traditional uses of water. The matter ended without any discussion of Land fragmentation and Land management systems.

Khan Alam Sha Mohammed (2006) has carried out his research on "Changing Land use pattern and rural transformation in Eastern Uttar Pradesh. He studied about agricultural sector as well as rural life. He emphasized the impact of Physiographic factor (relief, soil, climate, drainage, etc.) on agricultural advancement. Agriculture is a chief economic activity in this

region. He attempts to assess the transformation of land use patterns in this region and examine the agricultural transformation. He tried to discern the levels of development like industries, health, education, electricity supply, transportation, communication, etc. in the study area.

Dewan M Ashraf & Yamaguchi Yasushi (2008) published a paper, about land use and land cover change in Dhaka Metropolitan of Bangladesh. This paper illustrates the outcome of land use/ cover change in Dhaka Metropolitan of Bangladesh using topographic maps and multi-temporal remotely sensed data from 1960 to 2005. The Maximum likelihood supervised classification technique was used to extract information from satellite data, and post-classification change detection method was employed to detect and monitor land use/cover change.

The study quantified the patterns of land use/cover change for the last 45 years for Dhaka Metropolitan which forms valuable resources for urban planners and decision-makers to devise sustainable land use and environmental planning. In this study no more discussion about the impact of socio-economic life, which was highly affected by to loss of arable land and rural land.

Mingjie Shi (2008) discussed the changes and feedback on land use and Land-cover under Global Change. Land-use and land-cover changes mainly refer to replacing forests and grassland for agricultural use, intensifying farmland production and urbanization and the changes are local and area-specific and they currently become one of the most important facets of global environmental change. In the past two centuries, the impact of human activities on the land has grown significantly, altering entire landscapes and ultimately impacting the earth's nutrient and hydrological cycles as well as climate. He considered in his study only the physical and environmental side of changing land use patterns on a large scale but his study does not cover the socio-economic aspect of the concerned area.

Hussein Ali Oumer (2009) conducted a comparative study on Land use and Land cover Change, Drivers and its impact. His study aims to identify and compare changes in land use and land cover, their drivers and their impact on vegetation and animal feed dynamics in water-abundant (Kuhar Michael) and drought-prone (Lenche Dima) areas from the Nile and Awash basins of Ethiopia. In this regard, he emphasized population increase, occurrence of drought, land redistribution, and land degradation of the study area. He used Time-series satellite images that included Landsat MSS, TM, ETM+ and ASTER, which covered the time frame between 1972 to 2005 and discovered that the productivity of cropland has deteriorated over time due to continuous cultivation, requiring the use of fertilizers. In the past, traditional practices were undertaken to improve the fertility of farmland, known locally as Tiget Mewgat

and Chikcheka.The presence of the tse-tse fly is a source of threat for animals. He discussed grazing land, Expansion of cultivated land, land fragmentation, land certification process, land management, animal feed, Crops grown, Crops production, etc. Rice straw, millet straw, communal grazing, private grazing and maize stover are ranked as the top five livestock feed sources in Kuhar Michal. This study does not cover the trend of urbanization in that area.

Manonmani R, Mary G and Suganya D (2010) conducted a study on Change Detection in Urban Zone. In this study, Remote Sensing and geographic information system (GIS) are used to study land use/land cover changes. He explained that Land use change may influence many natural phenomena and ecological processes, including runoff, soil erosion and sedimentation, and soil conditions. Urban areas are changing due to various human activities, natural conditions and development activities. This study aims to detect land use changes between 1990 to 2005 using satellite images of Land Sat 7 ETM+ (1990) and IRSLISS III (2005) and digital topographic maps have also been used. He tries to comprehend the land use/land cover changes in urban areas and identify hotspots of land cover changes using multi-temporal satellite data. However, he left out his study without any explanation of the changing effects of land use in society.

Chann Sopheak, Nathan Wales, and Tim Frewer (2011) conducted a study on Land Cover and Land Use Change in Stung Chrey Bak Catchment, Cambodia. This study investigates the interaction between water resources, LULC, and local livelihoods over two decades within an agricultural catchment in the upper and middle sections of that catchment. He revealed that both the quality and quantity of the evergreen forest had declined over the study period within most of the Chrey Bak catchment. Findings also revealed a steady decline of remaining secondary forests in the midstream and some upstream areas. Such disturbance is a result of forest encroachment and illegal logging by local people and outsiders, charcoal production, and commercial agriculture (large-scale plantations). The implications of such disturbances must be taken into consideration if sustainable catchment management objectives across the catchment are to be achieved. Again, the study does not include the changing effect on the socioeconomic life of the people in that area. No discussion of crop production, cultivated land, irrigation systems, land management systems.

Atalel Getu Sahalu (2014) attempted to analysis on urban land use and land cover changes in Bahir Dar, Ethiopia by integrating remote sensing techniques and Land Change Modeler. He analyzes land use and land cover changes in the region by applying geospatial and land use change modeling tools. The spatial trend of built-up areas showed that there was a growing trend in the western part of Bahir Dar relative to other directions. He tries to provide better

information for urban planners and decision-makers to design strategies and solutions to manage the impacts of land use and land cover changes in both spatial and temporal scales. He points out deforestation, habitat fragmentation, urbanization, wetland and soil degradation and many other landscape-level phenomena. He tries to quantify gains and losses of land cover classes, examine land use transitions and asses spatial trends of changes in built-up areas. This topic does not consider the urbanization developmental factors like industries, health, education, electricity supply, transportation, communication, etc. in this study.

National Level

Several geographers and researchers carried out the study of general and agricultural land use/land cover changes in geography at the national level. Some of which are reviewed here.

Raina. R. A. (1957) researched Agricultural Land use in Kashmir Valley. He discussed Physiography, Climate, Soil (soil erosion, soil zone, soil type, soil cultivation, etc.), and Land use in detail including agricultural land, land classification, land fragmentation, land development, irrigation, flood control, land ownership, crop pattern, agronomy, fertilizer, pest and disease, livestock, etc. of this study area. The worth is way too illustrative.

Wase Tazin (1985) Studied on Changing Pattern of Crop Land use in Western Uttar Pradesh (Since 1950). In his studies, he discussed on Physiography, soil and climatic conditions of the study area and emphasized Crop patterns and crop combinations. Climate, soil and other variables influence cropping patterns.

Khan Alam Shah Mohammad (2006) attempted to analyze Changing land use patterns and rural transformation in eastern UP and came up with the relation that the Agricultural sector carries a double obligation to increase production and to provide capital for other sectors to promote economic growth. Hence emphasized agriculture for rural development. In this respect, he said, when economic development begins, agriculture commands a high proportion of the country's land, labour and capital resources and produces a high proportion of the national income.

He tries to assess the transformation of land use patterns, socio economic development, and find out the levels of development like industries, health, education, electricity supply, transportation, communication, etc. in the study area. He studied the relationship between land use patterns with agricultural development, population, and livestock and suggested that the land must be used according to its capability and the land use plans should be generated based upon soil capability and water resource profile.

Siddiqui Mujtaba Ahmad (2010) has carried out his research on the identification of driving forces for changing the land use pattern and policy implications in parts of Budaun district (U. P). The increasing pressure of population and the changing land use pattern of this area have introduced a variety of new conditions under various driving forces, like; advancement in the field of technological means, and extensive use of agricultural resources over the years. Improvement in socioeconomic conditions has enhanced the purchasing power of the agrarian society which has resulted in greater investment in agriculture. The percentage changes in the categories like Forest cover, uncultivable waste land, cultivable waste land, fallow land, grazing lands, groves, net sown area and area sown more than once. He finds out that good quality agricultural land has been brought under nonagricultural uses like roads, buildings and water channels, etc. resulting in a negative impact on the available agricultural land. These are the main causes of land and environmental degradation. He emphasized on cropping pattern and cropping intensity of that area. The matter ended without any discussion of land fragmentation, land certification and land management systems.

Lal. Tarsem (2011) presented a paper on Population pressure and changes in Land use patterns, a study of Akhnoor Tehsil, Jammu. He studied spatial variation in population and its spatial distribution, density of population, agricultural density, and agricultural development. The regional landscape has determined disparities in population distribution and scheduled caste-dominant villages have underdeveloped. Population is a dynamic phenomenon that is increasingly in geometric progression and agricultural production is in arithmetic progression and population exceeds and becomes double in 25 years. Occupational structure played a significant role in bringing socio-economic prosperity and changes in land use. In his research, Hexagonal Christallians model is partially accepted.

Vijay Laxmanrao Rajale (2012) published a research based on Agricultural land use in Buldhana district. He discussed in his study the agricultural problems of Buldhana district, pointing out agricultural implements, livestock, irrigation, agricultural land use and general land use. The researcher has noticed some important and basic fundamental problems of agricultural developments regarding the study region such as less irrigation, uneven rainfall, inadequate supply of electricity processing and Marketing, Low Productivity, Inadequate Transport and Storage facilities, lack of uniform Price Policy and incentives, inadequate use of HYV Seeds, chemical fertilizers and Manures deforestation, few number of agricultural training centers, unawareness about Government Schemes population pressure on agriculture. He suggested some measures to overcome those problems, which are noted:

Percolate every drop of rainwater in the soil. To stop the surface running water in the region more percolation tanks, more Kolhapur-type bandhares, and field tanks should be constructed in every village in the study region, increase the irrigational facilities in all the tahsils, rotational grazing, and crop rotation must be accepted for reducing soil erosion. Electricity rates should be reasonable and continuous electric supply should be provided, efficient marketing structure has to be developed in the study region, Source of manure should be increased to increase the productivity of agricultural land, all villages should connect with market centers by roads Scientific storage facilities should be made available in all blocks and market centers. The government should undertake the social forestry projects.

Kangalakshmia (2013) researched the impact of Land use on environmental quality due to urbanization of Tirumangalam taluk, Madurai. He discussed that a large number of natural lands have been converted to urban lands and the prior land use patterns are also getting changed in these activities. With rapid population growth and migration from rural to urban places agricultural land and water bodies around the urban areas are rapidly vanishing, giving place to other land uses like settlements and industrial development which leads to environmental degradation impacting environmental quality and causing pollution in the atmosphere, affecting ground water potential and depleting the special resource. Sustainable land management is a critical challenge to the earth's system and resources of the land. Due to the lack of space for the expansion of Madurai city, it is expanding towards urban sprawl linearly in a haphazard manner. Due to this fast expansion, the changes in Land use in Tirumangalam taluk were identified using new technology Geographical Information System (GIS), and Remote Sensing (RS). He finds out that Land use Land cover changes occur in settlements, water bodies, roads and agricultural lands. The researcher used GIS& RS techniques in his studies and successfully covered land use related to every necessary topic. Only a slight gap in the discussion, on the impact of changing land use on soil structure and agricultural production.

Anushridinkar Kadam (2013) wrote a research paper entitled Application of GIS in Urban Land Use Changes in the PCMC (Pimpri chinchand municipal corporation). She tries to detect the change in land use /land cover and understand the urban growth pattern and its developmental trend. in her study using satellite imagery of two different years. She discussed the effect of the population in an administrative ward on utility services. Through transport, educational and industrial facilities have mainly been studied and covered. The researcher, study also located the changes and explained the spatial relationship between land use change and utility service. She points out that the development of socio-economic infrastructure and

urban utility facilities shows the quality of life of the people of a particular area and utility services can also be affected by various socio-economic factors, like social group, economic structure, cultural or ethnic group and tradition of society. The unplanned migration along with the natural growth of the population led to the rapid increase in the population of Pimpri-Chinchwad in the last five decades. She observed that the rapid process of urbanization has affected land use area and only the built-up land measures have gone up. Land use in PCMC changes with utility services. The urban or built-up category of land use shows maximum changes from 2001 to 2011 in the central part of PCMC. There is no more discussion on the Physical factors of land use, like Physiography, soil, climate, drainage, vegetation, etc., and the effect of changing land use patterns on the environment.

Regional Level

Bagchi & Mukherjee (1982), Chatterjee (1974), and Bhattacharya & Barua (1980) have described briefly the geological formation of West Bengal including the characteristic features of river Hooghly. S.P. Dasgupta (1989) studied the problems of optimum land use plans and basic characteristics of land use patterns. K Chatterjee (2002) has discussed the problems of land use of parts of the Lower Ganga basin in the study of fluvial ecology. S P Chatterjee (1952) has described the land utilization with the ref of Howrah district. J.D. Ghosh (1988) explained the cause of the decaying of the river Saraswati in Hugli District including the occurrences of meander neck, levee, numerous shifts and diversion of the river. Swapna Basu & kuntala Lahiri (1985) touched upon the rural setup in Hugli district, explaining the lower Damodar cum west Hugli basin. Indira Das (1968) has focused on the changing landscape of Chandannagar in eastern Hugli. D.G. Crawford (1902) has described a brief history of Hugli district. To make a comprehensive analysis of the environment and its impact on land potentiality for land use planning is what the present worker is aiming at. R Chakraborty and R Halder have touched upon the changing land use pattern of the Indian agricultural scenario explaining crop diversification and crop production.

Some more related literatures are described below: -

Gupta P. S (1989) presented a paper on the Land use plan of Jhargram block in Medinipur District. His research topic is concerned with the study of the problem of the optimum land use plan of Jhargram. He emphasized the aspects of the basic characteristics of the land area of Jhargram block and its land use pattern, the probable needs of the people along the desirable land use pattern. He suggests achieving the optimum returns from the available land resources in the study area.

Sengupta T & Sen. (1996) presented a paper on the changing socio-economic landscape of Totopara, Jalpaiguri district. The present paper deals with the changes that have taken place in the economic and social spheres of the Totos. Who during the British rule was solvent as they used to trade in oranges produced there? But since independence, they have become economically depressed, as they lost their agricultural lands in the hands of the immigrant Nepalese and the orange fields are abandoned. In this paper does not consider the Physical setup of that study area.

Ghosh. J (1989) worked on the Agricultural land use of Noapara, Hooghly. He described the existing land use of Noapara and analyzed the condition that is responsible for the socio-economic problems, especially relating to agriculture and the future patterns as predictable from the ensuing trends. He concluded that the village is self-sufficient in food status. The rapidly growing population would inevitably result in disguised unemployment. The village would get its impulse of widening the existing socio-economic horizons, if and only if a good soil management program together with a scientific crop rotation, artificial rejuvenation of river Saraswati, construction of transport lines, educational institutions, medical and banking facilities are undertaken by the government. In this study includes no discussion of land classification, land fragmentation, land certification and sustainable land use plan. No application of GIS and Remote sensing techniques.

Bhattacharya. K (2001) studies the impact of soil and landform on the land use pattern of the Kangsabati basin. She discussed land use development with a special reference to the exogenesis inclusive of the soil-forming process actively engaged in different geomorphic divisions of the Kansabati basin. Like the peculiar landforms of the various origins, the soil mosaic of the basin is a complex order. She classified the major geomorphic division and concluded that the Kangsabati basin is marked by the evolution of a multicycle landscape under a fluvial environment. Soil profiles are regarded as the valuable archive of all the soil-forming processes thus forming the unit of study in the presently pedo-geomorphological investigation. These are found to be closely associated with the occurrences of a variety of agricultural land uses along with the other elements of the cultural landscapes in that basin. The existing land use patterns that have been developed in the area are nothing but the result of mainly the landform-soil interactions with many human interventions in the study area. The study is mainly based on a Physiographic discussion and the matter is ended without any discussion on the impact of changing land use patterns on socio-economic structure.

Bhattacharya (Roy). J (2002) published a paper on the potential land use Amodabad Mouza, Polba P.S., Hugli, West Bengal. The researcher has considered the land use parameters both

from physical and cultural areas of Amodabad mouza on the change of land use from 1995 to 2005 to project the land use potential. He finds out that arable agriculture is gradually decreasing than orchard farming due to various physical and cultural factors. He emphasized relief, drainage morphology, climate, and soil of the study area. The findings of that study are the agricultural practices that reveal the recent development of the land use status of this mouza in Amodabad, Hugli district. The significant feature of the recent agricultural land use is the new trend in the pursuits of common people engaged in rural areas towards an attempt for higher income through promoting orchards in their practices. No more discussion on land classification, demographic status, or sustainable land use of the study area.

Biswas Mery, (2005) Worked on the Impact of landform on land use of Tista-Jaldhaka interfluves, Jalpaiguri district, West Bengal. The main objectives of her study are the geological aspects and their impact on land use, especially the agricultural land use pattern of the study area with an emphasis on ascertaining the land potential of the area. She emphasized in her studies on Geomorphologic process and fluvial characteristics of the study area and found out that the entire area is to be typified by the suits of fluvial and tectonics landforms being sculptured by the active down cutting. Geomaterials are set in a neo-tectonically unstable and vulnerable terrain of North Bengal's undulating plains. This study mainly stressed the Physical factors of the concerned area. No more discussion of the effect of changing land use patterns on the environment.

Ghosh Tanusree (2012) has carried out her research work on the 'Impact of changing land use (1971-2001) on Environment' in the Southwest Birbhum District; West Bengal. Land use planning in this region is arbitrary, unplanned and unscientific from an ecological point of view. The land potentiality of the region is aggravating day by day due to rapid deforestation, faulty agricultural practices, and mining practices, etc. The researcher tries to assess the future impact of the present land use pattern. She finds out that there is a relationship between change in land use practices and decreasing land potentiality and also a relationship between ignorance of rural farmers and unscientific land use practices. She suggests that the land resource potentiality of the study area can be augmented by proper and scientific resource-harnessing techniques. She emphasized on impact of geology and lithology on land use, climatic impact on land use, variation of ground water availability, soil erosion & management, land classification, and water management. She suggests putting particular land units to suitable land uses which will not only enhance the productivity of the land but also maintain the susceptibility of the land on a long-term basis. This study does not cover the trend of urbanization in that area. Sarkar R (2012) researched the Terrain evolution for

agricultural land use and planning in the Burdwan upland, West Bengal. The main objective of her work is to analyze the techniques of terrain evaluation for an upland which is characterized by micro geomorphic aspects. For this purpose, the physical potentialities and socio-economic characteristics have been analyzed in detail. Major problems were identified by her, absence of aquifer and scarcity of drinking and irrigation water, rapid urbanization and loss of agricultural land, regional disparity in development, underuse and misuse of agricultural land and land-subsidence. The discussion of physical components (e.g. geology, vegetation, drainage, surface elevation and forms, morphometry, soil) which have been considered as inevitable important parameters for the classification and evaluation of terrain units exhibit that the Upland is not monotonous but presents various topographic features. The variation in surface elevation (80 meters to 220 meters), surface forms (spurs, valleys, residual hills with hilly, rugged, undulating, and rolling surfaces), slope (below 1º to 24º almost) soil (loam to clay) have greatly influenced and determined the drainage, irrigation and most importantly agriculture. Non-perennial first and second-order streams are dominating the area. The present study has attempted to analyze the physical as well as socioeconomic environment to classify and evaluate the terrain. Agriculture-related problems are singled out mainly concerning physical components. In this study no such discussion on the trend of land fragmentation and crop patterns.

Bandyopadhya, J., Mandal, M. and Roy, B. (2014) published a paper on changing detection of land use and land cover and the identification of the inter-relationship between geomorphology and land use and land cover in and around Bakhkhali-Fraserganj and Henry Island, South 24 Parganas, west Bengal. To find out the land use pattern and to delineate the lithology and structure remote sensing techniques have been used effectively in this study. The land cover and land use study were conducted by mapping LANDSAT data from two different years (1990, and 2013) with the help of ERDAS Imagine and Arc GIS. The years 1990 and 2013 are selected to detect the changes that have taken place in this area between these years. They find out the rapid growth in built-up land between the span of 1990 to 2013. Geomorphologic and Land use land cover studies reveal that two contrasting coastal environments are prevailing in the study area namely the macro-tidal Hooghly estuary in the east; and the meso-tidal Midnapore Coastal plain to the west. This paper does not consider the impact of changing land use patterns on socio economic structure.

1.7 Research Gap

There is no substantial work on the impact analysis of Land use Transformation in the rural areas of Hugli District., Earlier researchers, except a few, focused their attention on the district as a whole. Most of the research works have been conducted only on a village or selected block level. The present study deals with the total rural areas of Hugli District, comprising 18 C.D Block. The study aims to investigate land use dynamics at the Block level.

The previous studies put emphasis either on physical land attributes or on socio-economic land attributes. However, both the physical and socio-economic land attributes are complementary to each other. Therefore, the present study tries to integrate land, economy, and society in one frame.

Most of the studies related to the impact assessment of land use change were mainly related to the analysis of changing patterns of land use categories and their impact on the physical environment. However, the present study is more comprehensive in the sense that it aims to explore the cumulative impact of changing land use categories on both Physical and Socio-economic environments.

The previous workers related to Hugli District focused their thrust only on agricultural land use providing a partial result. The present study has a wider horizon as it incorporates all the land use categories and their spatio-temporal interchange in a single framework.

1.8 Justification for the Selection of the Study Area

Land is a scarce resource, whose supply is fixed for all practical purposes. At the same time, the demand for land for various competing purposes is consistently going up with the increase in human population and economic growth. The demand for land changes due to the changing needs of society. As socioeconomic conditions change, land use keeps on changing. The study of land use therefore is a subject of perpetual interest.

Hugli is especially known as an economically developed district of the state. By exploiting the modern technology to its fullest the district witnesses the burgeoning growth of industry and agriculture with approx. 70% of people derive their living from agriculture. The response of the tenant farmers to the upcoming market of Kolkata has made this region a field of diversified commercial agriculture. The district is also considered an industrial hub and shares a significant position in the industrial panorama of West Bengal. The growing industries of the district provide ample scope for employment. So, the land use pattern of this district slowly changed affecting the socio-economic condition of the district. The study will be highly

effective in assessing the present status to draw a perfect planning map for land use in the future. It is necessary to diversify the predominating agricultural rural economy to planned developed secondary and tertiary industries which is demanded of local people. So, from this study agriculture, industry sector, people, Govt. and also be nation will be benefitted.

In the previous two decades, it has been found that more than 65% of the area is agricultural land and industrial development has been noticed along the river belt of Hooghly and railway track. In addition, some projects have been taken up by some big entrepreneurs with full patronage of the Government to make large-scale industries in the area like Singur and also Polba-Dadpur. According to the record of the Department of Agriculture, this study area had been changed for land utilization from 2005. On another hand, it was found that the aforesaid projects had not come into proper force due to the Singur movement in 2007. Therefore, the field of land activity and its impact on socio-economic structure is mainly chosen from 1991 to 2021.

1.9 Database and Methodology

1.9.1 Database

The entire exercise in getting the theme materialized from both primary and secondary sources should be taken into account.

1.9.1.1 Primary Data Source

For collecting the primary data, a field survey is carried out in the study area through a questionnaire survey, in-depth interview, and observation method and a pilot survey was conducted before the final data collection process to test the validity and reliability of the questionnaire. A total of 400 respondents (n = 400) from 12 sample villages have been selected to study the socio-economic condition of the villagers, and perceived causes of land use transformation of their local. The questionnaire consisted of mixed types of questions such as open and closed questions and binary questions (Yes/ No).

The study area of Hugli District consists of four sub-divisions. The study only focuses on rural areas of this district. The total number of rural households in this area is 7697. The study involved the technique of multistage random sampling. In the first stage, the entire district has been administratively divided into 18 C.D Blocks and a total of 12 sample villages have been randomly chosen from all the C.D Blocks in the study area. The sample size of the study has been ceiled to 400 (Krejcie & Morgan, 1970).

In the next stage, stratified proportional sampling was applied. Considering the unequal distribution of households in each selected village, the sample size has also been distributed as per the proportion of households in each village out of the total number of households in all the selected sample villages in the study area.

The individual household was selected purposively by the researcher to study the socio-economic condition of the villagers. Considering the unequal distribution of the households in the selected sample villages, to give proportional weightage to all the households in the study area, the sample size of each selected village may be calculated as follows:

$$n/NxNi$$

Where, n= sample size

N= Total number of households in all the selected sample villages (7697)

Ni= Total number of households in each selected sample village

For example, Sankarbati: 400/7697x454 = 25

Table 1.2: Sample design and sample size

Sub-Division	C.D. Block	Village	Total no. of HH	Total no. of selected sample HH
Hugli Sadar	Mogra-Chuchura, Polba-Dadpur, Dhaniakhali, Pandua, Balagarh	Sankarbati	454	25
		Hatikanda	180	09
		Sripur	157	08
Chandannagar	Singur, Haripal, Tarakeswar	Bighati	1024	53
		Dakshinkul	370	19
Serampore	Jangipara, Chanditala-I, Chanditala-II, Serampore-Uttarpara	Mollarber	1264	66
		Basipota	233	12
		Thero	700	36
		Badpur- Pubpara	727	38
Arambagh	Goghat-I, Goghat-II, Arambagh, Khanakul-I, Khanakul-II, Pursurah	Kamarpukur	739	38
		Santipur	823	43
		Tirol	1026	53
Total			7697	400

1.9.1.2 Secondary Data Source

The secondary information and data namely, topographical map, land use map, block map, police station map, data on area, population, etc. are planned to be procured from different sources both from commercial as well as government institutions, viz offices of the District Magistrate, Zilla Parishad, Land and Land Reforms, Bureau of Applied Economics, Agriculture, Forest, Irrigation of Hugli district especially concerning the eastern zone. Apart from this the Office of the Geological Survey of India and the Libraries like the National Library, Calcutta University Library, and District Library of Hugli are also considered to be the sources of information.

1.9.2 Methodology

To fulfill the objectives, the present research work is framed on the application of modern technology, procuring the data to a maximum range with necessary information and evidence. The proposed work is taken up mainly in three phases. i.e.-

i) Pre-field work: The first phase of the proposed work includes a preliminary study through literature review, preparation of base maps of the studied area, preparation of questionnaire schedule, selection of target groups, and sample size.
ii) Field Work: The second phase includes a collection of primary data directly through a household survey along with an assemblage of secondary data sources.
iii) Post-field work: This third phase of the work is chiefly based on the analysis of the data procured from primary and secondary sources. Computer-based cartographic and statistical methods and techniques are considered to be applied to draft the maps and diagrams leading to the determination of the environmental status, land potentiality and flora of the studied area. These conjointly are helpful to draw a suitable land use planning.

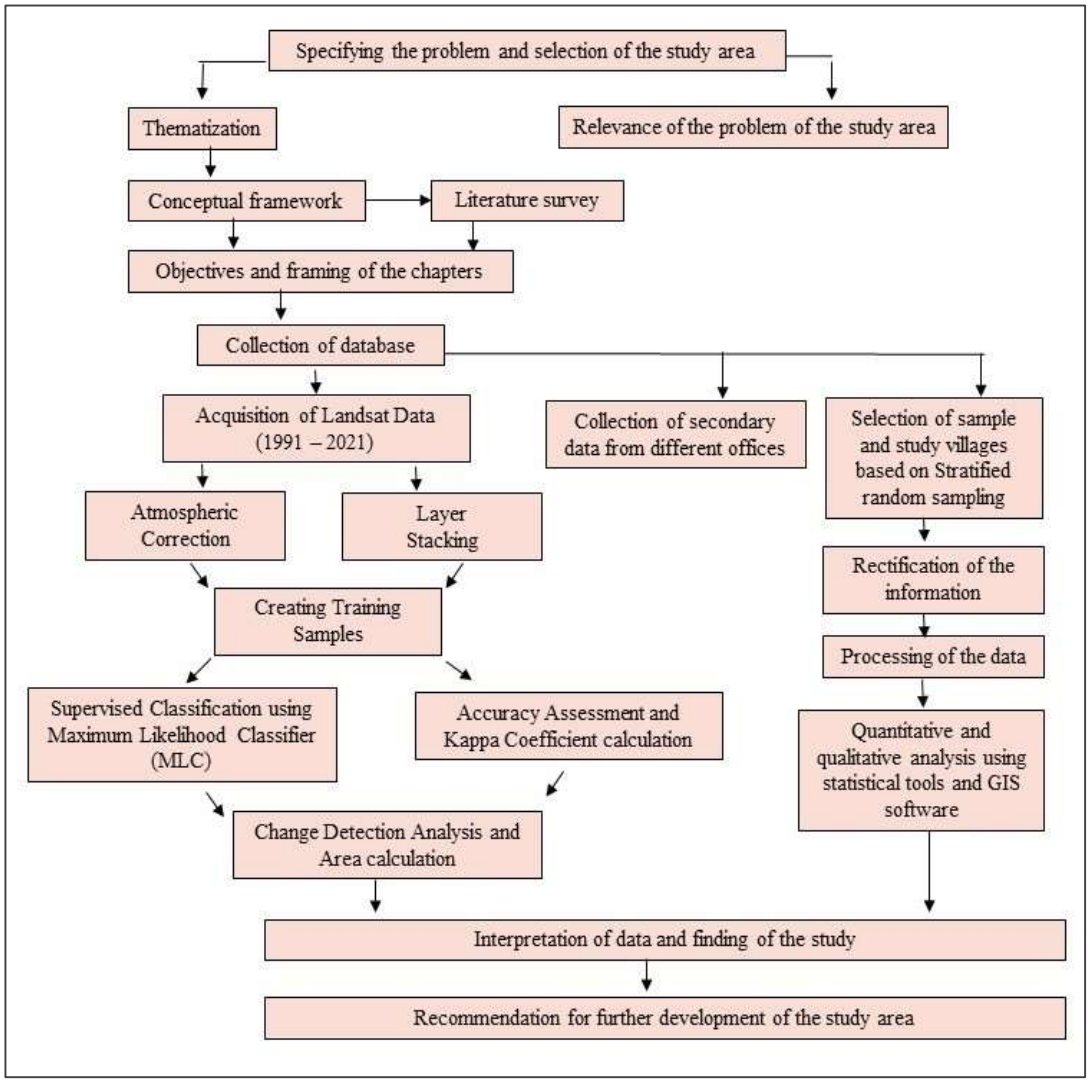
1.10 Adopted Technique

For the present study it has included qualitative as well as quantitative analysis which is systematically represented below.

1.10.1 Digital Image Processing

For preparation of the GIS database satellite remote sensing data of Landsat TM, ETM, and OLI (Spatial resolution 30 m) have been collected from the USGS Earth Explorer website. Indian Topographical sheets (1984, Scale 1:50, 000) have also been used. For the analysis, collected Topographical sheets were Georeferenced using several ground control points manually using ground control points (GCPs) collected through GPS surveys and projected with UTM (Northern Hemisphere, Zone 45; Datum WGS 84). Evaluation of spatio-temporal dynamics of land use has been done by using a set of Landsat images from four different years (1991, 2001, 2011, and 2021).

Figure 1.2: Methodological framework of the study



Source: Prepared by Researcher.

1.10.2 Land Use Classification and Accuracy Assessment

Modern Geoinformatics technique is mainly applied in supervised and unsupervised methods of classification for land use/land cover. Supervised classification is the most widely applied method, as well as an accurate classification algorithm in comparison to the unsupervised method (Richards, 2013). Moreover, the maximum likelihood algorithm is considered to be one of the most acceptable classifiers. Hence, in the present study, the maximum likelihood algorithm was used along with the supervised classification.

Assessment of accuracy is very important in terms of accurateness of the land use/land cover map prepared based on satellite images. Considering the accuracy, it mainly expressed the degree of correctness of a classification map along with the statistical application. For this purpose, Google Earth images are used and field visits have been done for ground truthing and validation of the land use conversion statistics. A confusion matrix was used for classification accuracy where the producer's accuracy, user's accuracy, Overall accuracy, and Kappa accuracy were calculated using this matrix table. The overall accuracy is mainly calculated by dividing the total correctly classified pixels by the total number of pixels in the error matrix whereas Kappa co-efficient mainly determines the degree of agreement among the classified map and reference data. Overall accuracy was validated by the Kappa coefficient which falls from 0 to 1. If it is more than 0.80 strong acceptance of classification accuracy is found and less than 0.4 signifies poor quality of the same. The classified area from each map and class-wise percentage of area change were extracted from processed and classified images. These are calculated using the following formula:

Kappa Coefficient equation:

$$k = \frac{N\sum_{i=1}^{r} X_{ii} - \sum_{i=1}^{r}\left(x_{i+} * x_{+i}\right)}{N^2 - \sum_{i=1}^{r}(x_{i+} * x_{+i})}$$

Overall accuracy assessment:

$$\text{Overall accuracy} = \frac{\text{Total number of correct samples}}{\text{Total number of samples}} \times 100$$

1.10.3 Percentages

Percentages were used to make the simple comparison of different groups, and it was particularly useful when the sample size of different respondents was uneven.

1.10.4 Composite index score Technique

This technique has been used to determine the changes in socio-economic development in the study area. It presents a single value, which represents the value of the multiple variables. So, we can also tell that it is a comprehensive and multidimensional index. It is a simple average of all indicators. The value of the composite index extends from 0 to 1. In this study, we have taken many dimensions to make a composite index, such as cultivated land, net irrigated area, percentage of agricultural workers, percentage of marginal farmers, percentage of salaried Govt. and private job to the total main workers, literacy rate, percentage of above poverty level, percentage of households having facilities from health care centre, water supply facilities, electricity facilities and transport facilities to show the level of development.
To classify the C.D. Block according to the development of socio-economic aspects composite index score was divided into three classes that are high, medium, and low.

1.10.5 Cartographic techniques

Various cartographical techniques like pie, bar diagrams, graphs, etc. are applied in this study. In the bar diagram columns/bars are proportional in length to the quantities they represent. In the pie diagram, the section of the circle is proportional in size to the quantity it represents. Relevant maps for the present study are prepared by Esri Arc GIS 10.3 software.

1.11 Limitations of the study

Municipal areas of the Hugli district have not been included in this study. During the period of this study, the researcher faced some basic complications, some of which are mentioned below-

i) During the households' survey, several problems appeared in case of the absence of a household head at the time of the survey, apathy in sharing their details such as monthly income, amount of farmland, source of income, etc. to strangers.
ii) Another difficulty confronted is the paucity of secondary data mainly Census based land use data after 2011. Therefore, the pattern of land use analysis has been carried out based on satellite data.
iii) Satellite data which is effective medium for research studies as the reality of the earth's surface is available for mapping and analysis in digital format could not be availed by the researcher many a time as per the need of the study. Apart from this,

numerous problems were being confronted during the image processing and analysis of the images because of the resolution of the satellite imagery.

However, the present research work has some limitations but this study will provide an idea about some unseen, unheard, and unspoken reality of the study region.

Chapter 2
Physical and Socio-Economic Aspects

Chapter 2

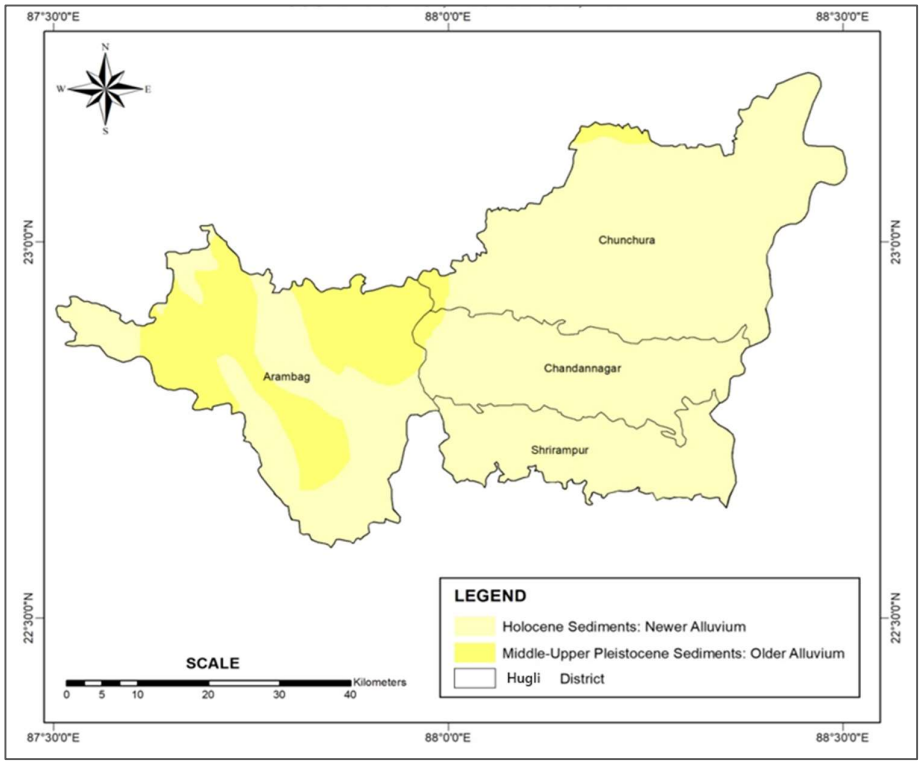
Physical and Socio-Economic Aspects

2.1 Physical Landscape

2.1.1 Geological Setup

Geologically, the area is located in the well-grounded shelf area of the western flank of the Bengal Basin and is entirely encrusted by alluvial formation. Sand is abundant in the river beds. Morphologically the coalescing of many alluvial fans forms a subsurface geological structure. The principal sedimentation of the area varies in age from the Cretaceous period to the Pleistocene epoch. The sedimentation in most of the area was deltaic in the last geological period and is fluvial at present as the deltaic stage has migrated southwards (Banerjee, 1972). Bagchi (1944) describes the area as a low-lying region characterized by swamps and unhealthy conditions extending up to the Hugli, which partakes of the nature of the deltaic region in some points. But it is considered more as Piedmont Plain.

Figure 2.1: Geological setup of the study area



Source: Geological Survey of India, Kolkata, 2001.

Moreover, this western tract is not included within the distributaries of any river. Hence, judging by the structure, hydrograph, origin, and landform, this region is excluded within the present detain region of Bengal'' However, Spate (1954) and Banerjee (1964) viewed the Hugli District as made up of two geomorphologic units, a high old deltaic plain to the west (Arambagh subdivision) and the remaining a dead delta (Chinsurh, Chandannagar and Srerampore Subdivision).

2.1.2 Physiographic Setting

The district is even and alluvial in formation. But with a gradual ascent towards the northwest and north, where it borders Burdwan. In the river beds sand and sandy chars are common, the sand being brought down from the uplands during floods and deposited wherever the stream is obstructed. The district is broadly classified into two main natural divisions, The Plain land and The Upland. With the river Darakeswar forms the dividing line between the two. The flat alluvial plains may again be subdivided into three regions, namely

i) The Darakeswar-Damoder inter-riverine plain (lowland)

ii) The Damoder – Bhagirathi inter-riverine plain and

iii) The Char lands (Banerjee, 1972)

However, the human intervention in building railways and roadways flood control measures has changed the region's topography.

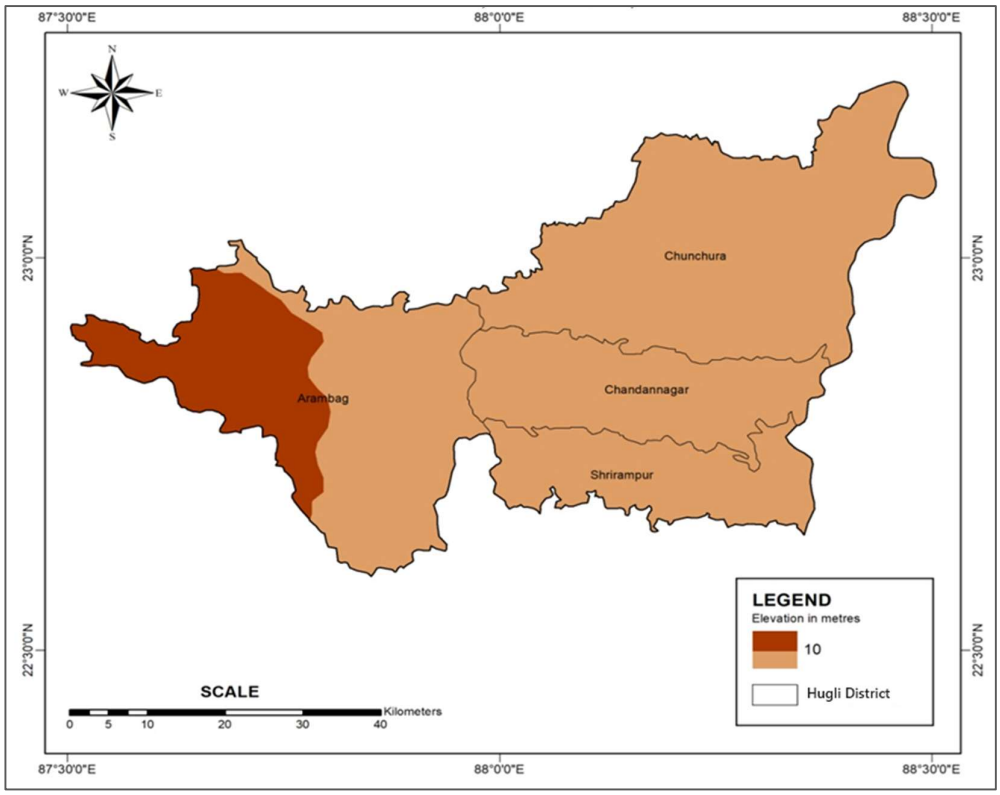
i) The Upland:- The upland is altogether comprised of thana Goghat, which has an area of 146 sq miles or less than one-eighth of the district, geologically alluvial in formation. The parts of the Goghat thana consist of low laterite fringe of the Bankura uplands or alluvium intermingled with laterite debris, and teracious clay or ghutting 10' to 30' thick is apparent here. The country inland has been formed by Damoder silt deposits which are loamy, easily percolated and fecund.

ii) The Darakeswar-Damoder inter-riverine plain (lowland):- Inland, between the Darakeswar and Damoder there is a tract of low-lying land which unless protected by embankments, is more or less liable to constant floods, as the peripheral rivers with their connected streams are steadily elevating raising their beds by annual deposits of silt and sand. In the rains, this tract becomes an envelope of water, from which the village sites stand out like Small Islands.

iii) The Damoder – Bhagirathi inter-riverine plain: - (Eastern part of Hugli District) In the tract encircled by the Hooghly and the Damoder, the rivers are restrained by embankments, and the level of country being somewhat higher, the crops are fairly secure against floods. These areas can broadly bifurcate into two sections which include the high riparian strips of land along the banks of the river and the saucer- shaped depressions between them. Another oddity is that most of the small streams have more or less silted up and no evident outfall.

iv) The Char lands: - The residue of the district presents several varieties of deltaic formations. First, the great rivers are busy chucking out chars year after year, a process of land formation which is noticed in the Hugli. Its deep stream is perennially varying its course, now swinging to the left and now to the right, severing the bank on one side and rebuilding it on the other, and all the while forming islands of banks on the sides or in the middle of its bed. The large bend between Guptipara and Sukhsagar, or at its confluence with the Kunti at Nayasarai, numerous chars have been ejected up, and the deep mid-stream is frequently altering and incidentally furnishing a fruitful source.

Figure 2.2: Physiography of the study area



Source: Based on Topographical map, Survey of India (2009).

2.1.3 Drainage Network

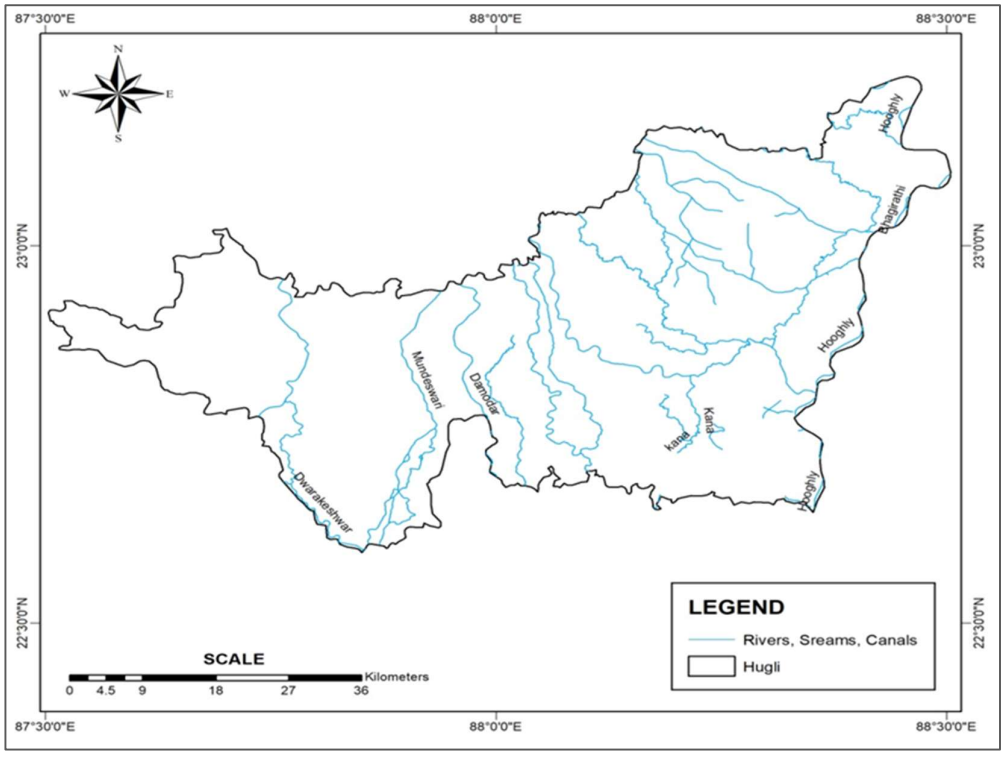
The redistribution of atmospheric precipitation takes place through the drainage network of a region which not only determines the surface water but also influences the position of the ground water table. The drainage of Hugli is nurtured by several principal rivers providing a key to its geography, regional economy, and Socio-cultural pattern. Thus, the district of Hugli can be said to be mainly the product of its rivers and is still watered, and drained.

The large river: - The large rivers are four in number, viz, the Hooghly, the Damoder, the Darakeswar, and the Rupnarayan.

The smaller streams: - Those are fairly numerous and from the main drainage channels of the district. Among them there are Behula,KanaNadi,Kuntinadi , the Saraswati , the Koushiki , Amoder , Kakinadi , Jhumjhumi , Ghiya nadi to mention a few.

Khals: - Among khals of the district, Dev khal, Sankari khal, Tarajali khal, Benia khal, Baidyabati khal, Bali Khal, Harinkhali khal, Kanaria khal, Kana Darakeswar khal, Kedermati Khal etc are worth mentioning.

Figure 2.3: Major Drainage System of the study area



Source: Based on Topographical map, Survey of India (2009).

2.1.4 Climatic Condition

A harsh summer, profuse rain and high humidity all through the year, are the main characteristic of the climate of the district. The hot season begins with strong westerly winds from the middle of March and continues up to the middle of May. Thunder storm commonly occurs in the afternoon in association with heavy rains with hails. The *Kalbaisakhi* or the Nor–wester storms are often violent and cause sharp drop in temperature (census of India - 2011). The district experiences the cold spell from middle of November to February followed by the hot spell from March to May. The span of June to September ushers in the South-West monsoon whereas October and the first half of November constitute the post-monsoon period.

Temperature: -The average minimum temperature varies from 15°C to 20°C and max temperature varies from 28°C to 35°C. The lowest temperature does not generally fall below 10°C. The day mercury reaches in maximum in April or May, when the mean maximum temperature is about 36°C and the mean minimum is about 24°C. With the onset of the Southwest monsoon by about the 1st week of June, there is an appreciable drop in day temperature. The monsoon ceases in early October and the temperature begins to fall rapidly from about the middle of November. January is the coldest month with minimum temperature ranging between 12°C to 13°C and the daily maximum around 25°C.

Rainfall: - The average annual rainfall of the district varies from 1200mm to 1700m. It is apparent from the normal pattern of rainfall distribution that rainfall is not equally distributed throughout the year. It is mainly concentrated between June and September. July and August experience 46.88% of the total rainfall in a year where the months from June to September account for 77.80% of the total. The period from Nov to April on the other hand is the season of the dry North East monsoon. The time of arrival of monsoon lies between 5th and 10th of June and the time of withdrawal lies between the 1st and 15th October with August being the rainiest month. On average the district experiences 75 rainy days in a year.

Humidity: - Subtropical humid climate prevails in this district and humidity is a major concern as far as infestation of pest disease is concerned on agricultural crops. In winter humidity decreases from South to North and East to West and on average the variation in relative humidity is lesser than in summer.

Sunshine and Cloudiness: - The duration of actual hours of bright sunshine increases gradually from 8.6 in January to 9.3 in April. This actual trend is much dependent on the character of the monsoon and associated cloud formation. The sky is moderately clouded in May. The Nor-wresters are, however, associated with cumulous and cumulo-nimbus. During the monsoon the sky is generally overcast mainly with stratus, strato-cumulous, alto-stratus and nimbo-stratus cloud. Cloudiness dwindles gradually from October when only stratus, strato-cumulous, and alto-stratus cloud remain and in winter and spring the afternoon sky is lightly clouded.

2.1.5 Soil

Land use of any region is the resultant product of its geological base. The nature of soil totally relies on parent materials which control the physical and chemical properties of soil and this variation of soil characteristics has a great impact on land use. The types of soil constituted this district viz.

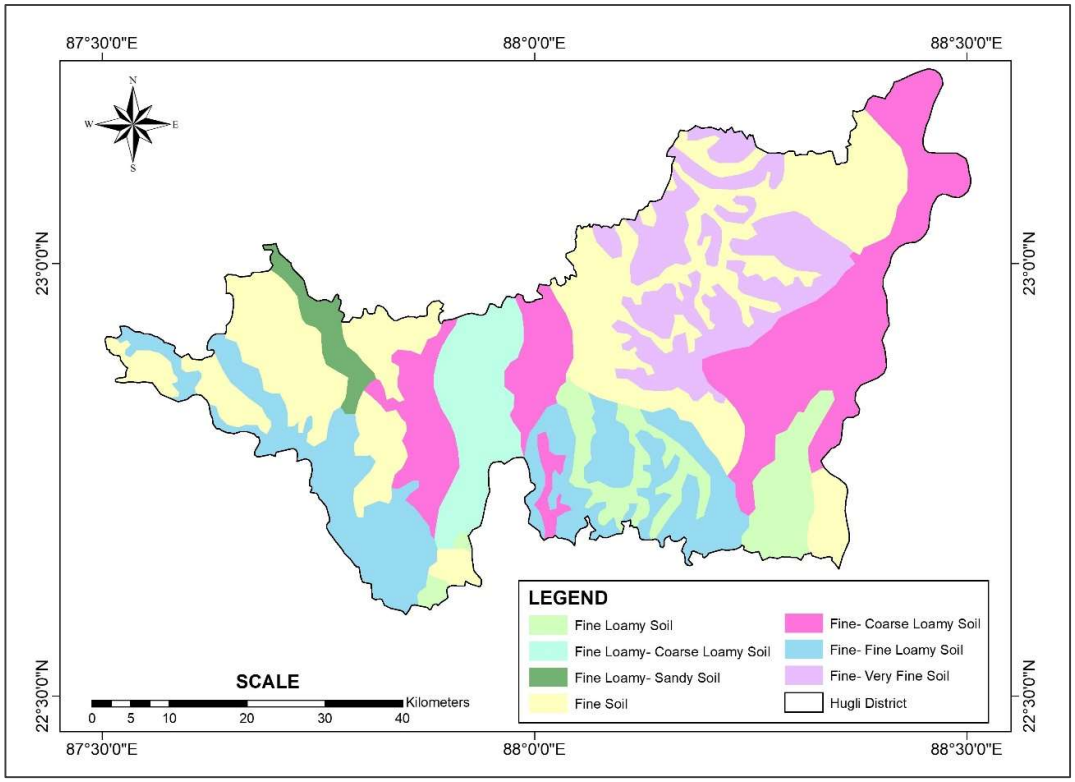
i) Gangetic Alluvial soil: - This soil belt comprises an area of 59,150 hectors and is rich in calcium. Fertile soil with high available potash and medium nitrogen covers area 32.0% and 48% cultivated part of the total area respectively.

ii) Vindhyan Alluvial soil: - This soil covers an area of 2, 48,950 hector and is less fertile than Gangetic Alluvial soil. The soil is rich in nitrogen with availability of phosphate and potash in moderate range. The soil is slightly in acidic.

iii) Red soil: - This soil is found in North western part of Goghat P.S. And actually covers 68000 hectors of land. Red soil is mainly infertile, acidic and low in organic carbon, calcium and available phosphate and potash.

The soil sedimentation of the Hooghly and the Saraswati are clayey, rather stiff, not easily permeated by water, and hence hard to plough; while the silt of the Damoder is loamy, easily percolated, and is therefore, more friable. The tract further west consists of loamy alluvium with a subsoil of tenacious clay and gutting, 10 to 30 feet thick, beneath which are found green sand and other alluvial deposits. The greater part of the Goghat Thana is rocky, consisting of the low laterite fringe of the Bankura or of alluvium mixed with laterite debris. The only minerals extracted are laterite and kankar in thana Goghat and fine sand in Kana Nadi, Mogra. Limestone is said to be found along the border of the Midnapur district. Clay soil persists in 8% area and clay loam in 12.0% area of the total tilth.

Figure 2.4: Soil Map of the study area



Source: NBSS & LUP Regional Centre, Kolkata.

2.1.6 Natural Vegetation

There are no forests in the district, but patches of scrub jungle in Thana Goghat. The vegetation is, on the whole, however, somewhat sparse, lacking both the gigantic trees of the uplands and the luxuriant undergrowth of the lowlands. The tract between the Damoder and the Hooghly contains the plants generally found in lower Bengal, both cultivated and wild which include reeds, sedges and aquatic plants in the marshes and swampy rice fields; followed by weeds, shrubs and smaller plants in the fields and commons a little higher up. Lastly encompasses the area, a belt of bamboos, coconuts, palms, mangoes, figs, jack and other trees. The river banks, where not occupied by houses, ghats or roads, are found with bamboos, figs, tamarisks and date- palms with thick undergrowth. The chars, being usually sandy, have fewer trees; but where covered with silt, grow excellent Rabi crops, and if slightly raised rice crops. Inland, the tanks and stagnant pools are wrapped with lotuses, lilies panas, both large and small, and other aquatic varieties.

2.2 Socio-Economic Landscape

2.2.1 Population

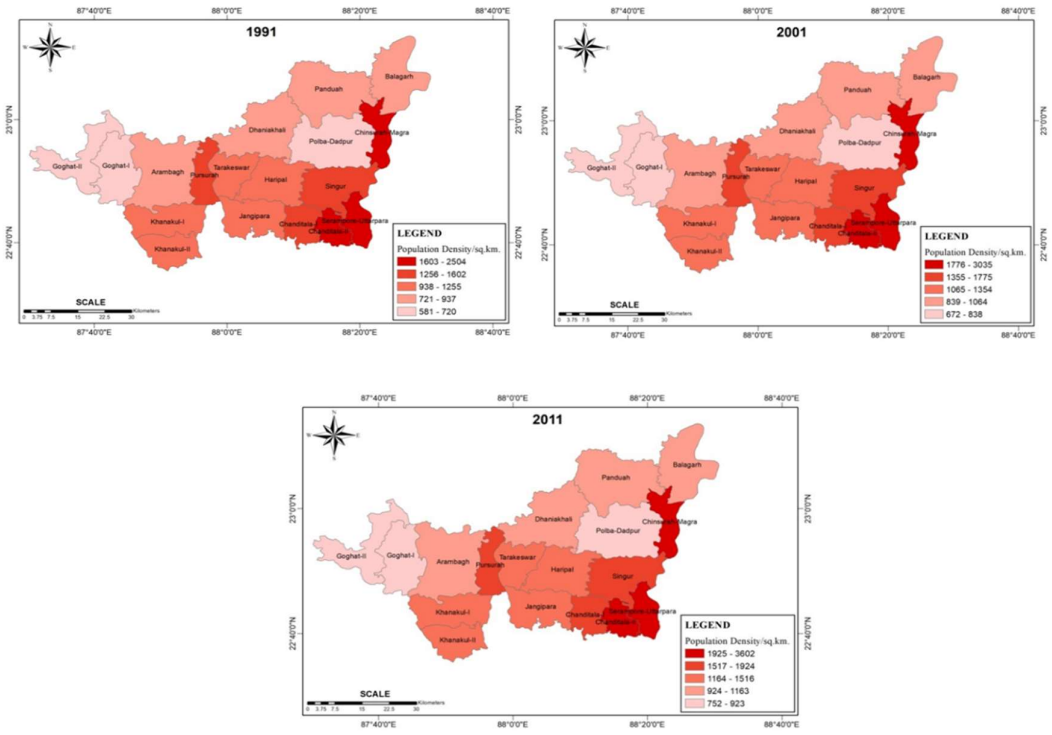
Hugli district shares only 3.55% of the geographical area of the state whereas its share in population is well over 6.29% of the state population. There is a total of 1866 villages and 64 census towns with 5519145 total inhabitants' population density of 1753 (according to 2011 census). The percentage of the male population here is 51.00 and the female is 49.00. 61.43% population is rural and 38.57% population is in urban. There are 14 villages having population of 10,000 and above. Bara Kamalpur (Singur C.D. block) is the most populous village in the district with a population of 20,047. Hugli is one of the major districts in West Bengal and ranks 6th in terms of population. The decadal growth rate is 15.77% in this district. 23.6% of the total population belongs to the SC category and 4.2% under ST category. However, it is to be noted that minorities, SC and ST population together constitute around 43% of total population (according to 2011 census).

Population density means the ratio between the size of the population and the area. It is defined as the number of human beings with the amount of land directly connected to environmental and economic opportunities (Roy, 1982). It has a very high population density of 1753 persons per sq km as compared to West Bengal, which has 1029 persons per sq km. In terms of density of Population, the district ranks 4th, next to Kolkata, Howrah and North 24 Parganas. The existence of both agricultural and industrial activities thriving side by side is the main reason for high population density. A major portion of this population is the result of migration. The density of population in the study area was 1601 persons per square kilometer in 2001 which was 1383 persons per square kilometer in 1991 (Table No. 2.1 in Appendix-A).

In 1991, due to migration, Industrialization and the effect of urbanization, population density suddenly increased by 249 people per square km. In this period population density was 1263 persons per square km. In total 18 C.D. blocks of the district, eleven (11) C.D. blocks overlapped the population density in 1000. Three (3) C.D. blocks, namely Serampore-uttarpara (2200), Chinsurh-Mogra (2228), Chanditala-II (2504) have exceeded 2000, density of population per square km. Chanditala-II has had the highest population density since 1991 due to proximity of Dankuni metropolis, residentially more attractive. Low population density was shown in Dhaniakhali, Panduah, Balagarh, Polba-Dadpur

Haripal, and Arambagh C.D. block respectively. Two C.D. blocks of Arambagh Sub-division, namely Goghat-I, and Goghat-II have noticed very low population density.

Figure 2.5: Population Density in Hugli District (1991 to 2011)



Source: Census of India 1991, 2001 and 2011[1].

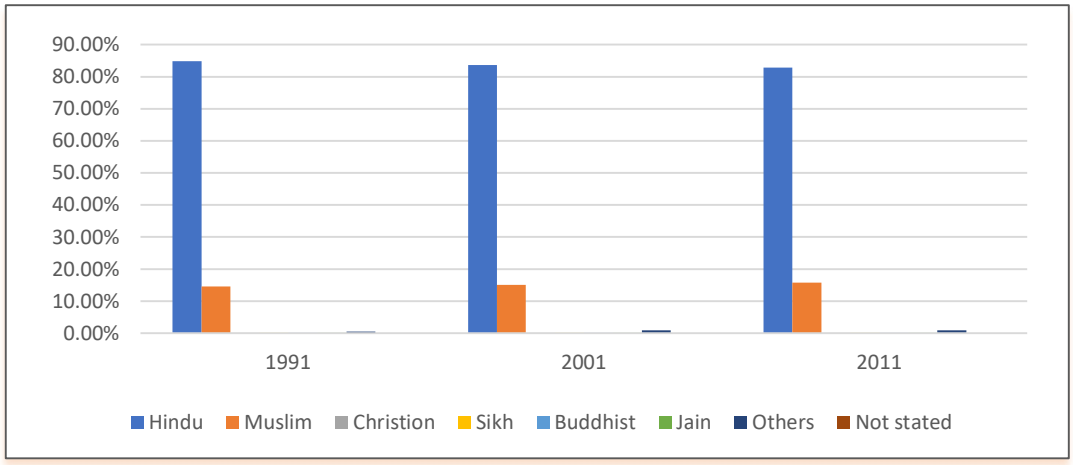
The pattern of changes in population density in 2001 and 2011 is almost the same. However, density of population was not uniform throughout the district. Population density was 1454, which was 1263 in 1981. In 2011 population density was 1646, which was 1454 in 2001. The average has increased by 191 people. Almost fifteen (15) C.D. blocks crossed 1000 population density in 2001 and 2011.Chanditala – II C.D. block has had the highest population density since 1951, it is 3602 per square km in 2011, due to various infrastructural facilities and irrigation facilities of canals and development of the Dankuni metropolis. This area connected with Kolkata through Durgapur Expressway and Delhi Road. The other two C.D. blocks Serampore-Uttarpara and Chinsurh-Mogra, where population density was 3399 and 3018 in 2011. Population density is very high due to concentration of trading and industrial activities. Serampore is an industrial hub. Recent

[1] For details, please see Appendix-A (Table No. 2.2)

days many large-scale units have become weak and entire area (more than 200 acres) has been transferred for developing Flat and Housing Complex. Chinsurh-Mogra is district headquarter. Extensive urbanization has taken place here. C.D. blocks with medium density (1700/per sq km-1300/sq km) are Pursurah, Khanakul-I, Khanakul-II, Chanditala-I, Singur, Tarakeswar, Haripal, Jangipara.These C.D. blocks are developed with agro-economy. Low population density noticed in Dhaniakhali, Panduah, Balagarh, Polba-Dadpur and Arambagh. Very low population density (below 900/sq km) noticed in two C.D. blocks of Arambagh subdivision, namely Goghat-I and Goghat-II. Because of infertile soil, drought, flood, lack of infrastructural facilities.

The percentage of Hindu, Muslim, Christian and others inhabiting Hugli is respectively 84.88, 14.52, 0.05 and 0.04 respectively followed by in 1991 and 83.63, 15.14, 0.09 and 1.08 in 2001. In the year 2011, this % had become 82.89, 15.77, 0.13 and 1.21 respectively. It can be observed that Hindu population declined by 1.99 % during 1991-2011 whereas Muslim population increased by 1.27% during the two decades (Table No. 2.3 in Appendix-A).

Figure 2.6: Religion-wise population in Hugli District (1991, 2001 and 2011)



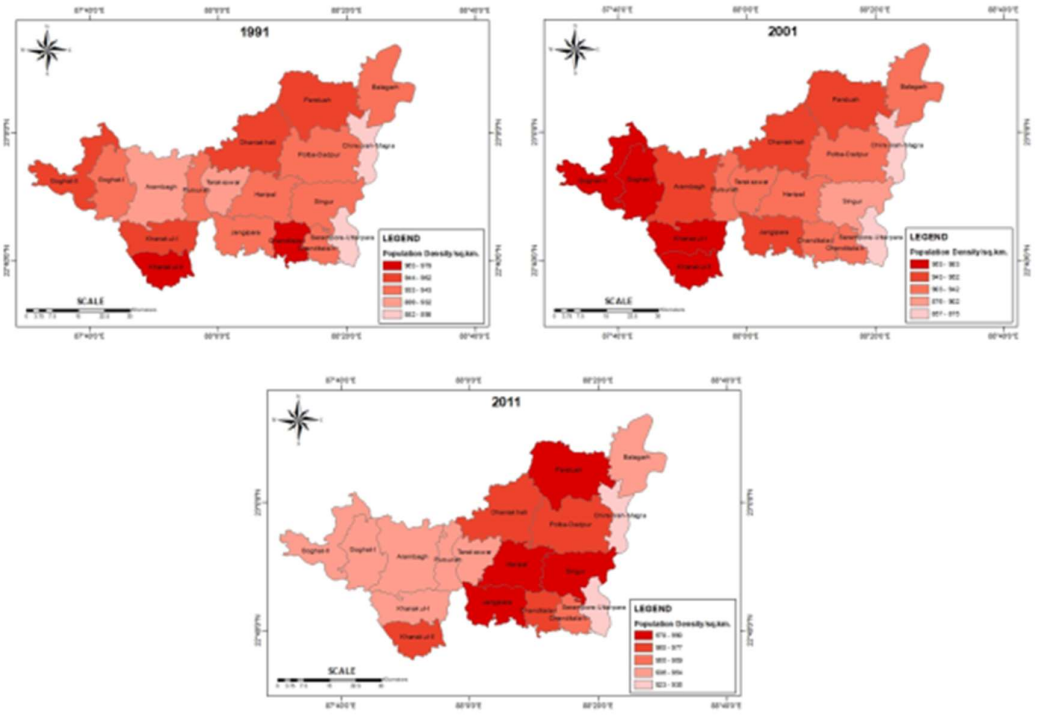
Source: Census of India, 1991, 2001 and 2011[2].

As per the 2011 census, 61.43 % of population of this district lives in rural areas. The total Hugli District population, living in rural areas is 3,390,646 out of which males and females are 17, 22,945 and 16, 67,101 respectively. In rural areas of the district, sex ratio is 968 females per 1000 males which fluctuated in a different decadal year. The sex ratio has been steadily declining since 1901, and by 1951 it had dropped to a low of 883 but after

[2] For details, please see Appendix-A (Table No. 2.3)

that, the growth graph has gone higher. In 2001 the sex ratio of the Hugli district was 947 and then in 2011 it increased to 961 which means the sex ratio of the study area has increased by 14 females per 1000 males from 2001 to 2011.The sex ratio growth rate was highest during the period 2001-2011. In 1991, maximum sex ratio (above 950) was observed in eleven C.D. blocks of the district. Moderate sex ratio was noticed in Khanakul-II, Goghat-II, Chanditala –I, Pursurah and Serampore – Uttarpara and Chinsurh-Mogra were observed low sex ratio. In the year 2011, it was observed that there was no C.D. block in the low sex ratio (below 900) zone. Only 4 C.D. blocks, namely Goghat-II, Serampore-Uttarpara, Chinsurh-Mogra and Balagarh had a moderate sex ratio (900-950) while the rest of the 14 C.D. blocks had a high sex ratio.

Figure 2.7: Sex ratio of the study area (1991 to 2011)



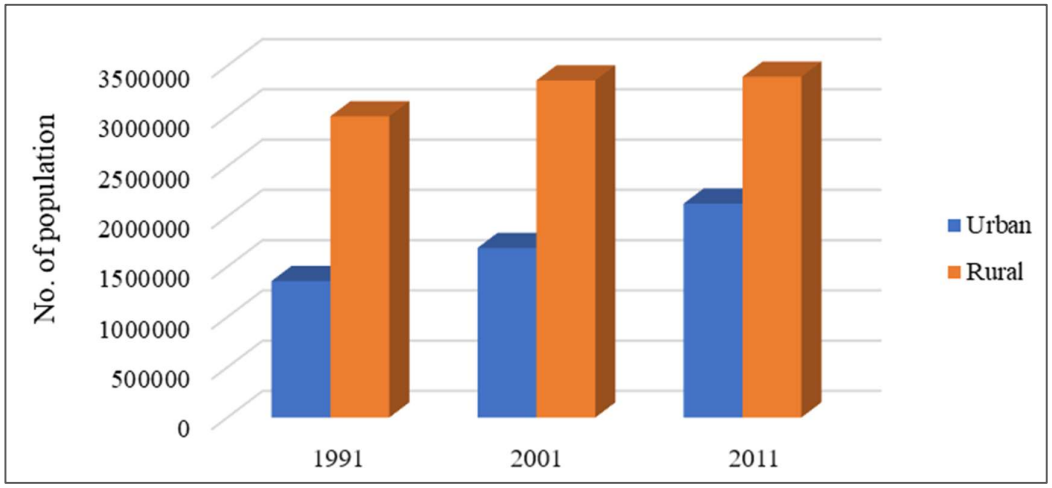
Source: Census of India 1991, 2001 and 2011[3].

The percentage of rural population slowly decreased from 1901 to 2001. From 2001 to 2011, the percentage of rural people dropped by 5.1% in one fell swoop due to rapid industrialization as well as urbanization. In 2011 percentage of rural population was 61.43, which was 66.53 in 2001. The inconsistency between rural and urban population in the

[3] For details, please see Appendix-A (Table No. 2.4)

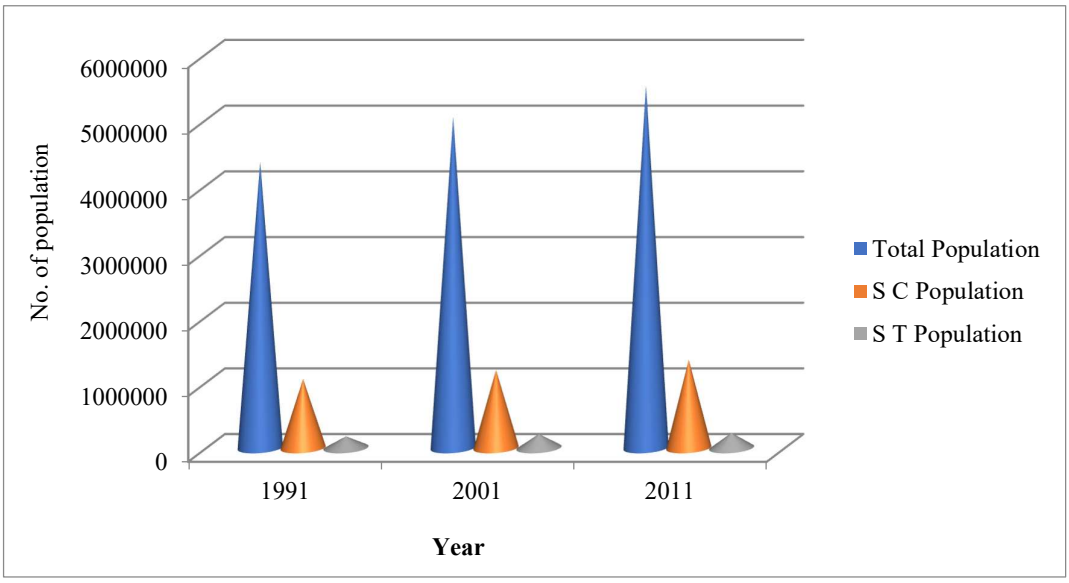
district rose to its peak in 1991 with 26.83% rural and 16.07% urban population whereas it was only 16.38% rural and 16.06% urban in 2001.

Figure 2.8: Decadal growth of Urban and Rural Population in the District Hugli (1991-2011)



Source: Statistical Handbook, 2012[4].

Figure 2.9: Decadal variation of Scheduled Caste and Scheduled Tribe Population (1991-2011)



Source: Census of India[5].

[4] For details, please see Appendix-A (Table No. 2.5)
[5] For details, please see Appendix-A (Table No. 2.6)

Figure 2.9 shows the distribution of Scheduled caste and Scheduled Tribe population in Hugli District since 1991. It is observed that absolute population of Scheduled Caste population is gradually increasing over the decades. The growth rate of Scheduled Caste population was increased by 13.2% in 1991-2001 and 2001-2011, it was 13.0%. This is true in rural areas but in urban area does not follow any specific trend. The decennial growth rate of Scheduled Tribe population followed a decreasing trend. In 1991, the SC population of the district was 24.11% and ST population of the district was 4.05%. A decade after (2001), SC population percentage (23.57%) slightly decreased but ST population (4.20%) increased a bit. In the year 2011, the SC population increased but ST population remained the same. The scheduled caste population is overwhelmingly rural (26.32%) than urban (19.15%) in 2011.

2.2.2 Literacy Rate

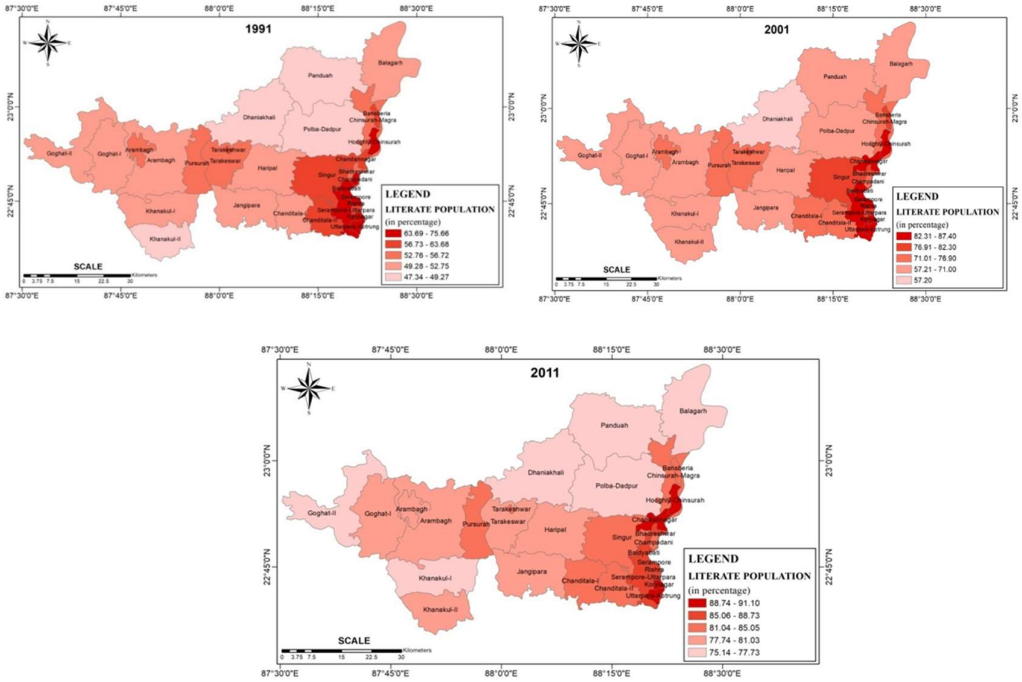
Continuing with the demographic profile, one very vital feature is the literacy. Hugli is known to be one District where historically education is the part of social culture. Each and every mouza of the district has one or more than one Primary School. Thus, the basic is imparted to the children, which in the long run is reflected in the literacy of the district (Report of the District agricultural plan, Hugli).

Gender disparity in literacy has been done away with significantly in the district. There are substantial differences among socio-religious groups in terms of schooling and dropping out, though literacy rates are quite similar across these groups. Scheduled Tribes and Muslims seem to be lagging behind (Human Development Report-2011).

Total literacy rate of Hugli District is 82.55%. This means 82.55 out of 100 persons of age more than 6 years are literate. It is ranked 5th in terms of literacy rate out of total 19 district of West Bengal. Male literacy of Hugli is 87.93% while female literacy stands for 76.95%. In Hugli, Polba-Dadpur has the least literacy rate (75.14%). There are about 4298 schools in Hugli District, out of them, Serampore – Uttarpara is on top with 809 schools where as Jangipara has least number with only 8 schools. Total 27,258 teachers are there in Hugli District, with 16,410 male and 10,848 female teachers. Total no of enrolled students is 60, 5861 out of which 50% boys and 50% girls. Out of total 60,5861students, 33% students are belonging to Scheduled Caste, 6% students belong to Scheduled Tribe, 7% students belong to other backward class respectively.

In 1991 the growth rate of literacy was about 8.69% which is the same as in the previous decade. Though urban literacy rate was 67%, low urban literacy rate was shown in Arambagh, Chandannagar and Bhadraswar Municipality areas. Among the urban areas different literacy rates can also be noticed. Cultural background, composition, size and function contribute to this variation. In C.D. block level, the highest literacy rate can be observed in Serampore-Uttarpara, where Missionary education spread. Khanakul-II, Polba-Dadpur, Panduah, Dhaniakhali C.D. blocks are lagging in terms of literacy.

Figure 2.10: Literacy rate of the study area (1991 to 2011)



Source: Census of India, 1991, 2001 and 2011[6].

In the year 2001, due to an extensive spread in the field of education, the literacy rate increased by 17% in one fell swoop. The good effects of adult education can be noticed. 82.58% literacy rate was recorded in urban centers. While around 72 % rural people were considered as literate. Significant improvement was observed in Serampore, Chandannagar, Uttarpara-Kotrang, Konnagar area.

The growth rate of literacy persisted in 2011. The average literacy rate reaches 83%. The impact of the Sarva Shiksha Mission has led to widespread expansion and development in the field of primary education. The literacy rate in Konnagar and Uttarpara-Kotrang

[6] For details, please see Appendix-A (Table No. 2.7)

Municipality is whopping 91%. There is a difference of about 7% in the literacy rate in rural and urban areas during this time.

2.2.3 Civic Amenities

2.2.3.1 Education

Education is one of the key components of social development. It is the mirror of the culture, dignity and personality which are reflected in the society. Due to early European settlement, this part of the state came in touch with the modern educational system way back in the 15th century. Historically education is the part of the social culture. The efforts of the Govt of West Bengal and the successful implementation of centrally sponsored schemes in spreading of education in the district have brought significant achievement in attaining the target of Millennium development Goals. Still around 20 percent of population of the district is illiterate.

From the Table No. 2.8 in Appendix-A, it is seen that the number of primary schools in the study area was 2933 in 1991, 3028 in 2008 and 3013 in 2014. There were 203 middle schools, 321 high schools, 115 higher Secondary schools, 21 colleges and universities, 16 special non formal schools and 5 technical colleges in 1992.But the educational structure of the Study area was decorated by 152 middle schools, 292 High Schools, 359 Higher Secondary Schools 33 Colleges and Universities, 6885 Non formal Schools and 19 Technical Schools, 19 Technical Colleges in 2014. So, it is evident that the numbers of educational institution are increasing in order to spread the education in all over the district. Middle schools are converted into High School and some High Schools are converted into Higher Secondary Schools. Enrollment ratio is far superior in the Study area showing almost full (100%) enrolment in the primary stages, and 98.5% in the middle stages. Enrolment ratio is high in Municipal areas. For the district, the Drop Out rate is 7.2%, which is much better than the national rate 40.3% in primary level. Completion rates (CR) in the district is 92.7 percent for the school stage and overall completion rate of the girls (94.8%) is higher than the boys (90.4%).

There is a disparity in the distribution of Primary School in different C.D. blocks. It is highest in Dhaniakhali C.D. block (199) and followed by Khanakul-I, Haripal, Panduah and Arambagh C.D. block, but only 63 in Goghat I C.D. block. No of primary schools are less than 100 in Chinsurh-Mogra, Chanditala-I, Serampore-Uttarpara, Tarakeswar,

Chanditala II and Pursurah C.D. block. Maximum increase in primary School has taken place in Chinsurh-Mogra C.D. block.

The progress in higher secondary education has been quite satisfactory. A remarkable change in Higher education in C.D. block level is found in the period is between 2001 to 2011. Several higher secondary schools and colleges have been set up during this decade. Some high schools are converted into higher secondary school. Total no of 100 higher secondary schools has increased in that period, e.g., 9 in Khanakul, 9 in Arambagh, 8 in Haripal and 8 in Jangipara. Besides there are 15-degree colleges in this district.

2.2.3.2 Health facilities

According to David Byrne, Good health is a state of physical and mental wellbeing necessary to live a meaningful, pleasant and productive life. Attaining good health for all implies promoting health care services, preventing disease and helping people making healthy choice. Health care is a social determinant as it is influenced by social policies. In the last few decades, the district of Hugli has achieved a considerable progress in providing access to healthcare service to the people. After independence, the health infrastructure of the district has expanded manifold, but the physical health infrastructures are inadequate to extend quality health services to the people of the district. The major type of diseases that have been identified are Respiratory problem, Water borne Disease (Diarrhoea, Malaria), disease out of mosquito bite (Malaria, Dengue, Kala-jar, Chikungunya), other including cardiac disease , nerve problem etc. .Almost every year the district is affected by flood in major areas of Khanakul –I and II, Arambagh, Goghat – I and II, Tarakeswar and some pockets of Balagarh C.D. block which area are cut- off from road communication and are vulnerable and prone to diarrhea and other water borne diseases. The health services are inaccessible during the period of flood. Balagarh C.D. block has an Arsenic prone area in Chandrahati and Dumurdaha Gram Panchayat. Dengue and Chikungunya affected areas are Serampore municipality, Singur, Chanditala-I, Chanditala-II, Polba, Chinsurh Municipality and Khanakul-I. National Leprosy Elimination Programme (NLEP) is effectively in operation in the district. After the implementation of that programme, the caseload of leprosy has declined in the district significantly. It is very alarming to note that, in this district HIV positive cases were also identified. In Hugli district, the life expectancy of people for the period 2005-2009 is estimated as 69.88 years (68.68 years for males and 71.19 years for females) which is

reasonably high compared to the state average of 68.2 years for males and 70.9 years for female during 2006-10 (Human Development Report, 2008).

In the study area, there were 6 hospitals, 8 rural hospitals, 10 C.D. block primary health centers, 60 primary health centers, 187 NGO or private bodies nursing home, and the total no of medical institution were 271 during the year 2014-15. The medical institution s was equipped with 4732 beds with 306 doctors (Table No. 2.10 and 2.11 in Appendix-A). Besides this, the district is also furnished with 49 family welfare centers in which the number of public family welfare are 46 and the number of private family welfare centers are 3 and no of sub center are 660. In 2014-15, about patients were treated in hospitals, health centers and sub centers, in which the numbers of indoor patients were 312025 and number of outdoor patients was 5932078 respectively. There are many private nursing homes in the study area, mainly in Municipal areas.

The study area has achieved a considerable success in health service but there is substantial variation in the availability of public health care facilities in rural –urban area and various C.D. blocks of the district. The people located in rural areas continue to be the most disadvantaged in terms of access to public health care facilities. The inadequate public health care services in rural areas compelled the people to choose alternative service providers, unqualified medical practitioners. Thus, the public health infrastructures have to be made stronger in the district to protect and promote the general health of the people of the district.

2.2.3.3 Electrification

Electricity is a life stream of a socio-economic development since it improves the quality of our social life. Proportion of electrification is a good herald of industrial infrastructure in any area. In rural areas, electricity is used for irrigation purpose in agriculture sector. In the study area, the development of electricity plays a vital role in irrigation system. It operates shallow and deep tubewells playing a vital role in exploiting ground water resource. Nowadays, the expansion of small-scale industries is linked with the gradual extension of electricity to the interior villages. More rice mills, cold storages, bricks and tiles manufacturing units, factories for production of agriculture implements and the like are expected to grow in number with better distribution of energy (District Gazetteers Hugli, P.318, 1972).

The main power provider of the district is, the Bandel Thermal Power Plant with an installed capacity of about 450 – megawatt. This power plant unit served the areas are, Serampore, Sheoraphuli, Uttarpara, Baidyabati, Mankundu, Bhadraswar and some part of Risra. Damoder Valley Corporation (DVC) under the state Electricity Board is another power provider of the district. Areas of Haripal and Singur Thana are electrified by DVC. The Singur-Haripal Electric Supply Ltd which is another power provider of the district controls the distribution of power in the Dhaniakhali and its surroundings areas. West Bengal State Electricity Board generates power most of the area in the district. These agencies supply power to the district for railway electrification, industrial consumption and also domestic purpose.

2.2.3.4 Drinking Water Facilities

Water is an indispensable aspect of human life. Supply of fresh uncontaminated drinking water is an important factor of any development area. For drinking water the inhabitants of the district are depend on drinking water supply from municipality, Deep Tubewell, covered and uncovered Well, Tank, Pond, Lake, Hand pump, Sajal Dhara and other sources. Majority of the people of the study area depend on the hand pump (43.68%). Rural inhabitants (60.72%) of the study area are dependent on hand pump for their drinking water. People of Balagarh, Chanditala-I and Khanakul C.D. blocks use hand pump the most. 34.86% people use Tap water for drinking purpose among which 65% tap water users live in cities.19.63% people use tube well for drinking water and the People of Haripal C.D. block top the list of tubewell users. Few people use river, canal, tank, pond, lake water.

2.2.4 Transport and Communication

Transport plays a pivotal role in the Socio-Economic growth. It enables communication, trade and other exchange between people and influences the economy of the district as well as land use pattern. In agricultural parts of the district, it plays a vital role to carry the seeds, manure, implements, fresh vegetable, fish, meat, milk to field or market. Good transport system attracts many agencies to set up their company along the riverside belt of the district which is an industrial belt. The district is well connected by means of communication. Road ways and Rail ways comprises the major components of transport in the Hugli District. Water ways are also included in the medium of transport in the district.

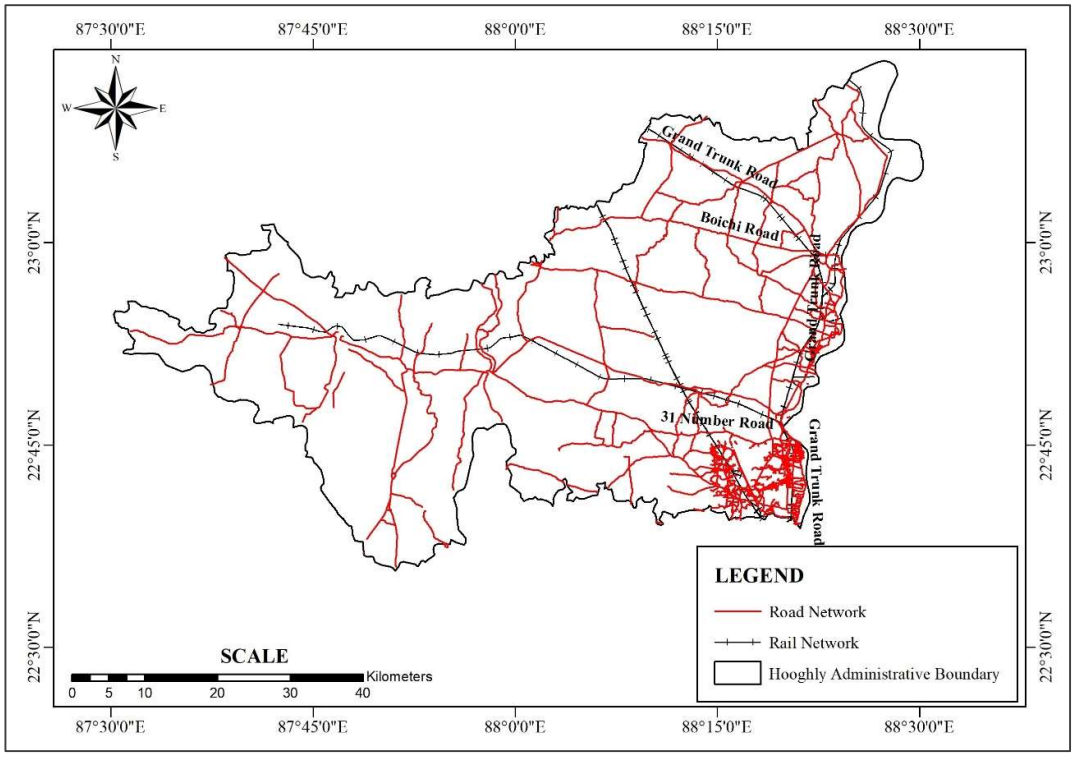
Grand Trunk Road is the most important road that passes by the river Bhagirathi covering Howrah to Burdwan via Hugli. The length of the road within the district is 55 km and it connects many other states with the district and Asansol, Durgapur, Burdwan, and Kolkata in west Bengal. Howrah, Burdwan, North 24 Parganas are connected with Hugli by this road. Several headquarters of the district are connected with Kolkata by this road. Another new road is Durgapur Expressway, runs through Hugli from southwest to northeast connected with Kolkata–Durgapur-Asansol. It is free from traffic jam. Arambagh road helps rural people to communicate urbanized area of the district. This route connected by its branch with Singur, Haripal, Tarakeswar, and Champadanga. The people of western part of the district communicate with eastern region by that means of transport. Old Banaras road is another important road in Serampore Subdivision which joint Champadanga, Jangipara, Mosat,Seahala, Chanditala-I and II C.D. blocks. Some other important roads are Tarakeswar Road, Arambagh-Tentulmari Road, Hajipur-Ramjibonpur Road, Mogra-Tribeni Road, Pandua-Kalna Road, Mogra-Polba Road etc.

Beside the National Highway and State Highway, People of Hugli district is also dependent on the P.W.D, Zilla Parishad and Gram Panchayet – Panchayet Samity Road. 850.2 km. road under Pradhan Mantri Gram Sadak Yojana in this district. Total length of the road (Surface and unsurfaced) was 11,175.08 km in the District Hugli in the year 2014. The length of the P.W.D road is 1039.28 km, which is the 9.30% of the total road in 2014.The East Indian Railway line from Howrah to Hugli was opened for passenger traffic on 15th August, 1854. It was extended to Pandua after few days. In 1885, the main line of East India Railway enters the district at Uttarpara, has a length of about 41 miles in the district with 19 stations. Two branches' lines, viz. from Sheoraphuli to Tarakeswar (22 miles) and from Bandel to Naihati (3 miles long) were opened in this period. The river Hugli is flowing along the right side of the district. It provides the transportation facility of the district. There are so many C.D. blocks in this district covered by waterways, Hooghly, Damoder and Darakeswar rivers connect the different C.D. blocks by waterways. The main routes of the ferry service in Hooghly River are Chinsurh – Naihati, Chandannagar – Jagaddal, Bhadreswar – Shyamnagar, Serampore – Barrackpore, etc.

The railway communication of the district, especially at the suburban area is very developed. There are mainly four railway routes which connect 69 stations of all over the Hugli district and this local railway network play an important role for transportation the fresh vegetable, fruits, milk to the market and to the processing area also. Bandel is the

railway headquarters of the district. Bandel is the largest and busiest rail way station of the district and a vital junction station in India. There are four junction stations of Hugli and they are; Bandel Junction, Dankuni Junction, Kamarkundu Junction and Seoraphuli Junction. Tarakeswar-Bishnupur new line project having a total length of 82.47 km, is a key project that can revolutionize the socio-economic condition of the western part of the district. In this section at present trains are running between Goghat and Tarakeswar.

Figure 2.11: Transport network of the study area



Source: Census of India, 2011.

2.2.5 Occupational Structure

Occupational structure is closely linked with the economic scenario of the district Hugli. Agriculture is the prime occupation of the people in this district; besides this, the inhabitants are also engaged in other occupations like household industry, manufacturing, construction, trade and commerce and transport communication are also present.

The Occupational structure of the study area (Table No. 2.12 in Appendix-A) reveals that out of the total workers agricultural labourers and household industry workers contributed the maximum followed by other workers in 1991. But in the Arambagh subdivision,

maximum workers were engaged in Cultivation and agricultural work with an average of 12% of people in agricultural activities in Arambagh subdivision whereas only 4.23 % of people engaged in this sector. In Serampore subdivision, 9.48% in Chandannagar and 7% in Chinsurah subdivision in 1991. Pursurah C.D. block under Arambagh subdivision had the maximum number of cultivators amounting to 13.60% and Serampore-Uttarpara C.D. block contributed the minimum amounting to 1.37% only. In case of agricultural activities, Dhaniakhali and Haripal C.D. block lead and it is minimum in Serampore C.D. block. Since Serampore is a industrial belt. So agricultural activity did not thrive there. Most of the inhabitants are engaged in other occupations there. An average of 16.50 % of people are engaged in other sectors in Serampore Subdivision. The percentage share of the household industrial workers is maximum in Jangipara (3.43%) and other workers are in Sreampore (25.05%), the lowest percentage in Serampore (0.26%) and Goghat–I (5.48%).

From Table No. 2.13 in Appendix-A, it is clear that two sub divisions, namely Sadar and Arambagh are depend upon Agriculture for occupation. In Serampore and Chandannagar Subdivisions the major share of population is other workers. Most cultivators are found in Goghat-I and Goghat-II C.D. block. Pandua and Polba-dadpur are two C.D. blocks where maximum people are agricultural labours. The major share of population in other works is shown in Serampore (86.3%) and chinsurah-Mogra C.D. block (80.0%). Fewer number of the population is engaged in Household Industry in the year 2001.

In 2011, it was observed that a maximum number of people were engaged in other works (Table No. 2.14 in Appendix-A). Hence, Arambagh subdivision and Sadar Subdivision, still now depend upon Agriculture sector. Average of 35.22% people working as agricultural labour in Arambagh C.D. block and 43.12% Sadar Subdivision. In Serampore subdivision maximum agricultural labour is seen in Jangipara C.D. block (34.77%). Most of the cultivators are present in Goghat–II (39.33%), an agrarian C.D. block in Arambagh subdivision. The lowest no of cultivators is present in Chinsurh- Mogra (3.73%) C.D. block. 14.86 % people were categorized in Household industry in Jangipara, and 3.79 % were included under the same occupation in Chinsurh-Mogra C.D. block. There were 89.08 and 84.11% of other workers in nature in Serampore and Goghat-II C.D. block respectively.

Participation of working population in an area denotes the economic sustainability of that region and the number of working population helps to move forward the economic

development. In 1991 participation rate was 31.43% which increased by 38.21% in the year 2001 and 39.59% in 2011 respectively. In 1991 Dhaniakhali (38.07%) and Polba-Dadpur (36.66%) provided the largest employment with its agro-based economy. Participation range is above 32% in Panduah, Balagarh, Tarakeswar, Haripal, and Jangipara. It was low in Chinsurh, Singur,Chanditala-I, Chanditala-II, Serampore, Pursurah, Khanakul-I, Khanakul-II, Arambagh. In the year 2001, there had been increase in the participation rate of working population, although the spatial pattern remains identical. Goghat–II recorded the highest figure (49.2%). During this period average participation rate changed from 31.43% – 38.21%. Goghat-I and Jangipara progressed significantly. There had been slight increase in the working force in 2011. Average participation rate being 39.59%. Proportion range was above 40.00% in Haripal, Jangipara, Polba-Dadpur, Balagarh, Pandua, Dhaniakhali. The rate of non-working population decreased from 68.53% to 61.78% in year 2001, and in 2011 it decreased by narrow margin. So, it is observed that the economic upliftment of the study region took place during this time.

Hugli is an important district in the tourist map of the west Bengal. Cultural tourism is an important means of income and employment opportunities in an around cultural tourist site. It motivates the young people by providing them with alternative economic and social-cultural benefits and educates and aware the local community including the most vulnerable section of the society regarding alternative economic benefits derivable from tourism.

Chapter 3
Land Use Pattern from 1991 to 2021

Chapter 3
Land Use Pattern from 1991 to 2021

3.1 Introduction

Land comprises the physical environment, including climate, relief, soil, hydrology, and vegetation, to the extent that these influence the potential for land use (Runtunuwu 2020). Land use is the outcome of scarcity of land which is the global context, and even when regarded per continent, has generally been relative. Some sort of land was sufficiently available whereas intrinsically fertile land producing sufficient fruits for human substance became scarce thousands of years ago in most continents for lack of systemic land use. Land use on earth's landscape primarily denotes the degree of human activity that reflects man's way of life. However, land use is governed by several other factors like soil, hydrologic, climatic, socioeconomic, and political matter.

Land use planning is the demarcation of land for specific uses, usually over an extensive area, based on environmental, social, and economic criteria, which takes into account present and possible future needs. Land use of an area chiefly hinges on the anthropogenic activities on the land which are of supreme importance to formulate developmental planning of that particular area. Land use planning is an activity for finding technically, ecologically, economically, and socially sound infrastructure of land (Jurgens, 1994). The need for such planning is to get optimum use of available land resources both in terms of economic and ecological purposes. It has become very much essential, especially after the gigantic enhancement of population pressure all over the country. The potentiality of land use planning also depends upon the geomorphologic nature of soil quality, drainage, climate, vegetation and other ecological and environmental attributes. Systemic assessment of such parameters is the pre-requisite condition for good planning. The growth of industry, commerce, and agriculture has not completely obliterated the traditional ways of life in modern societies. Spatial variation of socio-economic aspects exists with the variation in science and technology.

Land use means the purpose for which the land is utilized. Therefore, it means the 'activity of the land has been the major criterion for classifying land use' (Hirini, 1991, p.117). Land use of Hugli district is largely influenced by its extensive flat alluvial plain. Compatible monsoon climate, fertile soil along with economic and social factors like

irrigation, transport network, communication facility, early history of industrialization and urbanization, etc. exert great control over the use of its land. Compared to the western part of the district, the eastern part is more dynamic. This part of the district is comprised of agrarian as well as industrial zones. The land use pattern of this area is getting more important for its changing scenario due to the inheritable sprawling of urbanization followed by changing social and economic behavior of the people. The third chapter deals with the spatio-temporal analysis of the Land use pattern of Hugli District from 1991 to 2021 using remote sensing and GIS technique.

3.2 Land Use Classification (1991 -2021)

Land use analysis of the present study is discussed from the two following viewpoints by utilizing two different sources of information.

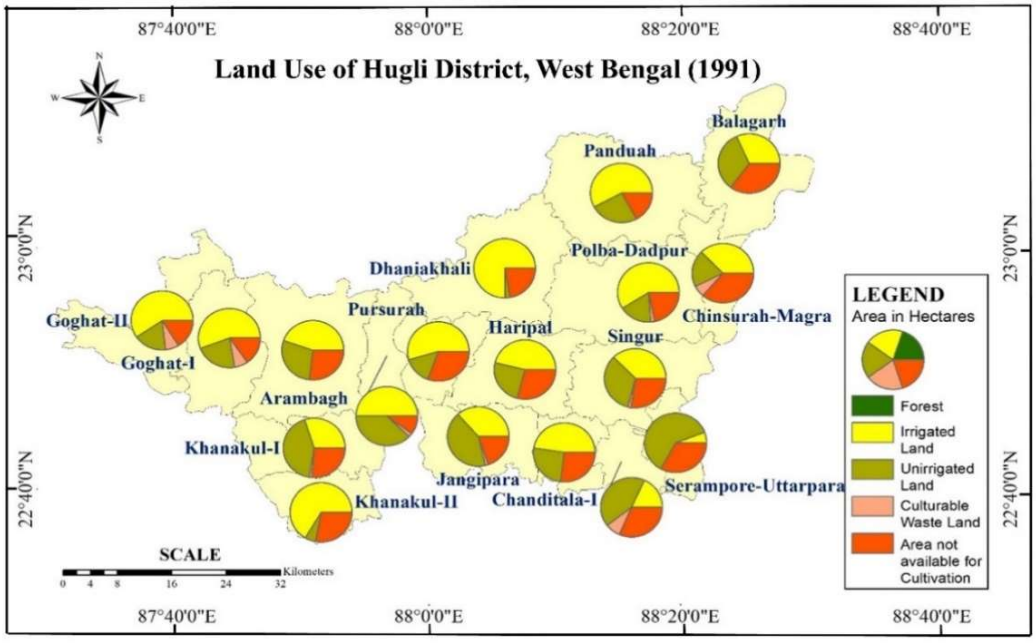
- Land use analysis based on Census information (1991 to 2011)
- Land use analysis based on Satellite imagery (1991 to 2021)

3.2.1 Land Use analysis based on Census information (1991 to 2011)

Before going into the details of agricultural land use, it is essential to have an overall picture of land use in brief. According to the district land use census categories (1991), the area is divided into five categories viz. area under forest, irrigated area, unirrigated area, cultivable waste area and area under non-agricultural use.

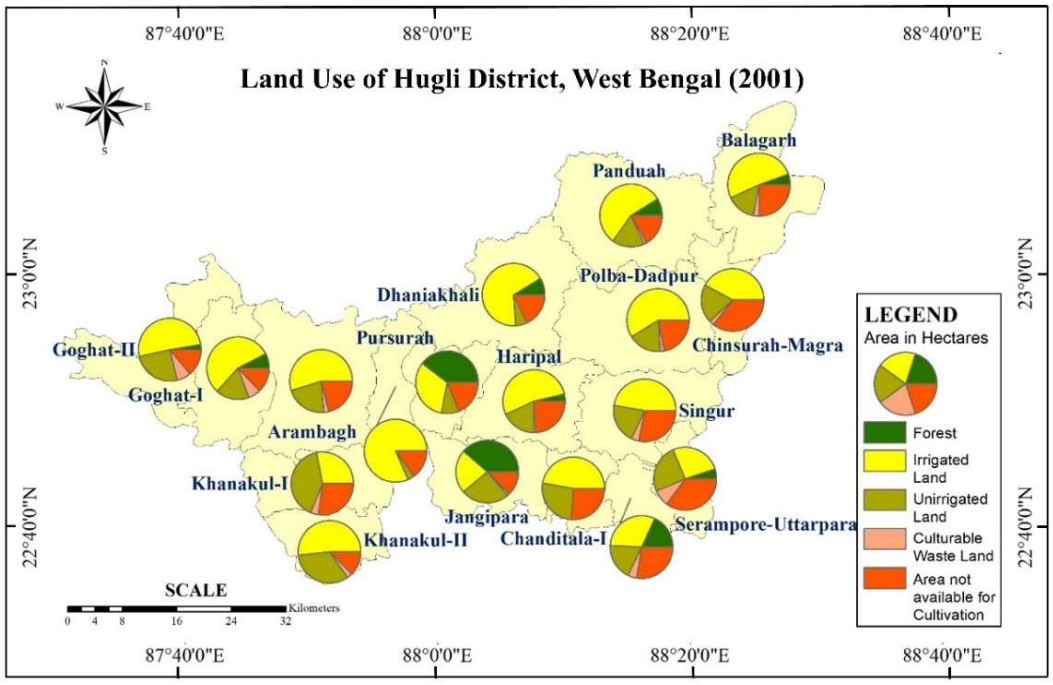
- Forest: - It pervades the areas with several trees owned by the state or by any private individual.
- Irrigated Land: - It relates to the land that has been irrigated under different types of irrigation for cultivation. Govt. canals, tanks, tubewells, submersible tubewells, river are the main sources of irrigation.
- Unirrigated land: - It includes all the areas under direct rainfall, and crops that are cultivated without irrigation water.
- Culturable Waste Land: - It is defined as the lands that have not been cultivated during the current years and last five years or more in succession.
- Areas not available for cultivation: - These stand for barren, uncultivable land which is put to non-agricultural use being occupied by buildings, roads, railways, rivers, canals, etc.

Figure 3.1: Land Use of Hugli District, 1991



Source: Census of India, 1991[1].

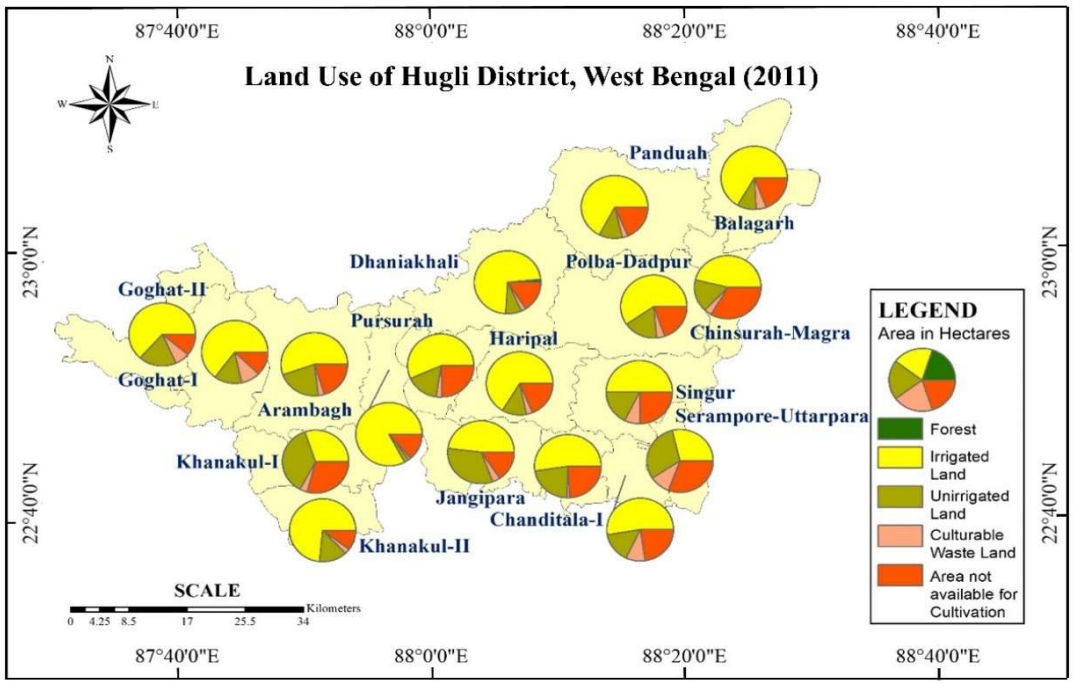
Figure 3.2: Land Use of Hugli District, 2001



Source: Census of India, 2001[2].

[1] For details, please see Appendix-A (Table No. 3.1)
[2] For details, please see Appendix-A (Table No. 3.1)

Figure 3.3: Land Use of Hugli District, 2011



Source: Census of India, 2001[3].

3.2.1.1 Net Sown Area

The cropped area in the year under consideration is called net sown area. This area has a special significance in an agricultural plot because agricultural production to a great extent depends upon this type of land. There is an urgent need to increase the net sown area to meet the food and other requirements of the rapidly increasing population, although there is not much scope for increasing area under this category due to natural limitations such as topography, soil, climate, etc.

In Hugli district has a high proportion of cultivated and this is largely due to gentle slope of the land with highly fertile alluvial soils, well-developed irrigation infrastructure and favorable agro climate for diversified agricultural production. The amount of net sown area is 217120 hectares. Irrigated land is such type of land which has been irrigated by different types of artificial water sources for agriculture purposes. Unirrigated area covers all the areas under direct rainfall crops or dry cultivation.

Irrigation is essentially the artificial application of water to overcome deficiencies in rainfall for growing crops (Cantor, L.M 1967).

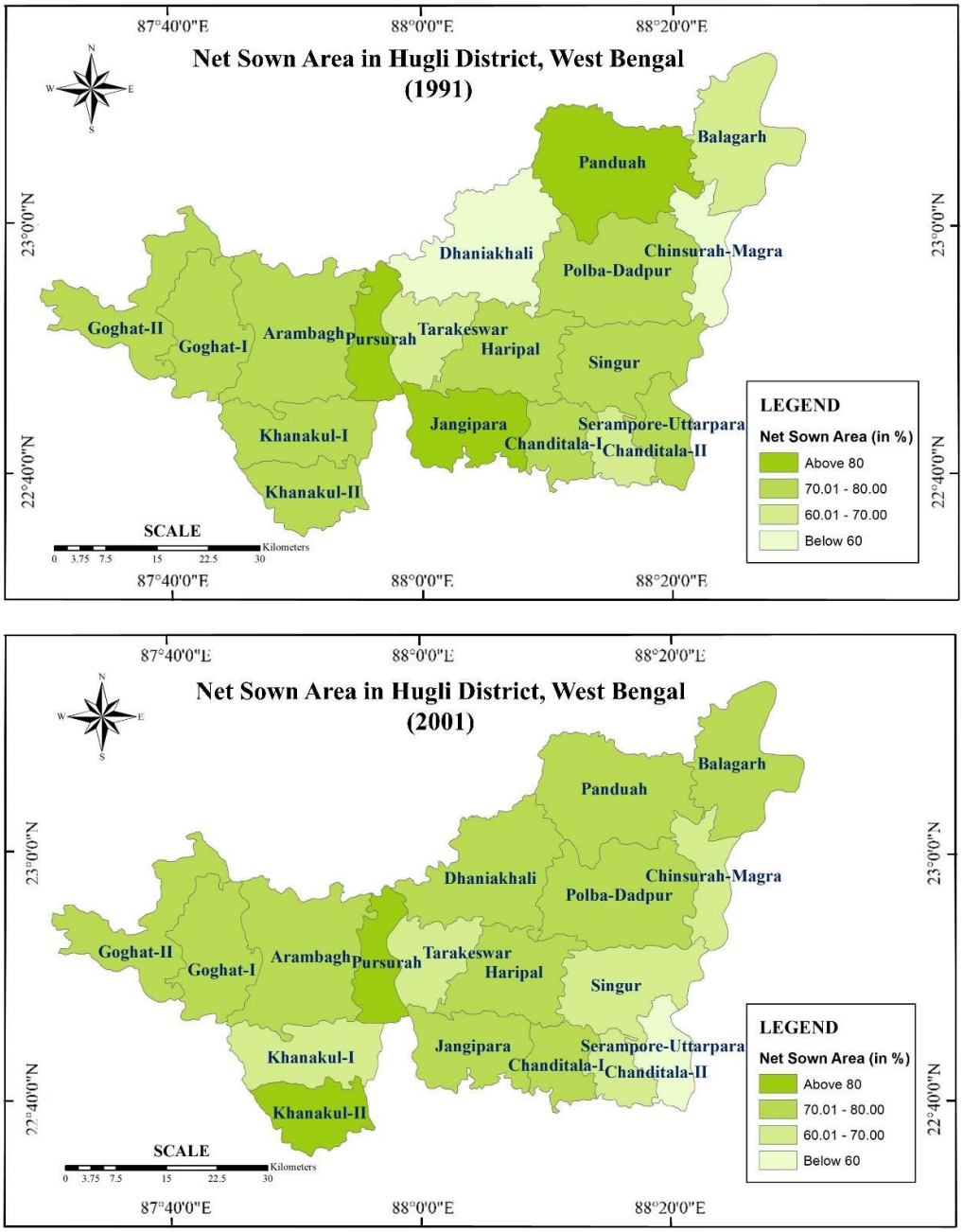
[3] For details, please see Appendix-A (Table No. 3.1)

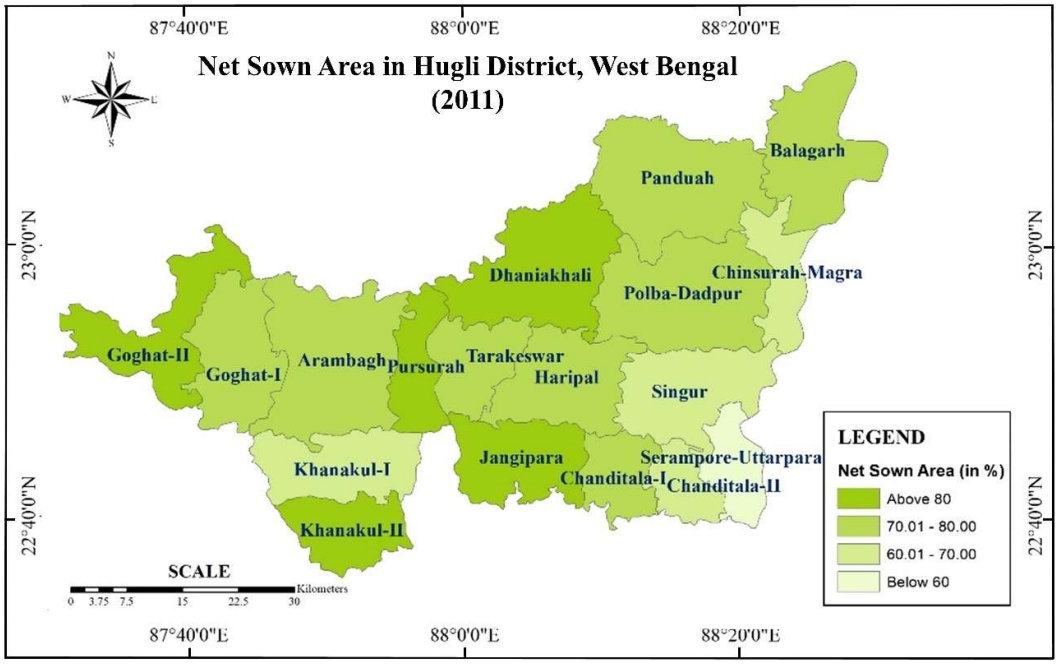
The main sources of irrigation in the district are river Bhagirathi, Damoder and a no of tributaries. Geographically the tract is considered to be a low delta region. This has resulted in several pockets of low-lying areas being subjected to floods and water logging.
The district has well developed irrigation infrastructure facilitating intensive agriculture with a higher cropping intensity of about 241% compared to state average of 184%. Out of the total cultivated area of 2188717 ha, 62% area is covered by irrigation. Groundwater forms the major source of irrigation accounting for 1.68 lakh ha (53%) of the gross irrigated area of 3.16 lakh ha. The area developed in extensive irrigation due to small and large number of perennial rivers, the alluvial low land, favorable rain-fall conditions, except during the winter months and a large number of percolations from the rivers, canals and distributaries and intake of rain waters which contribute to the subsoil water table for lift irrigation. The area under different irrigation sources is given below.
The Irrigation System in the district is served by tank, high density tube-well (HDTW), medium density tube-well (MDTW), low density tube well (LDTW), shallow deep tube well (SDW) and river lift irrigation (RLI).
In Hugli District, the total amount of Net Sown Area was 220453.32 hectares in 1991, 219158.42 hectares in 2001, and 217116.2 hectares in 2011 respectively which were 70.34 percent in 1991, 69.93 percent in 2001, and 69.28 percent in 2011, of the total land use area. About 1294.9 hectares of irrigated area decreased during the span 1991 to 2001 when it was 2042.22 hectares from 2001 to 2011. The irrigated area amounting to total of 3337.12 hectares was decreased from 2001 to 2011. It had been seen that the maximum decline of irrigated land took place from 2001 to 2011 for the Urbanization.

It is evident from the above table that all the blocks of Arambagh Subdivision; Khanakul-I, Khanakul-II, Pursurah, Goghat-I, Goghat-II and Chanditala-I, Jangipara, Polba-Dadpur, Balagarh, Serampore-Uttarpara,Panduah and Tarakeswar covering the proportion of the Net sown area was above 70 percent. Other blocks named Tarakeswar, Chinsurh-Mogra, Balagarh, Dhaniakhali, and Chanditala-II covered above 57% of the Net Sown Area in 1991. Chinsurh-Mogra has lowest percentage (57.32%) of Net Sown Area and Pursurah has highest percentage (80.94%) of Net sown Area observed. In 2001, all the blocks covered above 70 percent of Net sown area., except Singur, Chinsurh-Mogra, Tarakeswar, Khanakul-I, Serampore-Uttarpara and Chanditala-II. In 2011, it was shown that Arambagh , Khanakul-II , Pursurah , Goghat-I, Goghat-II , Chanditala – I, Jngipara, Polba –Dadpur, Dhaniakhali, Panduah, Balagarh, Haripal, Tarakeswar covered the proportion of Net sown

area in the range above 70 percent. Other blocks named, Chinsurh-Mogra, Khanakul-I, Serampore-Uttarpara, and Chanditala-II are covered in the range of below 70 percent net sown area.

Figure 3.4: Decadal variation of Net Sown Area in Hugli District, West Bengal (1991 – 2011)





Source: Census of India, 1991, 2001 & 2011[4].

Irrigated Land

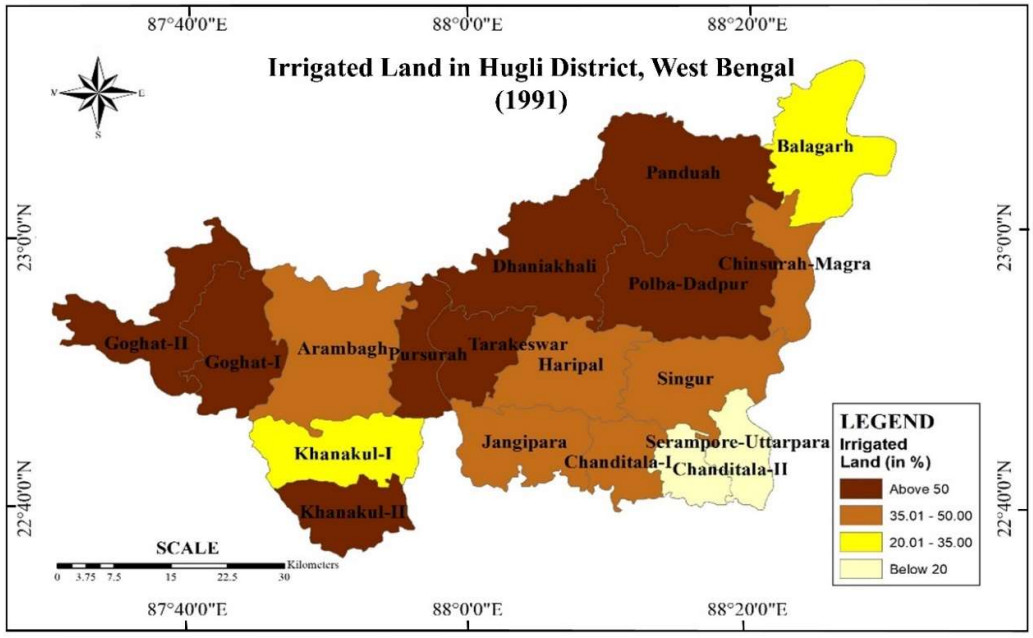
In Hugli District, the total sum of irrigated area was 147108.23 hectares in 1991, 158138.29 hectares in 2001, and 170141.04 hectares in 2011 respectively which were estimated to be 46.94 percent in 1991, 50.46 percent in 2001, and 49.55 percent in 2011, of the total land use area. About 11630.06 hectares irrigated area increased from 1991 to 2001 and the increase was 12002.75 hectares from 2001 to 2011. The irrigated area amounting to total of 23032.81 hectares was increased during the first decade of the millennium. It had been seen that the maximum increase in irrigated land took place from 2001 to 2011 for the development of irrigation systems.

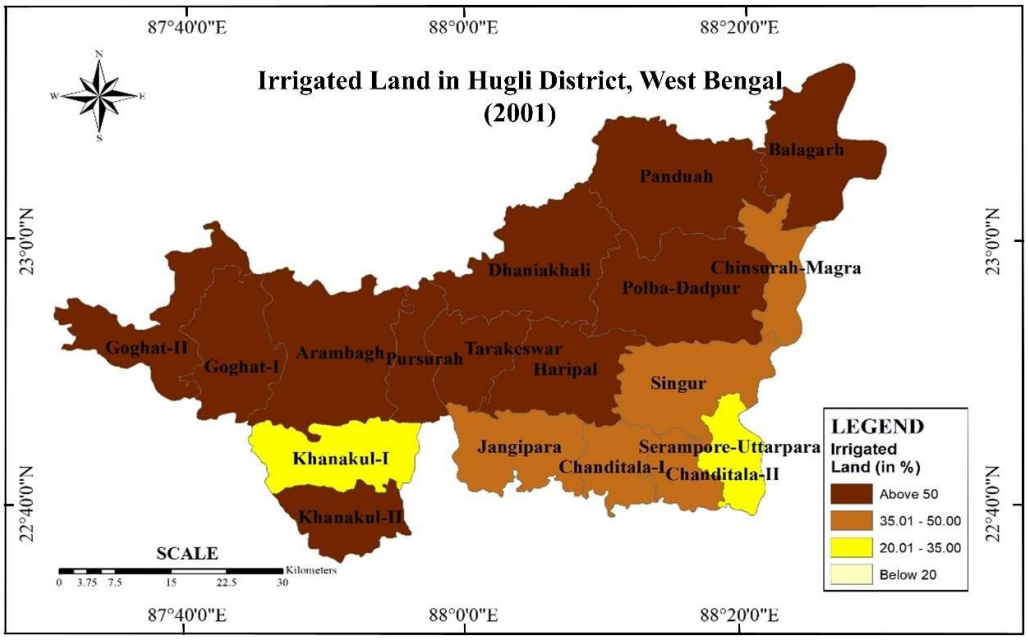
It was evident from the above table that the eight blocks such as Khanakul-II, Pursurah, Goghat-I, Goghat-II, Polba-Dadpur, Dhaniakhali, Panduah and Tarakeswar covered more than 50% of the irrigated area. Two blocks named Serampore-Uttarpara and Chanditala-II covered less than 20 percent while other blocks (name of the blocks) covered 20% - 50%of irrigated area in 1991. Again, the census year 2001 presented the situation of distribution of irrigated land among the blocks. The area of Arambagh, Khanakul-II, Pursurah, Goghat-I, Goghat-II, Polba-Dadpur, Dhaniakhali , were covered with more than 50 percent of irrigated land while it was between 25% -50% in six blocks such as Chanditala-I,

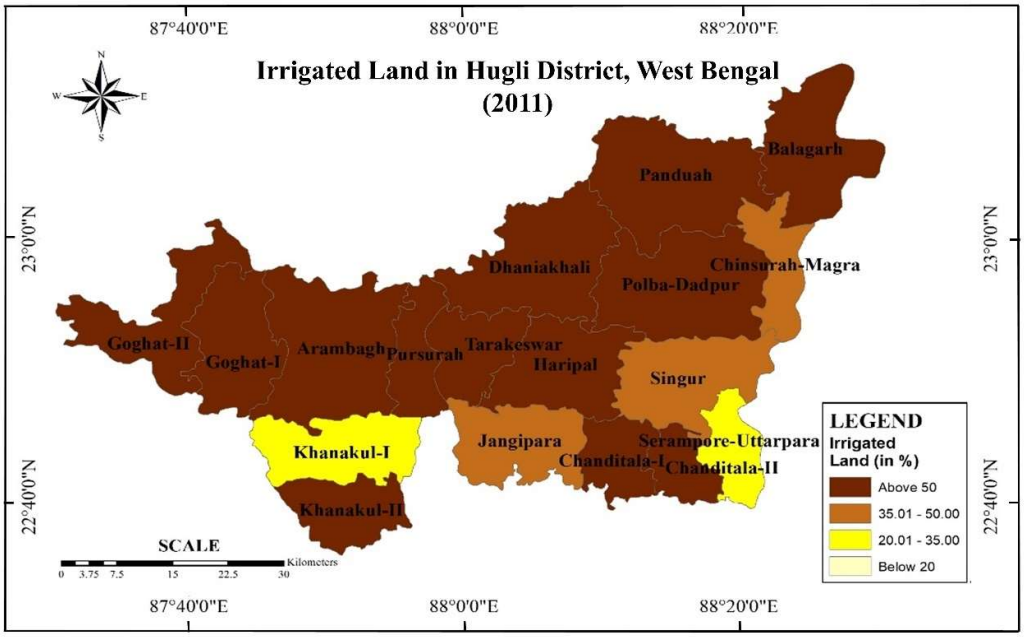
[4] For details, please see Appendix-A (Table No. 3.1)

Chanditala-II, Jangipara, Serampore-Uttarpara, Chinsurh- Mogra and Singur in the year 2001. The Highest percentage of irrigated land was observed in Pursurah (80%) Block during this period. In all the blocks, except the three blocks (Khanakul-I, Jangipara and Serampore-Uttarpara) irrigated area was more than 50 percent in 2011.

Figure 3.5: Decadal variation of Irrigated Land in Hugli District, West Bengal (1991-2011)







Source: Census of India, 1991, 2001 & 2011[5].

Unirrigated Land

The unirrigated area covers all the areas under direct rainfall crops or dry cultivation. The total stretch of unirrigated area was 73045.09 hectares in 1991, 61020.02 hectares in 2001, and 46977.5 hectares in 2011 respectively which were 23.30 percent in 1991, 19.47 percent in 2001 and 15 percent in 2011, of the total land use area. About 12,025 hectares unirrigated area dwindled from 1991 to 2001 when 14042.52 hectares unirrigated area underwent a decline from 2001 to 2011. The unirrigated area amounting to total of 26,067.59 hectares of land decreased from 1991 to 2011. It had been seen that the maximum decrease in unirrigated land took place from 2001 to 2011 for the development of irrigation systems.

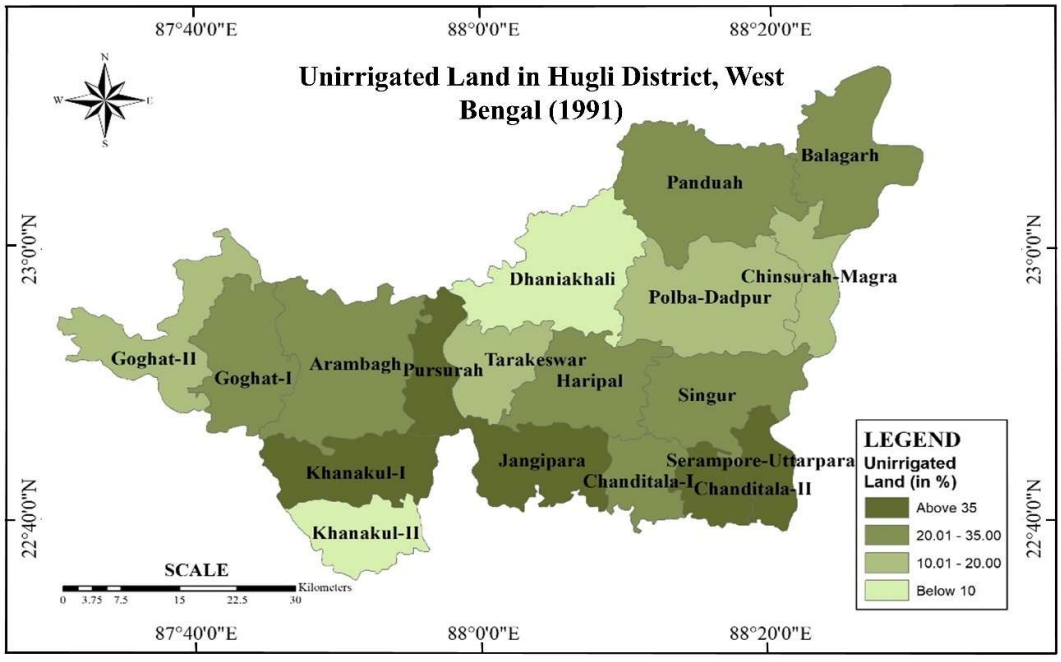
Figure 3.6 shows that the maximum concentration of unirrigated area in the range of above 35 percent was found in Khanakul-I, Pursurah, Chanditala-II, jangipara and Serampore-Uttarpara. The moderate concentration in the range of 20.01 to 35.00 percent was seen in Arambagh, Goghat-I,Chanditala-I Balagarh,Panduah, Singur, Haripal Blocks, the low concentration in the range of 10 – 20 percent was noticed in Goghat-II, Polba-Dadpur, Chinsurh-Mogra, Tarakeswar Blocks and the lowest concentration in the range below 10 percent was found in Khanakul and Dhaniakhali block in 1991.

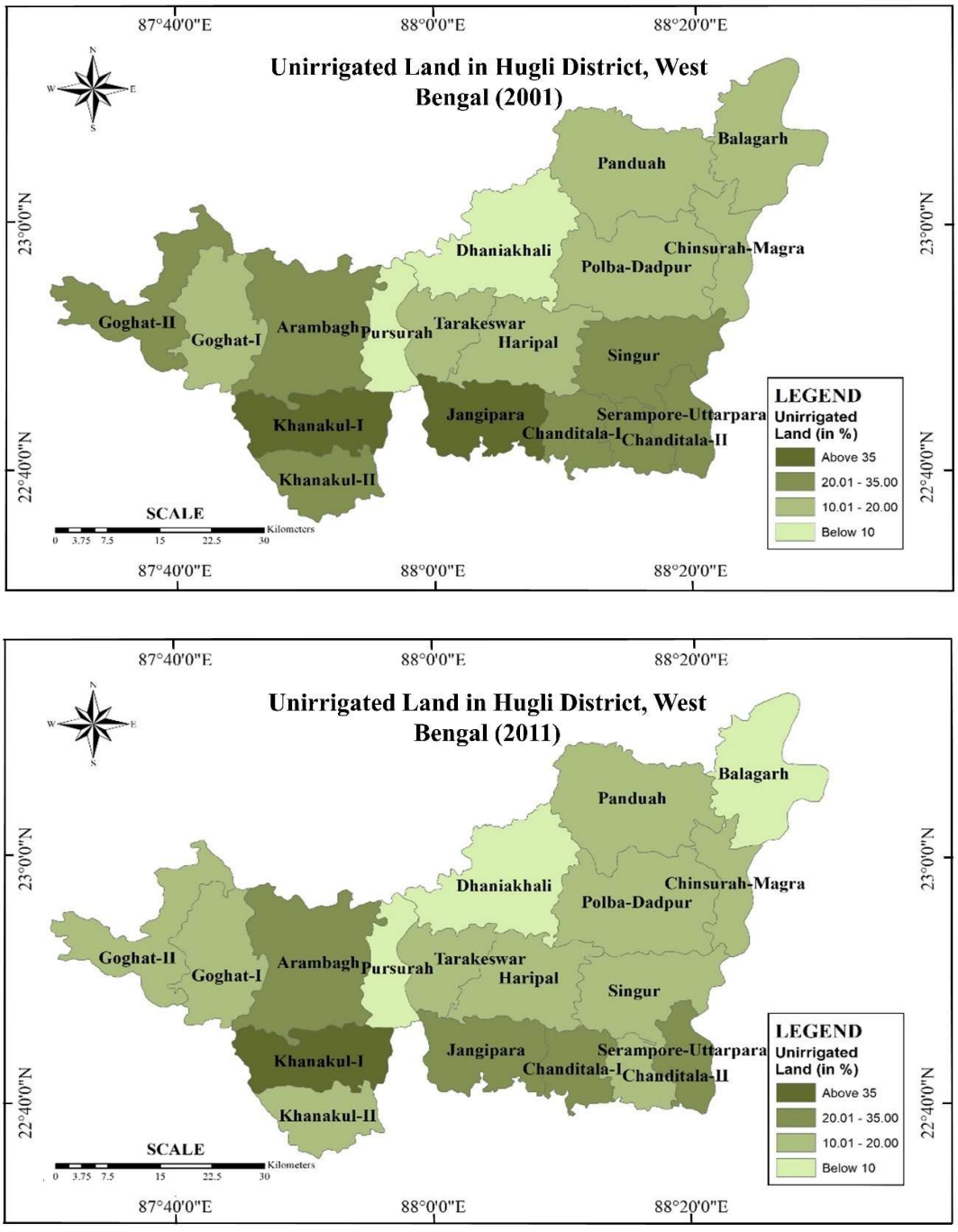
[5] For details, please see Appendix-A (Table No. 3.1)

The police stations which occupied the maximum concentration (above 35 percent) of unirrigated area were in Khanakul-I, jangipara and the medium concentration (20.0 – 35.0 percent) took place in Arambagh, Khanakul-II, Chanditala-I, Chanditala-II, Serampore-Uttarpara and Singur block. The low concentration (10.1-20percent) was in Tarakeswar, Haripal, Chinsurh-Mogra, Panduah,Balaarh, Polba-Dadpur, and Goghat-I and the least concentration (below10 percent) could be observed in Pursurah and Dhaniakhali block in 2001.

In 2011, Unirrigated area decreased in every block of Hugli District except in Serampore-Uttarpara and Tarakeswar. The above 30 percent unirrigated area is shown only in Serampore-Uttarpara, Khanakul-I and Jangipara blocks. Arambagh and Chanditala-I were covered by unirrigated areas in the range between 20-30 percent.and the rest of the blocks such as Panduah, Chinsurh-Mogra, Tarakeswar, Haripal, Singur, Polba-Dadpur, Chanditala-II, Goghat-I, Goghat-II were covered by unirrigated land below 20 percent in 2011. The lowest concentration of unirrigated area in the range below 10 percent was found in only Pursurah, Dhaniakhali, Balagarh Blocks.

Figure 3.6: Decadal variation of Unirrigated Land in Hugli District, West Bengal (1991-2011)





Source: Census of India, 1991, 2001 & 2011[6].

3.2.1.2 Culturable Waste Land

The "wasteland survey and reclamation committee" defines "culturable waste" as the land available for cultivation but not used for cultivation for one reason or another. This land was used in the past but has been abandoned for some reason. It is not being used at

[6] For details, please see Appendix-A (Table No. 3.1)

present due to such constraints as lack of water, salinity or alkalinity of the soil, soil erosion, water logging, an unfavorable physiographic position, or human neglect.

The cultivable waste, if brought under cultivation can be an important factor in augmenting the country's agricultural production. However, in the interest of long-term conservation and keeping eco-balance, this land should be put under afforestation and not under crop farming

In the study area, 11745.0 hectares of land were available in this category in 2011, which was 3.74% of the total area of Culturable Waste Land in Hugli district. But in 1991, about 5488.04 hectares were included in this category which was 1.75% of the total area. Again, the culturable waste land in the study area was 8149.8 hectares in 2001, which was 2.60% of the total area. From 1991, the area under culturable waste land kept increasing up to 2011 amounting to 6257.0 hectares.

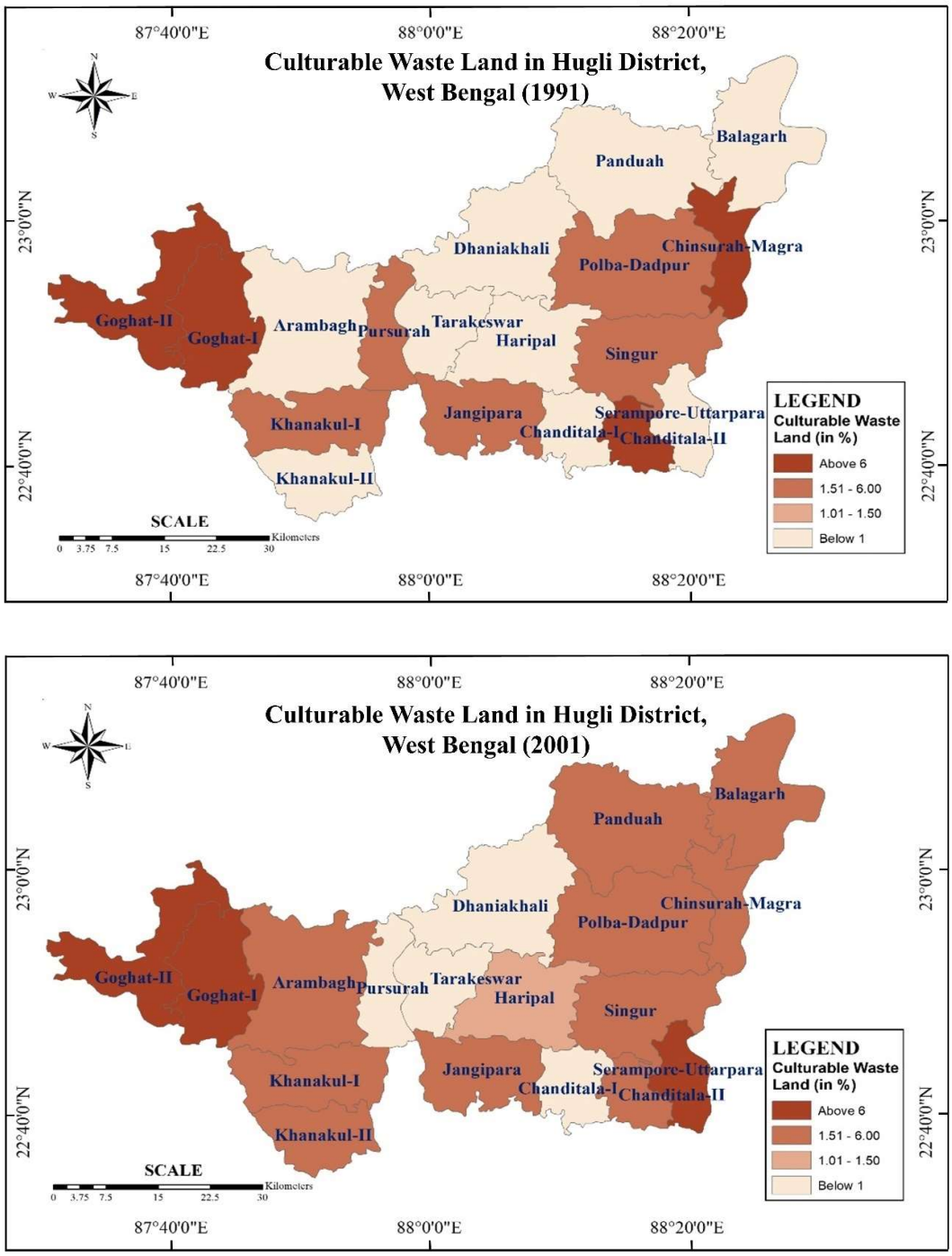
From the figure 3.7, the block wise profile shows that the highest percentage (<60%) of culturable waste land was found in Chanditala-II, Chinsurh-Mogra, Goghat-I and Goghat-II. Polba-Dadpur, Singur, Jangipara, Khanakul-I, were recorded to have moderate amount of the same followedby Panduah, Balagarh, Chanditala-I and Khanakul-II, Arambagh Block which contained less than 15% of the Culturable waste land, the lowest in the entire study area. No culturable waste land was found in Serampore-Uttarpara, Dhaniakhali, Haripal and Tarakeswar in 1991.

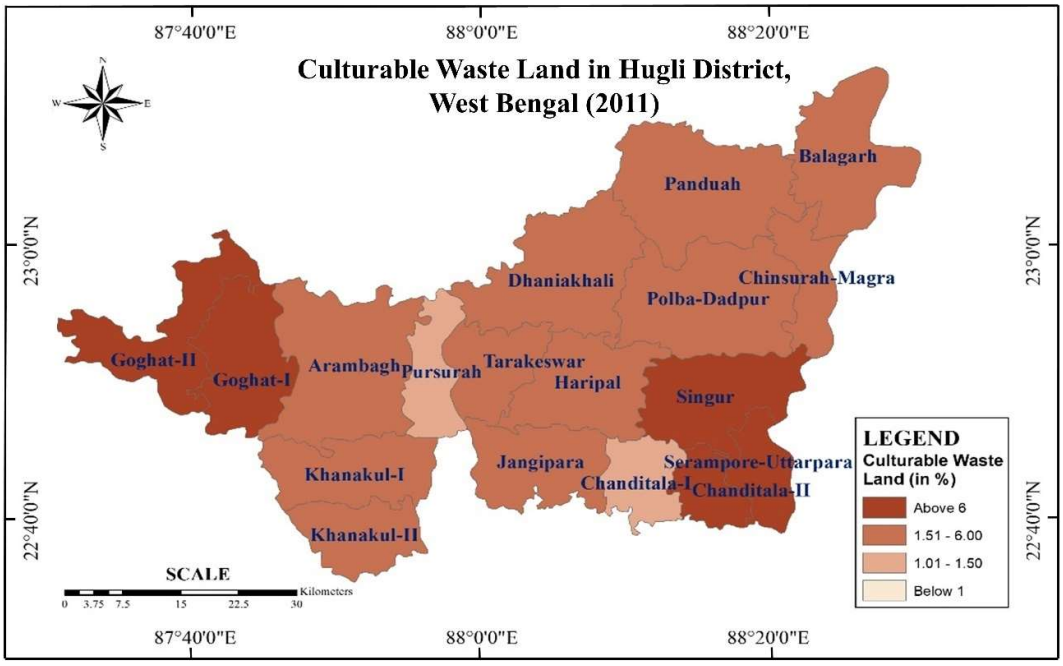
As per 2001 estimation, Serampore-Uttarpara, Goghat-I and Goghat-II of Hugli District had the highest share of culturable waste land amounting to 6 %. Chanditala-II Block occupied 5.61% Culturable waste land and other blocks, such as Arambagh, Khanakul-I, Khanakul-II, Jangipara, Balagarh, Singur, Panduah were covered by culturable waste land below 6%. Haripal, Tarakeswar, Chinsurh-Mogra, Dhaniakhali, Polba-Dadpur, Chanditala-I, Pursurah, Khanakul-I, Arambagh C.D. blocks contained less than 3% Culturable waste land in 2001.

A decade later more than 7% of culturable waste land was noticed in Serampore-Uttarpara, Chanditala-II, Singur, Goghat-I and Goghat-II blocks. The same year, the proportion of culturable waste land below 3% was found in Khanakul-II, Pursurah,Chanditala-I, Dhaniakhali, Panduah C.D. blocks. 3%-5% Culturable waste land was noticed in

Tarakeswar, Haripal and Arambagh, Khanakul-I, Chinsurh-Mogra, Balagarh, Khanakul-I C.D. blocks in the year 2011.

Figure 3.7: Decadal variation of Culturable Waste Land in Hugli District, West Bengal





Source: Census of India, 1991, 2001 & 2011[7].

3.2.1.3 Area Not Available for Cultivation

The area under non-agricultural uses include land occupied by villages, towns, roads, railways, or underwater i.e. rivers, lakes, canals, tanks, ponds, etc. The study area had 70692.9 hectares (22.55 percent of the total area) area in 1991, 74,600 hectares (23.80 percent of the total area) area in 2001; 96610 hectares (30 percent of the total area) area in 2011, under the category of the area not available for cultivation. The year 2001 witnessed an increase of about 3908 hectares of area that was not available for cultivation compared to 1991 and 2011 experienced an increase of 22010 hectares compared to 2001.

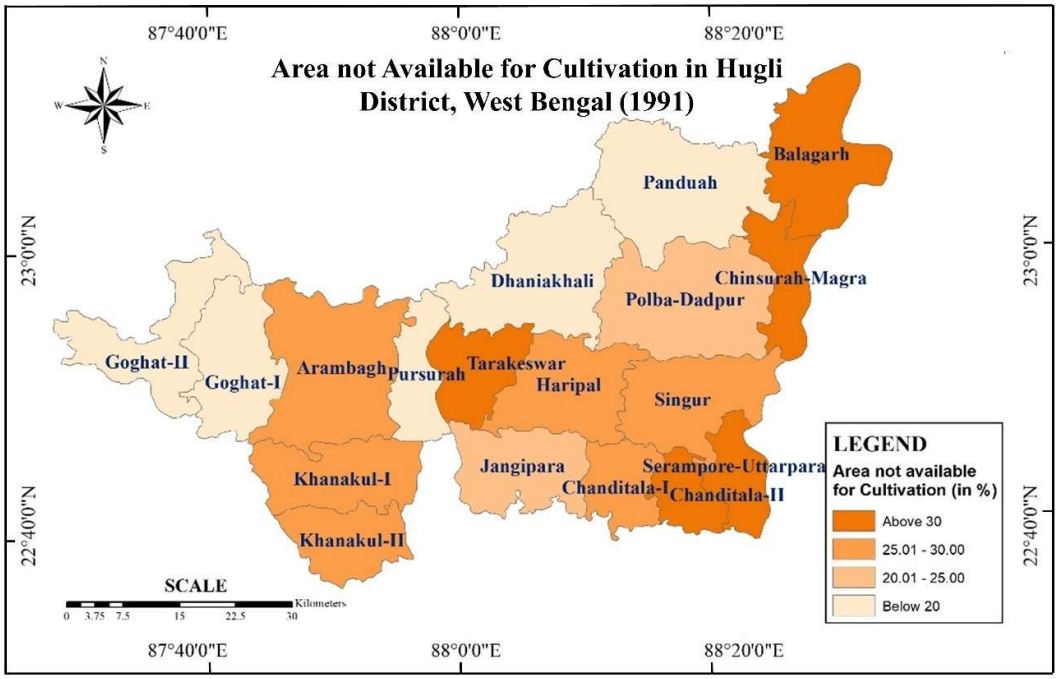
In five C.D blocks, (Arambagh, Khanakul-I, Chanditala-I, Chanditala-II, Singur) of the study area the proportion of the area not available for cultivation was above 20 to 30 percent. Above 30 percent of the area not available for cultivation was seen in two blocks, Chinsurh-Mogra and Serampore-Uttarpara block. Nine blocks (Goghat-I, Goghat-II, Pursurah, Khanakul-II, Jangipara, Haripal, Tarakeswar, Panduah, Balagarh) contained less than 20% area that fell under this category of land in 1991.

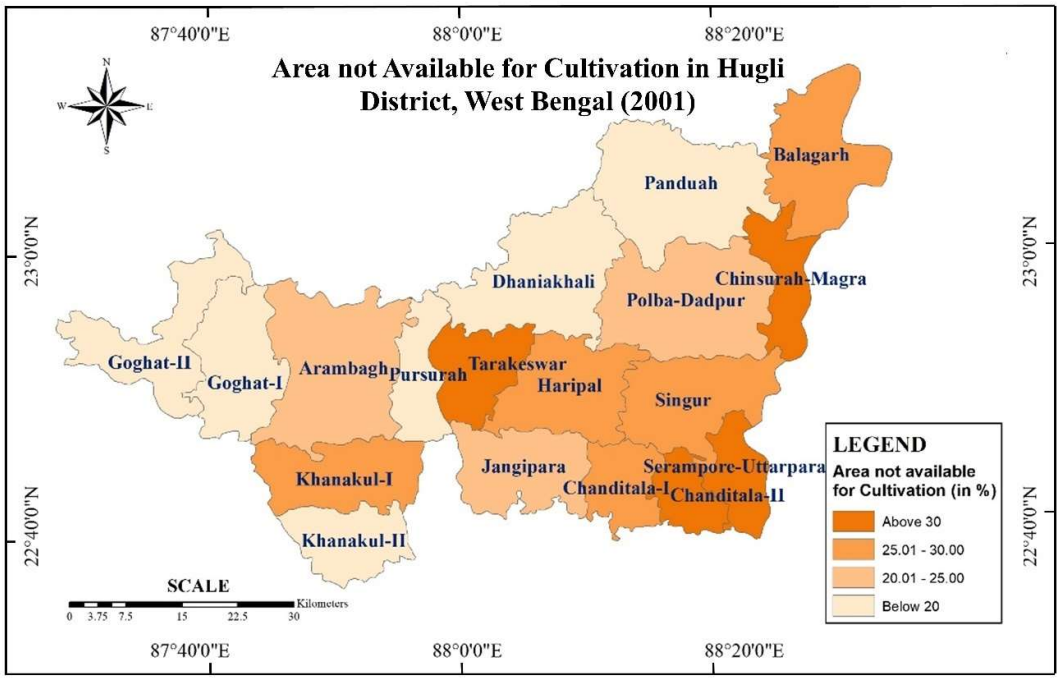
In 2001 Khanakul-II, Pursurah , Goghat-I, Goghat-II, Dhaniakhali, Panduah had below 20 percent of the area not available for cultivation while Chanditala-II, Serampore-Uttarpara,

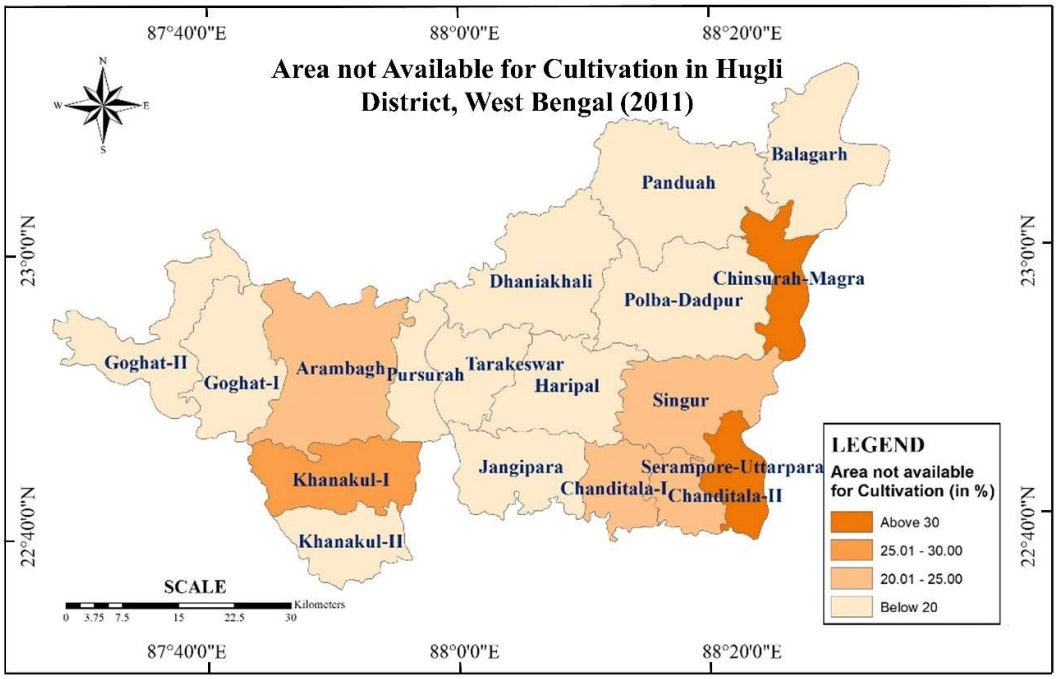
[7] For details, please see Appendix-A (Table No. 3.1)

Chinsurh-Mogra and Tarakeswar had above 30 percent this type of land and besides this other 8 blocks contained 20% to 30% area that are not available for cultivation in the year 2001.

Figure 3.8: Decadal variation of Area Not Available for Cultivation in Hugli District, West Bengal







Source: Census of India, 1991, 2001 & 2011[8].

In five blocks (Serampore- Uttarpara, Chanditala-II, Balagarh, Chinsurh – Mogra, Tarakeswar) of the study area, the proportion of the area not available for cultivation was above 30 percent. In 2001 six blocks (Arambagh, Khanakul-I, Khanakul-II, Chanditala-I, Singur, Haripal), the share of this category land varied between 25-30 percent and 20 to 25 percent, in two other blocks Polba-Dadpur, Jangipara. Less than 20% area was not available for cultivation in five other blocks namely Panduah, Dhaniakhali, Goghat-I, Goghat-II and Pursurah in 2011.

3.2.2 Land use analysis based on Satellite imagery (1991 to 2021)

Based on the prior knowledge of the study area, a general classification scheme has been developed based on the NRSA classification. In the present study, the classification categorization is designed based on the classification scheme developed by National Remote Sensing Agency (NRSA) in 1995. The modification in the categories is made by keeping in view the condition of the area under investigation. A classification scheme is formulated for the process of classification which is shown in Table 3.1.

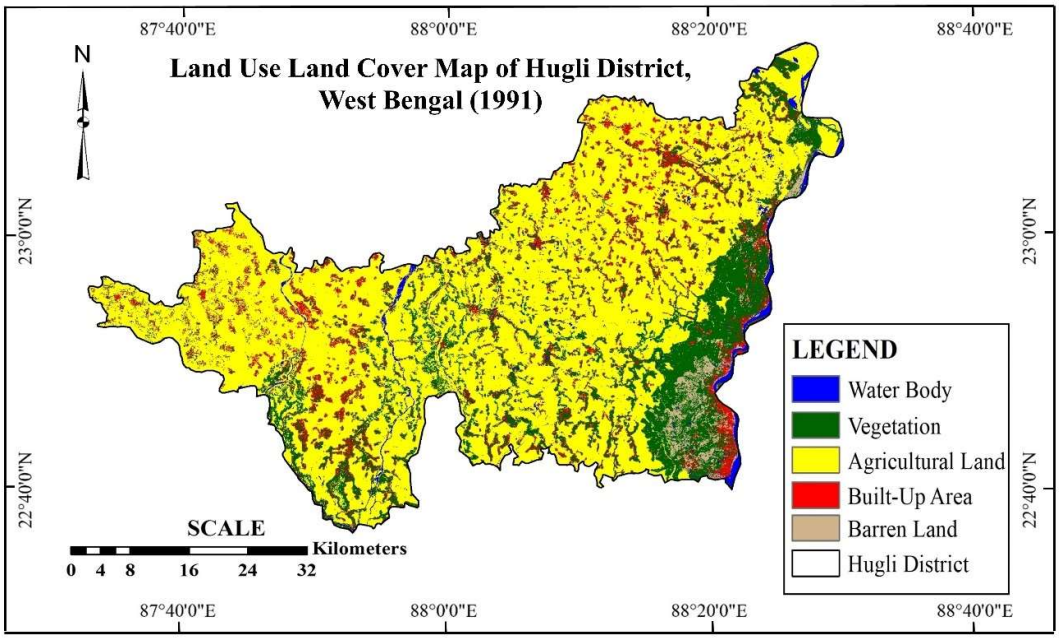
[8] For details, please see Appendix-A (Table No. 3.1)

Table 3.1: Classification scheme used for Land use assessment

SL No.	LULC Types	Description
1	Water body (W)	Open water features such as rivers, streams, ponds, and reservoirs
2	Vegetation (V)	Areas under dense and open forest
3	Agricultural land (AL)	Areas under cultivation
4	Built up area (B)	Temporary and permanent houses, villages, artificial infrastructure, industrial and mining areas, transportation, etc.
5	Barren land (BL)	The land is not suitable for either cultivation or any other beneficial use under the existing conditions of land management

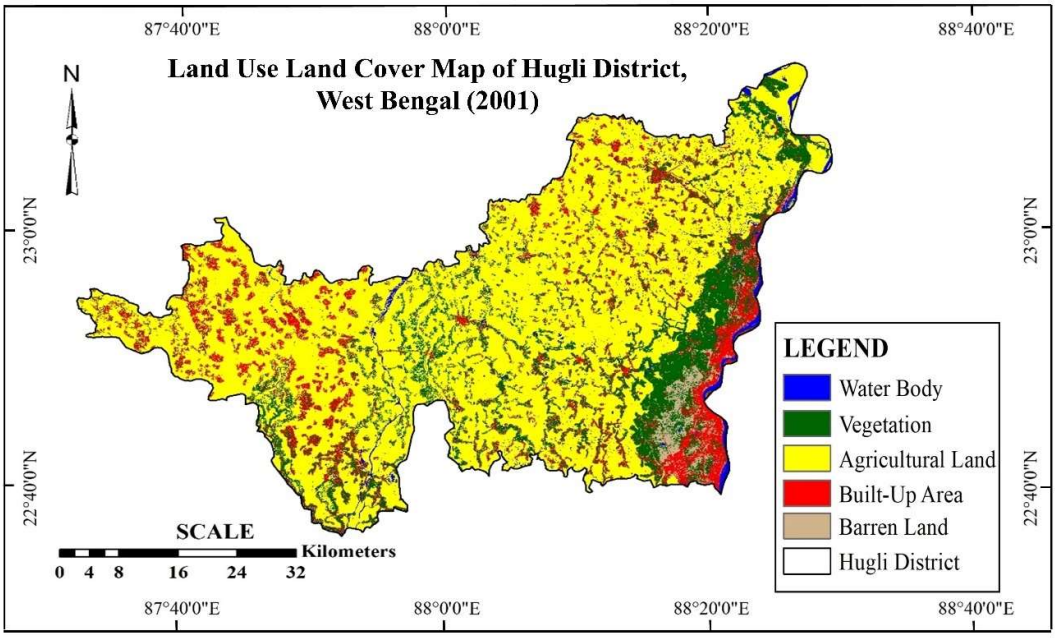
The entire work is mainly based on satellite data procured from USGS Earth Explorer and many other literature and research papers. Landsat 8 data was used to determine the LULC classes of the year 2021 and Landsat 5 for the years 2011, 2001 and 1991. To do so, supervised classification using Maximum Likelihood classifier ErDAS Imagine software is used. The area under each LULC class was calculated and expressed in percentage for analyzing the change in LULC over the years. The data is exhibited through textual, tabular and graphical presentation of mapping, bar diagram, pie diagram, column diagram and some field photography by using EXCEL and ErDAS Imagine.

Figure 3.9: LULC Map of Hugli District, 1991



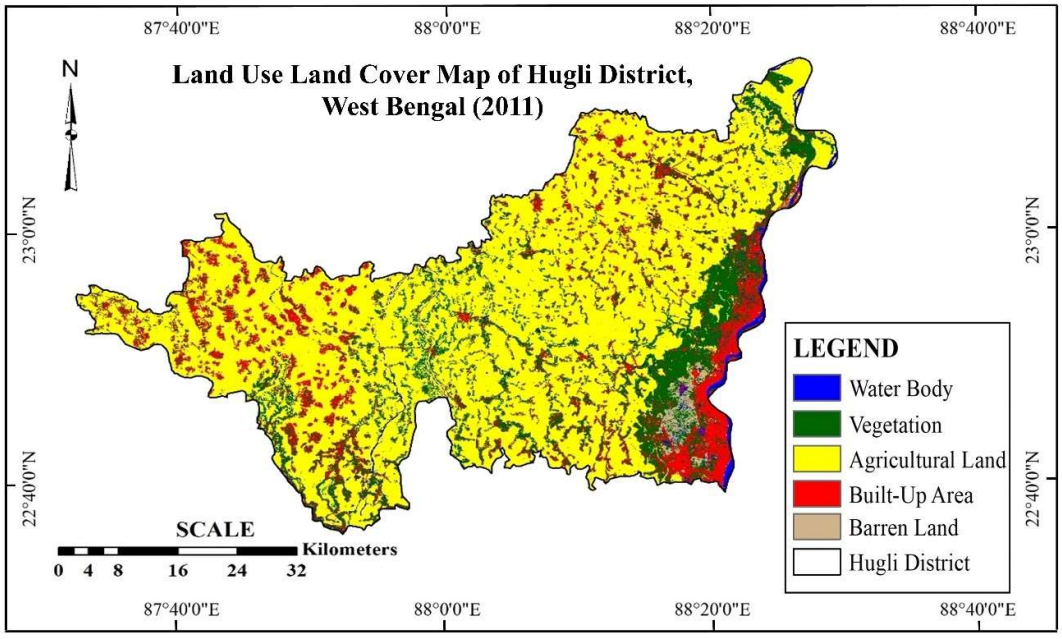
Source: Landsat 5 Imagery, USGS

Figure 3.10: LULC Map of Hugli District, 2001



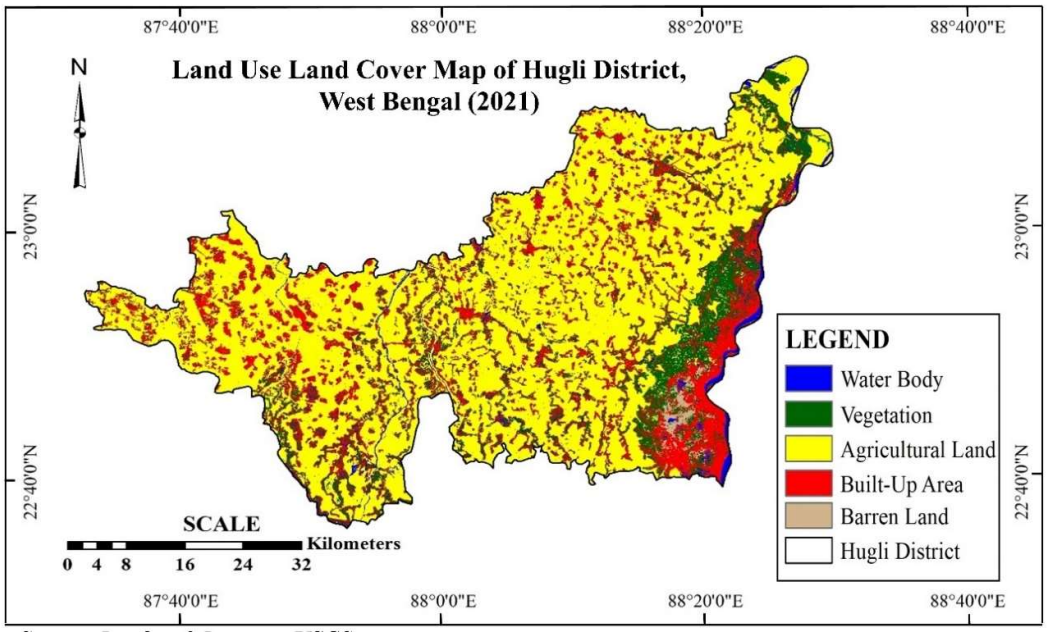
Source: Landsat 5 Imagery, USGS

Figure 3.11: LULC Map of Hugli District, 2011



Source: Landsat 5 Imagery, USGS

Figure 3.12: LULC Map of Hugli District, 2021



Source: Landsat 8 Imagery, USGS

Table 3.2: Area under each LULC class of Hugli District in 1991, 2001, 2011 and 2021

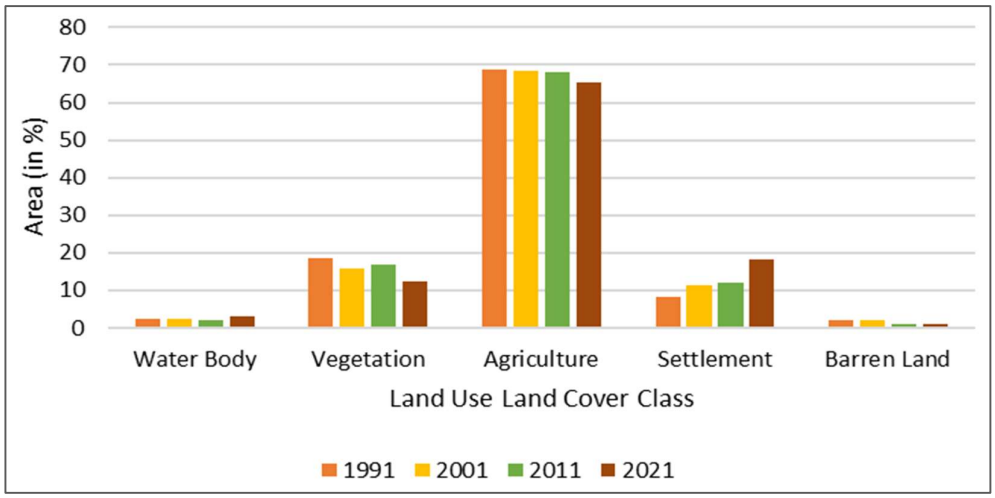
LULC Class Name	Area (in sq. km)			
	1991	2001	2011	2021
Water Body	73.25	71.58	62.34	96.58
Vegetation	583.23	504.71	535.51	394.98
Agricultural Land	2176.05	2156.55	2145.54	2060.36
Built-Up Area	260.78	358.79	378.68	576.08
Barren Land	64.99	66.76	31.35	29.94

Source: Landsat Imagery, USGS (1991, 2001, 2011 and 2021).

Figures 3.9 to 3.12 represent the LULC map of Hugli district using supervised classification for the years 1991, 2001, 2011 and 2021. The entire district was categorized into 5 LULC classes' viz., water body, barren land, settlement, agriculture and vegetation. The change in area (in %) under each LULC class has been depicted in Figure 3.13 LULC change is an incessant, dynamic and multidirectional process. The alteration in LULC due to rapid urbanization is the perfect reflection of expansion of human activities. The magnitude of evolution of the entire landscape has been captured and analyzed well using remote sensing and GIS technology. Overall, it can be concluded that over the years there has been a significant enhancement in settlement at the expense of agricultural fields, vegetation cover and barren land. Although the area under water body has increased from

1991 to 2021, it can be attributed to the seasonal influx of water in the rivers passing through Hugli district. The changes in each LULC class have been further discussed in detail below.

Figure 3.13: Land use class statistic of the classified map (in percentage) from 1991 to 2021 of Hugli District



Source: Area calculated by researcher based on Landsat data 1991 to 2021.

3.2.2.1 Water Body: A body of water forms a physiographical feature and is referred to as the accumulation of water on the earth's surface. It includes oceans, seas, rivers, lakes, or any wetlands like bills, ponds, khal[9], haors, etc. Water bodies vary in nature in terms of size, volume of water etc. Sometimes they flow naturally, but some are stationary. Sometimes people create wetlands for their own needs as well. Water bodies in each LULC map is depicted in blue color. The total surface water body in this area accounts for 2.37 % in 1991, 2.27% in 2001, 1.98% in 2011 and 3.06% in 2021, Thus the trend shows a gradual decline in water bodies between 1991 to 2011 and then a sudden increase in 2021. This increase can be attributed to the seasonal increase in the flow of rivers or the accumulation of water in pits in the concerned region.

3.2.2.2 Barren land: This category includes lands that are devoid of any vegetation or any other LULC category. In Hugli district barren land has gradually decreased over the years. It was estimated to be 2.9 %, 1.11%, 0.99% and 0.94% in 1991, 2001 2011 and 2021 respectively. Mostly, the barren lands have been converted into settlement areas.

[9] This is a Bengali word which signify canal.

3.2.2.3 Built-up area: Settlement means actual built-up areas which are occupied for residential, commercial, educational and any other infrastructural purposes. It is also associated with transportation networks, greeneries and orchards with household, commercial, or industrial buildings. Figure 3.13 illustrates that the area under settlement has increased gradually between 1991 to 2011 with rapid settlement growth between 2011 to 2021. The area under the built-up portion was 9.88%, 11.36%, 12.01% and 18.24% in 1991, 2001, 2011, and 2021 respectively. It is marked in red color on the map. Settlement area is increasing with infrastructural development due to the rapid growth of population in the Hugli District.

3.2.2.4 Agriculture: Agricultural land is the land, based upon which agriculture is practiced, particularly the rearing of livestock and cultivation of crops (commercial, horticulture), to produce food for humans. Permanent cropland, fallow land and pasture are different types of Agricultural Land. The utilization of land depends upon physical factors like Relief, Soil, and Climate as well as socio-economic factors like land tenures, population density, agricultural equipment, irrigation facilities, etc. In the study area, the lands are predominantly croplands. Among the major crops of the district, paddy covers 53% of the gross cropped area, second major crop, potato covers 17% of the area and wheat, mustard, jute, and pulses follow next. Vegetables are considered as the most remunerative crop in the district. The orchard areas (mango, banana, papaya, guava, coconut, etc.) are escalating day by day as these are more remunerative than the other crops and create more employment opportunities for rural unemployed youth in Food Processing Industries and Horticulture. Floriculture is not given the emphasis as compared to the other crops. Spices are also grown in some blocks of the district. Agricultural lands occupied 68.67%, 68.28%, 68.03% and 65.24% of the total landscape in 1991, 2001, 2011 and 2021 respectively. Agriculture forms the major LULC class for the district which has been shown using yellow color in the map. A steady decline can be noticed here with the development of urbanization or infrastructural development. In recent years, the agricultural scenario of the Hugli district has undergone an efficacious change. The response of the tenant farmers to the upcoming market of Kolkata has made this region a field of diversified commercial agriculture (CDAP, Hugli).

3.2.2.5 Vegetation: Vegetation cover defines the percentage of soil that is covered by flora which includes shrubs, bushes, grass land, woody trees etc. Vegetation plays an important role in maintaining the ecological balance of society. Mainly temperate deciduous type of

trees is found in the study area. In the lower Gangetic plain of the district, much of its natural vegetation is destroyed due to population pressure and increasing demand for agricultural land and urbanization. The forest area has been dwindling day by day. Vegetation cover in 1991 was 16.19%, in 2001 it was 15.98%, in 2011 it was 16.98% and in 2021 it was 12.51%. It has undergone a steady decrease in the last four decades. Maximum natural vegetation vanished due to anthropogenic activities. However, in 2011, it was seen that the situation slightly improved due to the strict implementation of policies by the Forest Department, Zilla Parishad and concerned Gram Panchayats. But, recently again it was seen that vegetation area decreased in 2021. Forestry has very little impact on the economy of the district since it covers an inconsiderable area of the district. About 211.92 hectares are included under the Reserve Forest category and 77.26 hectares under Protected Forest. As the area under forest cover is negligible, so naturally the revenue, production, and expenditure from forests are also very paltry.

3.2.3 Accuracy Assessment of Land Use Classification

Regarding accuracy of the Land Use maps of the Hugli District, producer's accuracy, user's accuracy, overall accuracy and Kappa co-efficient have been calculated for five different years. To check the accuracy of the assessment, about 300 sample references of five categories are tested. The details of the error matrix and accuracy totals are given in Table 3.3. The classified images show an overall accuracy of 94, 89, 92, and 91 percent in the year 1991, 2001, 2011, and 2021 with kappa coefficient of 0.92, 0.86, 0.89, and 0.88 respectively (Table 3.3). In the LULC map of the year 2001, different categories of vegetation and agricultural land have been classified more accurately. In case of 1991 map, all the categories have been classified as more or less accurate land as a result the overall accuracy of the map has reached 94 percent. The 2011 LULC map yielded overall accuracy of 92% and kappa coefficient of 0.89 and classes marked as to be high. In the classified map of 2011, both accuracies for all classes are 80 – 90% and 90% ≤; except barren land which is 76%. Moreover, the overall accuracy and kappa accuracy percentages of 2021 classified map attained 91 percent and 0.88 respectively as all the classified categories have been classified accurately. Therefore, strong acceptance of classification accuracy is found.

Table 3.3: Confusion Matrix table of LULC Supervised Classification (1991, 2001, 2011 and 2021)

LULC Types 1991	W	V	AL	B	BL	Total	Producer's accuracy (%)	User's accuracy (%)
W	31	0	1	0	3	35	96.88	88.57
V	0	61	3	0	0	64	95.31	95.31
AL	0	2	110	2	4	118	96.49	93.22
B	0	0	0	38	1	39	95.00	97.44
BL	1	1	0	0	42	44	84.00	95.45
Total	32	64	114	40	50	300		
Overall accuracy = 94%						Kappa coefficient = 0.92		

LULC Types 2001	W	V	AL	B	BL	Total	Producer's accuracy (%)	User's accuracy (%)
W	29	1	1	3	0	34	82.86	85.29
V	0	65	0	2	0	67	98.48	97.01
AL	1	0	105	6	3	115	93.75	91.30
B	2	0	4	40	3	49	78.43	81.63
BL	3	0	2	0	30	35	83.33	85.71
Total	35	66	112	51	36	300		
Overall accuracy = 89%						Kappa coefficient = 0.86		

LULC Types 2011	W	V	AL	B	BL	Total	Producer's accuracy (%)	User's accuracy (%)
W	28	0	0	1	0	29	87.50	96.55
V	0	56	0	0	3	59	100.00	94.92
AL	0	0	111	4	5	120	98.23	92.50
B	1	0	2	49	2	54	85.96	90.74
BL	3	0	0	3	32	38	76.19	84.21
Total	32	56	113	57	42	300		
Overall accuracy = 92%						Kappa coefficient = 0.89		

LULC Types 2021	W	V	AL	B	BL	Total	Producer's accuracy (%)	User's accuracy (%)
W	26	0	2	0	0	28	89.66	92.86
V	0	44	0	0	3	47	97.78	93.62
AL	0	1	113	6	2	122	93.39	92.62
B	2	0	3	55	1	61	88.71	90.16
BL	1	0	3	1	37	42	86.05	88.10
Total	29	45	121	62	43	300		
Overall accuracy = 91%						Kappa coefficient = 0.88		

W- Water body, V- Vegetation, GS- Grass land and Scrub, AL- Agricultural land, CF- Current Fallow, B- Built up area and WL- Waste land

3.3 Agricultural Land Use

Hugli is one of the intensive agriculture production districts in the state with over 2.80 lakh hectares of gross cultivated area. With well-developed irrigation infrastructure both surface (DVC projects) and ground water irrigation sources which area 62% of the total area is under assured irrigation. The cropping intensity is also high at 241% and the productivity levels are higher than State/National averages for selected crops. The district retains its basic rural characteristics with over 70% of its total population depending on Agriculture and its position as one of the major producers of cereals in the state.

3.3.1 Agricultural Production

Hugli is an economically developed district in the state. About 70% of the population derives their living from agriculture and therefore it holds a remarkable position in the arena of agriculture. Among the major crops of this district, paddy covers 53% of the gross cropped area at present. But the area, production and productivity of the crop, paddy remains almost stagnant. Second major crop of the district is potato accounting for 17% of gross cropped area which ranked first concerning area and production in the state.

The district is deficient in oilseed production. Crops like sunflower, groundnut and sesame are grown after harvesting potatoes. Sesame occupies presently second position after Midnapore. Poor attention is being paid to pulses by the farmers; as a result, the productivity of pulse crops is low compared to the potential yield of the crop. Jute production area is decreasing day by day due to high labour requirements and problems in marketing due to a reduction in industrial use which was mandatory once.

Dairy and fisheries are major allied sectors under agriculture. In Hugli district the per capita milk consumption is 198.30 g/day; meat 15 g/day and 38.62 numbers of eggs annually. The recommendation of ICMR for per capita daily requirement of milk, and meat are 240 g and 60 g, respectively while that of 188 numbers of eggs annually, leaving a huge demand-supply gap for milk, meat and eggs in the district. The prevalence of different kinds of water bodies offers scope for further development of fisheries sector through intensive production measures. (Cdap-2017-18 to 2019-20). The local demand for other products from agriculture and allied sectors viz., fruits, vegetables, milk and meat products and fish far exceed the production despite available opportunities for localized production.

The need is for a reorientation of the development process towards a balanced growth of both agriculture and allied sectors through judicious use of land, water and human resources.

Table 3.4: Agriculture, Horticulture and Livestock Production- Position of the district in terms of State's production:

Category	Crop/Veg/Fruits/Livestock	Rank in the state	Production, 000' MT	% of state production
Agricultural Produce	Potato	1st	3434.46	24.82
	Til (Sesamum)	2nd	21.70	14.17
	Groundnut	3rd	17.88	15.82
Vegetables	Onion	1st	57.21	19.20
	Beans	4th	3.47	9.00
Fruits	Banana	3rd	101.75	10.07
	Mango	5th	39.00	6.29
Livestock Product	Bovine milk	3rd	461.55	10.65
	Duck	5th	890064 (No)	7.39

Source: Evaluation Wing, Directorate of Agriculture Govt of WB 2009-10, Bureau of Applied Economics & Statistics, Livestock Population Handbook 2009.

3.3.2 Cropping pattern

Cropping Pattern means the production of an area under various crops at a point of time. It is a dynamic concept and changes over space and time (Hussain 1996). Physical, cultural and technological background of an area plays a dominating role in controlling the spatial pattern of cropping in the district. The economy of Hugli district is mainly based on agriculture. Favorable agro-climate is suitable for diversified agriculture production for almost all commercial cash crops. The total geographical area of this district is 314900 ha of which 215714 ha (69.17%) is under cultivation. The major cropping pattern of the district is Til/Jute/Aus Paddy/Vegetables; Kharif Paddy vegetables/oilseeds/Pulses / Boro Paddy.

Table 3.5: Prominent Cropping system of the Hugli District

Sl No	Name of the C.D. Block	Cropping Pattern				
1	Balagarh	Jute/Til/Kh. Paddy-Boro	Aman-Mustard-Boro	Jute/Til-Onion	Veg-Veg-Spices	Veg-Veg-Veg
2	Chinsurh-Mogra	Do	Do	Kh.Paddy-Mustard	Kh.Paddy-Veg/Til/G.Nut	

3	Polba-Dadpur	Do	Do	Kh.Paddy-Mustard/Veg/Potato	Do	
4	Singur	Do	Do	Do	Do	
5	Chanditala-I	Do	Do	Do	Do	
6	Serampur-Uttarpara	Do	Kh.Paddy-Boro	Kh.Paddy-Veg/Pulse	Do	
7	Pandua	Do	Do	Do	Do	Do
8	Dhaniakhali	Do	Do	Do	Do	Do
9	Haripal	Do	Do	Do	Do	Do
10	Jangipara	Do	Do	Do	Do	Do
11	Tarakeswar	Do	Do	Do	Do	Do
12	Chanditala-II	Do	Do	Do	Do	Do
13	Pursurah	Jute/Til/G.Nut-Kh.Paddy-Potato	Kh.Paddy-Mustard-Boro	Do	Do	
14	Arambagh	Do		Do	Do	Do
15	Khanakul-I	Do		Do	Do	Do
16	Khanakul-II	Do		Do	Do	Do
17	Goghat-I	Do		Do	Do	Do
18	Goghat-II	Do		Do	Do	Do

Source: CDAP-Hugli 2016-17.

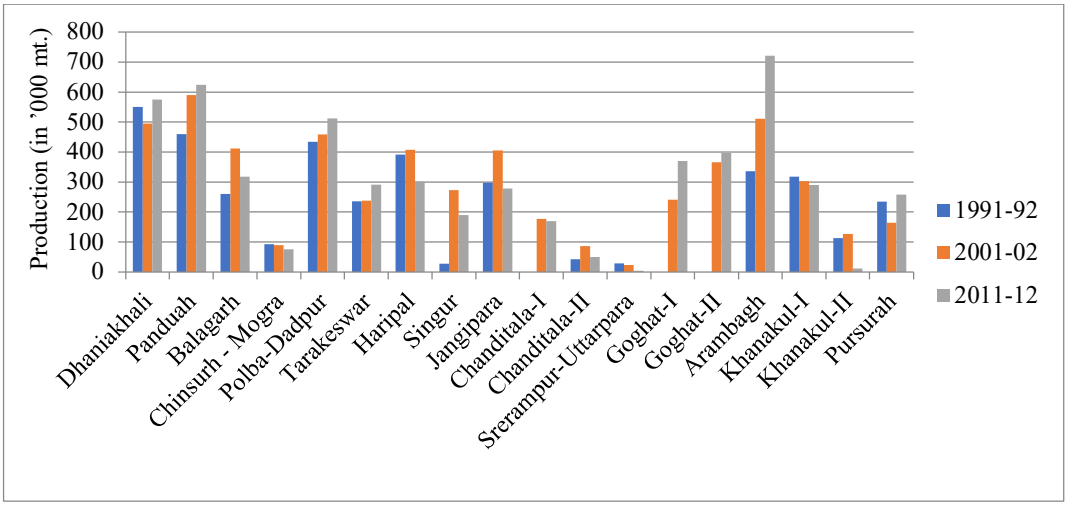
Among the major agriculture crops of this district Hugli, Paddy covered 53% of the gross cropped area of 543240 hectares (2014-2015) at present. But the area, production and productivity of the crop remain almost stagnant, sometimes it falls. The traditional variety of Kharif Aman occupies the major cultivated area (185270 ha area). In the case of Boro paddy negative growth in terms of productivity has been observed due to poor soil, water and pest management practices. Paddy is grown in all blocks of the district, but its proportion varies from one block to another. In the year 2016-17, 56138 ha area was allotted for Boro Paddy and only 5119 ha area was allotted for Aus Paddy. Table No. 3.2 in Appendix-A represents the variation of Aman and Boro paddy production in different blocks of Hugli District. Main Aman producing blocks are Arambagh (720.93 mt), Panduah (624.15 mt), Dhaniakhali (574.52 thousand mt), Polba-Dadpur (511.92 thousand mt). Aman production reached its peak from 1992 – 2012 with Arambagh block (384.57 thousand mt), Panduah (163.97 thousand mt) and in Singur blocks (161.3 thousand mt) leading in the same. But production mainly decreased in Haripal Block. Boro cultivation is mainly confined to Arambagh, Khanakul, Goghat, Panduah and Polba-Dadpur area. Increased production could be seen in Goghat (194.96 thousand mt), Arambagh (186.36 thousand mt) blocks from 1992 to 2012 but it decreased in Chinsurh – Mogra (49.83)

block, mainly due to urbanization and population pressure. A very small number of Aus Paddy is produced in a few blocks (Arambagh, Goghat, Pandua and Haripal) of the district.

Though Aman paddy area decreased in maximum blocks of the District Hugli, it mainly decreased in Haripal (40.64 hact), Singur (45.38 hect) and Khanakul –I (38.65 hect) blocks (Figure 3.14). Aman Paddy area expanded from 1992-2016, in Arambagh (10.82 hect) and Panduah block. Boro Paddy area declines steadily. Maximum downturn observed in Panduah (50.07 hect), Polba-Dadpur (45.57 hect), Tarakeswar (46.50 hect) (Figure 3.15). Area increased mainly in Balagarh (34.17 hect) C.D block.

Second major crop of the district (99830 ha as per 2014-15) is potato which occupies 3 % of the gross cropped area, largest area (25%) and production (38%) of the state. The steady expansion of potato area and production after rice and jute has already occurred in the district despite strong price seasonality and higher risk. It will also depend on factors such as prices and cold storage availability.

Figure 3.14: Production (in ’000 mt.) of Aman in the Blocks of Hugli for the year 1991-92, 2001-02 and 2011-12



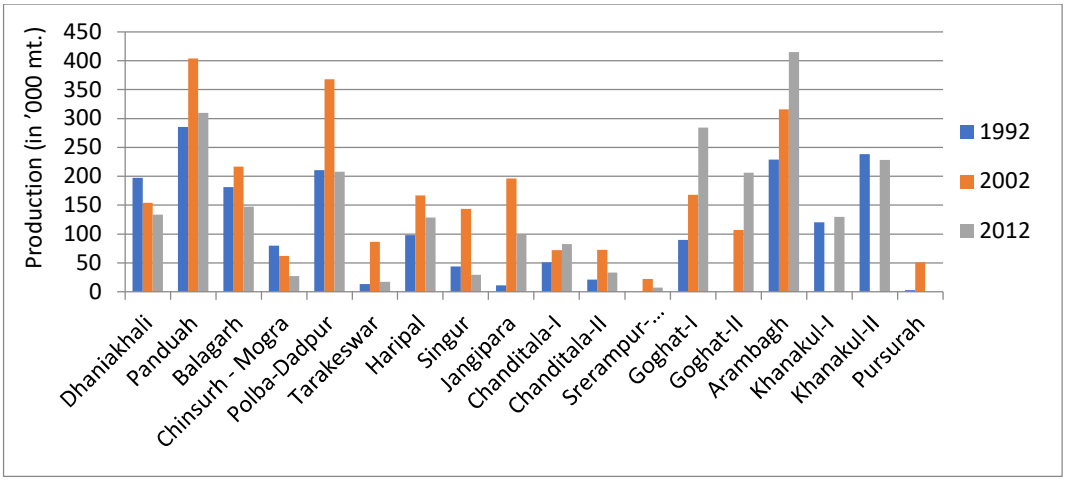
Source: CDAP Hugli, 2017-18[10].

The main harvest of potatoes occurs in February and March. The temperature rises steadily until the onset of the southwest monsoon in June. Traditional storage is not an effective option from mid-April onwards, but prices continue to escalate until the monsoon crop is harvested in October. Recent public and private sector initiatives have focused on

[10] For details, please see Appendix-A (Table No. 3.2)

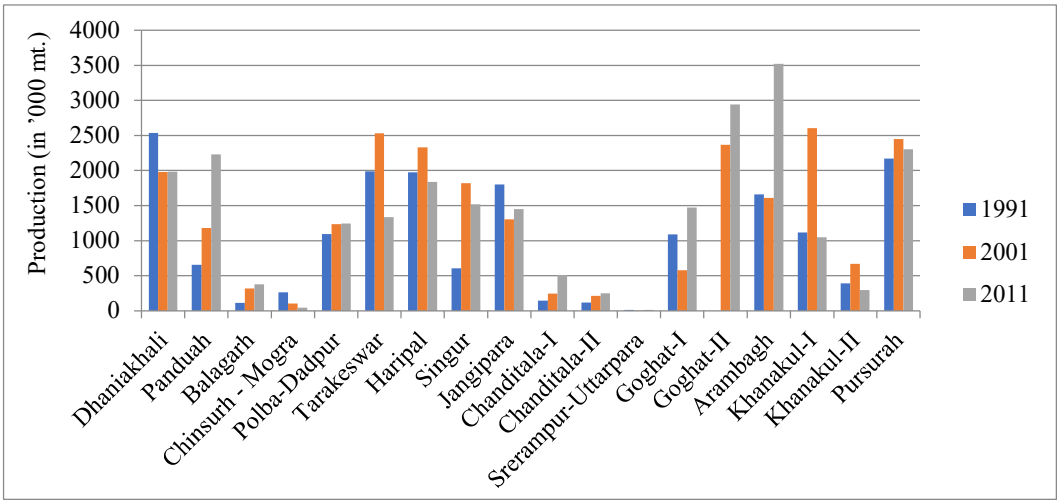
increasing the cold storage area, expansion of potato exports and diversified processing, thus reducing the risk of price decline and improving the overall potato market. Productivity fluctuates due to natural calamity (20811 kg/ha in 2013-14 compared to 34802 kg/ha in 2014-15) and farmers suffer from price uncertainty.

Figure 3.15: Production (in '000 mt.) of Boro in the Blocks of Hugli for the year 1991-92, 2001-02 and 2011-12



Source: CDAP Hugli, 2017-18[11].

Figure 3.16: Production (in '000 mt.) of Potato in the Blocks of Hugli for the year 1991-92, 2001-02 and 2011-12



Source: CDAP Hugli, 2017-18[12].

[11] For details, please see Appendix-A (Table No. 3.2)
[12] For details, please see Appendix-A (Table No. 3.3)

Hugli is the largest potato producer in West Bengal, summing to nearly 25% of the area and 35% of the production in the state. Potato occupies the premier position in agricultural economy of Hugli District. During 2009-10, Hugli produced 2770040 Mt of potato from an area of 88,348 ha with a productivity of about 31.35 t/ha. Major varieties of potato grown in the district are, Kufri Jyoti (more than 80% area) Kufri Chandramukhi, Kufri Pukhraj, Kufri Ashoka as table potatoes and processing varieties, namely Kufri Chipsona-1 and Kufri Chipsona-2 and exotic variety Atlantic. The major impediments in successful and profitable cultivation of potatoes are, lack of sufficient and timely availability of good quality seed, un-remunerative market price, and lack of sufficient cold storage space.

Jute is an important Cash crop of the district. It is grown in low land with silty to clay soil. Jute also occupies a good acreage, but its area is dwindling day by day due to high labour costs, requirements and marketing problems. Jute is mainly grown in Balagarh (675.66 thmt), where it occupies the second position after rice. Other jute-producing areas are Tarakeswar, Singur and Khanakul. Table No. 3.4 in Appendix-A represents the variation of area under jute cultivation. Jute cultivation area increased in Khanakul – II (25.98 thmt), Khanakul – I (12.03 thmt) Balagarh (16.52 thmt) and decreased in Singur (15.0 thmt) and Chanditala-II C.D block. No cultivated area has been shown in Goghat I and II block in the year 2012.

Yield rate of mustard, a commercial crop also depends upon the span of cold spells along with a poor selection of land. Therefore, Productivity as well as production also fluctuates from year to year. Since the District is deficient in oilseed production, these constraints are being minimized by expanding area under sunflower, groundnut, and summer- Til with residual soil moisture after potato. In 1990 mustard production was very - popular in the western part (Arambagh, Goghat) of the district, but nowadays (2012) three blocks of eastern part namely Jangipara, Balagarh and Dhaniakhali perform well. In 2016 Balagarh kept its position and Tarakeswar has developed its position in the same. The yield rate is very high in Polba-Dadpur, but the production is minimum (0.491 mt). Dhaniakhali, Pursurah, Goghat–II and Haripal are major producing area of Til cultivation. Oilseed cultivation has increased day by day following the increasing market price of edible oil.

Since Pulse is not so much remunerative, poor attention is being paid to it by the farmers. As a result, the productivity of pulses crop is low as compared to the potential yield of the crop. However, state Govt has taken a positive approach to increase area, production and productivity of Pulse crops through different schemes. Pulses are Gram, Musur, Maskalai,

Khesari, Moog and Arhar. These are grown both as kharif and rabi crops in Hugli. Pulses are cultivated using the available moisture on the low-lying paddy fields. It is mainly grown in some blocks (Balagarh, Polba, Panduah, Dhaniakhali) of Chinsurh- Mogra subdivision.

The district can be categorized as a major horticulture producer with a gross area of over 72,869 ha. This includes 13,640 ha under fruit crops and the area under vegetable crop is 55,471 ha. The area under spices and plantation crop is 3,583 ha and 175 ha area for flower cultivation. Among the different food crops which are being cultivated in the district, mango, banana, papaya and coconut are most important. Fruit crops are increasing day by day as these are more remunerative than the other crops and create more employment opportunities for rural unemployed youth. National Horticulture Mission (NHM) schemes are prevailing in Hugli district for increasing the area and production of perennial fruits (mango, Guava), non-perennial fruits (banana), organic farming of fruits and vegetables etc. Perennial fruit crops are confined to a few blocks, viz. Balagarh, Pandua, Chinsurg-Mogra, Polba-Dadpur, Singur, Chanditala-I, Chanditala-II and Goghat-I, Goghat-II. Total fruit production in the district is 2,00,003 tonnes; and productivity of fruit is 14.66 t/ha.

Major flower-growing block of the district is Pandua. Pandua is the leading producer of flowers like marigold, tuberose, gerbera etc. Flowers are produced both in open field as well as in polyhouses which are naturally ventilated tubular structures. Due to favourable atmosphere and proximity to Kolkata and better income; many farmers are opting for vegetable cultivation in the district. Predominant vegetables are brinjal, bhendi, tomato, cucurbits (cucumber, bitter gourd, bottle gourd, pumpkin, ridge gourd and pointed gourd) chilli, yam and Cold crops (winter vegetables). Several private nurseries engaged in fruit and ornamental plants are concentrated in Balagarh block. Total vegetable Production in the district is 734147 tones and average Productivity of the District is 13.24 t/hac.

3.3.3 Cropping Intensity

Cropping Intensity refers to the number of crops grown in an area during a particular year. It is the extent to which the net sown area is redropped or re-sown (Singh 1997) Intensive use of land for cropping acts as an indicator of regional development. It is determined by cropping intensity which denotes the number of crops cultivated per unit area per year (Boyce.) Cropping intensity is the magnitude of net cropped area to its gross cropped area. It implies the number of crops raised in an arable area within the agricultural area. To

determine the intensity of crop, an important formula has been used which is that gross cropped area is divided by net sown area and the result is multiplied by 100. Mathematically, it may be written as:

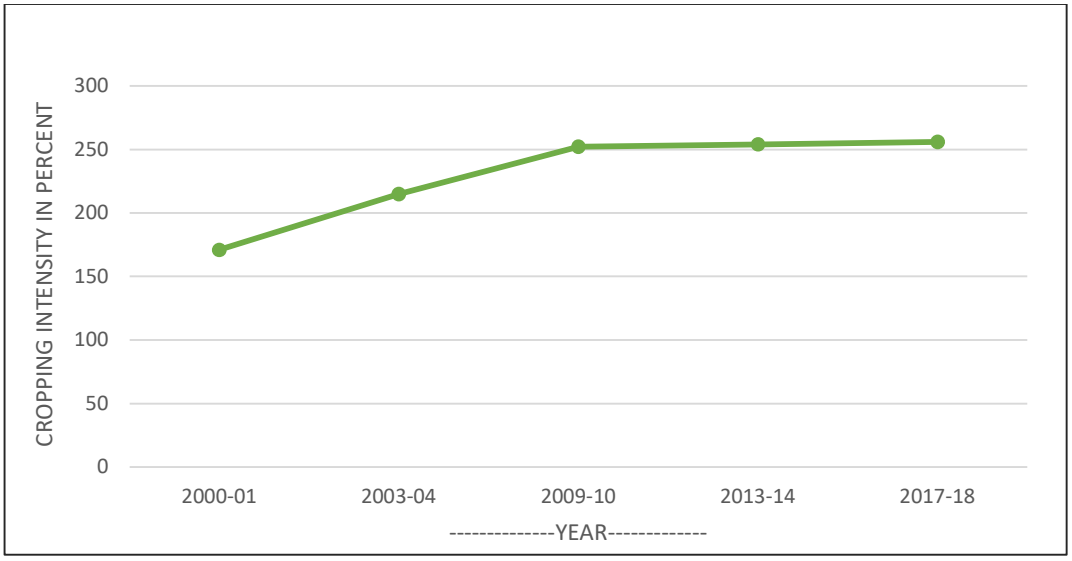
Cropping Intensity = (Gross Cropped Area / Net Cropped Area) x100

Table 3.6: Year-wise Cropping Intensity, Hugli District

Year	Gross Cropped Area (in Thousand Hector)	Net Cropped Area (in Thousand Hector)	Cropping Intensity in percent
2000-01	396.38	230.54	171 %
2003-04	478.51	225.17	215 %
2009-10	540.04	214.25	252 %
2013-14	539.37	212.58	254 %
2018-19	468.09	212.09	256 %

Source: Director of Agriculture, Govt of West Bengal.

Figure 3.17: Year wise cropping intensity of Hugli District



Source: Director of Agriculture, Govt of West Bengal.

Table 3.7: C. D. Block-wise Cropping Intensity of Hugli District.

Name of C. D Blocks	Cropping Intensity in percent (1994-1995)	Cropping Intensity in percent (1999-2000)	Cropping Intensity in percent (2004-05)	Cropping Intensity in percent (2017-2018)
Dhaniakhali	221.1	229.8	242	240
Panduah	193	186	190	260
Balagarh	198	202.5	248	265
Chinsurh - Mogra	180	200	200	255
Polba-Dadpur	187.6	176	193	255

Tarakeswar	281	162.6	279	290
Haripal	230	221.6	230	285
Singur	271	270	236	280
Jangipara	200	207.5	220	270
Chanditala-I	190	220.3	210	230
Chanditala-II	214	186.5	189	260
Serampur-Uttarpara	170	170	168	230
Goghat-I	176	167	159	240
Goghat-II	NA	NA	NA	245
Arambagh	238	214.5	221	250
Khanakul-I	220	216.3	238	245
Khanakul-II	204	225.4	205	240
Pursurah	281	280	302	260

Source: Annual action plan on Agriculture 2019-20.

The increasing rate of cropping intensity is not uniform and shows a disparity in block level. The block level rate of cropping intensity in different years is displayed in the above table. In the year 1994-95, Low cropping intensity (below 200%) was found in 7 blocks, viz, Serampore-Uttarpara (170%), Goghat (176%), Chinsurh-Mogra (180%), Polba-Dadpur (187.6%), Chanditala-I (190%), Panduah (193%), Balagarh (198%).

Moderate intensity (200-240%) was registered in Jangipara (200%), Khanakul-II (204%), Khanakul-I (220%), Chanditala-II (214%), Dhaniakhali (221.1), Haripal (230%), Arambagh (238%). It was distinctly high at Pursurah (281%), Tarakeswar (281%), and Singur (271%) in 1994-2000. In the year 1999-2000, six (6) blocks (Dhaniakhali, Balagarh, Chinsurh-Mogra, Jangipara, chanditala-I, Khanakul-II) improved their cropping intensity position from low to high, while remaining 5 blocks (Panduah, Polba-Dadpur, Chanditala-II, Goghat-I, Tarakeswar) lost their former position and got degraded. The Block Serampore-Uttrpara keeps its position unchanged. Haripal, Arambagh and Khanakul belong to the moderate group (200-240%). Positive changes in Cropping Intensity have been recorded in the district, except for 4 blocks (Singur, Chanditala-I, Serampore-Uttarpara, Khanakul-II) in a year, 2004-05. But slower progress in agriculture sector was shown in some urbanized blocks namely Singur, as a consequence of Singur movement. Pursurah recorded the highest cropping intensity (302%) at this time. Due to Land reforms, improved irrigation management, using of H.Y.V seeds and chemical fertilizer and application of high agricultural management training, and mechanization in the sector, positive cropping intensity was recorded in every block of the district in 2017-18. Total area came into a very stable position in agriculture sector cropping intensity of Serampore -Uttarpara and Chanditala blocks are a little bit slower than others due to their urbanized position.

Table 3.8: C. D. Block-wise cropping intensity classification

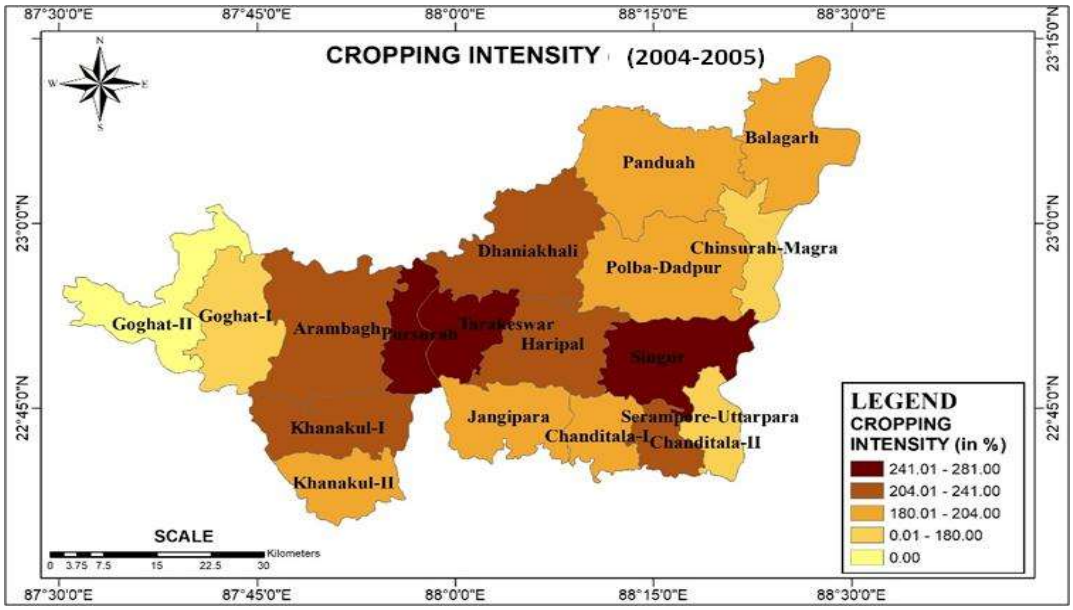
Catagory	1994-95	1999-2000	2004-05	2017-18
High (Above 240%)	Tarakeswar, Singur, Pursurah	Singur,Pursurah	Tarakeswar , , Pursurah, Dhaniakhali, Balagarh	Tarakeswar, Pursurah, Dhaniakhali, Balagarh, Singur, Haripal , Jangipara , Arambagh, Khanakul-I, Khanakul-II, Chinsurh-Mogra, Panduah, Polba-Dadpur, Chanditala-II, Goghat-I
Moderate (200%-240%)	Dhaniakhali, Haripal, Jangipara, Chanditala-II , Arambagh , Khanakul-I , Khanakul-II	Dhaniakhali, Chinsurh-Mogra, Haripal , Jangipara , Chanditala-I , Arambagh , Khanakul-I , Khanakul-II	Singur,Haripal , Jangipara , Chanditala-I , Arambagh , Khanakul-I , Khanakul-II, Chinsurh-Mogra,	Serampore-uttarpara, Chanditala-I
Low (Below 200%)	Panduah, Balagarh, Chinsurh-Mogra, Serampore-Uttarpara, Goghat-I and II	Chanditala-II, Serampore-Uttarpara, Goghat-I and II	Panduah, Polba-Dadpur, Chanditala-II, Serampore-Uttarpara, Goghat-I	

Source: Director of Agriculture, Govt of West Bengal.

Cropping Intensity plays an important role in agricultural development of any region. The scope for expanding net shown area has already reached a saturation level and potential for raising the yield nearly exhausted in many crops and areas, stepping up crop diversification will be necessary to augment agricultural production.

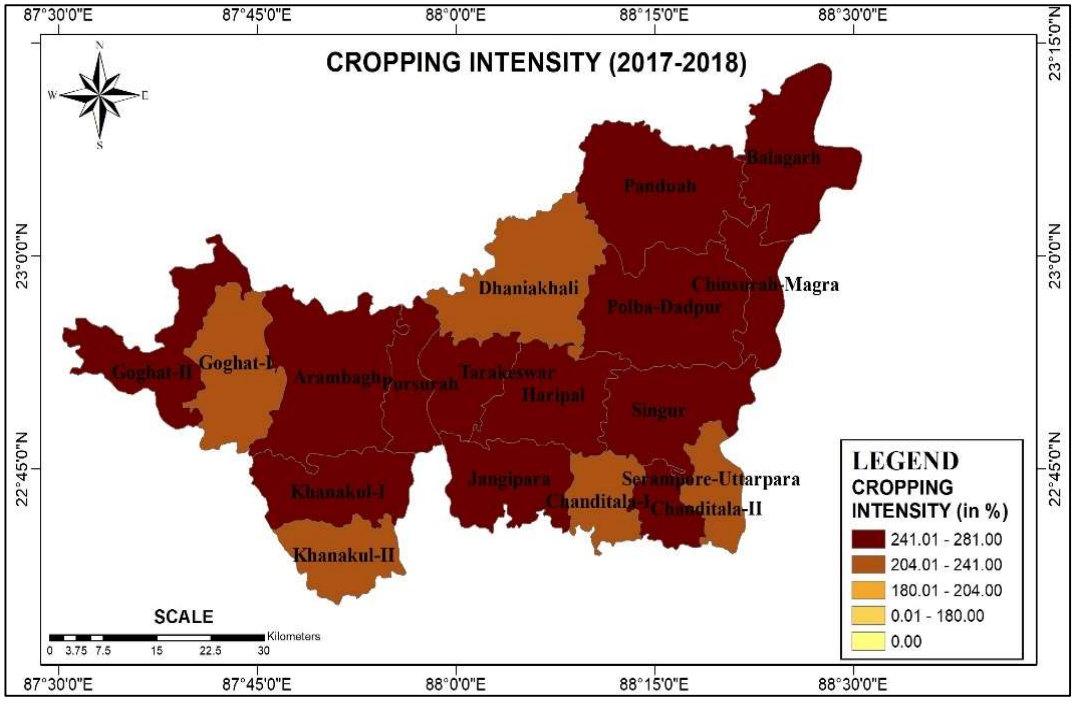
The Cropping intensity in Hugli District has shown remarkable changes in the last few years. The gross cropped area has increased sharply from 396.38 thousand hectares in 2000-01 to 542.68 thousand hectares in 2010-11 but then it decreased to 539.37 thousand hectares in 2013-14. The net cropped area has fallen to 212.58 thousand hectares from 230.54 thousand hectares during this time. Due to the promotion of land intensive technologies, the cropping intensity has increased from 171 to 255 in this period.

Figure 3.18: Cropping Intensity of Hugli District (2004-05)



Source: CADP, Hugli 2017-2018.

Figure 3.19: Cropping Intensity of Hugli District (2017-18)



Source: CADP, Hugli 2017-2018.

3.3.4 Irrigation

Irrigation is essential for the artificial application of water to overcome deficiencies in rainfall for growing crops (Cantor, L.M 1967). Nearly 70% of the country's gross cropped area depends exclusively on rainfall, which is unevenly distributed both in respect of time and space (Mamoria, C.B, 1999).

The district is characterized by humid tropical climate with an average precipitation of 1279.7 mm, over 70% of rainfall is received during the monsoon season extending from June to September. The main source of irrigation in the district is river Bhagirathi, Damoder and many tributaries. Geographically the tract is considered to be low delta region. This has resulted in several pockets of low-lying areas being subjected to floods and water logging.

The district has well-developed irrigation infrastructure facilitating intensive agriculture with a higher cropping intensity of about 241% compared to the state average of 184%. Out of the total cultivated area of 2188717 ha, 62% area is covered by irrigation. Ground water forms the major source of irrigation accounting for 1.68 lakh ha (53%) of the gross irrigated area of 3.16 lakh ha. The area developed in extensive irrigation due to small and large number of perennial rivers, the alluvial low land, favorable rain-fall conditions, except during the winter months and a large number of percolations from the rivers, canals and distributaries and intake of rain waters which contribute to the subsoil water table for lift irrigation. The area under different irrigation sources is given below.

The Irrigation System in the district is served by tank, high density tube-well (HDTW), medium density tube-well (MDTW), low density tube well (LDTW), shallow deep tube well (SDW) and river lift irrigation (RLI). While coverage by tank irrigation has multiplied by almost 2.5 times in the considered years (as in Figure 3.20), that by STW has decreased. Coverage by LDTW has remained the same while that by others has increased only moderately.

Figure 3.20 indicates the sources of irrigation and the amount of irrigated land. Figure 3.20 also reveals the dominant role of shallow tube well from 1998 to 2007 because near about 47% of land was irrigated by this during this period. Except for the year 2004, from 1999-2007 the average irrigated land was 330250 hectares. In 2008 irrigation had suffered due to severe drought situation. Then gradually irrigated area decreased, majorly decreasing in the year 2010-11. In the year 2013-14, the total irrigated area was 24430 hectares. The dominant role of shallow tubewell decreased from 2008-09 and Canal irrigation has taken

over its place. From 2008-09 to 2013-14, an average of 26% area was irrigated by Shallow tube well and 42% area was irrigated by Govt. Canal.

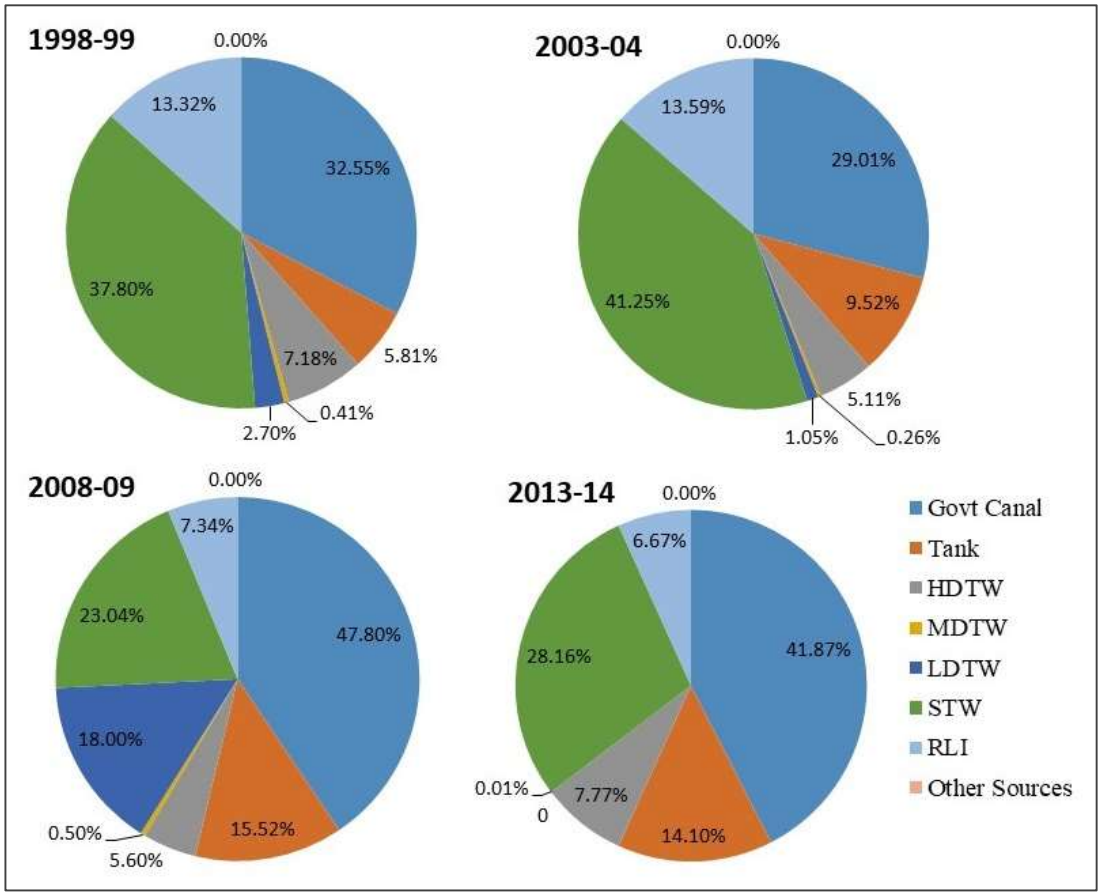
3.3.5 Intensity of Irrigation

The Intensity of irrigation varies in different parts of the district. For measuring the intensity of irrigation, an Index has been prepared with the technique as:

Intensity of Irrigation = GI / GSx 100

GI is the Gross Irrigated Area and GS is the Gross Cropped Area

Figure 3.20: Different sources of irrigation



Source: District Statistical Hand Book (2001, 2006, 2011 & 2015).

(HDTW- High density tube well, MDTW- Medium density tube well, LDTW- Low density tube well, STW- Shallow tube well, RLI- River lift irrigation).

Table 3.9: Irrigation Intensity of Hugli District

Regions	Intensity of Irrigation on percentage to gross cropped area	Name of the blocks (2003-04)	Name of the blocks (2018-19)
Low	Below 50	Chanditala-II	Goghat –I, Goghat – II
Medium	50 -70	Srerampur-Uttarpara, Jangipara, BalagarhChinsurh – Mogra, Polba-Dadpur, Haripal	Polba – Dadpur, Chanditala-II, Tarakeswar, Khanakul – I
High	70 -90	Pandua, Dhaniakhali, Singur, Arambagh, Pursurah, Goghat –I, Goghat-II, Khanakul-I,Khanakul-II	Balagarh, Singur, Arambagh, Khanakul-II, Dhaniakhali, Haripal
Very High	90 above	Chanditala – I, Tarakeswar	Chinsurh – Mogra, Serampore-Uttarpara, Pandua, Jangipara, Pursarh ,Chanditala-I

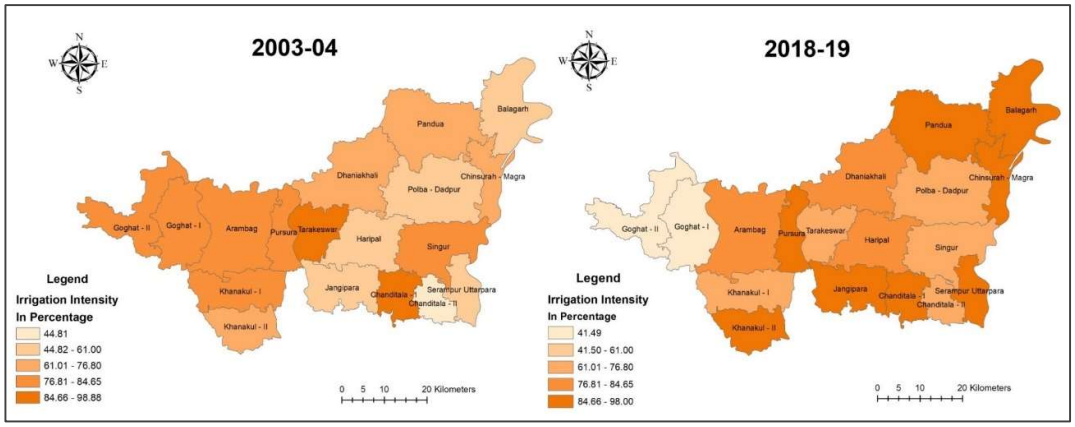
Source: Computed by author based on data collected from CADP, Hugli.

Low intensity of irrigation was seen in the blocks of Chanditala II in 2003-04 and Goghat –I and Goghat-II in 2018-19. Moderate intensity of irrigation was found in Serampore-Uttarpara, Jangipara, Balagarh, Chinsurh-Mogra, Polba-Dadpur and Haripal in 2003-04. It is also found in also Polba-Dadpur, Chanditala-I, Tarakeswar and Khanakul-I C.D block in 2018-19, where the percentage of index varies from 50-70 percent. High intensity of irrigation has been visible in the blocks of Panduah, Dhaniakhali, Singur, Arambagh, Pursurah, Goghat-I, Goghat-II, Khanakul-I, Khanakul-II in 2003-04 and Balagarh, Singur, Arambagh, Khanakul-Ii, Dhaniakhali and Haripal in 2018-19. In these blocks intensity of ierrigation varies from 70-90 percent. Very high intensity of irrigation has been seen in only two blocks (Chanditala-I, Tarakeswar) in 2003-04 and six C.D blocks (Chinsurh-Mogra, Serampore-Uttarpara, Panduah, Jangipara, Pursurha and Chanditala –I) in 2018-19.

There has been a positive change in the intensity of irrigation shown in the study area (Table 3.10). Highest changes have been marked in the block Serampore-Uttarpara (41.15%). In Jangipara block the change has been 34.86, in Balagarh C.D block the change has been (30.37%) and in Chinsurh-Mogra block the change has been (27.63%). Moderate change varies from 12-24 percent and has been restricted in the blocks Khanakul-I, Pursurah, Haripal, Chanditala-II, Panduah, Khanakul –I . Low change below 12 percent

has been found in the blocks Polba-Dadpur, Dhaniakhali, Chanditala-I, Singur, Arambagh, Goghat –I, Goghat-II, and Khanakul–II.

Figure 3.21: Irrigation Intensity of Hugli District



Source: CADP, Hugli 2017-2018.

Table 3.10: Relative changes in Irrigation Intensity of Hugli District

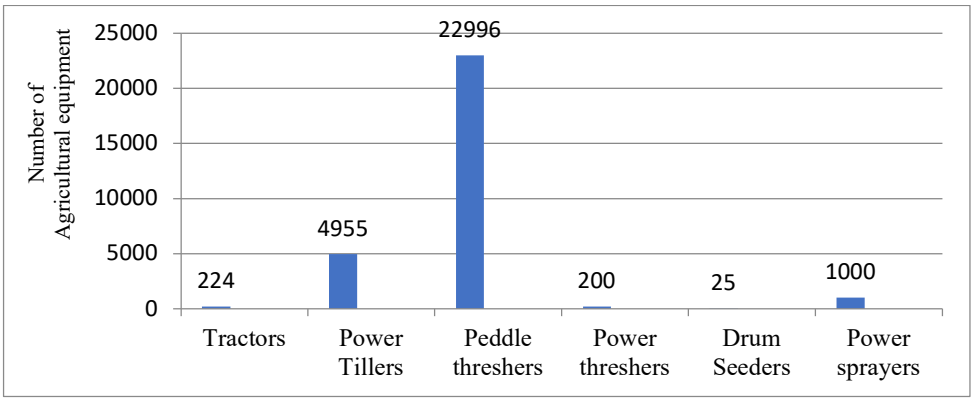
Region	Percent increase	Name of the C.D Block
Low	Below 12	Polba-Dadpur, Dhaniakhali, Chanditala-I, Singur, Arambagh, Goghat –I, Goghat-II, Khanakul – II.
Medium	12- 24	Khanakul-I, Pursurah, Haripal, Chanditala-II, Panduah, Khanakul –I
High	24-36	Jangipara, Balagarh, Chinsurh-Mogra
Very High	Above 36	Serampore-Uttarpara

Source: Computed by author based on data collected from CADP, Hugli (2017-18).

3.3.6 Agriculture implements and fertilizer consumption

Agriculture mechanization in the district is high due to intensive agriculture. Use of implements increases the efficiency of agricultural production. Farmers use agricultural equipment such as wooden sprayers, weeders, plough, hoe, paddy thresar, pump set etc for production. Usage of Power tillers for farming operations is more predominant compared to tractors. Predominance of small and marginal farmers and the average land holding of 0.66 ha limit the scope of owning the farm equipment at individual farmer level (CDAP, Hugli).

Figure 3.22: Different types of Agricultural implement use in the Hugli District



Source: CDAP, Hugli 2017-18[13].

3.3.7 Fertilizer

Fertilizer is considered to be one of the most critical inputs as far as Agriculture is concerned. Well-managed irrigation essentially needs adequate dosages of fertilizer to get optimum yield. Due to dependence on continuous use of chemical fertilizers continuously for a long-time soil health is being deteriorated day by day. As a result, a negative growth rate is observed in agricultural production. Therefore, an attempt is being made to augment nutrient status of soil by the addition of organic manure or bio-fertilizer. As per govt records, less than 10% of the area is covered in the organic manure application. Fertilizer is applied mostly for Rabi season crop, about 80% of the fertilizer consumption is during October – December period. Farmers cannot give balanced fertilizer to the land as they need due to delays of supply and availability of inadequate capital credit facilities.

Being an intensive agriculture district, the consumption of fertilizer is high in the district. The above table shows the consumption of different fertilizers from 1991-92 to 2013-14. The consumption of fertilizer has been escalating year after year. In 1991-92, it was 74.4 thousand tons, in 2001-02; it was 107.1 and in 2011-12 it increased to 154.44 thousand tons. But it decreased in 2013-14 from 153.6 thousand tons to 107.8 thousand tons. The amount of Nitrogen used in fertilizers has been increasing sharply whereas the use of Phosphate (P) and Potash (K) decreased from 1991-92 though it continued to grow again during the first couple of years of the millennium i.e. 2001-02 (Table No. 3.6 in Appendix-A).

[13] For details, please see Appendix-A (Table No. 3.5)

Chapter 4

Assessment of Land Use Transformation

Chapter 4

Assessment of Land Use Transformation

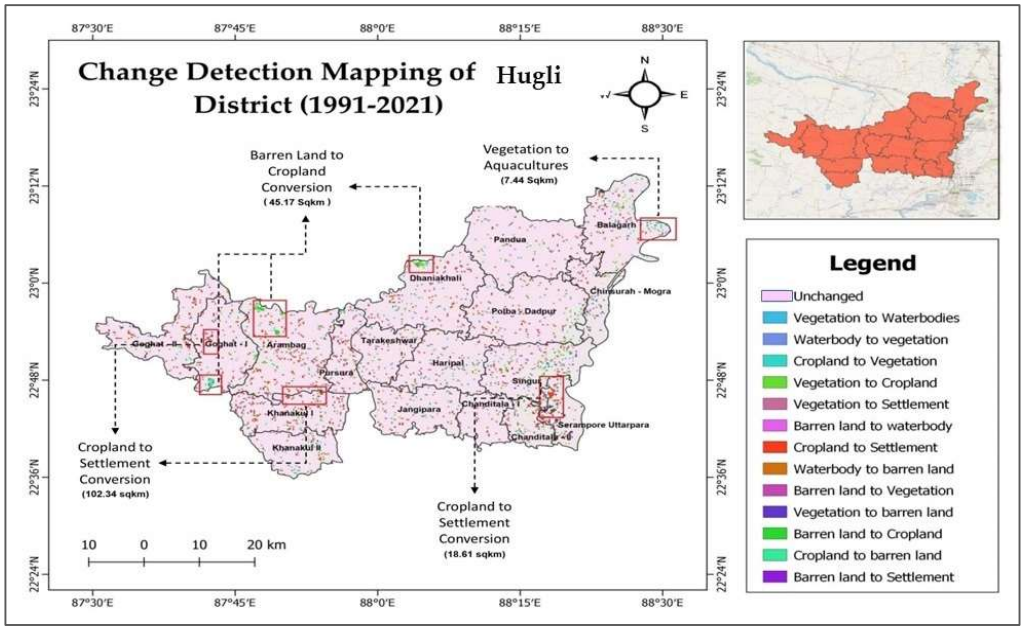
4.1 Introduction

Hugli district is characterized by a diverse landscape comprising urban areas, agricultural fields, forests, waterbodies, and industrial zones. The district is situated along the Hugli River, which is a lifeline for irrigation and transportation, contributing to its socio-economic significance. However, rapid urbanization, industrialization, population growth, and agricultural practices have pressured the district's land resources, leading to significant changes in its land use and cover patterns. The period from 1991 to 2021 witnessed a transformation in Hugli district's land use dynamics. The expansion of urban areas and industrial zones has resulted in the conversion of agricultural lands and natural vegetation. The establishment of industrial units, infrastructure development, and urban sprawl have altered the landscape, leading to the loss of valuable natural habitats and agricultural land. The construction of roads, highways, and other transportation networks has also impacted the district's land cover patterns. Agriculture, which has been a dominant land use in Hugli district, has also changed during this period.

The adoption of modern agricultural practices, including the use of high-yielding crop varieties, irrigation facilities, and mechanization, has led to changes in cropping patterns and land use intensification. Traditional agricultural practices have been replaced by commercial farming, impacting the extent and distribution of agricultural land in the district. To comprehensively assess the land use changes in Hugli district, remote sensing and geospatial analysis techniques have been widely employed. Satellite imagery from sensors, such as Landsat, have been utilized to derive land cover classifications and monitor changes over time. Geospatial tools and software, including Geographic Information Systems (GIS), have facilitated spatial analysis and mapping of land use dynamics. This background study highlights the significance of understanding the land use changes in Hugli district from 1991 to 2021. This chapter analyses land use change detection of Hugli district and C. D. block-wise land use transformation with the help of change matrix statistics. It underscores the need for comprehensive research and monitoring to evaluate the drivers, impacts, and implications of these changes on the district's environment, biodiversity, and socio-

economic conditions. Such knowledge will support effective land management strategies, conservation efforts, and sustainable development planning in the region.

Figure 4.1: Land Use change detection map of Hugli District from 1991 to 2021



Source: Based on Landsat Imageries of 1991 and 2021.

4.2 Land Use change detection analysis

The overall study period from 1991 to 2021 experienced a significant change in the land use pattern of the Hugli District of West Bengal. Post Classification Comparison (PCC) is considered a most prolific comprehensive method for change detection analysis (Debnath et al., 2017) where each particular imagery has been classified independently, then overlaid and compared using the pixel-by-pixel method, and thus the Land use/land cover change map, also called as 'From-to' map has been established (Bouziani et al., 2010; Henits et al., 2016). To quantify the alteration of the land use pattern of Hugli District, a change map has been prepared by overlaying the maps of 1991 and 2021. The change map has been displayed as a 'From-to' map. This change map gives information about the unchanged areas of defined land use categories and also altered areas from one category to another which have been depicted in Figure 4.1.

It is evident from the 'From-to' map of the entire study period (30 years) from 1991 – 2021 (Figure 4.1) that agricultural land is the major occupier in comparison to other land use categories of Hugli District. Observing the nature of data, it has been noticed that the

quantity of the area that has been transformed into built-up areas from different land use categories is significantly high.

4.3 C. D Block-wise analysis of land use changes

4.3.1 Arambagh C.D Block

There has been no observed change from Waterbody to Vegetation, indicating that areas covered by waterbodies have remained stable without converting into vegetated areas. The change from Waterbody to Agricultural Land accounts for 3.72 square units. This suggests the conversion of waterbodies into agricultural land in certain areas. There have been no observed changes from Waterbody to Settlement, indicating that waterbody areas have not transformed into settlement areas. There have been no observed changes from Waterbody to Barren Land, indicating the stability of waterbody areas without transformation into barren land.

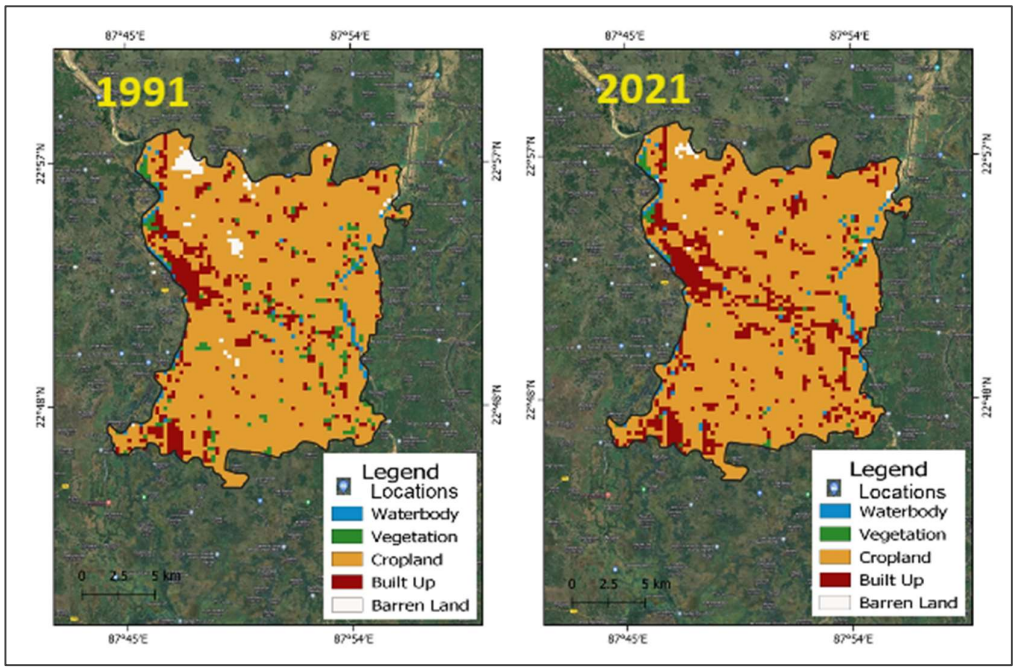
There has been a change of 1.48 sq. km from Vegetation to Waterbody. This suggests the conversion of vegetated areas into waterbodies. The change from Vegetation to Agricultural Land accounts for 26.81 sq. km. This indicates the conversion of vegetated areas into agricultural land. There has been a change of 52.87 sq. km from Vegetation to Settlement. This suggests the transformation of vegetated areas into human settlement areas. There has been no observed change from Vegetation to Barren Land, indicating that vegetated areas have not transformed into barren land.

There has been a change of 14.89 sq. km from Agricultural Land to Waterbody. This suggests the conversion of agricultural land into waterbodies. There has been a change of 5.21 sq. km from Agricultural Land to Vegetation. This implies the transition of agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 111.71 sq. km. This indicates the conversion of agricultural land into human settlement areas. The change from Agricultural Land to Barren Land amounts to 5.21 sq. km. This suggests the conversion of agricultural land into barren land.

There have been no observed changes from Settlement to Waterbody, indicating that settlement areas have not transformed into waterbodies. There has been no observed change from Settlement to Vegetation, indicating the stability of settlement areas without transformation into vegetated areas. There has been a change of 9.68 sq. km from Settlement to Agricultural Land. This suggests the conversion of settlement areas into agricultural land.

There have been no observed changes from Settlement to Barren Land, indicating the stability of settlement areas without transformation into barren land.

Figure 4.2: Land use changes of Arambagh C.D Block



Source: Based on Landsat Imageries & Google Earth[1].

There has been a change of 0.74 sq. km from Barren Land to Waterbody. This suggests the transformation of barren land into waterbodies. There have been no observed changes from Barren Land to Vegetation, indicating the stability of barren land without transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 40.21 sq. km. This indicates the conversion of barren land into agricultural land. There have been no observed changes from Barren Land to Settlement, indicating the stability of barren land without transformation into settlement areas.

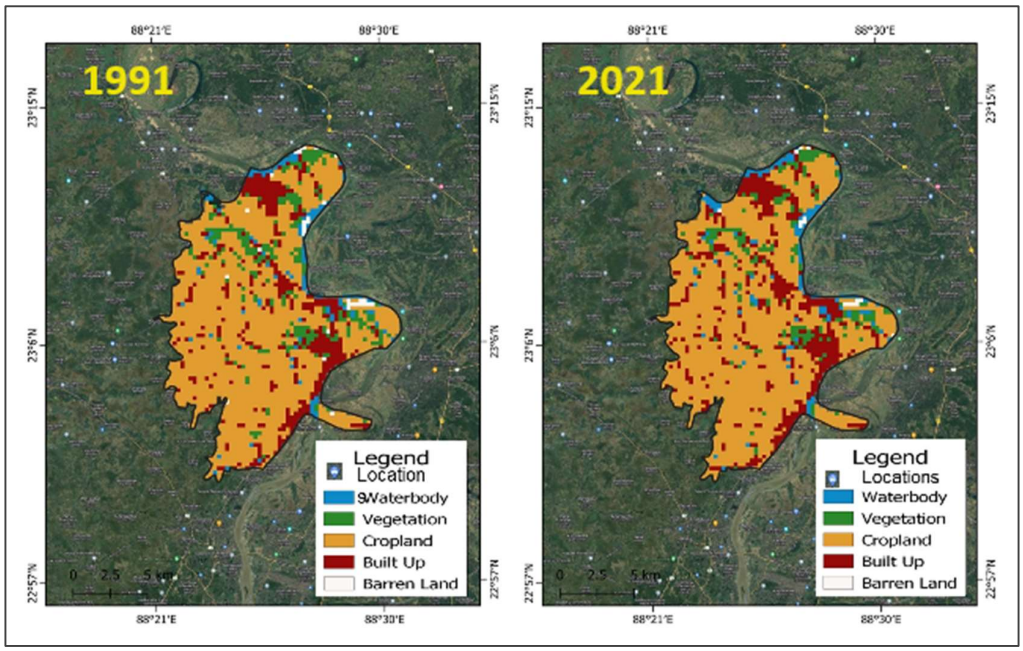
4.3.2 Balagarh C.D Block

There has been a change of 0.74 sq. km from Waterbody to Vegetation. This suggests that certain areas previously covered by waterbodies have experienced a transition and are now covered by vegetation. This change may be the result of natural processes or human activities that have led to the growth of vegetation in these areas. Additionally, there has been a change of 5.21 sq. km from Waterbody to Agricultural Land. This indicates a significant conversion

[1] For details, please see Appendix-A (Table No. 4.1)

of waterbodies into agricultural land over the specified period. Human interventions such as land clearing and irrigation may have played a role in facilitating this transformation.

Figure 4.3: Land use changes of Balagarh C.D Block



Source: Based on Landsat Imageries & Google Earth[2].

There have been no observed changes from Vegetation to Waterbody, indicating that areas covered by vegetation have remained stable without conversion into waterbodies. However, there has been a change of 27.55 sq. km from Vegetation to Agricultural Land. This implies the expansion of agricultural activities into areas previously covered by vegetation. Additionally, there has been a change of 32.02 sq. km from Vegetation to Settlement, indicating the encroachment of human settlements into vegetated areas.

There have been no observed changes from Agricultural Land to Waterbody, indicating that areas under agriculture have not transformed into waterbodies. However, there has been a change of 16.38 sq. km from Agricultural Land to Vegetation, indicating a decrease in agricultural land and a corresponding increase in vegetated areas. Moreover, there has been a change of 37.98 sq. km from Agricultural Land to Settlement, suggesting the conversion of agricultural land for human settlement. Lastly, there has been a change of 1.48 sq. km

[2] For details, please see Appendix-A (Table No. 4.2)

from Agricultural Land to Barren Land, indicating a small portion of agricultural land becoming barren over time.

There has been a change of 3.72 sq. km from Settlement to Vegetation, implying the expansion of vegetation within previously settled areas. Additionally, there has been a change of 5.21 sq. km from Settlement to Agricultural Land, indicating the conversion of settlements into agricultural areas.

There has been a change of 2.97 sq. km from Barren Land to Vegetation, suggesting the growth of vegetation in areas previously categorized as barren land. Moreover, there has been a change of 5.95 sq. km from Barren Land to Agricultural Land, indicating the conversion of barren land into agricultural areas. Additionally, there has been a change of 3.72 sq. km from Barren Land to Settlement, suggesting the transformation of barren land into human settlement areas. Finally, there has been no observed change from Barren Land to Barren Land, indicating the stability of barren land areas without significant transformations.

4.3.3 Chanditala-I C.D Block

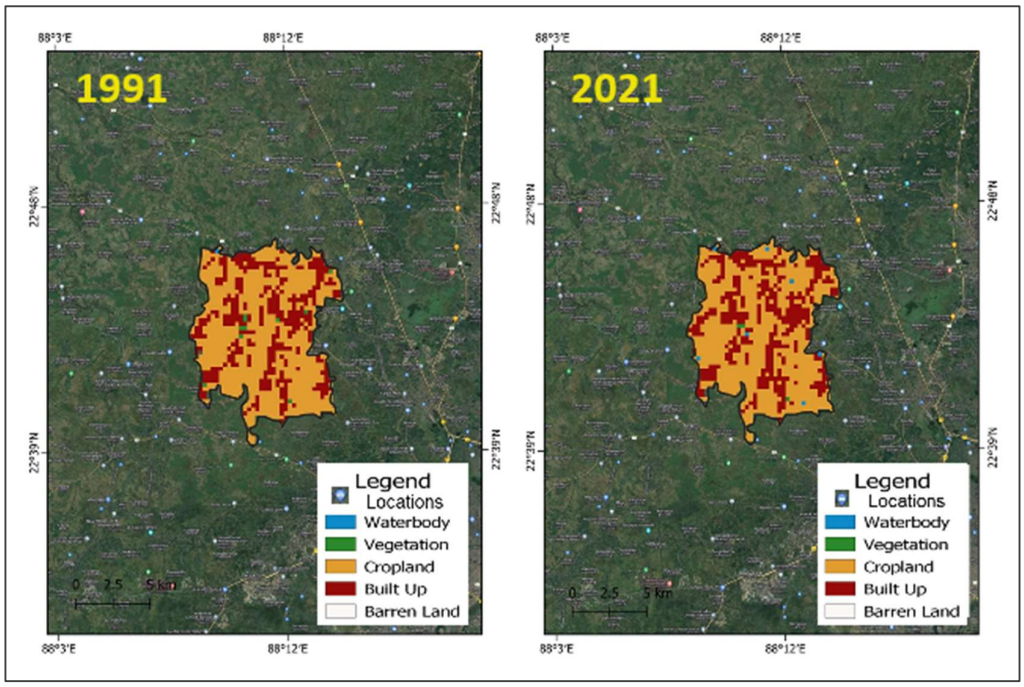
There has been no observed change from Waterbody to Vegetation, indicating that areas covered by waterbodies have remained stable without converting into vegetated areas. There have been no observed changes from Waterbody to Agricultural Land, indicating the stability of waterbody areas without transformation into agricultural land. There have been no observed changes from Waterbody to Settlement, indicating that waterbody areas have not transformed into settlement areas.

There has been no observed change from Vegetation to Waterbody, indicating the stability of vegetated areas without transformation into waterbodies. The change from Vegetation to Agricultural Land accounts for 14.89 sq. km. This suggests the conversion of vegetated areas into agricultural land. There has been a change of 17.23 sq. km from Vegetation to Settlement. This suggests the transformation of vegetated areas into human settlement areas.

There have been changes of 4.68 sq. km. areas observed from Agricultural Land to Waterbody, indicating that areas under agricultural land have not transformed into waterbodies for commercial fishing cultivation. There has been no observed change from Agricultural Land to Vegetation, indicating the stability of agricultural land without transformation into vegetated areas. The change from Agricultural Land to Settlement

accounts for 28.53 sq. km. This indicates the conversion of agricultural land into human settlement areas.

Figure 4.4: Land use changes of Chanditala-I C.D Block



Source: Based on Landsat Imageries & Google Earth[3].

There have been no observed changes from Settlement to Waterbody, indicating that settlement areas have not transformed into waterbodies. There have been no observed changes from Settlement to Vegetation, indicating the stability of settlement areas without transformation into vegetated areas. There has been a change of 6.82 sq. km from Settlement to Agricultural Land. This suggests the conversion of settlement areas into agricultural land.

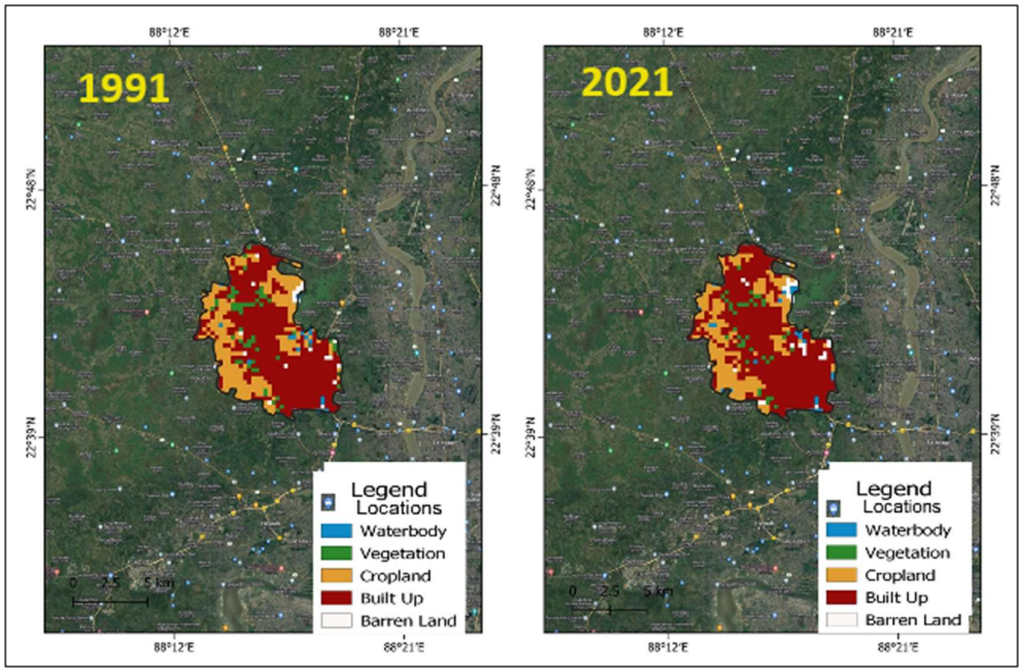
4.3.4 Chanditala-II C.D Block

There have been no observed changes from Waterbody to vegetation, indicating that waterbodies have not transformed into vegetation. The change from Waterbody to Agricultural Land accounts for 7.44 sq. km. This indicates the transformation of waterbodies into agricultural land. The change from Waterbody to Settlement accounts for 2.34 sq. km. There has been no change from Vegetation to Waterbody, indicating the stability of vegetated areas without transformation into waterbodies. The change from Vegetation to Agricultural

[3] For details, please see Appendix-A (Table No. 4.3)

Land accounts for 5.13 sq. km. This indicates the conversion of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 14.50 sq. km. This suggests the transformation of vegetated areas into human settlement areas.

Figure 4.5: Land use changes of Chanditala-II C.D Block



Source: Based on Landsat Imageries & Google Earth[4].

There has been no change from Agricultural Land to Waterbody. The change from Agricultural Land to Vegetation accounts for 4.89 sq. km. This suggests the transition of agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 30.88 sq. km. This indicates the conversion of agricultural land into human settlement areas. The change from Agricultural Land to Barren Land accounts for 0.37 sq. km. This suggests that a small amount of agricultural land have been converted into barren land.

The change from Settlement to Vegetation accounts for 2.79 sq. km. This indicates the transformation of settlement areas into vegetated areas. The change from Settlement to Agricultural Land accounts for 3.23 sq. km. This suggests the conversion of settlement areas into agricultural land.

[4] For details, please see Appendix-A (Table No. 4.4)

The change from Barren Land to Waterbody accounts for 1.34 sq. km. This suggests the transformation of barren land into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land without transformation into vegetated areas. The change from Barren Land to Settlement accounts for 4.89 sq. km. This suggests the conversion of barren land into settlement areas.

4.3.5 Chinsurah Mogra C.D Block

There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 0.74 sq. km. This suggests a minor conversion of waterbody areas into agricultural land. The change from Waterbody to Settlement accounts for 6.70 sq. km. This indicates a significant transformation of waterbody areas into settlement areas. There has been no observed change from Waterbody to Barren Land, indicating the stability of waterbody areas without transformation into barren land.

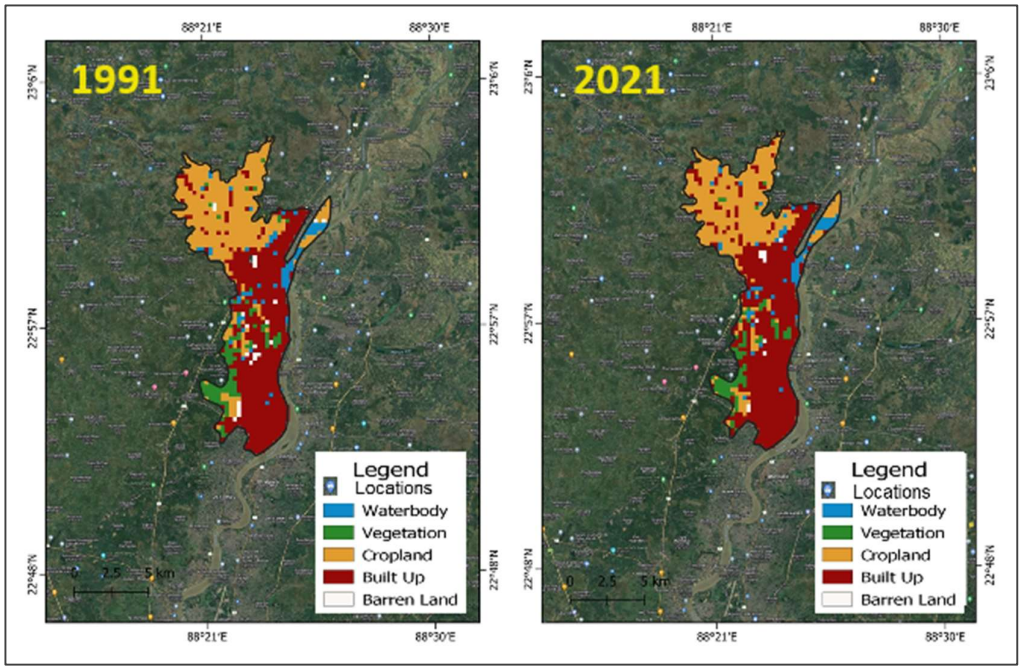
The change from Vegetation to Waterbody accounts for 0.74 sq. km. This suggests a minor conversion of vegetated areas into waterbodies. The change from Vegetation to Agricultural Land accounts for 5.21 sq. km. This indicates the transition of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 17.87 sq. km. This suggests the transformation of vegetated areas into settlement areas. There has been no observed change from Vegetation to Barren Land, indicating the stability of vegetated areas without transformation into barren land.

The change from Agricultural Land to Waterbody accounts for 3.72 sq. km. This suggests a minor conversion of agricultural land into waterbodies. The change from Agricultural Land to Vegetation accounts for 5.21 sq. km. This indicates the transformation of agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 17.12 sq. km. This suggests the conversion of agricultural land into settlement areas. There has been no observed change from Agricultural Land to Barren Land, indicating the stability of agricultural land without transformation into barren land.

The change from Settlement to Waterbody accounts for 0 square units, indicating no conversion of settlement areas into waterbodies. The change from Settlement to Vegetation accounts for 0.74 sq. km. This suggests a minor transformation of settlement areas into vegetated areas. The change from Settlement to Agricultural Land accounts for 4.46 sq. km.

This indicates the conversion of settlement areas into agricultural land. The change from Settlement to Barren Land accounts for 0.74 sq. km. This suggests a minor conversion of settlement areas into barren land.

Figure 4.6: Land use changes of Chinsurah Mogra C.D Block



Source: Based on Landsat Imageries & Google Earth[5].

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land without transformation into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land without transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 5.21 sq. km. This indicates the conversion of barren land into agricultural land. The change from Barren Land to Settlement accounts for 5.21 sq. km. This suggests a minor conversion of barren land into settlement areas.

4.3.6 Dhaniakhali C.D Block

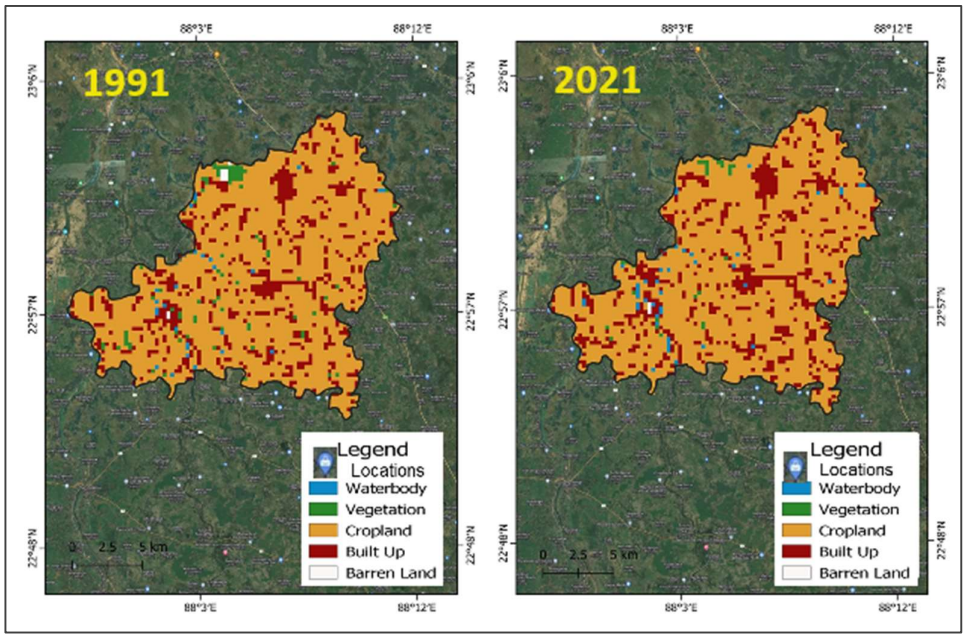
There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 2.23 sq. km. This suggests a minor conversion of waterbody areas into agricultural land. There has been no observed change from Waterbody

[5] For details, please see Appendix-A (Table No. 4.5)

to Settlement, indicating the stability of waterbody areas without transformation into settlement areas. There has been no observed change from Waterbody to Barren Land, indicating the stability of waterbody areas without transformation into barren land.

The change from Vegetation to Waterbody accounts for 2.23 sq. km. This suggests a minor conversion of vegetated areas into waterbodies. The change from Vegetation to Agricultural Land accounts for 28.30 sq. km. This indicates the transformation of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 23.08 sq. km. This suggests the conversion of vegetated areas into settlement areas. There has been no observed change from Vegetation to Barren Land, indicating the stability of vegetated areas without transformation into barren land. The change from Agricultural Land to Waterbody accounts for 10.42 sq. km. This suggests the conversion of agricultural land into waterbodies. The change from Agricultural Land to Vegetation accounts for 5.21 sq. km. This indicates the transformation of agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 63.30 sq. km. This suggests the conversion of agricultural land into settlement areas. There has been no observed change from Agricultural Land to Barren Land, indicating the stability of agricultural land without transformation into barren land.

Figure 4.7: Land use changes of Dhaniakhali C.D Block



Source: Based on Landsat Imageries & Google Earth[6].

[6] For details, please see Appendix-A (Table No. 4.6)

There has been no observed change from Settlement to Waterbody, indicating the stability of settlement areas without transformation into waterbodies. The change from Settlement to Vegetation accounts for 1.48 sq. km. This suggests a minor transformation of settlement areas into vegetated areas. The change from Settlement to Agricultural Land accounts for 29.79 sq. km. This indicates the conversion of settlement areas into agricultural land. The change from Settlement to Barren Land accounts for 0.74 sq. km. This suggests a minor conversion of settlement areas into barren land.

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land without transformation into waterbodies. The change from Barren Land to Vegetation accounts for 2.23 sq. km. This indicates the transformation of barren land into vegetated areas. The change from Barren Land to Agricultural Land accounts for 2.97 sq. km. This suggests a minor conversion of barren land into agricultural land. There has been no observed change from Barren Land to Settlement, indicating the stability of barren land without transformation into settlement areas.

4.3.7 Goghat-I C.D Block

There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 2.23 sq. km. This suggests a minor conversion of waterbody areas into agricultural land. The change from Waterbody to Settlement accounts for 1.48 sq. km. This indicates a slight transformation of waterbody areas into settlement areas. There has been no observed change from Waterbody to Barren Land, indicating the stability of waterbody areas without transformation into barren land.

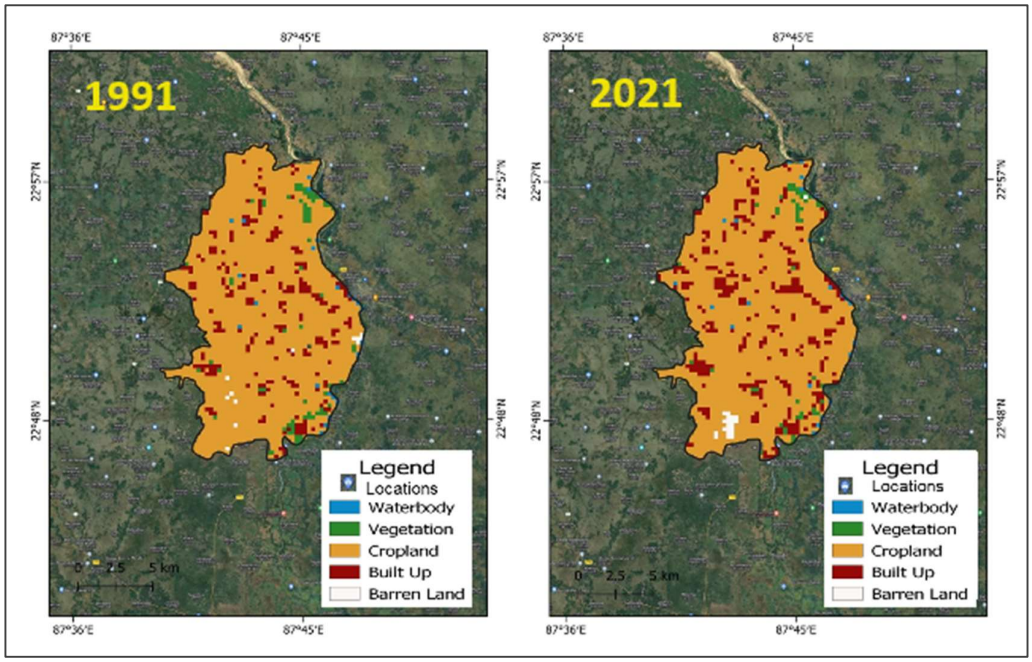
The change from Vegetation to Waterbody accounts for zero square units, indicating no conversion from vegetated areas to waterbodies. The change from Vegetation to Agricultural Land accounts for 7.44 sq. km. This indicates the transformation of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 12.66 sq. km. This suggests the conversion of vegetated areas into settlement areas. The change from Vegetation to Barren Land accounts for 0.74 sq. km. This indicates a minor conversion of vegetated areas into barren land.

The change from Agricultural Land to Waterbody accounts for 1.48 sq. km. This suggests a minor conversion of agricultural land into waterbodies. The change from Agricultural Land

to Vegetation accounts for 3.72 sq. km. This indicates the transformation of agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 67.77 sq. km. This suggests the conversion of agricultural land into settlement areas. The change from Agricultural Land to Barren Land accounts for 14.15 sq. km. This indicates the conversion of agricultural land into barren land.

There has been no observed change from Settlement to Waterbody, indicating the stability of settlement areas without transformation into waterbodies. There has been no observed change from Settlement to Vegetation, indicating the stability of settlement areas without transformation into vegetated areas. The change from Settlement to Agricultural Land accounts for 11.91 sq. km. This indicates the conversion of settlement areas into agricultural land. There has been no observed change from Settlement to Barren Land, indicating the stability of settlement areas without transformation into barren land.

Figure 4.8: Land use changes of Goghat-I C. D Block



Source: Based on Landsat Imageries & Google Earth[7].

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land without transformation into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land without

[7] For details, please see Appendix-A (Table No. 4.7)

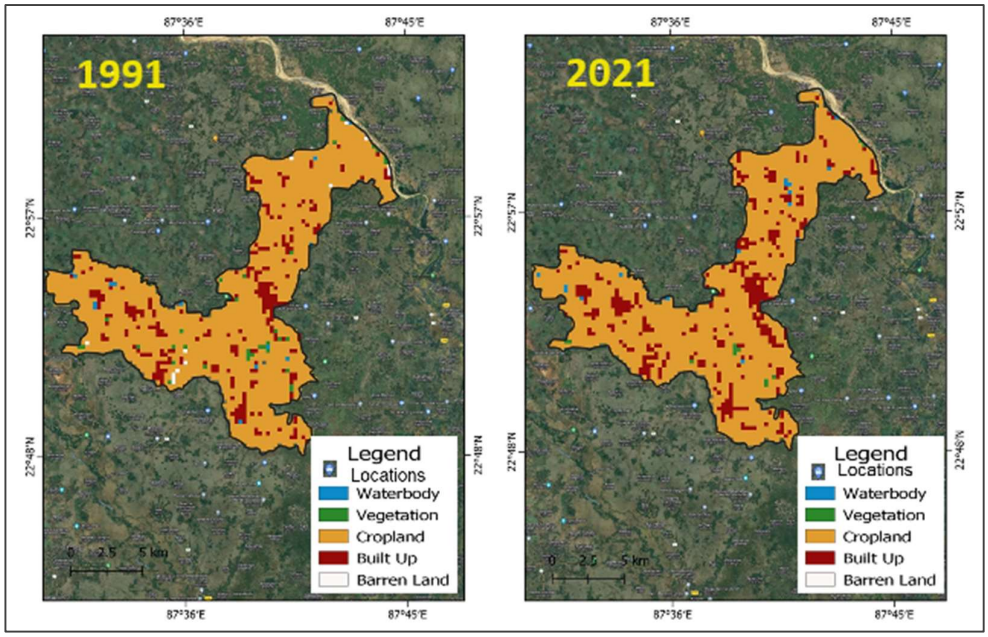
transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 7.44 sq. km. This suggests the conversion of barren land into agricultural land. There has been no observed change from Barren Land to Settlement, indicating the stability of barren land without transformation into settlement areas.

4.3.8 Goghat-II C.D Block

There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 2.13 sq. km. The change from Waterbody to Settlement accounts for 14.89 sq. km. This indicates a significant conversion of waterbody areas into settlement areas.

There has been no observed change from Vegetation to Waterbody, indicating the stability of vegetated areas without transformation into waterbodies. The change from Vegetation to Agricultural Land accounts for 26.61 sq. km. This indicates a significant transformation of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 7.03 sq. km. This suggests the conversion of vegetated areas into settlement areas.

Figure 4.9: Land use changes of Goghat-II C.D Block



Source: Based on Landsat Imageries & Google Earth[8].

[8] For details, please see Appendix-A (Table No. 4.8)

The change from Agricultural Land to Waterbody accounts for 1.92 sq. km. This suggests a minor conversion of agricultural land into waterbodies. The change from Agricultural Land to Vegetation accounts for 2.34 sq. km. This indicates a moderate transformation of agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 25.61 sq. km. This suggests a significant conversion of agricultural land into settlement areas.

There has been no observed change from Settlement to Waterbody, indicating the stability of settlement areas without transformation into waterbodies. There has been no observed change from Settlement to Vegetation, indicating the stability of settlement areas without transformation into vegetated areas. The change from Settlement to Agricultural Land accounts for 15.61 sq. km. This indicates the conversion of settlement areas into agricultural land.

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land without transformation into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land without transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 7.03 sq. km. This suggests the conversion of barren land into agricultural land. The change from Barren Land to Settlement accounts for 37.23 sq. km. This indicates the conversion of barren land into settlement areas.

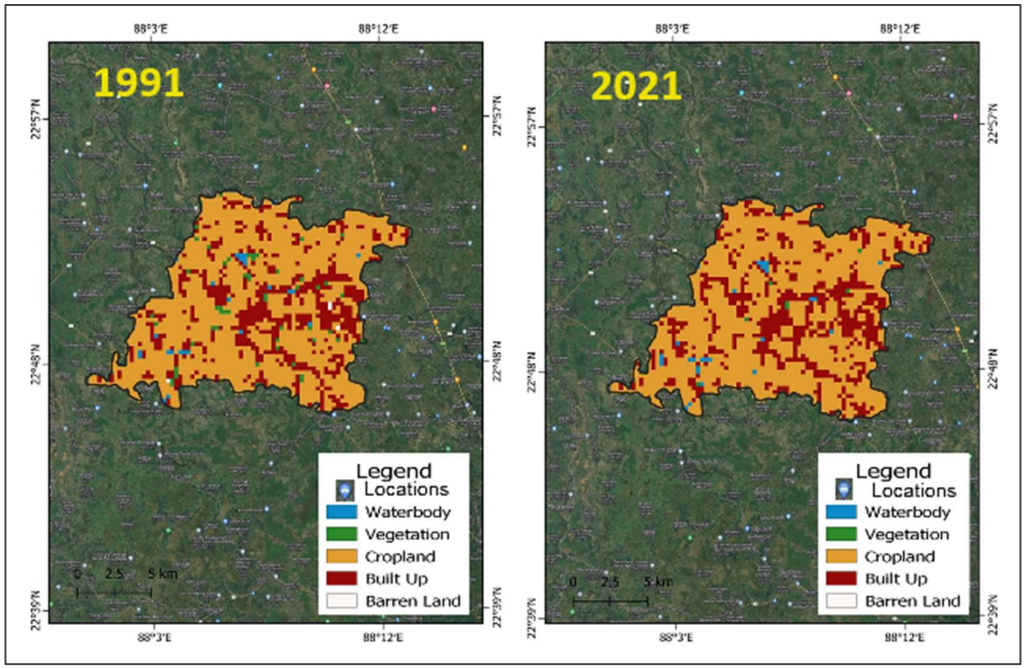
4.3.9 Haripal C.D Block

There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 0.74 sq. km. This suggests a minor conversion of waterbody areas into agricultural land. The change from Waterbody to Settlement accounts for 0.74 sq. km. This indicates a minor transformation of waterbody areas into settlement areas.

There has been no observed change from Vegetation to Waterbody, indicating the stability of vegetated areas without transformation into waterbodies. The change from Vegetation to Agricultural Land accounts for 11.91 sq. km. This indicates a moderate transformation of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 23.08 sq. km. This suggests the conversion of vegetated areas into settlement areas.

The change from Agricultural Land to Waterbody accounts for 1.48 square units. This suggests a minor conversion of agricultural land into waterbodies. There has been no observed change from Agricultural Land to Vegetation, indicating the stability of agricultural land without transformation into vegetated areas. The change from Agricultural Land to Settlement accounts for 40.96 sq. km. This suggests a moderate conversion of agricultural land into settlement areas.

Figure 4.10: Land use changes of Haripal C.D Block



Source: Based on Landsat Imageries & Google Earth[9].

The change from Settlement to Waterbody accounts for 2.23 sq. km. This indicates a minor conversion of settlement areas into waterbodies. There has been no observed change from Settlement to Vegetation, indicating the stability of settlement areas without transformation into vegetated areas. The change from Settlement to Agricultural Land accounts for 26.81 sq. km. This suggests the conversion of settlement areas into agricultural land.

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land without transformation into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land without transformation into vegetated areas. The change from Barren Land to Agricultural Land

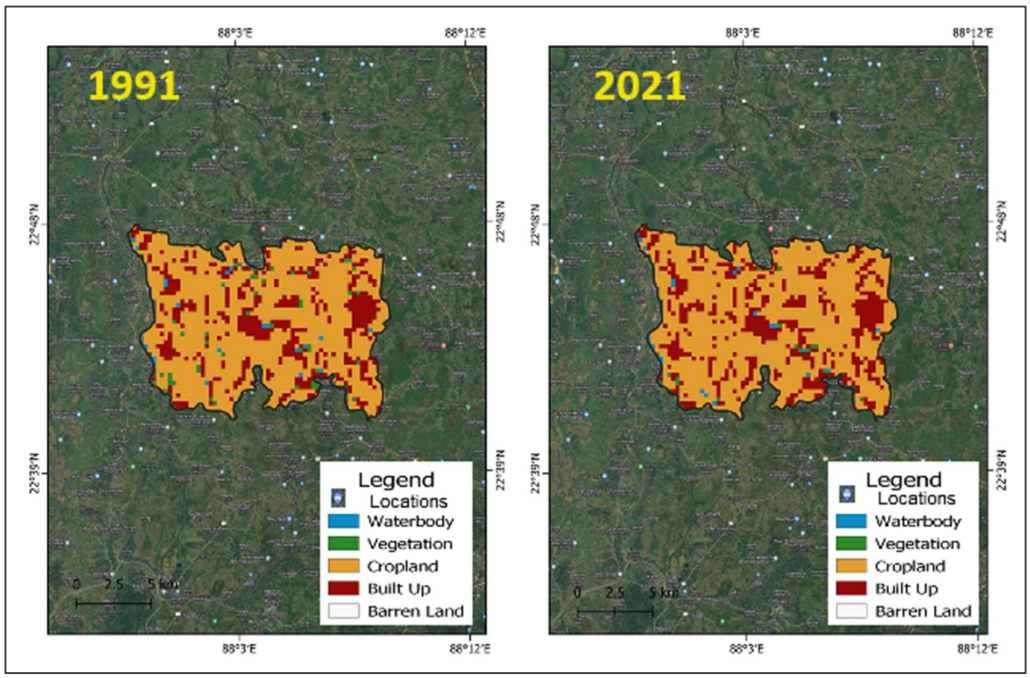
[9] For details, please see Appendix-A (Table No. 4.9)

accounts for 2.97 sq. km. This suggests a minor conversion of barren land into agricultural land. There has been no observed change from Barren Land to Settlement, indicating the stability of barren land without transformation into settlement areas.

4.3.10 Jangipara C.D Block

The change from Waterbody to Vegetation accounts for 0.74 sq. km. This indicates a minor conversion of waterbody areas into vegetated areas. The change from Waterbody to Agricultural Land accounts for 2.97 sq. km. This suggests a moderate conversion of waterbody areas into agricultural land. The change from Waterbody to Settlement accounts for 0.74 sq. km. This indicates a minor transformation of waterbody areas into settlement areas.

Figure 4.11: Land use changes of Jangipara C.D Block



Source: Based on Landsat Imageries & Google Earth[10].

The change from Vegetation to Waterbody accounts for 0.74 sq. km. This suggests a minor conversion of vegetated areas into waterbodies. The change from Vegetation to Agricultural Land accounts for 10.42 sq. km. This indicates a significant transformation of vegetated

[10] For details, please see Appendix-A (Table No. 4.10)

areas into agricultural land. The change from Vegetation to Settlement accounts for 15.64 sq. km. This suggests a substantial conversion of vegetated areas into settlement areas.

The change from Agricultural Land to Waterbody accounts for 2.23 sq. km. This indicates a minor conversion of agricultural land into waterbodies. There has been no observed change from Agricultural Land to Vegetation, indicating the stability of agricultural land without transformation into vegetated areas. The change from Agricultural Land to Settlement accounts for 39.47 sq. km. This suggests a moderate conversion of agricultural land into settlement areas.

The change from Settlement to Waterbody accounts for zero sq. km, indicating no observed transformation of settlement areas into waterbodies. The change from Settlement to Vegetation accounts for 1.48 sq. km. This suggests a minor conversion of settlement areas into vegetated areas. The change from Settlement to Agricultural Land accounts for 16.38 sq. km. This indicates a significant conversion of settlement areas into agricultural land.

4.3.11 Khanakhul-I C.D Block

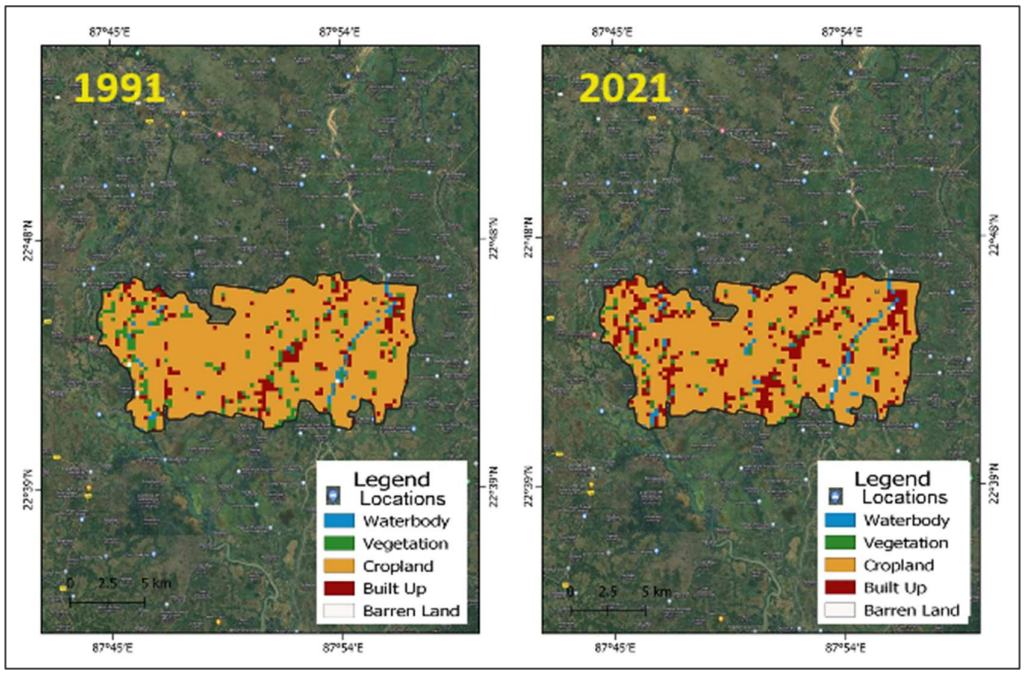
The change from Waterbody to Vegetation accounts for 2.23 sq. km. This indicates a moderate conversion of waterbody areas into vegetated areas. The change from Waterbody to Agricultural Land accounts for 13.40 sq. km. This suggests a significant conversion of waterbody areas into agricultural land. There has been no observed change from Waterbody to Settlement, indicating the stability of waterbody areas without transformation into settlement areas. The change from Waterbody to Barren Land accounts for 0.74 sq. km. This suggests a minor conversion of waterbody areas into barren land.

The change from Vegetation to Waterbody accounts for zero sq. km, indicating no observed transformation of vegetated areas into waterbodies. The change from Vegetation to Agricultural Land accounts for 17.12 sq. km. This indicates a significant conversion of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 52.87 sq. km. This suggests a substantial conversion of vegetated areas into settlement areas. There has been no observed change from Vegetation to Barren Land, indicating the stability of vegetated areas without transformation into barren land.

The change from Agricultural Land to Waterbody accounts for zero sq. km, indicating no observed transformation of agricultural land into waterbodies. The change from Agricultural Land to Vegetation accounts for 8.19 sq. km. This suggests a minor conversion of

agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 81.18 sq. km. This indicates a significant conversion of agricultural land into settlement areas. The change from Agricultural Land to Barren Land accounts for 0.74 sq. km. This suggests a minor conversion of agricultural land into barren land.

Figure 4.12: Land use changes of Khanakhul-I C.D Block



Source: Based on Landsat Imageries & Google Earth[11].

There has been no observed change from Settlement to Waterbody, indicating the stability of settlement areas without transformation into waterbodies. The change from Settlement to Vegetation accounts for 2.97 sq. km. This indicates a minor conversion of settlement areas into vegetated areas. The change from Settlement to Agricultural Land accounts for 8.93 sq. km. This suggests a minor conversion of settlement areas into agricultural land. There has been no observed change from Settlement to Barren Land, indicating the stability of settlement areas without transformation into barren land.

The change from Barren Land to Waterbody accounts for zero sq. km, indicating no observed transformation of barren land into waterbodies. The change from Barren Land to Vegetation accounts for zero sq. km, indicating no observed transformation of barren land into vegetated areas. The change from Barren Land to Agricultural Land accounts for 1.48 sq. km. This

[11] For details, please see Appendix-A (Table No. 4.11)

suggests a minor conversion of barren land into agricultural land. There has been no observed change from Barren Land to Settlement, indicating the stability of barren land areas without transformation into settlement areas.

4.3.12 Khanakhul-II C.D Block

The change from Waterbody to Vegetation accounts for 0.74 sq. km. This indicates a minor conversion of waterbody areas into vegetated areas. The change from Waterbody to Agricultural Land accounts for 2.97 sq. km. This suggests a moderate conversion of waterbody areas into agricultural land. There has been no observed change from Waterbody to Settlement, indicating the stability of waterbody areas without transformation into settlement areas. The change from Waterbody to Barren Land accounts for 0.74 sq. km. This suggests a minor conversion of waterbody areas into barren land.

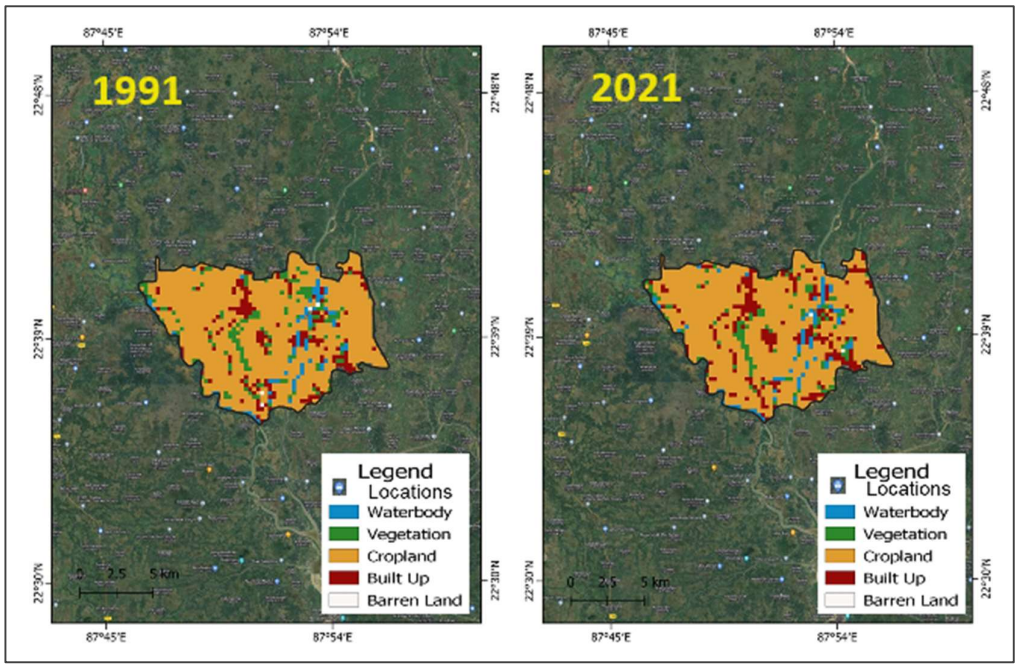
The change from Vegetation to Waterbody accounts for zero square units, indicating no observed transformation of vegetated areas into waterbodies. The change from Vegetation to Agricultural Land accounts for 9.68 sq. km. This indicates a moderate conversion of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 29.79 sq. km. This suggests a significant conversion of vegetated areas into settlement areas. There has been no observed change from Vegetation to Barren Land, indicating the stability of vegetated areas without transformation into barren land.

The change from Agricultural Land to Waterbody accounts for zero square units, indicating no observed transformation of agricultural land into waterbodies. The change from Agricultural Land to Vegetation accounts for 7.44 sq. km. This suggests a minor conversion of agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 20.10 sq. km. This indicates a minor conversion of agricultural land into settlement areas. The change from Agricultural Land to Barren Land accounts for 0.74 sq. km. This suggests a minor conversion of agricultural land into barren land.

There has been no observed change from Settlement to Waterbody, indicating the stability of settlement areas without transformation into waterbodies. The change from Settlement to Vegetation accounts for 7.44 sq. km. This indicates a minor conversion of settlement areas into vegetated areas. The change from Settlement to Agricultural Land accounts for 4.46 sq. km. This suggests a minor conversion of settlement areas into agricultural land. There has

been no observed change from Settlement to Barren Land, indicating the stability of settlement areas without transformation into barren land.

Figure 4.13: Land use changes of Khanakhul-II C.D Block



Source: Based on Landsat Imageries & Google Earth[12].

The change from Barren Land to Waterbody accounts for 0.74 sq. km, indicating a minor conversion of barren land into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land areas without transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 2.23 sq. km. This suggests a minor conversion of barren land into agricultural land. There has been no observed change from Barren Land to Settlement, indicating the stability of barren land areas without transformation into settlement areas.

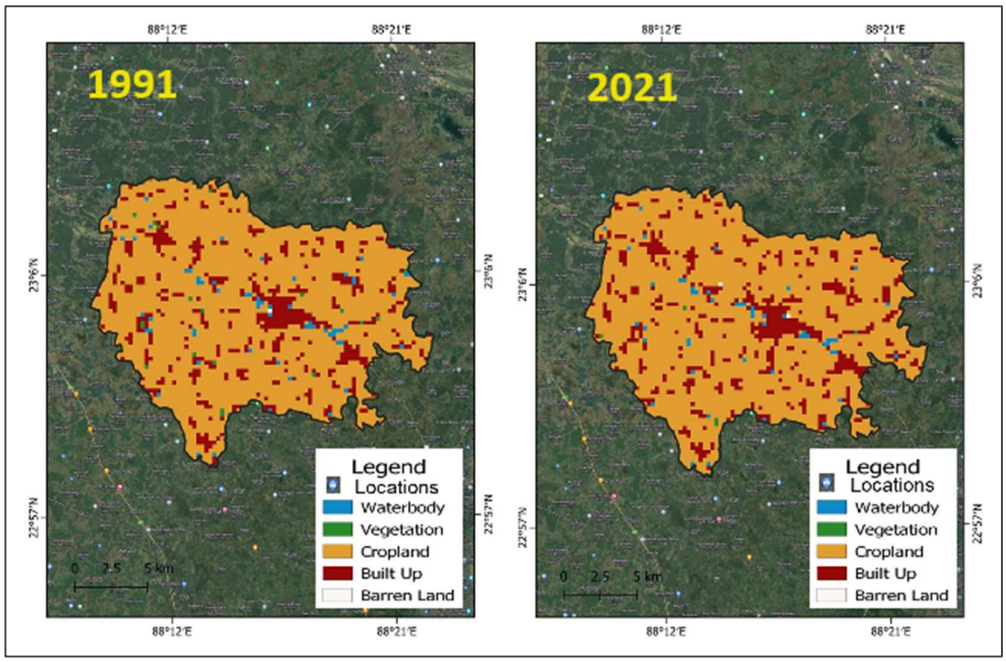
4.3.13 Pandua C.D Block

There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 5.95 sq. km. This suggests a moderate conversion of waterbody areas into agricultural land. The change from Waterbody to Settlement accounts for 2.97 sq. km. This indicates a minor conversion of waterbody areas into settlement areas.

[12] For details, please see Appendix-A (Table No. 4.12)

There has been no observed change from Waterbody to Barren Land, indicating the stability of waterbody areas without transformation into barren land.

Figure 4.14: Land use changes of Pandua C.D Block



Source: Based on Landsat Imageries & Google Earth[13].

There has been no observed change from Vegetation to Waterbody, indicating the stability of vegetated areas without transformation into waterbodies. The change from Vegetation to Agricultural Land accounts for 7.44 sq. km. This suggests a minor conversion of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 4.46 sq. km. This indicates a minor conversion of vegetated areas into settlement areas. There has been no observed change from Vegetation to Barren Land, indicating the stability of vegetated areas without transformation into barren land.

The change from Agricultural Land to Waterbody accounts for 0.74 sq. km. This suggests a minor conversion of agricultural land into waterbodies. The change from Agricultural Land to Vegetation accounts for 0.74 sq. km. This suggests a minor conversion of agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 46.17 sq. km. This indicates a moderate conversion of agricultural land into settlement areas. The

[13] For details, please see Appendix-A (Table No. 4.13)

change from Agricultural Land to Barren Land accounts for 1.48 sq. km. This suggests a minor conversion of agricultural land into barren land.

The change from Settlement to Waterbody accounts for 1.48 sq. km. This suggests a minor conversion of settlement areas into waterbodies. There has been no observed change from Settlement to Vegetation, indicating the stability of settlement areas without transformation into vegetated areas. The change from Settlement to Agricultural Land accounts for 19.36 sq. km. This indicates a moderate conversion of settlement areas into agricultural land. There has been no observed change from Settlement to Barren Land, indicating the stability of settlement areas without transformation into barren land.

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land areas without transformation into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land areas without transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 0.74 sq. km. This suggests a minor conversion of barren land into agricultural land. There has been no observed change from Barren Land to Settlement, indicating the stability of barren land areas without transformation into settlement areas.

4.3.14 Polba-Dadpur C.D Block

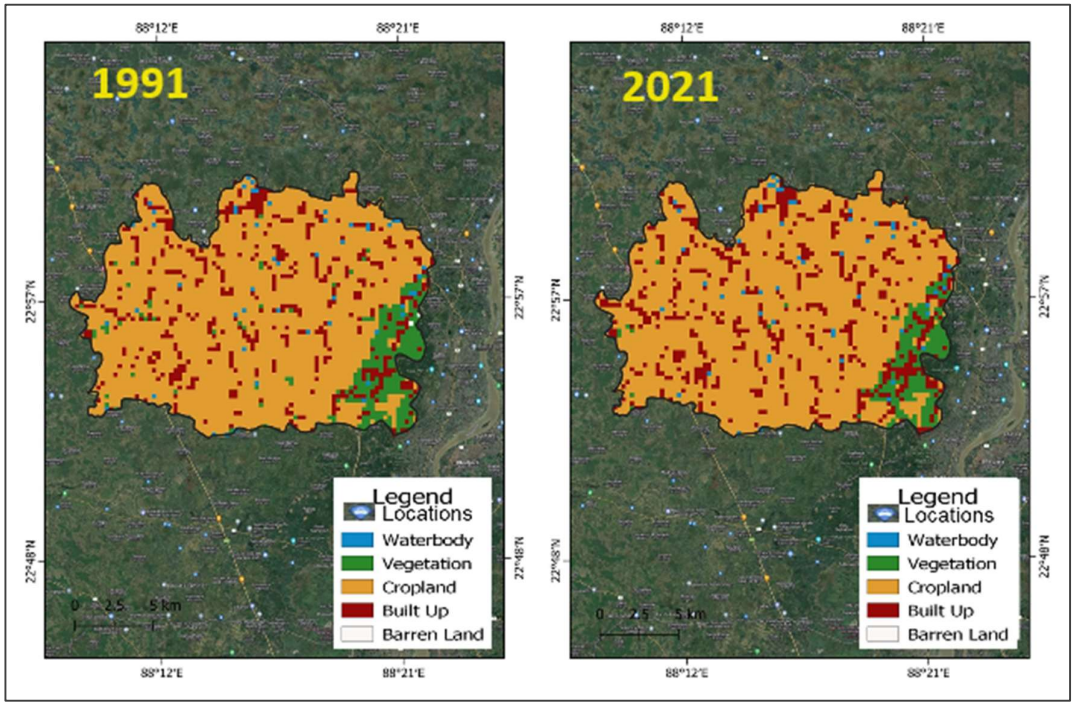
There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 0.67 sq. km. This suggests a minor conversion of waterbody areas into agricultural land. The change from Waterbody to Settlement accounts for 0.14 sq. km. This indicates a minor conversion of waterbody areas into settlement areas.

There has been no observed change from Vegetation to Waterbody, indicating the stability of vegetated areas without transformation into waterbodies. The change from Vegetation to Agricultural Land accounts for 2.01 sq. km. This suggests a moderate conversion of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 3.94 sq. km. This indicates a moderate conversion of vegetated areas into settlement areas.

The change from Agricultural Land to Waterbody accounts for 0.14 sq. km. This suggests a minor conversion of agricultural land into waterbodies. The change from Agricultural Land to Vegetation accounts for 0.07 sq. km. This suggests a minor conversion of agricultural land

into vegetated areas. The change from Agricultural Land to Settlement accounts for 6.47 sq. km. This indicates a significant conversion of agricultural land into settlement areas.

Figure 4.15: Land use changes of Polba-Dadpur C.D Block



Source: Based on Landsat Imageries & Google Earth[14].

The change from Settlement to Waterbody accounts for 0.07 sq. km. This suggests a minor conversion of settlement areas into waterbodies. The change from Settlement to Vegetation accounts for zero sq. km, indicating no observed change from Settlement to Vegetation. The change from Settlement to Agricultural Land accounts for 1.41 sq. km. This suggests a minor conversion of settlement areas into agricultural land. The change from Settlement to Barren Land accounts for 36.34 sq. km. This indicates a significant conversion of settlement areas into barren land.

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land areas without transformation into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land areas without transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 0.14 sq. km. This suggests a minor conversion of barren land into agricultural

[14] For details, please see Appendix-A (Table No. 4.14)

land. There has been no observed change from Barren Land to Settlement, indicating the stability of barren land areas without transformation into settlement areas.

4.3.15 Pursura C.D Block

There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 0.74 sq. km. This suggests a minor conversion of waterbody areas into agricultural land. There has been no observed change from Waterbody to Settlement, indicating the stability of waterbody areas without transformation into settlement areas. There has been no observed change from Waterbody to Barren Land, indicating the stability of waterbody areas without transformation into barren land.

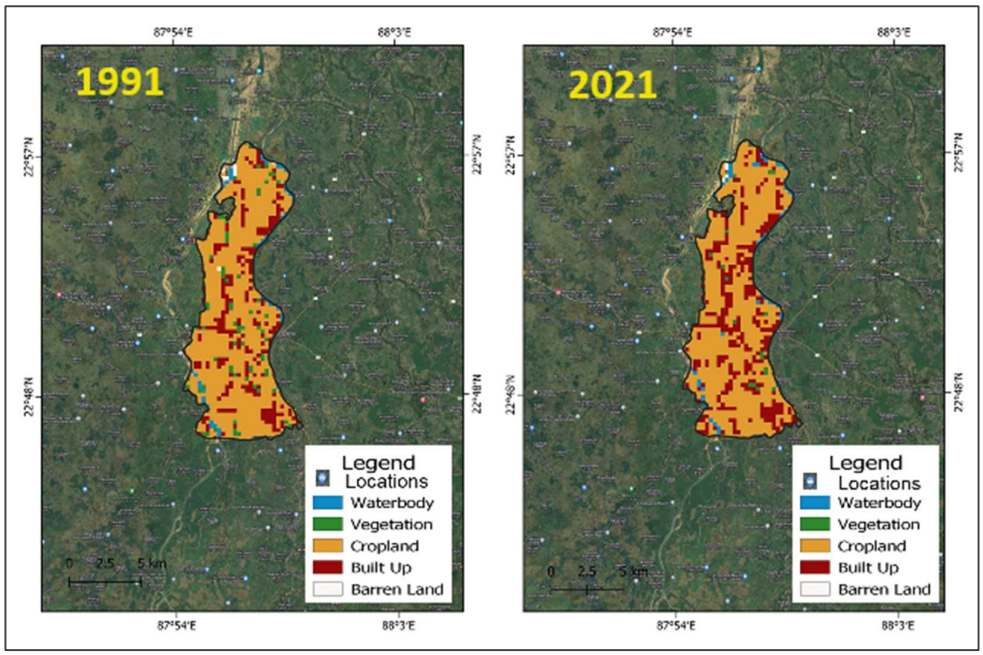
The change from Vegetation to Waterbody accounts for 0.74 sq. km. This suggests a minor conversion of vegetated areas into waterbodies. The change from Vegetation to Agricultural Land accounts for 5.95 sq. km. This indicates a significant conversion of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 32.02 sq. km. This indicates a significant conversion of vegetated areas into settlement areas. There has been no observed change from Vegetation to Barren Land, indicating the stability of vegetated areas without transformation into barren land.

The change from Agricultural Land to Waterbody accounts for zero sq. km, indicating no observed change from Agricultural Land to Waterbody. There has been no observed change from Agricultural Land to Vegetation, indicating the stability of agricultural land areas without transformation into vegetated areas. The change from Agricultural Land to Settlement accounts for 48.41 sq. km. This indicates a significant conversion of agricultural land into settlement areas. There has been no observed change from Agricultural Land to Barren Land, indicating the stability of agricultural land areas without transformation into barren land.

The change from Settlement to Waterbody accounts for 0.74 sq. km. This suggests a minor conversion of settlement areas into waterbodies. The change from Settlement to Vegetation accounts for 0.74 sq. km. This suggests a minor conversion of settlement areas into vegetated areas. The change from Settlement to Agricultural Land accounts for 7.44 sq. km. This suggests a conversion of settlement areas into agricultural land. There has been no observed

change from Settlement to Barren Land, indicating the stability of settlement areas without transformation into barren land.

Figure 4.16: Land use changes of Pursura C.D Block



Source: Based on Landsat Imageries & Google Earth[15].

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land areas without transformation into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land areas without transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 4.46 sq. km. This indicates a conversion of barren land into agricultural land. There has been no observed change from Barren Land to Settlement, indicating the stability of barren land areas without transformation into settlement areas.

4.3.16 Serampore-Uttarpara C.D Block

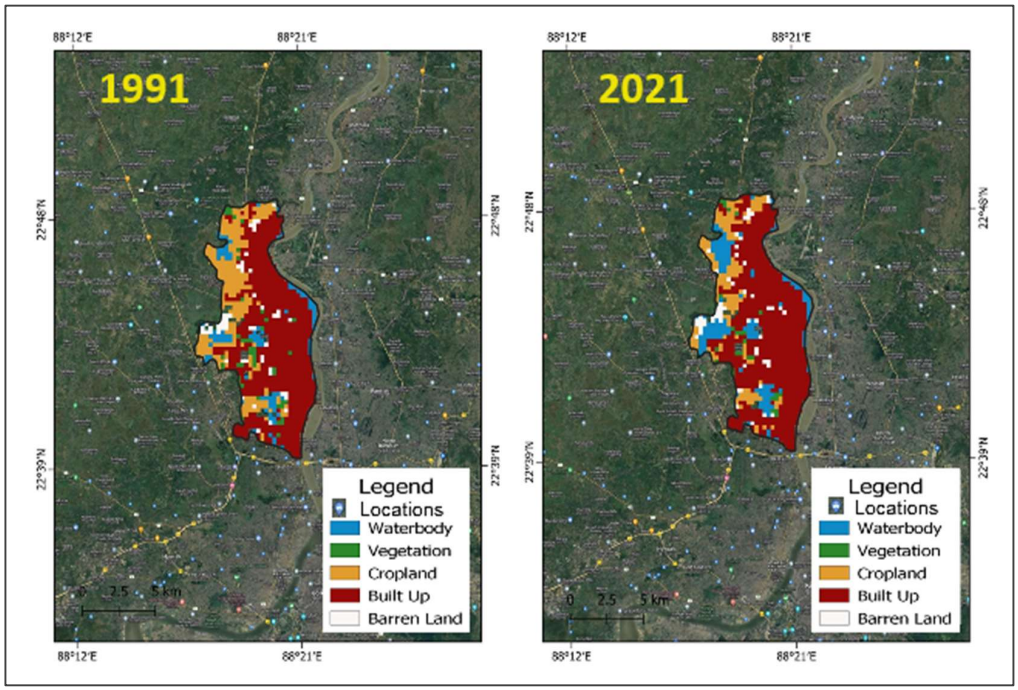
There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 0.74 sq. km. This suggests a minor conversion of waterbody areas into agricultural land. The change from Waterbody to Settlement accounts for 0.74 sq. km. This indicates a conversion of waterbody areas into settlement areas.

[15] For details, please see Appendix-A (Table No. 4.15)

There has been no observed change from Vegetation to Waterbody, indicating the stability of vegetated areas without transformation into waterbodies. The change from Vegetation to Agricultural Land accounts for 2.23 sq. km. This indicates a conversion of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 11.17 sq. km. This indicates a conversion of vegetated areas into settlement areas.

The change from Agricultural Land to Waterbody accounts for zero sq. km, indicating no conversion from agricultural land to waterbody. The change from Agricultural Land to Vegetation accounts for 1.48 sq. km. This suggests a minor conversion of agricultural land into vegetated areas. The change from Agricultural Land to Settlement accounts for 18.61 sq. km. This indicates a conversion of agricultural land into settlement areas.

Figure 4.17: Land use changes of Serampore-Uttarpara C.D Block



Source: Based on Landsat Imageries & Google Earth[16].

The change from Settlement to Waterbody accounts for 0.74 sq. km, indicating a minor conversion of settlement areas into waterbody areas. There has been no observed change from Settlement to Vegetation, indicating the stability of settlement areas without transformation into vegetated areas. The change from Settlement to Agricultural Land

[16] For details, please see Appendix-A (Table No. 4.16)

accounts for 0.74 sq. km, indicating a minor conversion of settlement areas into agricultural land.

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land areas without transformation into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land areas without transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 3.72 sq. km. This suggests a conversion of barren land into agricultural land. The change from Barren Land to Settlement accounts for 7.44 sq. km. This indicates a conversion of barren land into settlement areas.

4.3.17 Singur C.D Block

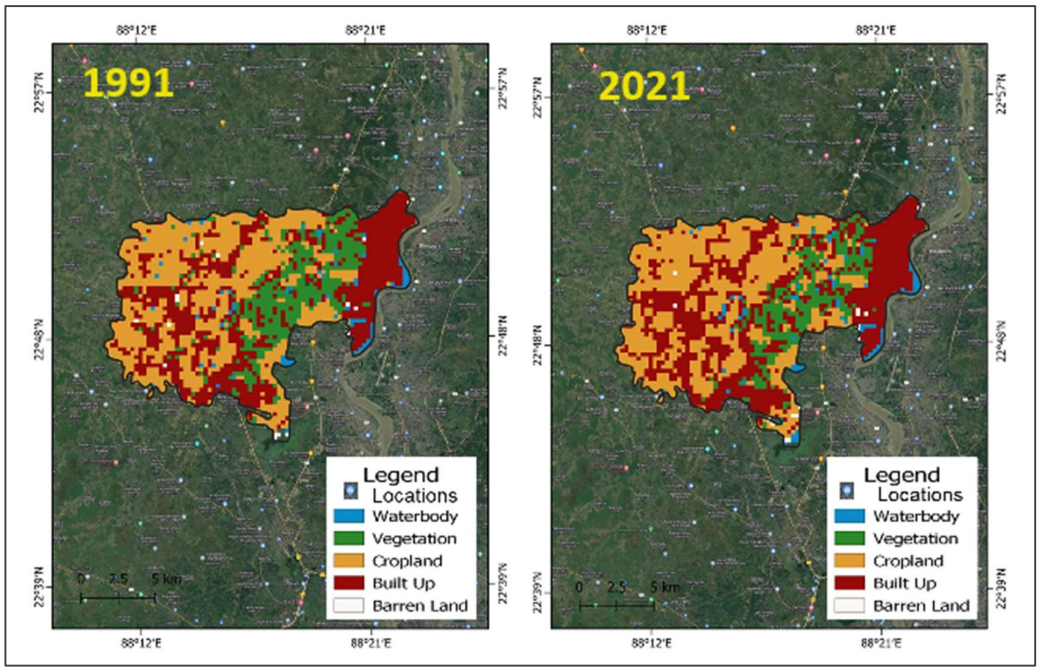
There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 7.44 sq. km. This suggests a conversion of waterbody areas into agricultural land. The change from Waterbody to Settlement accounts for 3.72 sq. km. This indicates a conversion of waterbody areas into settlement areas. The change from Waterbody to Barren Land accounts for 0.74 sq. km. This suggests a minor conversion of waterbody areas into barren land.

The change from Vegetation to Waterbody accounts for 3.72 sq. km. This indicates a conversion of vegetated areas into waterbodies. The change from Vegetation to Agricultural Land accounts for 26.81 sq. km. This indicates a conversion of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 64.05 sq. km. This indicates a significant conversion of vegetated areas into settlement areas. There has been no observed change from Vegetation to Barren Land, indicating the stability of vegetated areas without transformation into barren land.

The change from Agricultural Land to Waterbody accounts for zero sq. km, indicating no observed change from Agricultural Land to Waterbody. There has been no observed change from Agricultural Land to Vegetation, indicating the stability of agricultural land areas without transformation into vegetated areas. The change from Agricultural Land to Settlement accounts for 46.17 sq. km. This indicates a conversion of agricultural land into settlement areas. The change from Agricultural Land to Barren Land accounts for 6.70 sq. km. This suggests a minor conversion of agricultural land into barren land.

The change from Settlement to Waterbody accounts for 0.74 sq. km. This suggests a minor conversion of settlement areas into waterbodies. The change from Settlement to Vegetation accounts for zero sq. km, indicating no observed change from Settlement to Vegetation. The change from Settlement to Agricultural Land accounts for 14.89 sq. km. This indicates a conversion of settlement areas into agricultural land. There has been no observed change from Settlement to Barren Land, indicating the stability of settlement areas without transformation into barren land.

Figure 4.18: Land use changes of Singur C.D Block



Source: Based on Landsat Imageries & Google Earth[17].

The change from Barren Land to Waterbody accounts for 1.48 sq. km. This suggests a minor conversion of barren land into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land areas without transformation into vegetated areas. The change from Barren Land to Agricultural Land accounts for 2.97 sq. km. This suggests a minor conversion of barren land into agricultural land. Barren Land to Settlement: The change from Barren Land to Settlement accounts for 2.97 sq. km. This suggests a minor conversion of barren land into settlement areas.

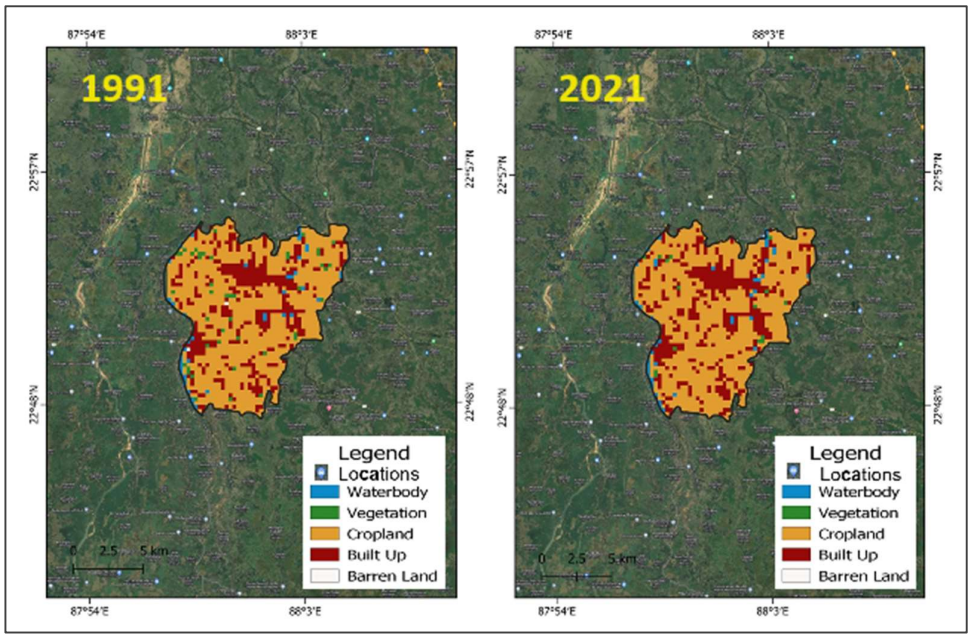
[17] For details, please see Appendix-A (Table No. 4.17)

4.3.18 Tarakeshwar C.D Block

There has been no observed change from Waterbody to Vegetation, indicating the stability of waterbody areas without transformation into vegetated areas. The change from Waterbody to Agricultural Land accounts for 0.74 sq. km. This suggests a minor conversion of waterbody areas into agricultural land. The change from Waterbody to Settlement accounts for 1.48 sq. km. This indicates a conversion of waterbody areas into settlement areas.

There has been no observed change from Vegetation to Waterbody, indicating the stability of vegetated areas without transformation into waterbodies. The change from Vegetation to Agricultural Land accounts for 11.17 sq. km. This indicates a conversion of vegetated areas into agricultural land. The change from Vegetation to Settlement accounts for 13.40 sq. km. This indicates a conversion of vegetated areas into settlement areas.

Figure 4.19: Land use changes of Tarakeshwar C.D Block



Source: Based on Landsat Imageries & Google Earth[18].

The change from Agricultural Land to Waterbody accounts for 2.97 sq. km. This suggests a conversion of agricultural land into waterbody areas. There has been no observed change from Agricultural Land to Vegetation, indicating the stability of agricultural land areas without transformation into vegetated areas. The change from Agricultural Land to

[18] For details, please see Appendix-A (Table No. 4.18)

Settlement accounts for 24.57 sq. km. This indicates a conversion of agricultural land into settlement areas.

The change from Settlement to Waterbody accounts for 0.74 sq. km. This suggests a minor conversion of settlement areas into waterbody areas. There has been no observed change from Settlement to Vegetation, indicating the stability of settlement areas without transformation into vegetated areas. The change from Settlement to Agricultural Land accounts for 16.38 sq. km. This indicates a conversion of settlement areas into agricultural land.

There has been no observed change from Barren Land to Waterbody, indicating the stability of barren land areas without transformation into waterbodies. There has been no observed change from Barren Land to Vegetation, indicating the stability of barren land areas without transformation into vegetated areas. There has been no observed change from Barren Land to Agricultural Land, indicating the stability of barren land areas without transformation into agricultural land. The change from Barren Land to Settlement accounts for 1.48 sq. km. This suggests a minor conversion of barren land into settlement areas.

4.4 Reasons for changes in land use of study area

The changes in land use observed in the Hugli district from 1991 to 2021 can be attributed to several factors. Here are some possible reasons for these changes:

- **Urbanization and Infrastructure Development:** The expansion of settlements and urban areas has led to the conversion of natural land covers such as waterbodies, vegetation, and agricultural land into built-up areas. This change is driven by population growth, increased urbanization, and the need for infrastructure development.
- **Agricultural Expansion and Intensification:** The conversion of waterbodies and vegetation into agricultural land may be a result of agricultural expansion and intensification. As the demand for food and agricultural products increases, there is a need to convert land for agricultural purposes, leading to the transformation of other land covers.
- **Industrialization and Economic Growth:** The establishment and growth of industries and industrial zones can contribute to changes in land use. Industrial activities often require large areas of land, leading to the conversion of natural land covers into industrial land or settlements to accommodate the workforce.

- **Land Use Policies and Planning:** Changes in land use can also be influenced by land use policies and planning decisions. Government regulations, zoning policies, and urban planning initiatives can shape the conversion of land covers based on designated land use categories and development priorities.
- **Environmental Factors and Natural Processes:** Environmental factors such as erosion, sedimentation, natural disasters, and climate change can impact land use and land cover changes. These processes can alter the dynamics of waterbodies, vegetation, and barren land, leading to shifts in land cover patterns.
- **Human Interventions and Land Management Practices:** Human interventions such as deforestation, land clearing for agriculture, reclamation projects, and land management practices play a significant role in transforming land covers. These activities are often driven by economic, agricultural, or infrastructure development objectives.
- **Initiation of the Tarakeswar - Bishnupur Railway Project:** From the Land use change matrix statistics, it has been observed that maximum land conversion has been noticed in the Arambagh, Goghat I, and Khanakul I C.D. Blocks which are located in the western part of the Hugli District. The conversion of cropland to settlement for 81.18 sq. km. and 67.77 sq. km in Khanakul I and Goghat I respectively signifies expansion of built-up areas and population growth. After the initiation of the Bishnupur-Tarakeswar new Railway Project, the land use pattern of this area has gained importance, especially for its changing scenario due to the inevitable sprawling of urbanization followed by the changing socio-economic behavior of the local people. Sanctioned in 2001, the Bishnupur-Tarakeswar new line project spans over 87 kilometers and would serve as an alternate route for goods traffic between the South Eastern Railway and Eastern Railway. The economy of the Arambagh Subdivision is mainly based on agriculture. Most of the people in this area maintain their livelihood in agriculture. But the marketing system was very poor possibly due to lack of transport system. The only road system, pucca and kuchha in nature, was there which was insufficient enough to facilitate the rural people to carry their produce to the market. A New Railway project has been undertaken to mitigate the transport problem to some extent which was a long-awaited demand of the local people, but as a result of the project the population pressure, as well as settlement increase will certainly affect the land use pattern of this area.

4.5 Conclusion

The analysis of the statistics reveals several trends and changes in the Hugli District over the years. Waterbody areas have generally shown an increase, possibly due to the construction of reservoirs and conservation efforts. The vegetation cover has exhibited mixed patterns, with both increases and decreases observed. Factors such as deforestation, urbanization, and changes in agricultural practices could be contributing to these variations. Agricultural land has experienced significant changes, with notable expansions in some areas, indicating the growth of agricultural activities. This expansion could be driven by population growth, technological advancements, and changes in land use policies. Settlement areas associated with human habitation and infrastructure have expanded over time, reflecting urbanization and the development of residential, commercial, and industrial sectors. On the other hand, barren land areas have generally remained stable or experienced minor fluctuations. Overall, the data highlights the dynamic nature of the Hugli District, with varying patterns of land use and cover changes over the years.

Chapter 5

Socio-Economic Scenario and Land Use Pattern of Sample Villages

Chapter 5

Socio-Economic Scenario and Land Use Pattern of Sample Villages

5.1 Introduction

To evaluate the available land resources and create a land use plan, it is essential to do a thorough analysis of how each village in all the four subdivisions of Hugli district uses its land. There are 1866 villages in the district. So, it is difficult to collect every part of the land of all the villages. Hence, twelve villages were chosen from the four subdivisions viz., Arambagh, Serampore, Chandannagar and Chunchura. The present chapter focuses on socio-economic condition of households and also attempts to explain and highlight land use pattern of sample villages and its spatio-temporal changes. In this chapter socio-economic scenario have been highlighted through primary data and land use pattern of the sample villages have been discussed through census data of 1991, 2001 and 2011.

5.2 Socio-economic profile of the respondents

Table 5.1 and 5.2 represent socio-economic profile of respondents from selected sample village. It is observed that 8% respondents were old aged category followed by middle (48.25%) and young aged category (26.50%) whereas 52% were male respondents. Majority of respondents belongs to upto class ix (30.25%) and secondary to higher secondary (26.50%) category in their educational achievement. 63.25% respondents belong to general caste where 33.75% were schedule caste followed by 3.25% (other backward class) and 2% were schedule tribe. Most of the household (62.5%) have 4 to 8 family members.

Table 5.1: Social characteristics of the respondents

Sl. NO.	Character	Category	Frequency	Percent
1	Sex	Male	210	52.50
		Female	190	47.50
2	Age Structure	Below 15	81	20.25
		15-30	106	26.50
		30-45	105	26.25
		45-60	88	22.00
		Above 60	32	8.00
3	Caste Structure	General	253	63.25
		OBC	13	3.25

		SC	135	33.75
		ST	8	2.00
4	Educational structure	Upto – class v	90	22.5
		Upto class ix	121	30.25
		Secondary to higher secondary	106	26.5
		Graduate	45	11.25
		Post graduate	6	1.5
		Technical degree / others	6	1.5
5	Family size	< 4	104	26
		4 to 8	250	62.5
		>8	46	11.5

Source: Researcher's compilation based on field survey, 2022 – 2023.

Total number of Sample Respondents (N) = 400.

Table 5.2: Economic characteristics of the respondents

Sl. NO.	Character	Category	Frequency	Percent
1	Workforce	Male Working population	145	36.25
		Female Working population	13	3.25
		Child Working population	0	0.00
2	Dependency ratio	No of depended (Male)	19	4.75
		No of Depended (Female)	99	24.75
		No of Depended (Child)	118	29.50
3	Occupation	Agricultural labour	48	12.00
		Cultivators	70	17.50
		Fish cultivation	24	6.00
		Livestock farming	11	2.75
		Shopkeeper (in Grocery shop)	12	3.00
		Non-agricultural wage labour	40	10.00
		Salaried Govt.+ Pvt. Job	119	29.75
		Others	76	19.00
4	Income structure (Monthly)	0-10000	84	21
		10000-30000	89	22.25
		30000-70000	31	7.75
		Above 70000	3	0.75
5	Poverty level	APL	75	18.75
		BPL	255	63.75
6	House structure	Kuchha	39	9.75
		Pucca	266	66.50
		Mixed (kuccha -pucca)	95	23.75
7	Household land holding (bighas)*	< 2	234	58.50
		2 to 4	97	24.25
		4 to 6	51	12.75
		>6	17	4.25

8	Use of land holding	Bastu	100	25.00
		Agricultural land	70	17.50
		Fishing land	26	6.50
		Plantation	126	31.50
		Fallow land	34	8.50
		Waste land	42	10.50
9	Types of agriculture land	Mono crop	132	33.00
		Double crops	175	43.75
		Multi crops	93	23.25

Source: Researcher's compilation based on field survey, 2022 – 2023.

Total number of Sample Respondents (N) = 400.

Note: * 1 bighas = 20 katha.

With respect to the monthly income 21% respondents belongs to low level of income group (₹ ≤ 10,000) followed by 22.25% (₹ 10,000–30,000), 7.75% (₹ 30,000–70,000), and 0.75% with high annual income groups (₹ ≥ 70,000). Majority of respondents belongs to below poverty level (63.75%). Number of male working population is high in compare to female working population.

Majority of respondents (29.75%) engaged in Governmental and private salaried job followed by cultivators (17.50%), agricultural labour (12%), and non-agricultural wage labour (10%). Most of the houses (66.50%) are pucca[1] in nature. Whereas 23.75% houses are in mixed (kuccha -pucca) type and 9.75% are kuccha[2] in nature. 58.50% respondents having <2 bighas of land holding followed by 24.25% having 2 to 4 bighas, 12.75% having 4 to 6 bighas and 4.25% having >6 bighas. Most of the respondents used their land for plantation purpose (31.50%) followed by bastu (25%), agricultural land (17.50%), waste land (10%), fallow land (8.50%) and fishing land (6.50%). Out of the total agricultural land 43.75% respondents used their agricultural land as a double cropping pattern, 33% as a mono cropping pattern and 23.25% as a multi cropping pattern.

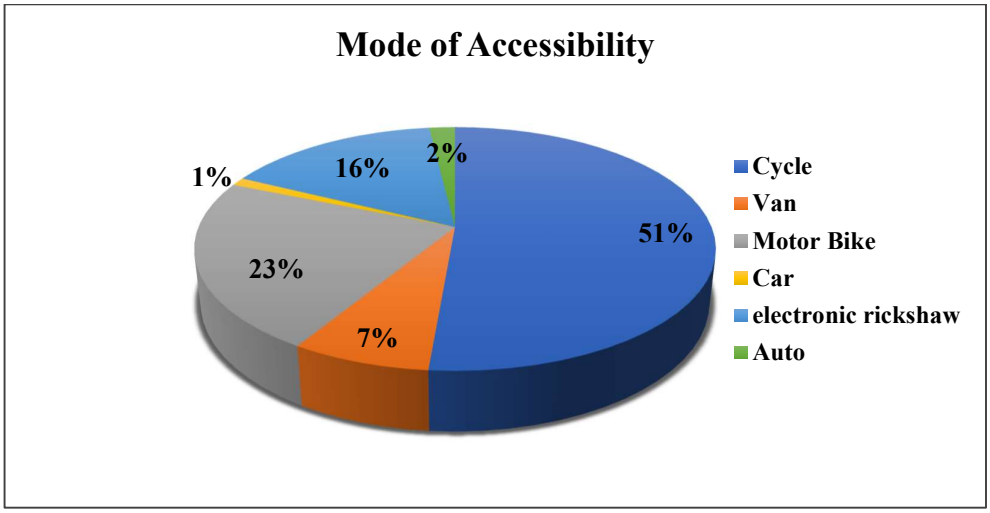
There are so many modes of accessibility present in the study area (Figure 5.1). Among all the modes of accessibility, majority of respondents (47.25%) have availed the facilities of cycle followed by motor bike (20.75%), electronic rickshaw (14.5%), van (6.75%), auto (1.75%) and car (1%). Observing the nature of data, it has been noticed that 74.75% of respondents have used LPG as domestic fuels. Out of the total respondents, 51.75% have

[1] Houses, the walls and roof of which are made of permanent materials namely, Stones (duly packed with lime or cement mortar), G.I/metal/asbestos sheets, burnt bricks, Cement bricks, Concrete (Census of India, 2011).

[2] Houses in which both walls and roof are made of materials, which have to be replaced frequently namely, grass, un-burnt bricks, bamboos, mud, grass, reeds, thatch, plastic/polythene, loosed packed stone, etc. (Census of India, 2011).

also used crop residue, 42.75% have used wood and 6.5% have used kerosene for their domestic fuel purpose.

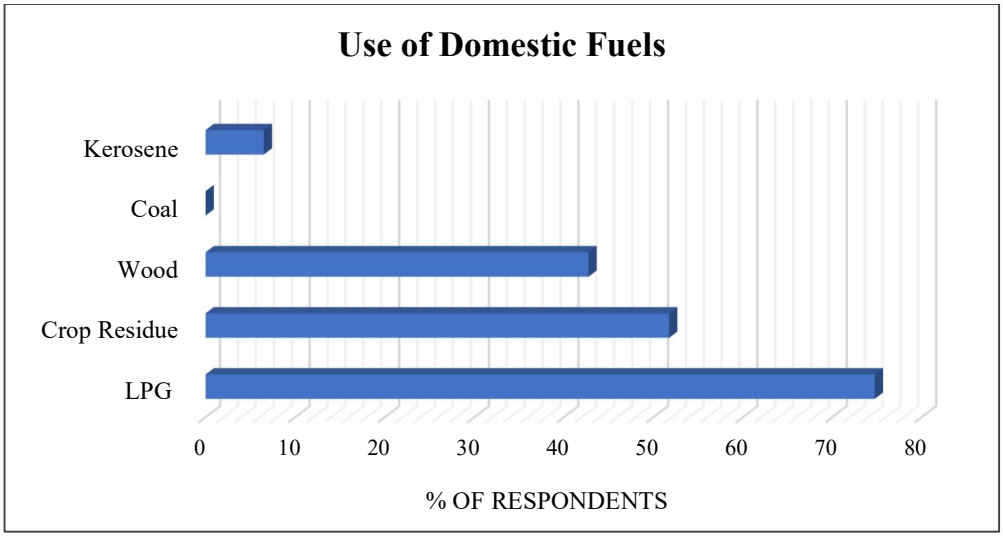
Figure 5.1: Mode of Accessibility among the respondents



Source: Researcher's compilation based on field survey, 2022 - 2023[3].

Total number of Sample Respondents (N) = 400.

Figure 5.2: Domestic Fuels used by the respondents



Source: Researcher's compilation based on field survey, 2022 - 2023[4].

Total number of Sample Respondents (N) = 400.

[3] For details, please see Appendix -A (Table No. 5.1)
[4] For details, please see Appendix -A (Table No. 5.2)

5.3 Land use pattern of sample villages

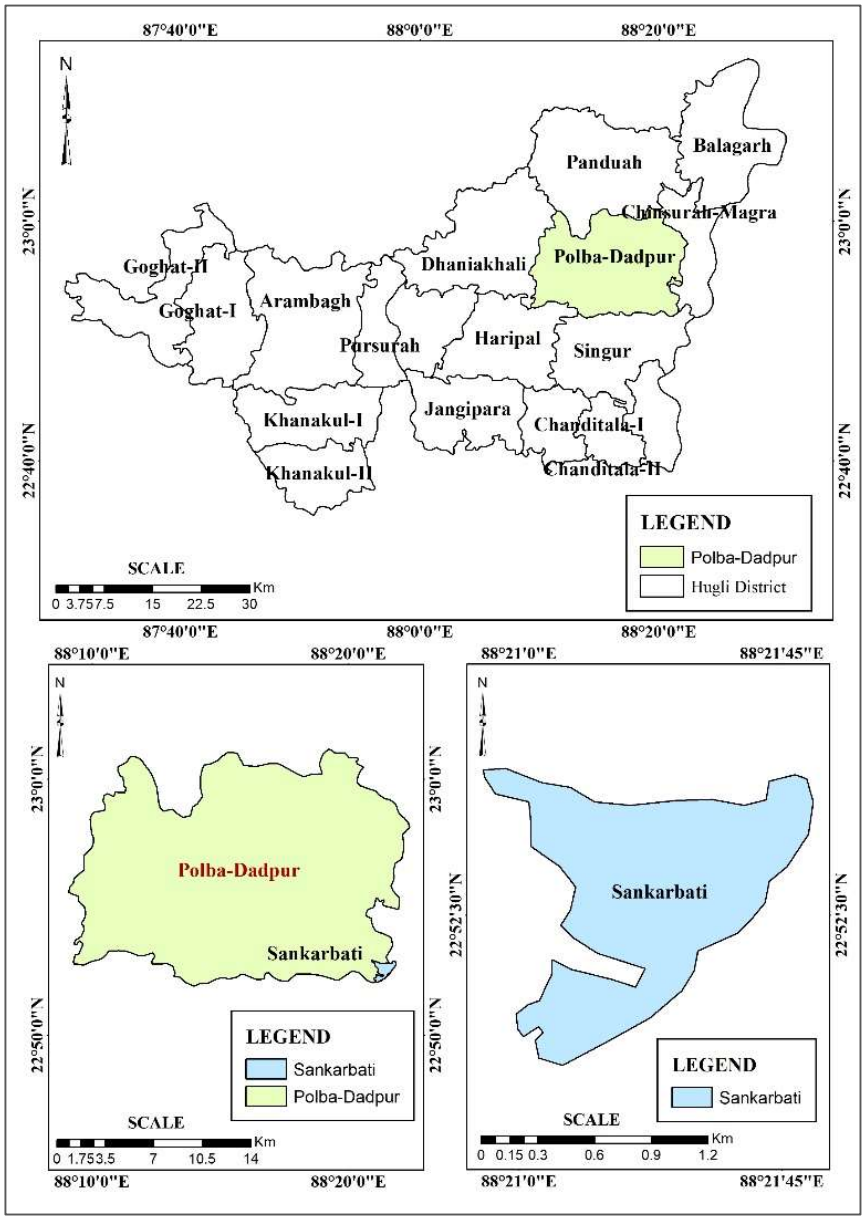
5.3.1 Sankarbati village

Sankarbati village is located in Polba Dadpur C.D block of Hugli district in West Bengal. It is situated 14.1km away from sub-district headquarter Polba and 5.9 km away from district headquarter Chinsura. The total area of this village is 117.81 hectares. with total population of 1,831. Out of which male population is 938 while female population is 893. Literacy rate of Sankarbati village is 79.90%. The total households of Sankarbati village are 454 (Census of India, 2011). In Sankarbati village population of children with age 0-6 is 170 which makes up 9.28 % of total population of village. Average Sex Ratio of Sankarbati village is 952 which is higher than West Bengal state average of 950. Child Sex Ratio for the Sankarbati as per census is 1024, higher than West Bengal average of 956.

Sankarbati village has higher literacy rate compared to West Bengal. In 2011, literacy rate of Sankarbati village was 88.08 % compared to 76.26 % of West Bengal. In Sankarbati Male literacy stands at 92.39 % while female literacy rate was 83.52 %. In Sankarbati village out of total population, 718 were engaged in work activities. 92.20 % of workers describe their work as Main Work (Employment or Earning more than 6 Months) while 7.80 % were involved in Marginal activity providing livelihood for less than 6 months. Of 718 workers engaged in Main Work, 91 were cultivators (owner or co-owner) while 108 were Agricultural labourers. Shankarbati is a village with one primary and one high school, although some children from the village go to private English medium schools in neighboring areas. The rate of higher education in villages is low and children of this generation are going to distant places for higher education.

Due to lack of water required for crop cultivation, the people of the village cultivate fruits and vegetables. Among the fruits, mango, jam, litchi, papaya and banana are cultivated. Seasonal vegetables are cultivated. Cultivated land area is small and isolated. Most families do not have cultivated land; they work as labourers on other people's land. Shankarbati is a non-agricultural village where more than 60 hectares land was used for non-agricultural purposes. Out of total land 33.5 hectares was irrigated land, unirrigated land was 18.7 hectares and area not available for cultivation was 65.6 hectares in 2001. But the amount of these three categories of land utilization has remain same in 2011. Rapid changes of these three categories have been occurred between 1991 to 2001 (Figure 5.4). In Shankarbati village culturable waste land has completely absent.

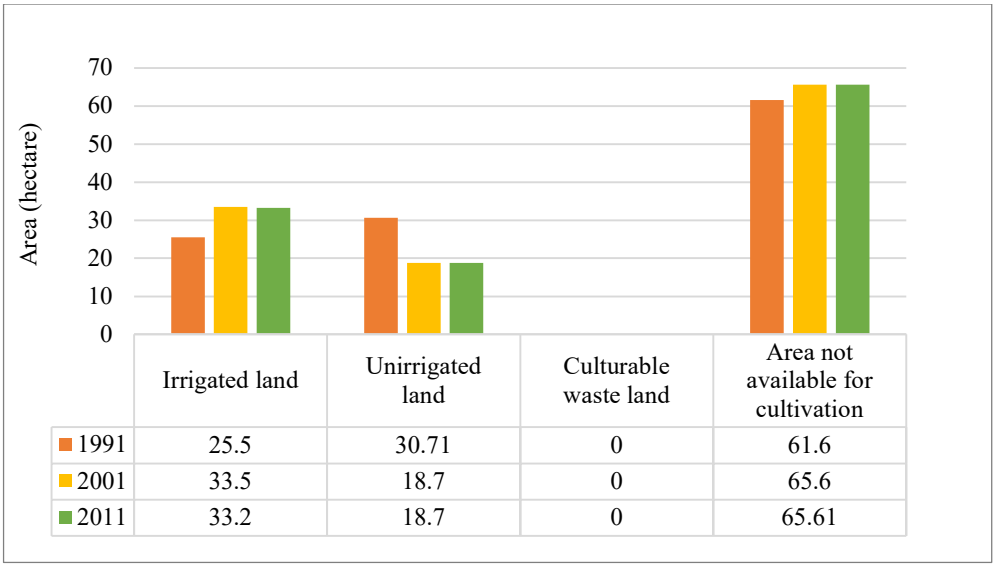
Figure 5.3: Location map of Sankarbati village



Source: Prepared by Researcher based on Census of India (2011).

The main problem of Shankarbati village is the problem of drinking water. There is potable water at a depth of 280 feet. Even though the Panchayat has installed taps in every house, the water from the taps is very little. Many people buy drinking water. Several poor families in the village live in mud houses. Several families are deprived of poverty allowance, old age allowance and widow allowance. House to house waste material is not collected from Panchayet. The village has no health center of its own. People go to the health center in neighboring Amodpur village and the area adjacent to Chandannagar station for treatment.

Figure 5.4: Area under different types of Land use of Sankarbati village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	25.5	30.71	0	61.6
2001	33.5	18.7	0	65.6
2011	33.2	18.7	0	65.61

Source: Census of India (1991, 2001 and 2011).

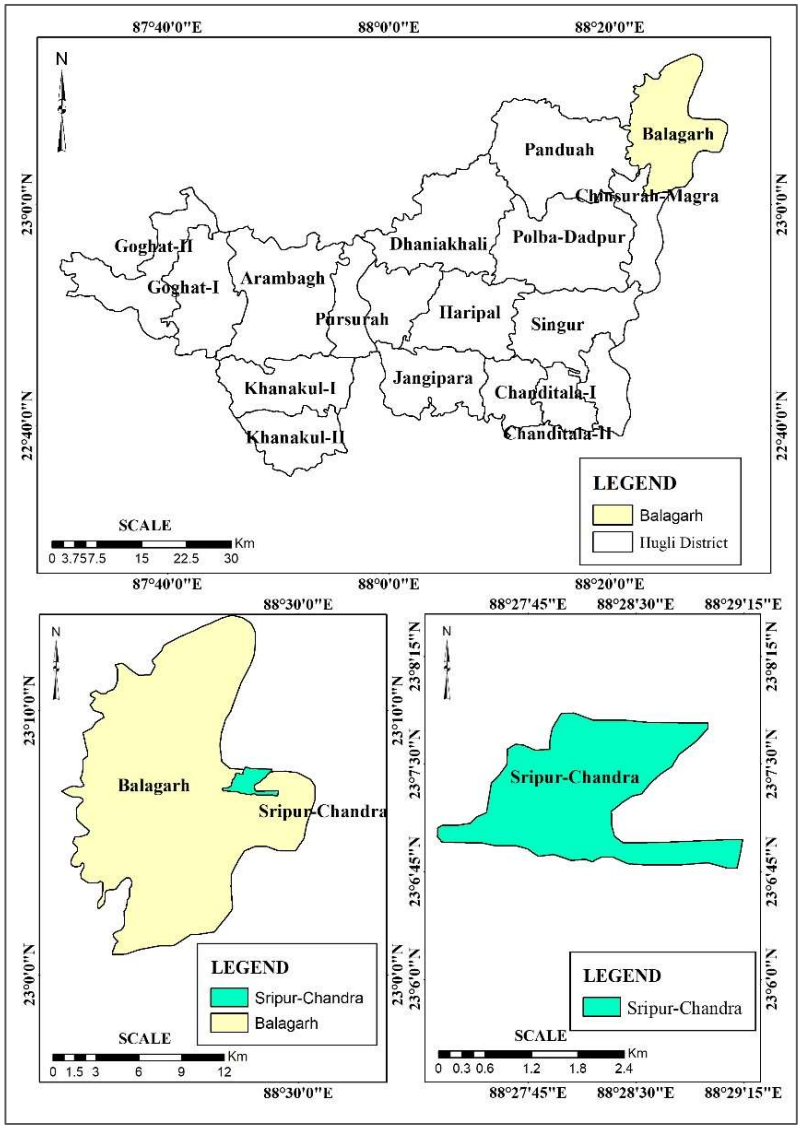
Photograph 5.1: Survey in Sankarbati village

Source: Captured by the Researcher.

5.3.2 Sripur village

Serpur village is located in Balagarh C.D block of Hugli district. It is situated 5.6 km away from sub-district headquarter Patuligram (tehsildar office) and 17.6 km away from district headquarter Chinsura. According to census 2011, the total geographical area of village is 72.13 hectares. Sripur has a total population of 5,983, out of which male population is 3,108 while female population is 2,875. Literacy rate of this village is 69.05% out of which 74.94% males and 62.68% females are literate. There are about 1,317 houses in Sripur village.

Figure 5.5: Location map of Sripur village

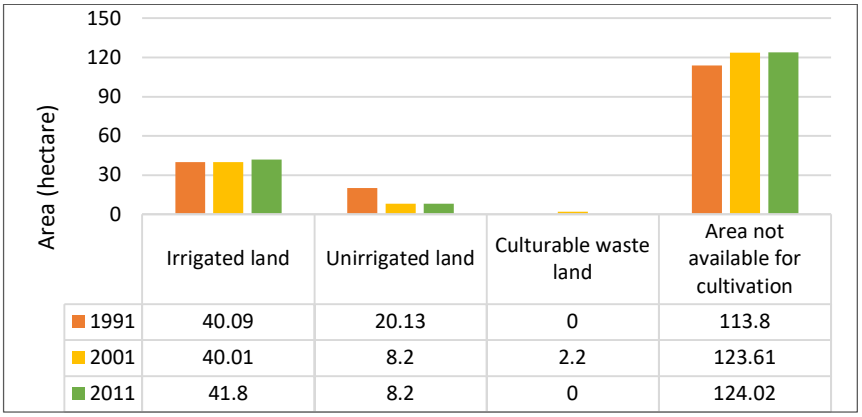


Source: Prepared by Researcher based on Census of India (2011).

About 40.01 hectares land was occupied by irrigated land in 2001 which was 40.09 hectares in 1991. It was evident that there was a ups and downs in the amount of irrigated land by from 1991 to 2011 but the irrigated land has been quite increased amounting 40.09 hectares in 1991 to 41.52 hectares in 2011. The mode of irrigation system of this village was mainly by tube-well. The amount of unirrigated land was 20.13 hectares in 1991 and it became 8.2 hectares in 2001 and 2011. So, figure 5.6 represents the declining rate of unirrigated land during 1991 - 2011. The amount of culturable waste land was recorded only 2.2 hectares during 2001 to 2011 without changing throughout the decades. The amount of area not

available for cultivation was 113.8 hectares in 1991 and it was increased by 9.81 hectares in 2001. The total amount of area not available for cultivation in 2001 was 123.61 hectares and it became increased by 0.41 hectares during 2001-2011. A special feature here is the naval industry. Balagarh has been famous for its naval industry since ancient times. Many people in this village have been making boats for their livelihood for many years. People associated with this industry are now in quite crisis.

Figure 5.6: Area under different types of Land use of Sripur village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	40.09	20.13	0	113.8
2001	40.01	8.2	2.2	123.61
2011	41.8	8.2	0	124.02

Source: Census of India (1991, 2001 and 2011).

Photograph 5.2: Naval industry in Sripur village of Balagarh C.D. Block

Source: Captured by the Researcher.

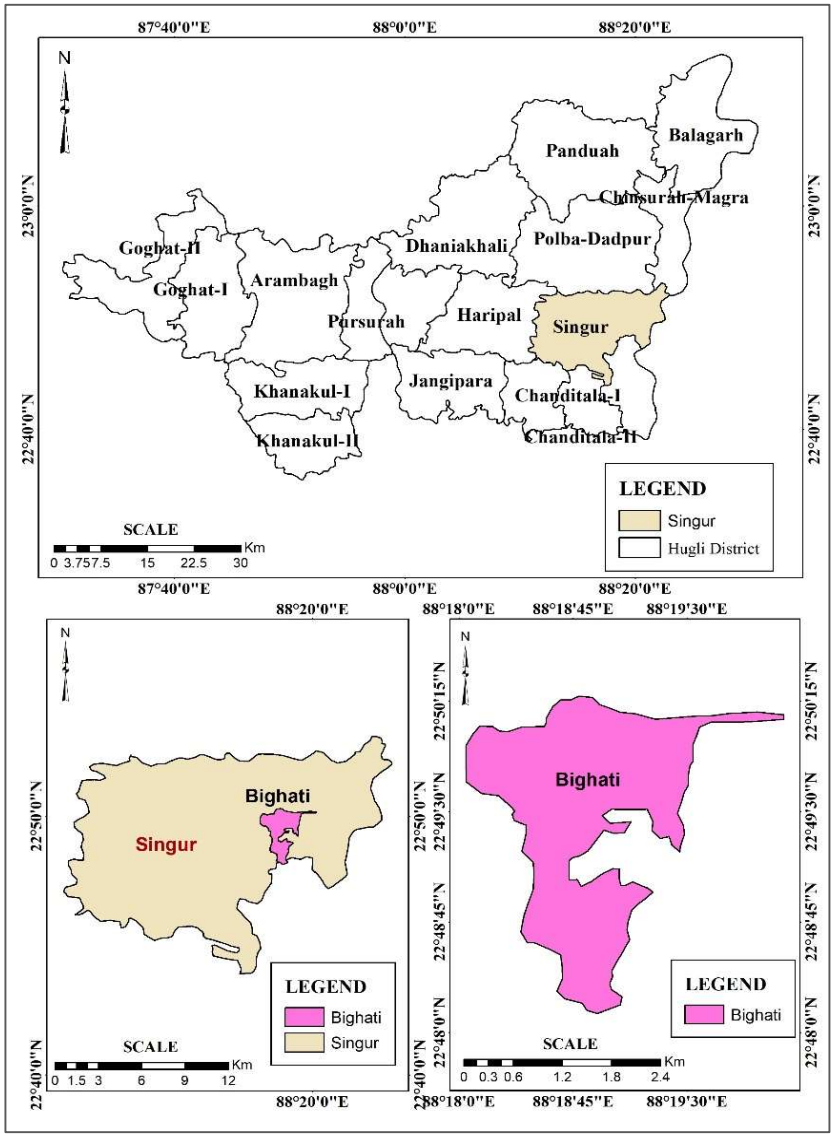
5.3.3 Bighati village

Bighati village is located in Singur C.D block of Hugli district. It is situated 8.9 km away from sub-district headquarter Singur. The total geographical area of village is 521.7 hectares. Bighati has a total population of 4,388 peoples, out of which male population is 2,271 while

female population is 2,117. Village literacy rate is 78.6% and the Female Literacy rate is 35.9%. There are about 1,024 houses in Bighati village. Bhadreshwar is nearest town to Bighati for all major economic activities, which is approximately 2 km away.

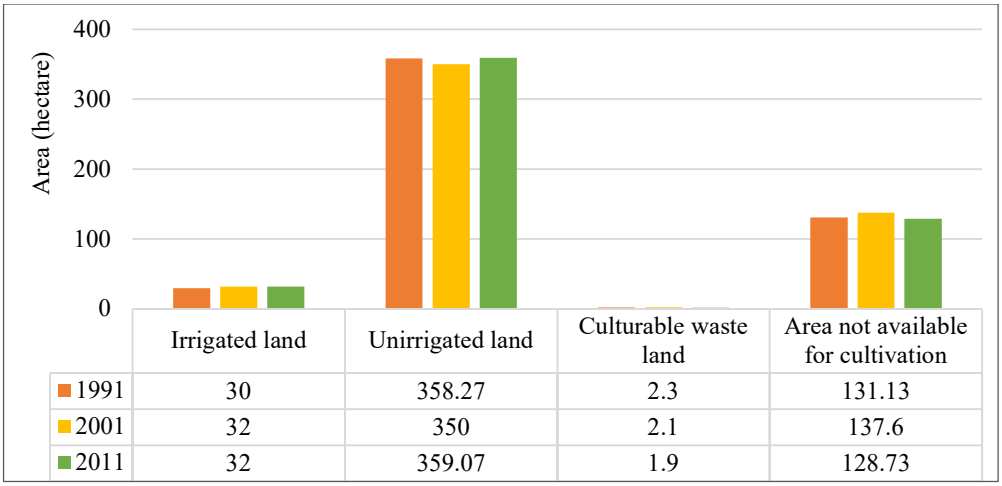
There are 800 scheduled castes persons of which 387 are females and 413 are males. Females constitute 48.38% and males constitute 51.62% of the scheduled castes population (Census of India, 2011). Scheduled castes constitute 18.23% of the total population. There are 11 scheduled tribes persons of which 4 are females and 7 are males. Females constitute 36.36% and males constitute 63.64% of the scheduled tribes population. Scheduled tribes constitute 0.25% of the total population.

Figure 5.7: Location map of Bighati village



Source: Prepared by Researcher based on Census of India (2011).

Figure 5.8: Area under different types of Land use of Bighati village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	30	358.27	2.3	131.13
2001	32	350	2.1	137.6
2011	32	359.07	1.9	128.73

Source: Census of India (1991, 2001 and 2011).

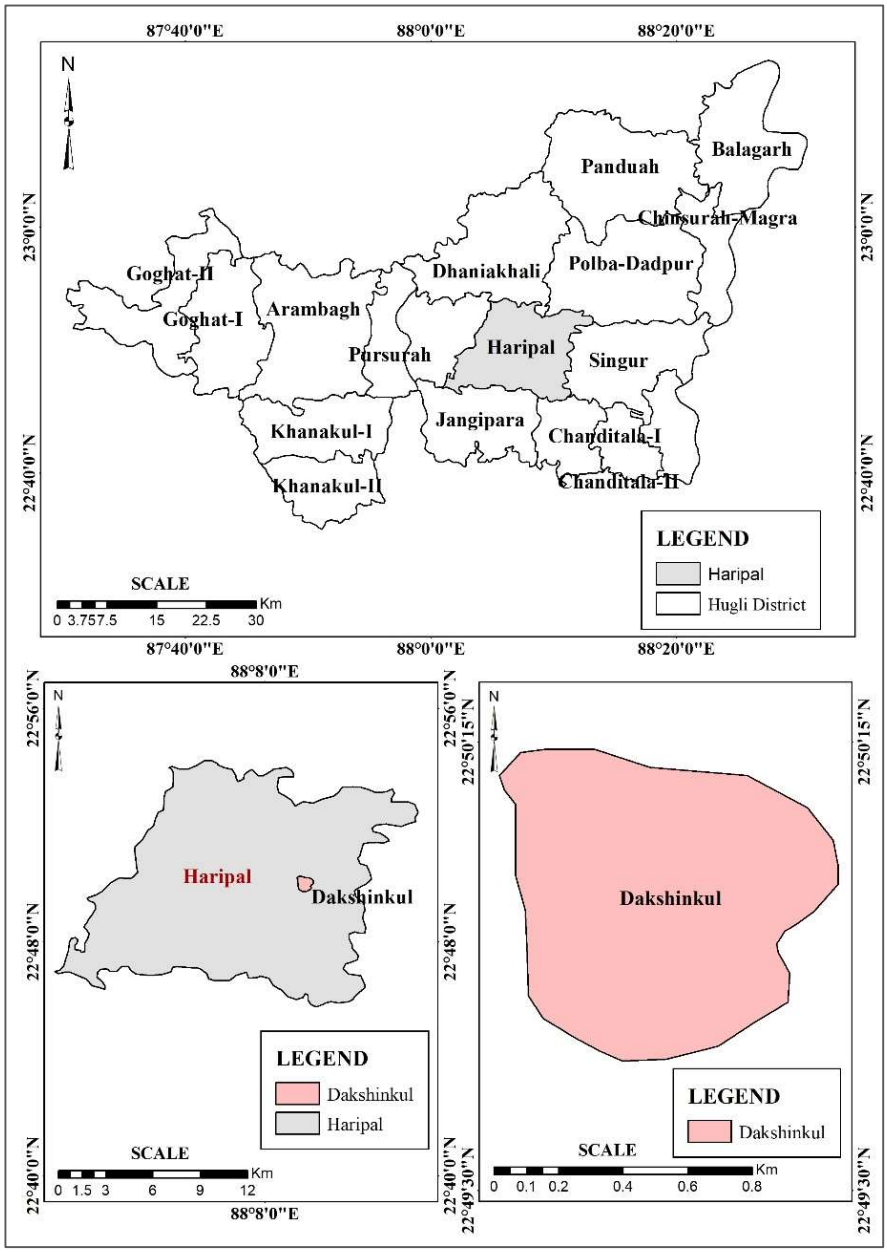
Total net sown area was recorded as 388.27 hectares in 1991 and the amount has quite increased (2.8 hectares) during the time span of 1991 to 2011. In 2011, 32 hectares of land has been occupied by irrigated land and major portion of net sown area (359.07 hectares) has been recorded as unirrigated area. Major sources of irrigation of this village are tube wells and tanks. Paddy, Potato and Fruits (Mango, Papaya, Lichhies, Banana, Jam), Seasonal Vegetable (Brinjal, Chillies, Cauliflower, cabbage, ladies' finger, Broken, Bitter gourd) are agricultural commodities grown in this village which mainly sell for the local urban market. Area under non-agricultural uses has been occupied by 131.13 hectares of land in 1991 but it has quite decreased during 1991 to 2011. The amount of area not available for cultivation has recorded as 128.73 hectares in 2011. Government Pre-Primary, Govt Primary, Govt Middle and Govt Secondary Schools are available in this Village. Nearest Govt Engineering College, Govt Polytechnic College and Govt ITA College are in Hugli. Nearest Govt Senior Secondary School and Govt Arts and Science Degree College are in Bhadreswar. Nearest Govt Medical College is in Kolkata. Nearest Private MBA college is in Mankundu.

Hand Pump and Tube Wells/Boreholes are other Drinking Water sources. Some families have Sub Marshall Pump. Public Bus and railway services, Autos, Man pulled Cycle Rickshaws are the important modes of transportation in this village. National Highway and also State Highway passes through this village. District Road passes through this village. Pucca road, Kuccha Road and Foot Path are other Roads and Transportation within the village. House to House waste Collection is available. There is no system to collect garbage on the street. Drain water is discharged directly into water bodies.

5.3.4 Dakshinkul village

The village Dakshinkul is located in Haripal C.D block of Hugli District, which is a part of Chandannagar Subdivision. The village covers a total area of 70.4 hectares. It nearest railway junction is Nalikul which is situated ~0.5km away from the village. The town of Arambagh municipality is located to the western part of the study area and is connected via several metalled roads. The nearest town is Haripal which is 10km away.

Figure 5.9: Location map of Dakshinkul village

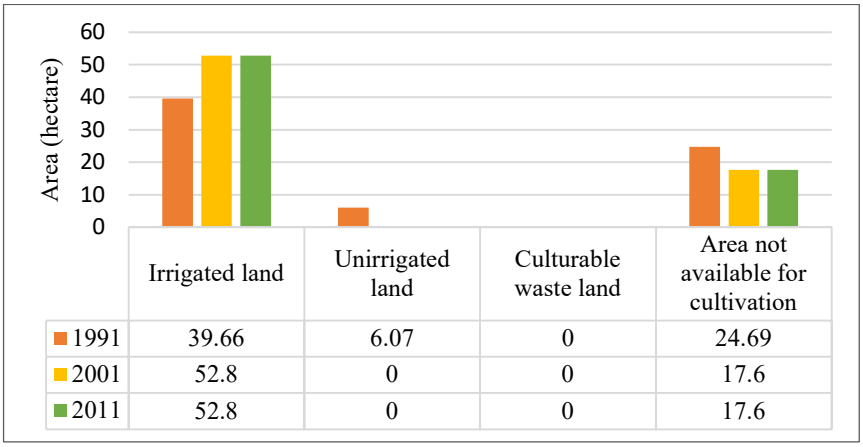


Source: Prepared by Researcher based on Census of India (2011).

This village is situated in a region which has favourable drainage and soil characteristics. Kana Nadi, which is an inundation canal of the Damodar Valley Corporation (DVC), flows through the eastern side of the village. Here, the level of groundwater is nearer to the surface as it is situated in a geologically skewed region. Dakshinkul falls on the flat plain of the Gangetic Alluvial soil zone and is thus rich in Calcium (Ca), Potash (K), Nitrogen (N) and Phosphate (PO_4^{3-}). The soil texture of the village generally varies from loam, sandy-loamy to clay-loam.

The total population of Dakshinkul was 1499 in 1991, 1527 in 2001 and 1680 in 2011 (Census of India 1991, 2001 and 2011) with a population density of 21 persons/ha, 22 persons/ha and 24 persons/ha respectively. The total number of households in the village increased from 264 to 370 between 1991 and 2011. The maximum growth of population was recorded during 1991 to 2001 with an increase of ~10%.

Figure 5.10: Area under different types of Land use of Dakshinkul village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	39.66	6.07	0	24.69
2001	52.8	0	0	17.6
2011	52.8	0	0	17.6

Source: Census of India (1991, 2001 and 2011).

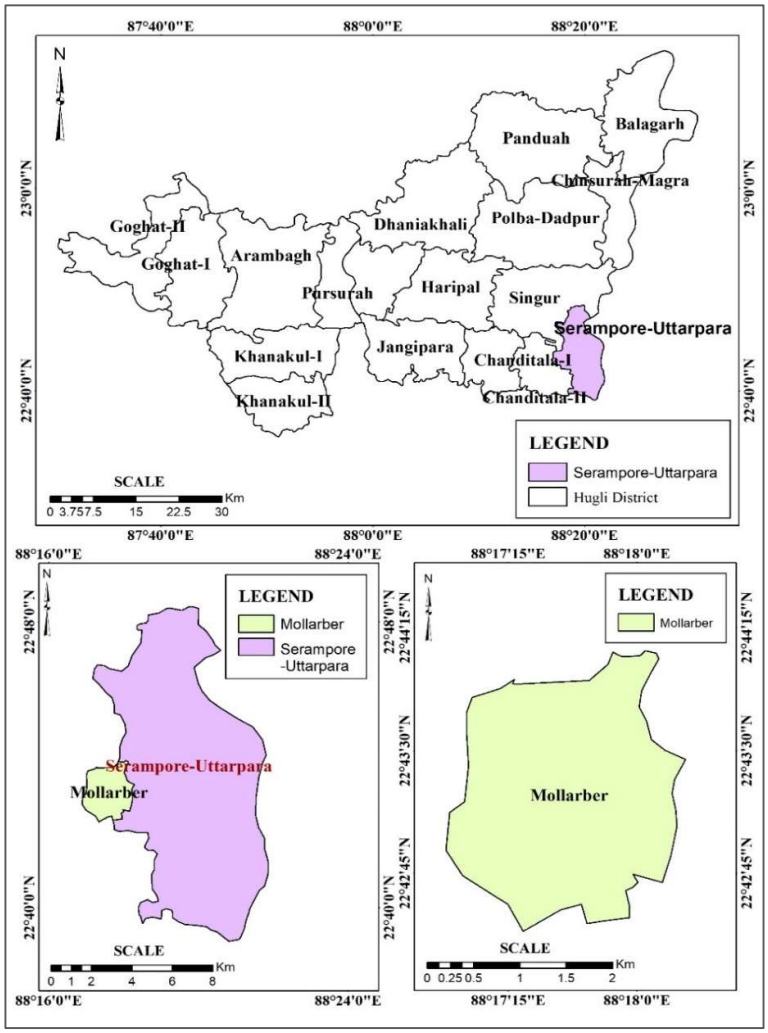
Dakshinkul is considered as one of the most agriculturally thriving village of Hugli district owing to the availability of proper river lift irrigation from Kana Nadi and fertile soils. In fact, the overall trend of land use pattern (Figure 5.10) indicates that the 6.07 hectares of unirrigated land that was present in 1991 was converted to irrigable lands by 2001 (Census of India, 2001 and 2011). Hence, positive agricultural development was observed in the village with more lands (~7ha) being brought under cultivation. Rice (mainly aman and boro) cultivation is carried out extensively in the village along with jute and vegetables. Cropping intensity is quite high here due to the practice of multiple cropping among the farmers. From the Census 2011 it is revealed that educational facilities in the village includes 1 pre-primary and 1 primary schools. Middle, secondary, senior secondary schools and

colleges are yet to be built in the village. Villagers have to travel a distance of minimum 10 km for higher education. Other amenities including several medical facilities, drinking water and electricity availability, telephone connection, transportation, banks, etc. are present mostly within a distance of 10 km from the village.

5.3.5 Mollarber village

Mollarber village is located in Serampore-Uttarpara C. D block of Serampore Subdivision in Hugli district. The village covers a total area of 492.3 ha. The town of Hugli-Chunchura municipality, which is the district headquarter is located to the north of the study area. The nearest town is Rishra which is nearly 4km from Mollarber.

Figure 5.11: Location map of Mollarber village



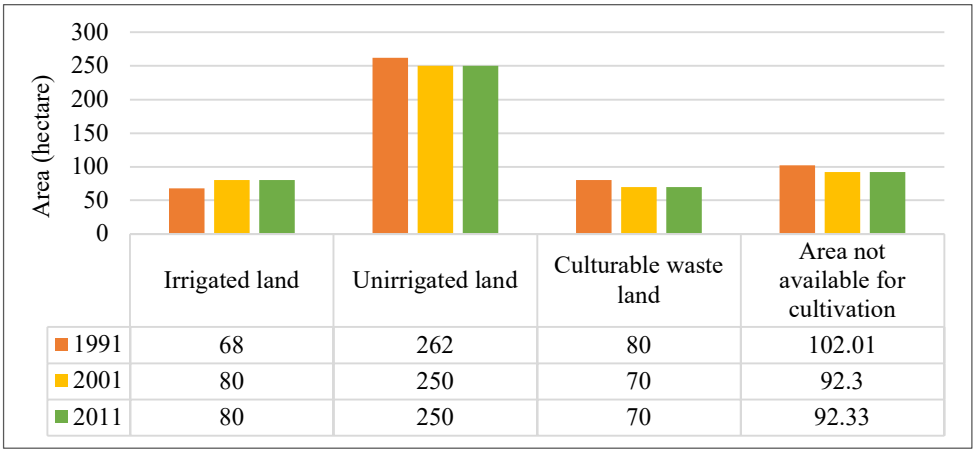
Source: Prepared by Researcher based on Census of India (2011).

The village is a part of the Hugli flood plain region which is quite fertile owing to the alluvial deposits from the river. The soil is rich in calcium (Ca) deposits with normal pH levels (~6.0 to ~6.8). The texture of the soil varies from loam, sandy-loam to clay-loam. Climate of the village is similar to that of the Hugli district i.e., hot and humid summers, abundant rains with high humidity and dry winters. The total population of the village was 3016 in 1991, 3727 in 2001 and 6006 in 2011 (Census of India, 1991, 2001 and 2011) with a population density of 6.13 persons/ha, 7.57 persons/ha and 12.20 persons/ha respectively. The total number of households in the village increased from 511 to 1264 between 1991 and 2011. The maximum growth of population was recorded during 2001 to 2011 with an increase of ~61%.

The land use pattern of Mollarber (Figure 5.12) has shown a dominant increment in the total irrigated area under agriculture from 68 hectares in 1991 to 80 hectares in 2011. Fallow and waste lands were brought under agricultural activity resulting in the sudden boom of the net sown area eventually. This development could be attributed to the availability of irrigation facilities from tanks and lakes which resulted in the increased use of high-yielding variety crops and eventually enhanced productivity. Mainly, agricultural plots are occupied by rice (aman and boro), jute and vegetables cultivation.

According to the 2011 Census report, educational facilities in the village includes 3 pre-primary, 3 primary schools, 1 middle school and 2 senior secondary schools. Colleges are present within a distance of 10-15km from the village. Few health centres are present in the village. Drinking water and electricity availability, telephone connection, transportation, banks, etc. are also present mostly within a distance of 10 km.

Figure 5.12: Area under different types of Land use of Mollarber village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	68	262	80	102.01
2001	80	250	70	92.3
2011	80	250	70	92.33

Source: Census of India (1991, 2001 and 2011).

Photograph 5.3: a) & b) Conversion of Agricultural lands to Fishery; c) Conversion of Agricultural lands to poultry farming

Source: Captured by the Researcher.

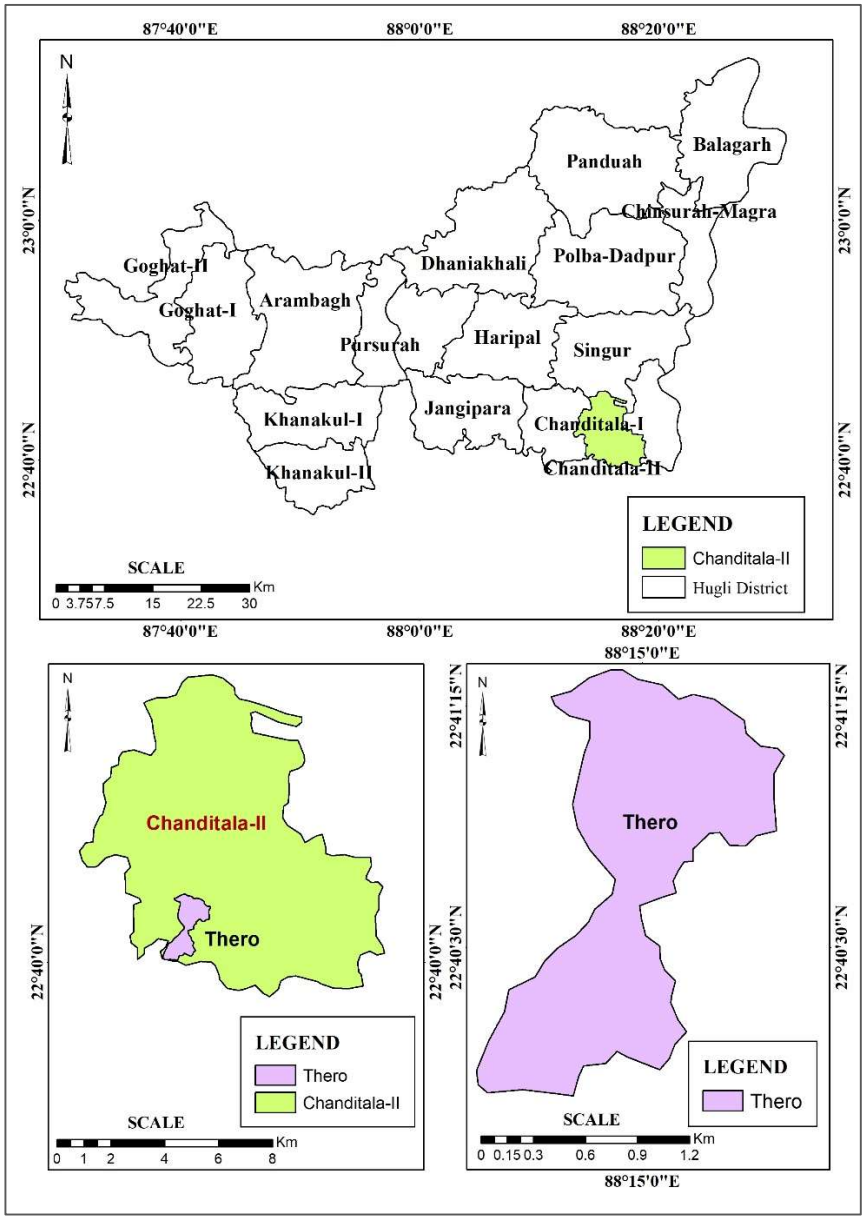
5.3.6 Thero village

Thero village is located in Chanditala II C.D Block of Hugli district. It is situated 2.8km away from sub-district headquarter Chanditala. The total geographical area of village is 171.28 hectares. Thero has a total population of 3,051 peoples, out of which male population is 1,579 while female population is 1,472. Literacy rate of Thero village is 69.78%. Total households of this village are 700. There is no scarcity of Drinking water as PHE (Public Health and Engineering Department) has supplied drinking water through pipe line at every household in the village.

There are mainly four categories of land use types such as cultivated land with irrigation, land without irrigation, culturable waste land and area not available for cultivation. The amount of irrigated land was 84.6 hectares in 1991 and 98.3 hectares in 2011. So, the growth of irrigated land was 13.7 hectares during 1991-2011. About 21.73 hectares area was covered by unirrigated land in 1991 which was reduced by 0.03 hectares in 2001 and total amount reached at 21.70 hectares in 2001. In 2011, unirrigated land has completely absent. The amount of culturable waste land was 10.15 hectares in 1991 which was increased by 25.25 hectares in 2011. On the other hand, the area not available for cultivation was recorded as 54.8 hectares in 1991 and 2001. But this amount has decreased by 17.2 hectares during 2001 to 2011.

Paddy is the main crops produced in both Kharif season and Rabi season. Besides vegetables, pulses, wheat, muster seeds etc are also produced in the village. Some portion of land is covered by vegetation with orchard which are scattered all over the village.

Figure 5.13: Location map of Thero village



Source: Prepared by Researcher based on Census of India (2011).

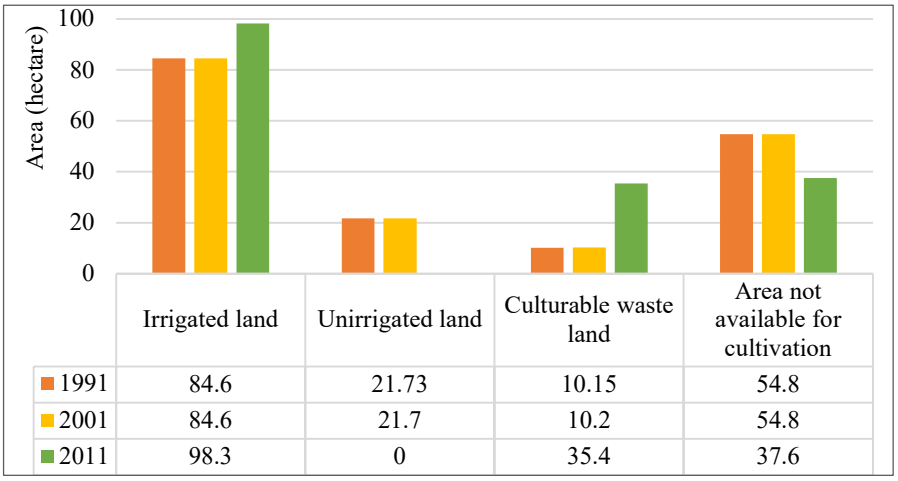
The main source of irrigation in this village depends on governmental irrigation canal (Dankuni canal). But nowadays, there is scarcity of irrigated water because Dankuni canal is polluted by the industrialization of the locality. Most of the agricultural low land have lose their fertility by the polluted water of this canal. Some people cultivated seasonal vegetable in very small scale, but now they totally stopped this farming due to pig attack. Dunkuni Municipality import some pigs at their waste projects site, from outsides area to destroy the household garbage. Now the number of pigs increasing. In search of food, they spread in

Barijhati Panchayet area and destroy the vegetables. Govt initiative to motivate the farmers fails totally and the farmers are shifted their occupation from agriculture to semi skill or unskilled labour to Duankuni Industrial Project. Source of fuel in most of the houses are wood but gas connection also available in this family.

Photograph 5.4: Irrigation (Deep tube well) system and Cultivation of fodder gamma grass at Thero village

Source: Captured by the Researcher.

Figure 5.14: Area under different types of Land use of Thero village



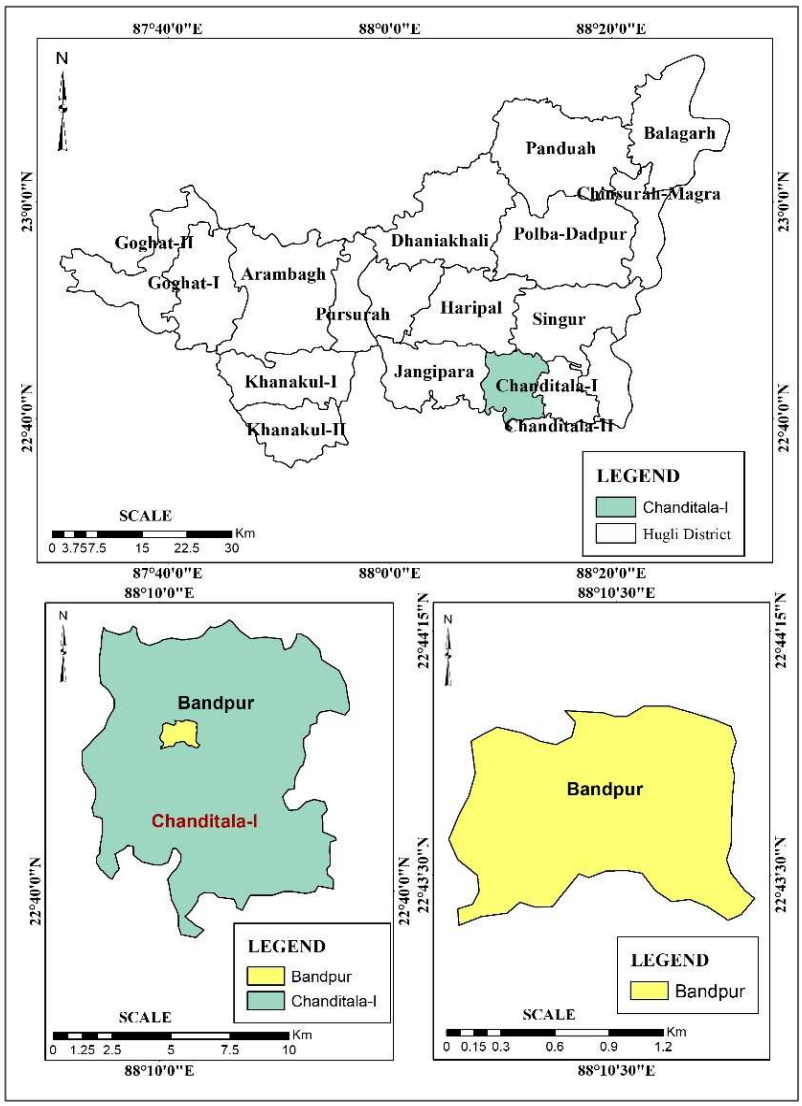
	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	84.6	21.73	10.15	54.8
2001	84.6	21.7	10.2	54.8
2011	98.3	0	35.4	37.6

Source: Census of India (1991, 2001 and 2011).

5.3.7 Bandpur-Pubpara village

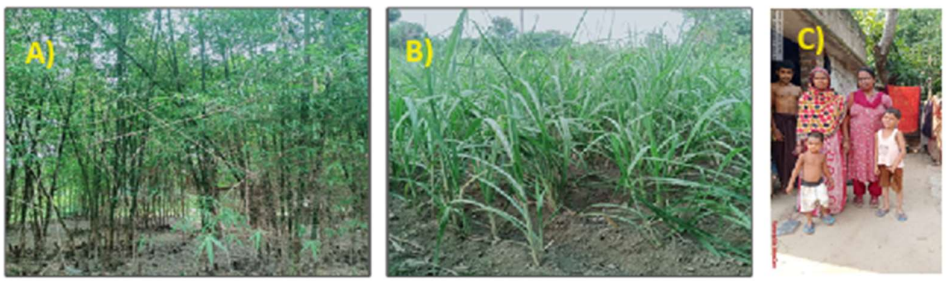
Bandpur-Pubpara village is situated in the Chanditala-I C.D. Block of Hugli District. It is situated 12.9 km away from sub-district headquarter Chanditala. This village occupied 116.93 hectares land area. The total population of this village was 3594 and the total number of households was 727 in 2011. Out of the total population, male population was 1825 and female population was 1769. Literacy rate of this village is 71.62%.

Figure 5.15: Location map of Bandpur-Pubpara village



Source: Prepared by Researcher based on Census of India (2011).

Photograph 5.5: A) & B) Agricultural practices in Bandpur-Pubpara village; C) Researcher interact with respondents

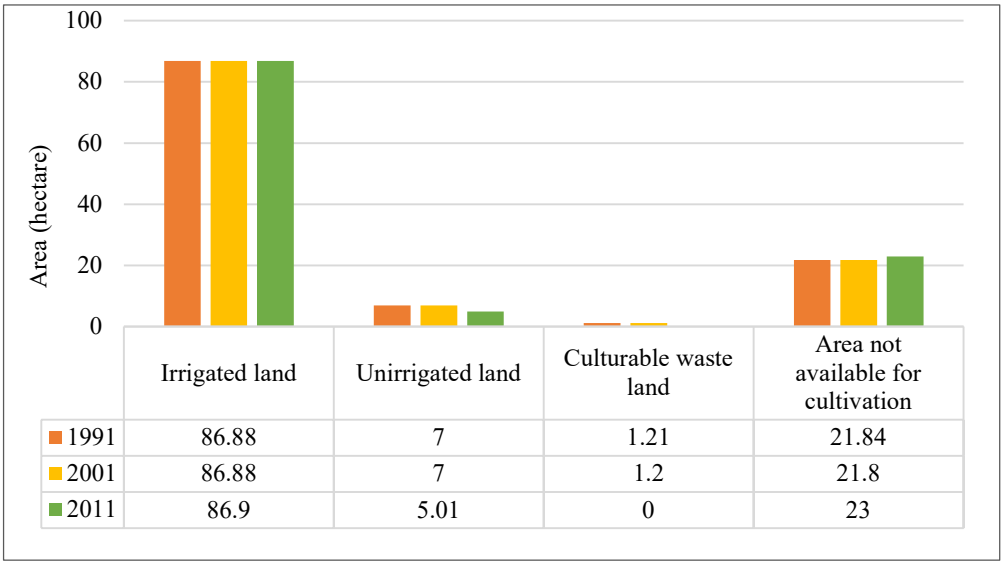


Source: Captured by the Researcher.

There are mainly four categories of land use pattern such as irrigated area, unirrigated area, culturable waste land and area not available for cultivation. The amount of irrigated area was 86.88 hectares in 1991, 86.9 hectares in 2001, and remain same in 2011. So, the irrigated land was increased about 0.02 hectares during 1991 to 2011. The main source of the irrigation are wells and tube wells. There was no change of unirrigated area in this village during 1991 to 2011 (Figure 5.7). The least portion of land of about 1.21 hectares was used as culturable waste land. The amount of area not available for cultivation was 21.84 hectares in 1991 and 23 hectares in 2011. It had been noticed that about 1.16 hectares land under this category was increased during 1991-2011.

About 70 percent of the total area is cultivated which includes more than one crop and single crop and 30 percent area is uncultivated which includes roads, settlements, shops, schools, wet lands, vegetation with orchards etc. Owing to the views of villages, Bandpur-Pubpara village face some problem such as lack of systematic house-to-house waste collection by the Panchayet, supply of drinking water in every household. In Bandpur, several underprivileged families reside in mud houses, and some do not receive poverty allowances, old age allowances, or widow allowances. The village also contends with unpaved roads that become muddy during the monsoon season, posing challenges for transportation and mobility.

Figure 5.16: Area under different types of Land use of Bandpur-Pubpara village



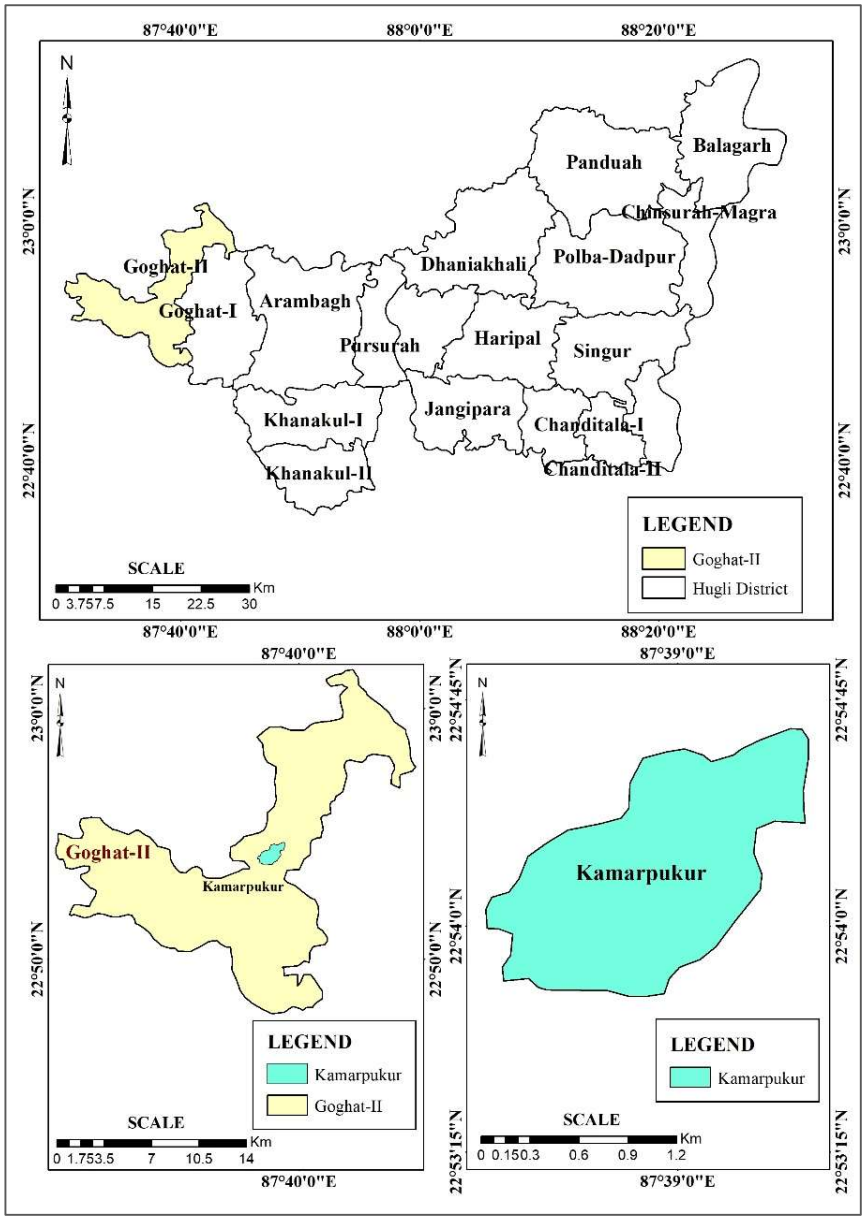
	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	86.88	7	1.21	21.84
2001	86.88	7	1.2	21.8
2011	86.9	5.01	0	23

Source: Census of India (1991, 2001 and 2011).

5.3.8 Kamarpukur village

The Kamarpukur village is located in Goghat-II C.D block of Hugli district, which is a part of Arambagh Subdivision. The village covers a total area of 166 hectares. It nearest railway junction is Tarakeshwar which is 45 km away from the village. The town of Arambagh municipality is located to the eastern part of the study area which is around14km from Arambagh.

Figure 5.17: Location map of Kamarpukur village



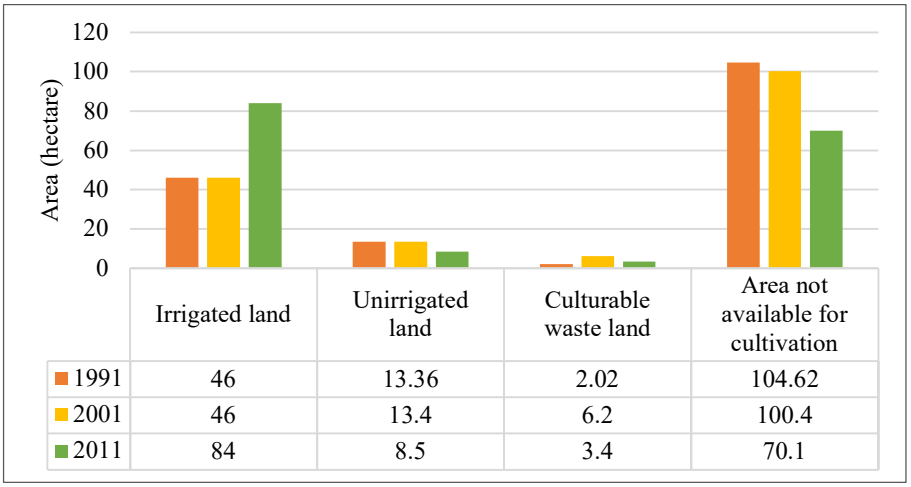
Source: Prepared by Researcher based on Census of India (2011).

Kamarpukur lies in the Vindhya alluvial soil stretch formed by the depositional activities of rivers Darakeshwar and Damodar. The Amudar river (a distributary of river Damodar) flows past the village. The region is comparatively less fertile than the Gangetic alluvial plains having a slightly acidic characteristic (pH value ranging between 5.0 to 6.8). Kamarpukur is famous for being the birthplace of Sri Ramkrishna Paramhansha who is one of the famous sages from Bengal.

The total population of the village was 2726 in 1991, 3105 in 2001 and 3121 in 2011 (Census of India, 1991, 2001 and 2011) with a population density of 16.42 persons/ha, 18.70 persons/ha and 18.80 persons/ha respectively. The total number of households in the village increased from 499 to 739 between 1991 and 2011. The maximum growth of population was recorded during 1991 to 2001 with an increase of ~14%.

The land use of Kamarpukur (Figure 5.18) reveals that it has a typical agrarian economy bringing ~38 hectares of land under irrigation between 2001 and 2011. The utilization of high-yielding variety (HYV) seeds, chemical fertilizers, pesticides, and different equipment, etc., further increased the intensity of cultivation. Rice (aus, aman and boro) cultivation dominates in the village along with pulses and vegetables. Due to the presence of the Ramkrishna Mission, several innovative and modern technologies were implemented to boost income from agricultural activities. With several missionary activities taking place in the village, it hosts the assemblage of people from different areas, thus establishing a bridge between agricultural and social changes.

Figure 5.18: Area under different types of Land use of Kamarpukur village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	46	13.36	2.02	104.62
2001	46	13.4	6.2	100.4
2011	84	8.5	3.4	70.1

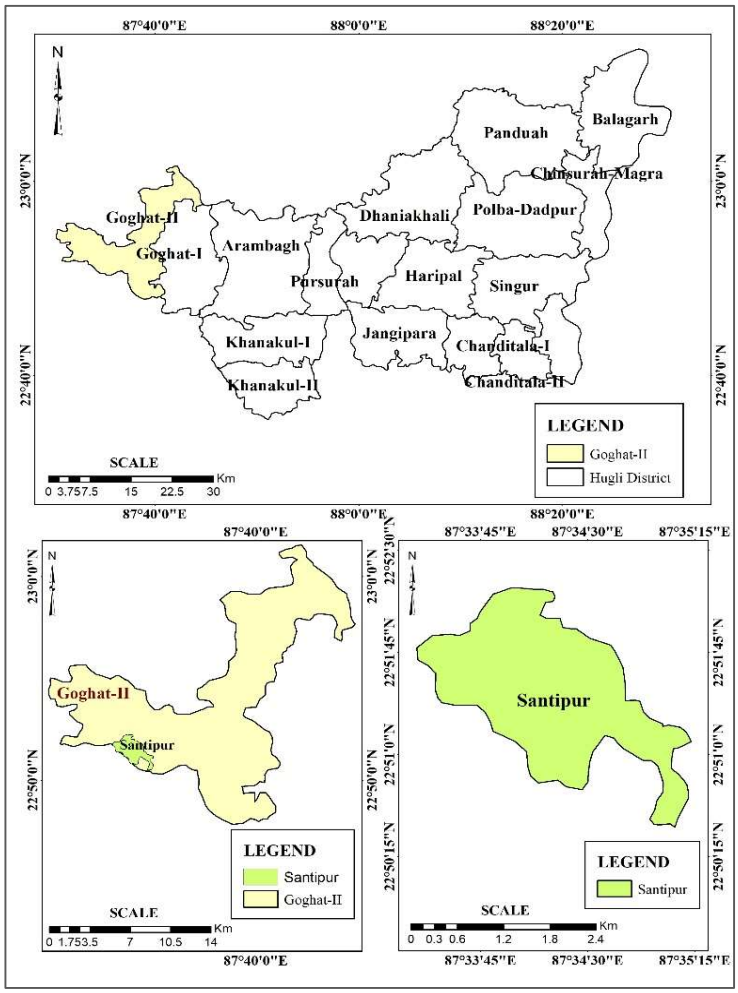
Source: Census of India (1991, 2001 and 2011).

2011 Census reveals that the village has 3 pre-primary, 2 primary, 1 middle, 1 secondary and 1 senior secondary school, and a degree college situated within 5km. Kamarpukur has a primary health sub-centre among other amenities that includes several specialised medical facilities, drinking water and electricity availability, telephone connection, transportation, banks, etc. mostly within a distance of 10km from the village.

5.3.9 Santipur Village

Santipur village is located in Goghat-II C.D block of Hugli District, that lies in Arambagh Subdivision. It is located on the Kamarpukur-Badanganj route lying 10km from Kamarpukur and 7km from Badanganj. The town of Arambagh municipality is located to the eastern part of the study area which is within 10 km from Arambagh.

Figure 5.19: Location map of Santipur village

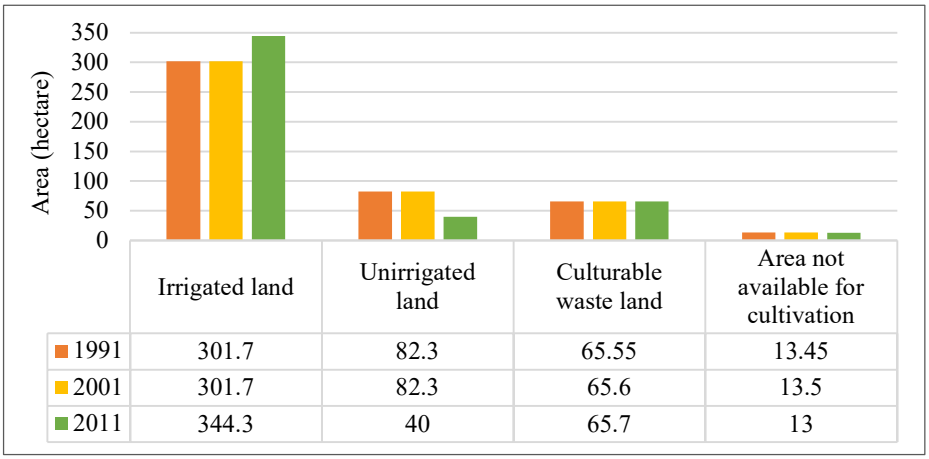


Source: Prepared by Researcher based on Census of India (2011).

The nature of the soil is similar to that of Kamarpukur as it lies in the Vindhya alluvial soil stretch formed by the siltation of rivers Darakeshwar and Damodar. The Amudar river (a distributary of river Damodar) flows past the village. Similarly, it is less fertile than the Gangetic alluvial plains just like Kamarpukur having a slightly acidic characteristic (pH value ranging between 5.0 to 6.8).

The total population of the village was 2617 in 1991, 3006 in 2001 and 3768 in 2011 (Census of India, 1991, 2001 and 2011) with a population density of 6.00 persons/ha, 6.89 persons/ha and 8.14 persons/ha respectively. The total number of households in the village increased from 444 to 823 between 1991 and 2011. The maximum growth of population was recorded during 2001 to 2011 with an increase of ~25%. According to 2011 Census of India, Santipur village has 3 pre-primary and 3 primary schools. Medical facilities available in the quite poor as there are no health centres and hospitals in the village. In order to avail treatment, the villagers have to travel ~10km to reach the nearest primary health sub-centre. Other miscellaneous amenities including drinking water, electricity, telephone connection, transportation, banks, etc. are present in the village.

Figure 5.20: Area under different types of Land use of Santipur village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	301.7	82.3	65.55	13.45
2001	301.7	82.3	65.6	13.5
2011	344.3	40	65.7	13

Source: Census of India (1991, 2001 and 2011).

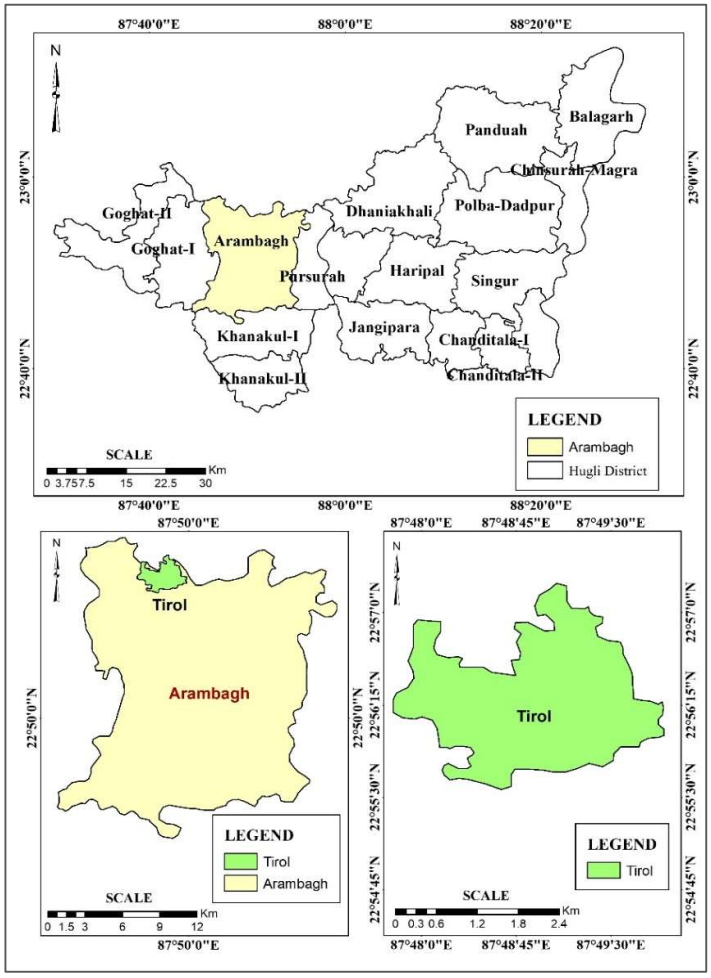
Santipur village also possess an agricultural economy as it can be clearly visible from the land use pattern. Figure 5.20 demonstrates that the total area under irrigation remained stagnant throughout from 1991 to 2001, hence due to the shortage of water, there is maximum dependency on monsoons every year. As a result, kharif crops forms the most important production of the entire year. From 2001 to 2011, irrigated land has increased to 42.6 hectares. During winters, availability of water is dependent on canals, tanks and tube-wells (~180ft below the surface). The utilization of high-yielding variety (HYV) seeds,

chemical fertilizers, pesticides, and different equipment, etc., further increased the intensity of cultivation. Rice (mainly aman) cultivation predominates in the village as it is mostly rainfall reliant. Other crops cultivated include pulses, vegetables, mustard, till, sugarcane, etc.

5.3.10 Tirol village

Tirol village is located in Arambagh C.D block of Hugli district in West Bengal. It is situated 14.7 km away from sub-district headquarter Arambagh and 78.6 km away from district headquarter Chinsura. The total area of this village is 583.19 hectares with total population of 4523. out of which male population is 2293 while female population is 2230. Literacy rate of Tirol village is 75.95%.

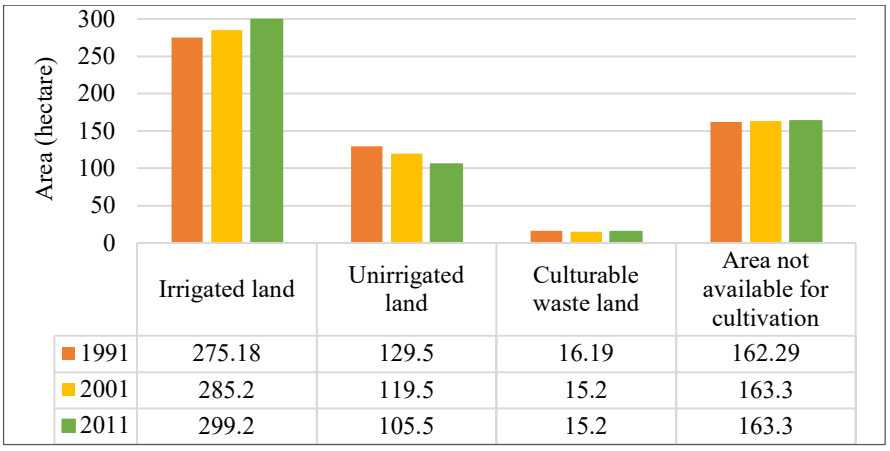
Figure 5.21: Location map of Tirol village



Source: Prepared by Researcher based on Census of India (2011).

The amount of irrigated land was 275.18 hectares which was 47.19 percent to the total area in 1991. This amount has been increased in 2011 and recorded as 299.2 hectares. Unirrigated land was occupied by 129.5 hectares in the census year of 1991 but unirrigated land was declined at 6.41 hectares during 1991-2011. The amount of culturable waste land was 16.19 hectares until 1991 and after 1991; it was decreased about 0.99 hectare in 2001 and 0.89 hectare in 2011. On the other hand, the area not available for cultivation was 162.29 hectares in 1991, which was remained same in 2001. But the area not available for cultivation increased about 1.10 hectares in 2011 from 1991. The maximum cultivated area of this village is contained by single and double crop which depends on tube wells irrigation system. The main crops of this region are rice, oil seeds, til, pulses etc. Some plots of this village are occupied by vegetation with orchard.

Figure 5.22: Area under different types of Land use of Tiroli village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	275.18	129.5	16.19	162.29
2001	285.2	119.5	15.2	163.3
2011	299.2	105.5	15.2	163.3

Source: Census of India (1991, 2001 and 2011).

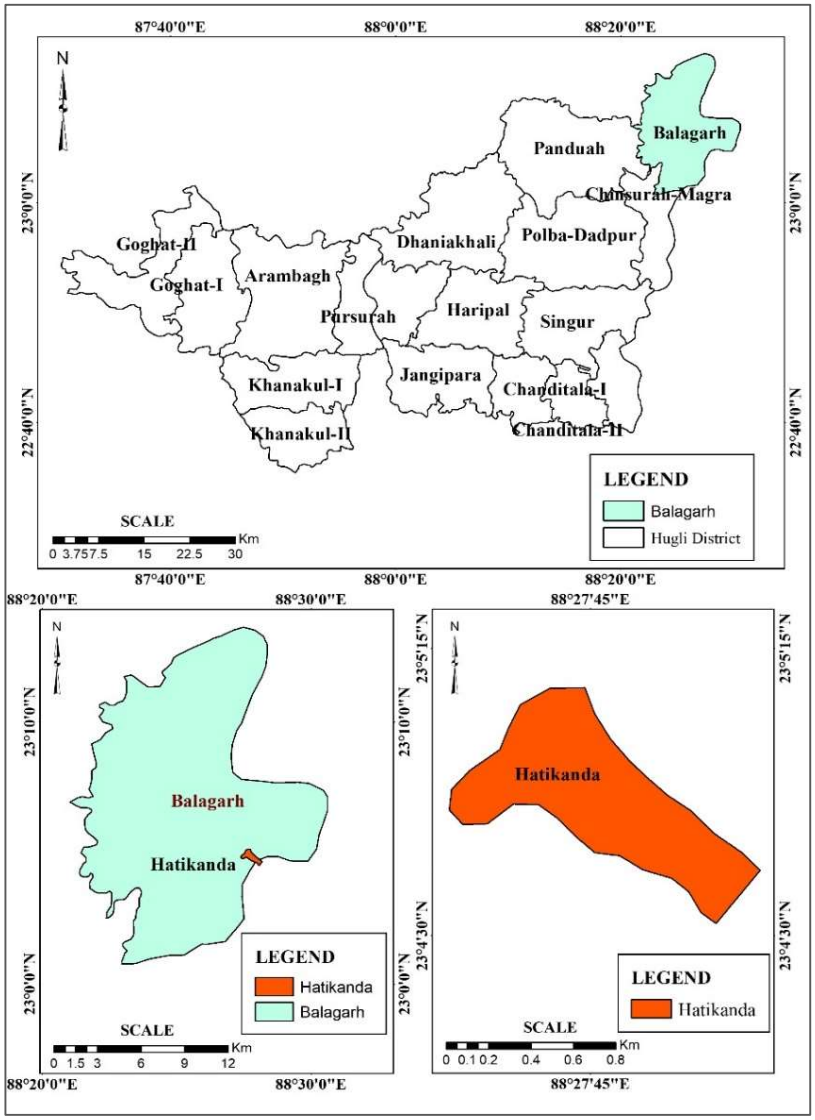
5.3.11 Hatikanda village

Hatikanda village is located in Balagarh subdivision of Hugli district in West Bengal, India. It is situated 5.7km away from sub-district headquarter Patuligram and 25.4km away from district headquarter Chinsura. The total geographical area of village is 55.04 hectares. Hatikanda has a total population of 682 peoples, out of which male population is 346 while female population is 336. Literacy rate of Hatikanda village is 71.70% out of which 78.61% males and 64.58% females are literate. There are about 180 houses in Hatikanda village.

The land use pattern of Hatikanda village was classified into four categories like irrigated land, unirrigated land, culturable waste land and area not available for cultivation. There was

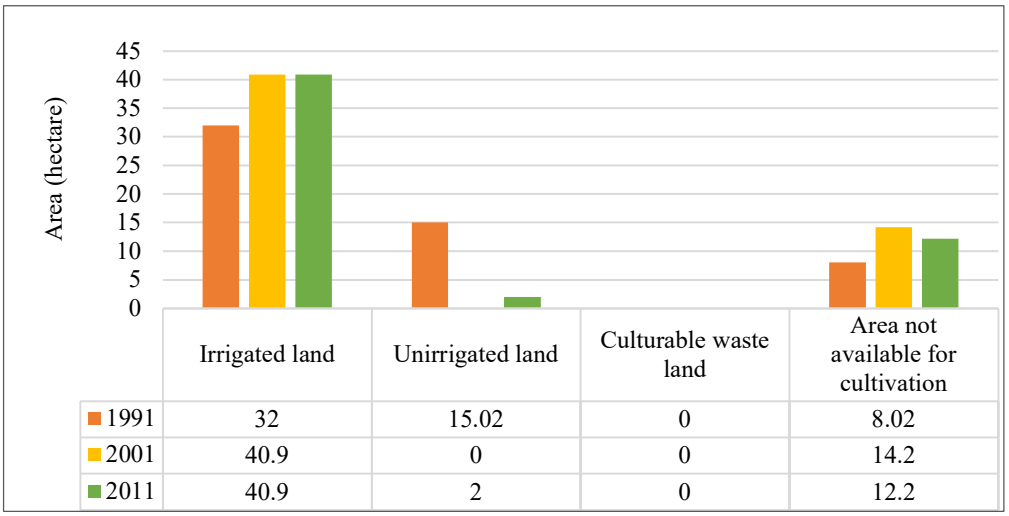
no culturable waste land in this village. About 32 hectares area was included under irrigated land in 1991 and 40.9 hectares in 2001 and 2011. So, 8.9 hectares irrigated area was increased from 1991 to 2001. The amount of unirrigated area was recorded as 15.02 hectares in 1991 and it reached at only 2 hectares in 2011. So, it was observed that 13.02 hectares unirrigated land was decreased during 1991-2011. The amount of area not available for cultivation was 8.02 hectares in 1991, 14.2 hectares in 2001 and 12.2 hectares in 2011. So, about 6.18 hectares land under area not available for cultivation was increased during 1991-2001 whereas, decline rate of area not available for cultivation was 2 hectares during 2001-2011.

Figure 5.23: Location map of Hatikanda village



Source: Prepared by Researcher based on Census of India (2011).

Figure 5.24: Area under different types of Land use of Hatikanda Village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	32	15.02	0	8.02
2001	40.9	0	0	14.2
2011	40.9	2	0	12.2

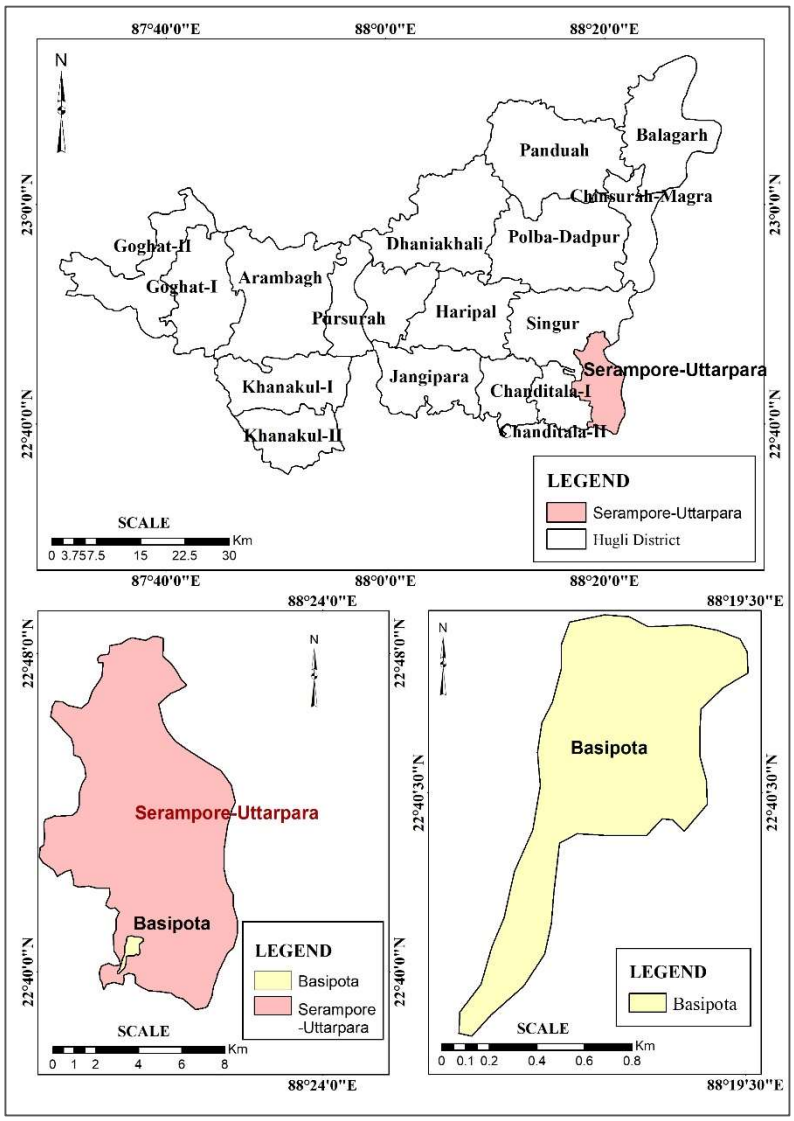
Source: Census of India (1991, 2001 and 2011).

5.3.12 Basipota village

Basipota village is located in Serampore-Uttarpara C.D block in Hugli District. Raghunathpur is the Gram Panchayet of the Basipota village. It is situated 8.6 km away from Sub- district head quarter Serampore and 25.2 km. away from District Headquarter Chinsurh. The total geographical area of village is 55.41 hectares. Basipota has a total population of 958 peoples, out of which male population is 473 while female population is 485. Literacy rate of Basipota village is 73.80% out of which 75.90% males and 71.75% females are literate. The total households of this village 233.

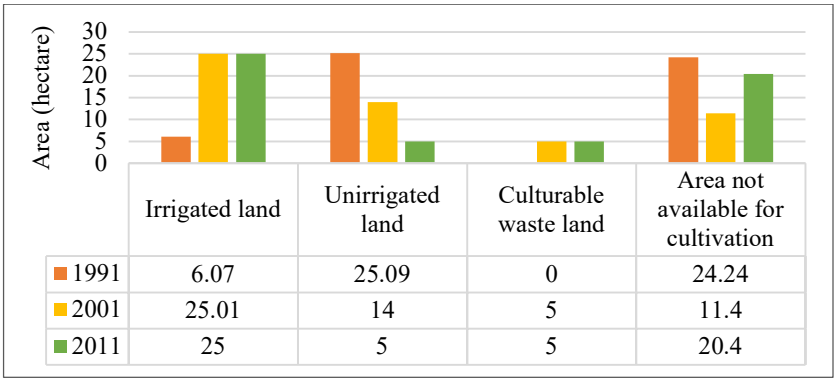
On the basis of Census of India, the land use of this village is generally categorized into four types, such as irrigated land, unirrigated land, culturable waste land and area not available for cultivation. About 25 hectares land was occupied by irrigated land in 2001 which was only 6.07 hectares in 1991. It was evident that there was an increasing rate of irrigated land by 18.83 hectares from 1991 to 2001 but the irrigated land remained same amounting to 25 hectares in 2011 from 2001. The mode of irrigation system of this village was mainly by tube-well. The amount of unirrigated land was 25.09 hectares in 1991 and it became 14 hectares during 1991 - 2001. So, the decline rate of unirrigated land has been noticed. The amount of culturable waste land was increased 5 hectares of land during 1991-2001 and remain same in 2011. The amount of area not available for cultivation was 24.24 hectares in 1991 and it was decreased by 3.84 hectares in 2011.

Figure 5.25: Location map of Basipota village



Source: Prepared by Researcher based on Census of India (2011).

Figure 5.26: Area under different types of Land use of Bosipota Village



	Irrigated land	Unirrigated land	Culturable waste land	Area not available for cultivation
1991	6.07	25.09	0	24.24
2001	25.01	14	5	11.4
2011	25	5	5	20.4

Source: Census of India (1991, 2001 and 2011).

5.4 Conclusion

Revision of land utilization is necessary due to changing needs and an increasing population (Maiti, 2014). The study of land use makes it necessary to offer a first-rate chance to use scientific approaches to correct previous mistakes and overrule new ones. The right use of land is essential to the success of national planning. In our nation, land use patterns will eventually be regulated by a planned program that includes more than just tamed animals and crops. Indirectly, human planning and deliberate use of the land will determine many things (Klages, K.H.W.1947).

Goghat II, Chanditala I & II, Arambagh, and Haripal C.D. blocks are important for agricultural practices in the district. In those C.D. blocks net sown area is higher than the others land utilization. Therefore, the impact of agricultural growth is immense on the spatio temporal variation of economic development in these C.D. blocks. Therefore, the economic development of the area depends largely on agricultural activities.

Dakshinkul village of Haripal C.D. block, Kamarpukur and Santipur of Goghat II C.D. block and Thero village of Chanditala II C.D. block of Hugli district have experienced positive growth of irrigated land. The maximum cultivated area of these villages is contained by single and double crop which totally depends on the Governmental canal and tube wells irrigation system. The utilization of high-yielding variety seeds, chemical fertilizers, pesticides, and different equipment of agricultural practices have triggered factors to increase the intensity of cultivation.

However, agricultural growth has a positive impact on the socio-economic conditions of the region. Sripur village of Balagarh C.D. block and Sankarbati village of Polba-Dadpur C.D. block where area not available for cultivation is higher than net sown area. A large number of people are engaged in non-agricultural work as an alternative to agriculture. Transport network extends even into interior areas where electricity, drinking water facilities, health care facilities education system etc. are available. Hence, there is an uneven distribution of land utilization throughout the district.

Chapter 6

Impact of Land Use Transformation on Socio-Economic Changes

Chapter 6

Impact of Land Use Transformation on Socio-Economic Changes

6.1 Introduction

Land is a fundamental and finite resource with human and non-human dimensions. Land and its various uses provide the foundation of our national economic prosperity, quality of life and wellbeing, and cultural identity. Nowadays land use transformation has significance at global, regional and local levels (Lambin et al. 2001; Turner et al. 1990). Often a combination of economic, institutional, and political factors drive deforestation, including logging, agricultural expansion, infrastructure expansion, shifting cultivation and the extraction of non-timber forest products (NTFPs) and fuel wood (EIA 2015; Geist/Lambin 2001). Within the study area, the majority of land is agricultural land and the main source of income are cultivation, Government and private salaried job. In the fourth chapter, some perceived socio-economic factors have been discussed that contribute to land use change, but in this chapter socio economic impacts of land use changes in Hugli district have been discussed. The focus of this chapter is on the changes of socio-economic dimensions of the land-use system. In this context, the land-use system refers to the relationship between human activities on land, socio-economic conditions and the natural environment, and also the systems of governance which manages these interactions. This chapter also focus on the spatio-temporal variation and level of socio-economic development of Hugli District. A case study of two sample villages have also conducted to study the land use transformation and related socio-economic changes of the study area.

6.2 Land use Change and Socio-Economic dimension

6.2.1 Growth of population

From a social perspective, demography and the spatial distribution of population is a critical factor in driving land use change in any area. The population of Hugli district has increased by almost 1.16 million since the 1991, rising from 4,355,230 in 1991 to 5,519,145 in 2011 (Census of India, 1991 and 2011). According to the Census of India 1991, total number of households was recorded as 803280. This number has been continuously increasing and reached 1287423 at 2011. In chapter 3, it has been identified that many agricultural land and vegetation covered area have been transformed into built-up area. The area has experienced significant change in human population density throughout the study period, and it is

therefore evident that a reduced land cover and land use change witnessed in the study area. High population growth and density in rural areas increases pressure on the available arable land resulting to fragmentation and encroachment into marginal lands, reduced fallow periods, and methods of cultivation that lead to land degradation (Birungi, 2007). As urbanization intensifies, agricultural and non-agricultural land use conflicts become more severe (JunJie Wu, 2008). Urbanization also presents important opportunities to farmers. The emergence of a new customer base provides farmers new opportunities for selling higher value crops. The explosion of nurseries, vegetable farms, and other high–value crop industries in many suburban areas illustrates how quickly agricultural economies can evolve.

6.2.2 Impact on Agricultural land

As urbanization intensifies, agricultural and non-agricultural land use conflicts become more severe. This may lead to an increase in local ordinances designed to force farmers to pay for some of the negative impacts generated by agriculture. As the nearest input suppliers close because of insufficient demand for farm inputs, a farmer may have to pay more for inputs or spend more time to obtain equipment repairs (Lynch and Carpenter, 2003). Competition for labour from non-agricultural sectors may raise farmers' labour costs. When the total amount of farmland falls below a critical mass, the local agricultural economy may collapse as all agricultural supporting sectors disappear.

In 1991, total amount of net sown area was recorded as 220 thousand hectares. This amount has decreased to 2.88 thousand hectares during 1991–2011. This significant decrease in net sown area caused by increasing number of population as well as number of households, population density, improvement of literacy rate and conversion of farmland to other land types especially built-up area during the study period. From the perspective of agricultural development of Hugli district cropping pattern has uniquely transform from mono cropping to double or multiple cropping pattern.

6.2.3 Change of Livelihood

Land use and land cover change affects the livelihoods of local residents (Middleton and Lamb, 2019). Within the study area, the majority of land is under the agricultural land and the main source of income is cultivation. In the third and fourth chapter the study finds that land use patter in this area have changed significantly from 1991 to 2021, and especially after 2001. The declining rate of forest cover in this area has been caused by legal and illegal

extraction of timber, together with over-cutting of fuel wood for domestic use and sale. During the study time span majority of agricultural land have been transform into built-up area. There is a decreasing trend of number of agricultural labour and cultivators have been noticed. In 1991 only 14.6 % out of total workers have engaged in agricultural activities. In 2001, this scenario has improved and the percentage reached up to 39.26. From 2001 to 2011 there is a declining rate of agricultural workers have been noticed.

6.3 Case Study

6.3.1 Hatikanda village

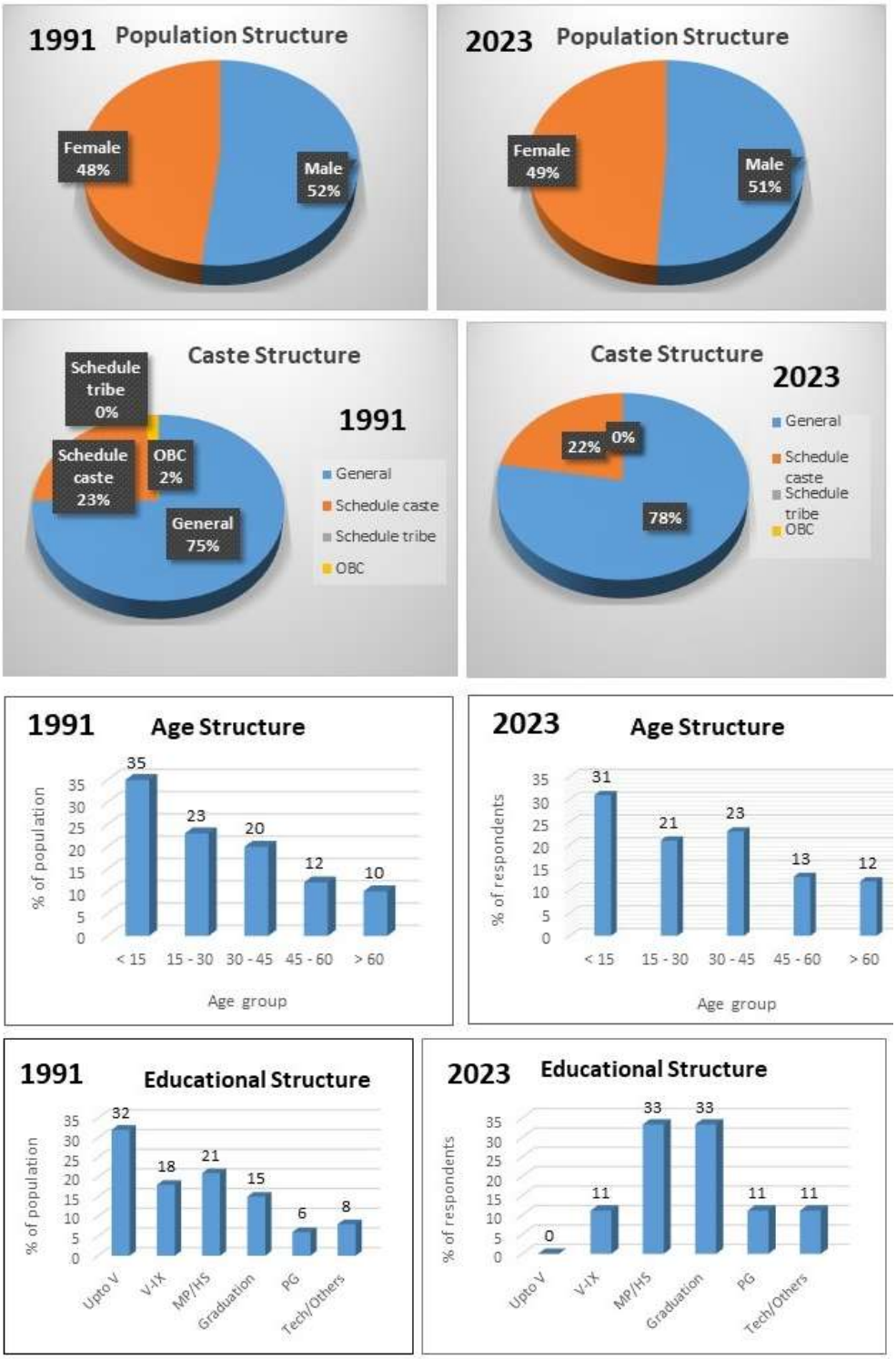
- **Location of the village**

Hatikanda village is located in Balagarh C.D block of Hugli district in West Bengal, India. It is situated 5.7km away from sub-district headquarter Patuligram and 25.4km away from district headquarter Chinsura. The total geographical area of village is 55.04 hectares. Hatikanda has a total population of 682 peoples, out of which male population is 346 while female population is 336. Literacy rate of Hatikanda village is 71.70% out of which 78.61% males and 64.58% females are literate. There are about 180 houses in Hatikanda village. In Balagarh C.D block, most of the villages have experienced river bank erosion but according to the respondents' views there is no record of river bank erosion in Hatikanda village.

- **Socio-economic scenario**

Figure 6.1 and 6.2 represent socio-economic profile of Hatikanda village. According to the census 1991, it was observed that 10% population were old aged category followed by middle (20%) and young aged category (35%) whereas 52% were male population, it is observed that 11% respondents were old aged category followed by middle (22%) and young aged category (33%) whereas 56% were male respondents in 2023. In 1991 the ratio of males and females was 52% and 48%. Majority of respondents have completed secondary and higher secondary level and also graduation (33%) in their educational achievement. 78% respondents belong to general caste where 22% were schedule caste. 21% population have completed secondary and higher secondary level and also graduation (15%) in their educational achievement in 1991.

Figure 6.1: Social characteristics of Hatikanda village



Source: Census of India, 1991 and Field survey, 2023[1].

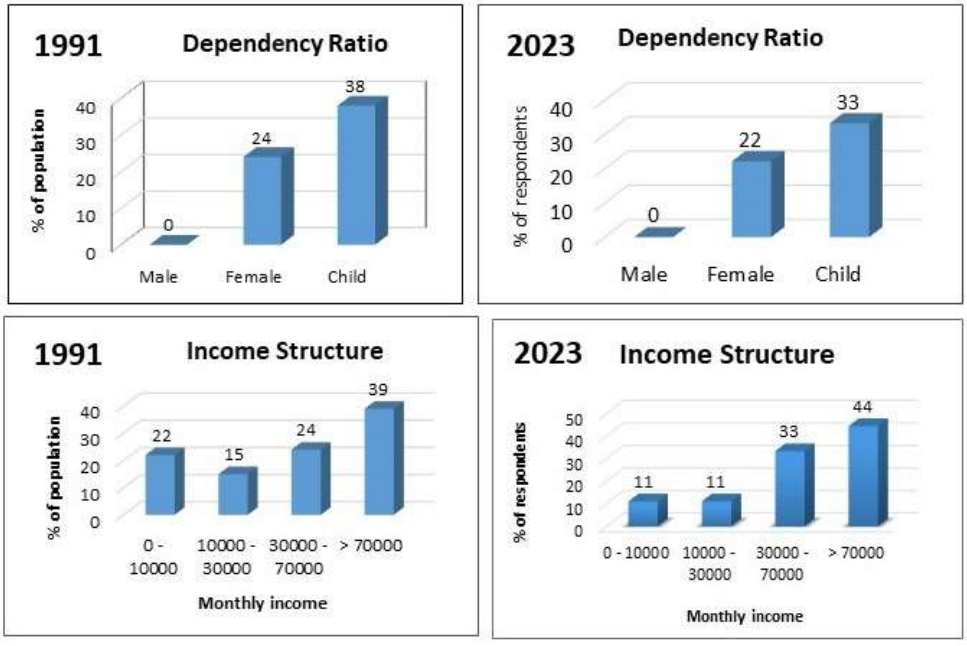
[1] For details, please see Appendix-A (Table No. 6.1)

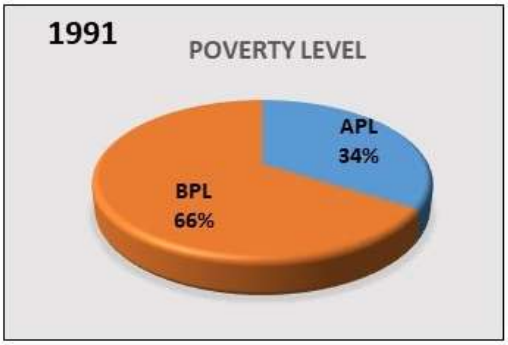
From the census data of 1991, it is revealed that 22% population belongs to low level of income group (₹ ≤ 10,000) followed by 15% (₹ 10,000–30,000), 24% (₹ 30,000–70,000), and 39% with high annual income groups (₹ ≥ 70,000). From the field investigation, it is revealed that 11% respondents belong to low level of income group (₹ ≤ 10,000) followed by 11% (₹ 10,000–30,000), 33% (₹ 30,000–70,000), and 44% with high annual income groups (₹ ≥ 70,000). Majority of respondents belongs to Above poverty level (56%) in the year 2023. In 1991, majority of the population belongs to below poverty level (66%).

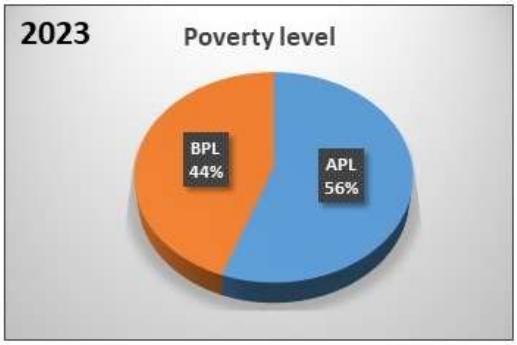
From the field investigation, it is observed that majority of respondents (44%) engaged in agricultural labour followed by cultivators (22%), Governmental and private salaried job followed by cultivators (22%), and non-agricultural wage labour (11%). 33% respondents having 2 to 4 bighas and 4 to 6 bighas respectively followed by 22% having <2 bighas and >6% having > 6 bighas. Most of the houses (78%) are pucca in nature in the year 2023. In 1991, 54% houses were pucca in nature.

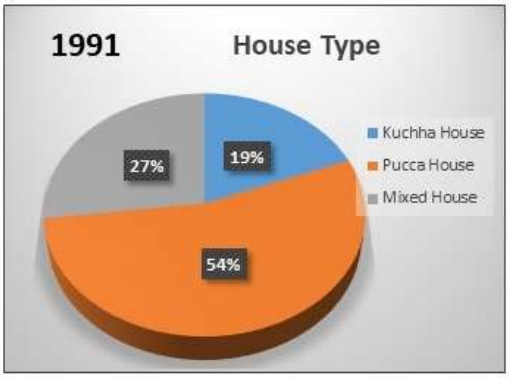
There are so many modes of accessibility present in the study area. Among all the modes of accessibility majority of respondents (44%) have avail the facilities of motor bike followed by cycle (22%), electronic rickshaw (11%) and van (11%). In 1991, most of the people avail cycle (50%) and motor bike (36%). Out of the total respondent's majority of these have used LPG (89%), whereas in 1991 people have used wood (59%), LPG (54%) and crop residue (45%) for their domestic fuel purpose.

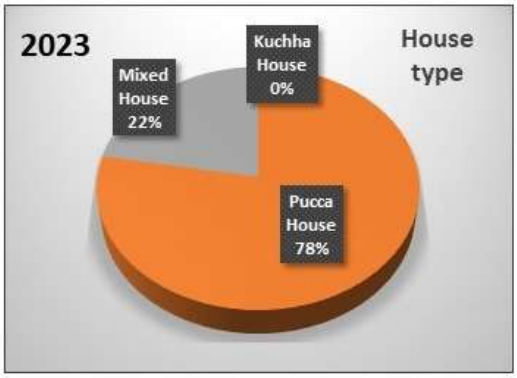
Figure 6.2: Economic characteristics of Hatikanda village

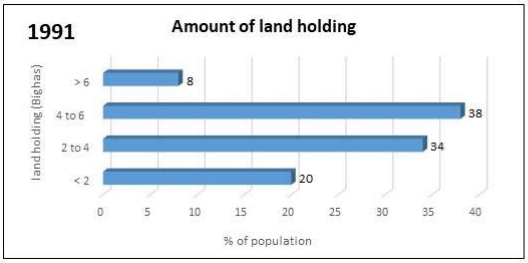


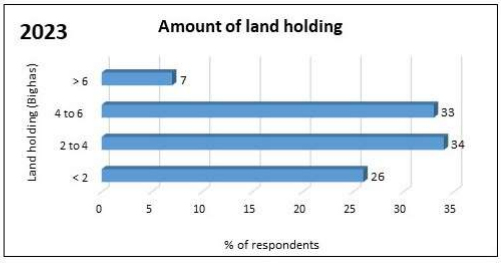

1991
POVERTY LEVEL
APL
34%
BPL
66%

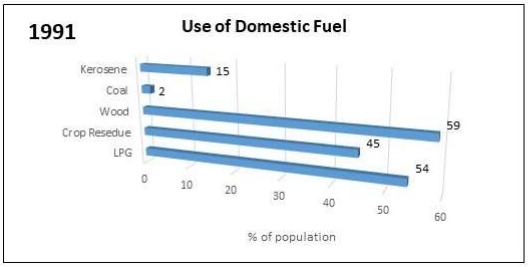

2023
Poverty level
BPL
44%
APL
56%

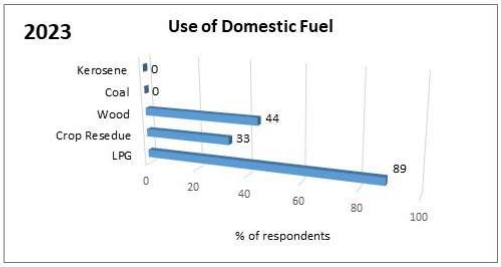

1991
House Type
27%
19%
54%
Kuchha House
Pucca House
Mixed House

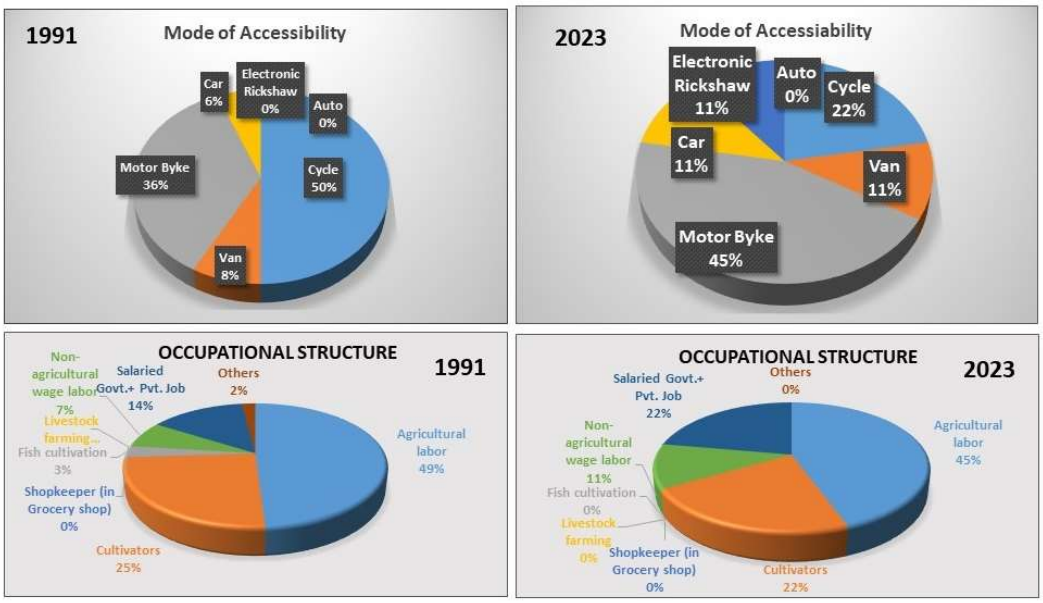

2023
House type
Kuchha House 0%
Mixed House 22%
Pucca House 78%


1991
Amount of land holding
land holding (Bighas)
> 6
4 to 6
2 to 4
< 2
8
38
34
20
0 5 10 15 20 25 30 35 40
% of population


2023
Amount of land holding
Land holding (Bighas)
> 6
4 to 6
2 to 4
< 2
7
33
34
26
0 5 10 15 20 25 30 35
% of respondents


1991
Use of Domestic Fuel
Kerosene
Coal
Wood
Crop Resedue
LPG
15
2
59
45
54
0 10 20 30 40 50 60
% of population


2023
Use of Domestic Fuel
Kerosene
Coal
Wood
Crop Resedue
LPG
0
0
44
33
89
0 20 40 60 80 100
% of respondents



Source: Census of India, 1991 and Field survey, 2023[2].

- **Land use pattern**

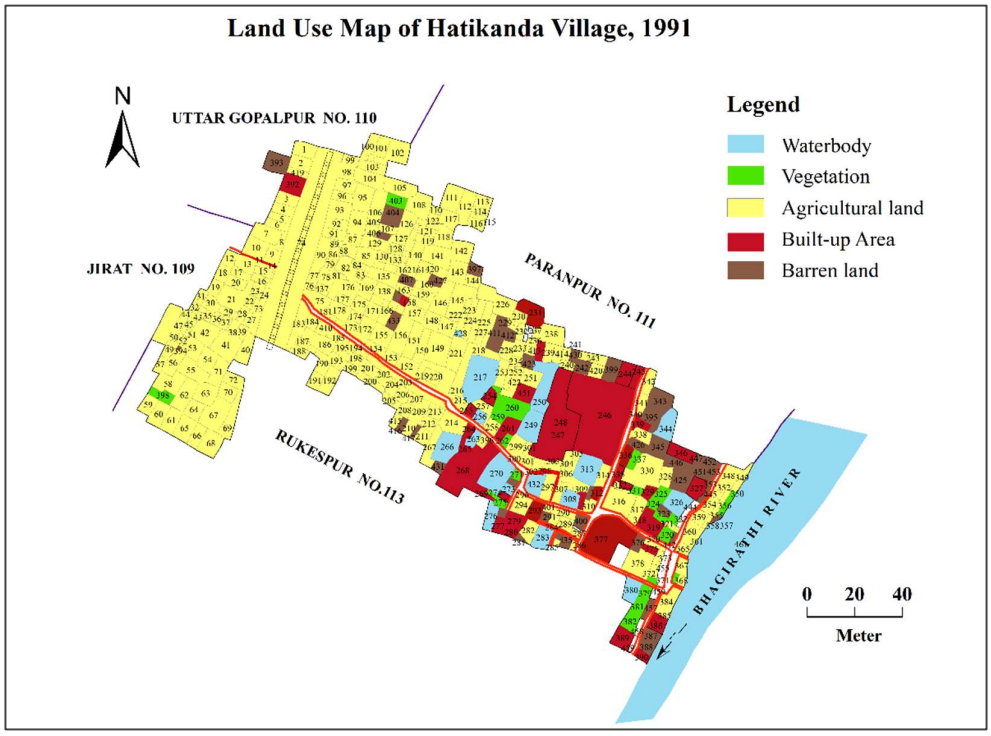
The land use pattern of Hatikanda village was classified into four categories like irrigated land, unirrigated land, culturable waste land and area not available for cultivation. There was no culturable waste land in this village. About 32 hectares area was included under irrigated land in 1991 and 40.9 hectares in 2001 and 2011. So, 8.9 hectares irrigated area was increased from 1991 to 2001. The amount of unirrigated area was recorded as 15.02 hectares in 1991 and it reached at only 2 hectares in 2011. So, it was observed that 13.02 hectares unirrigated land was decreased during 1991-2011. The amount of area not available for cultivation was 8.02 hectares in 1991, 14.2 hectares in 2001 and 12.2 hectares in 2011. So, about 6.18 hectares land under area not available for cultivation was increased during 1991-2001 whereas, decline rate of area not available for cultivation was 2 hectares during 2001-2011.

Figure 6.3 reveals that land use pattern of 1991 was primarily occupied by Sali land i.e. agricultural land (69.26% out of total area) followed by built up area (14.94%), water body (7.95%), barren land (4.80 %) and vegetation (3.04%). Agricultural land has been found in the north-western portion of the village. Hatikanda village is included in an agrarian economy where 67 percent area is covered by cultivated land and rest of the area remains

[2] For details, please see Appendix-A (Table No. 6.2)

uncultivated. The total cultivated land is included into more than one crop where rice (both Aus and Aman), was grown. Besides this, Jute, mustard seeds, khesari, mug, tils are also cultivated here. Potatoes and onions were grown on several plots. Main sources of irrigation were boreholes / tube wells, tanks irrigation etc. 16 hours agricultural power supply in summer, and 20 hours agricultural power supply in winter is available in this village.

Figure 6.3: Land use map of Hatikanda Village, 1991

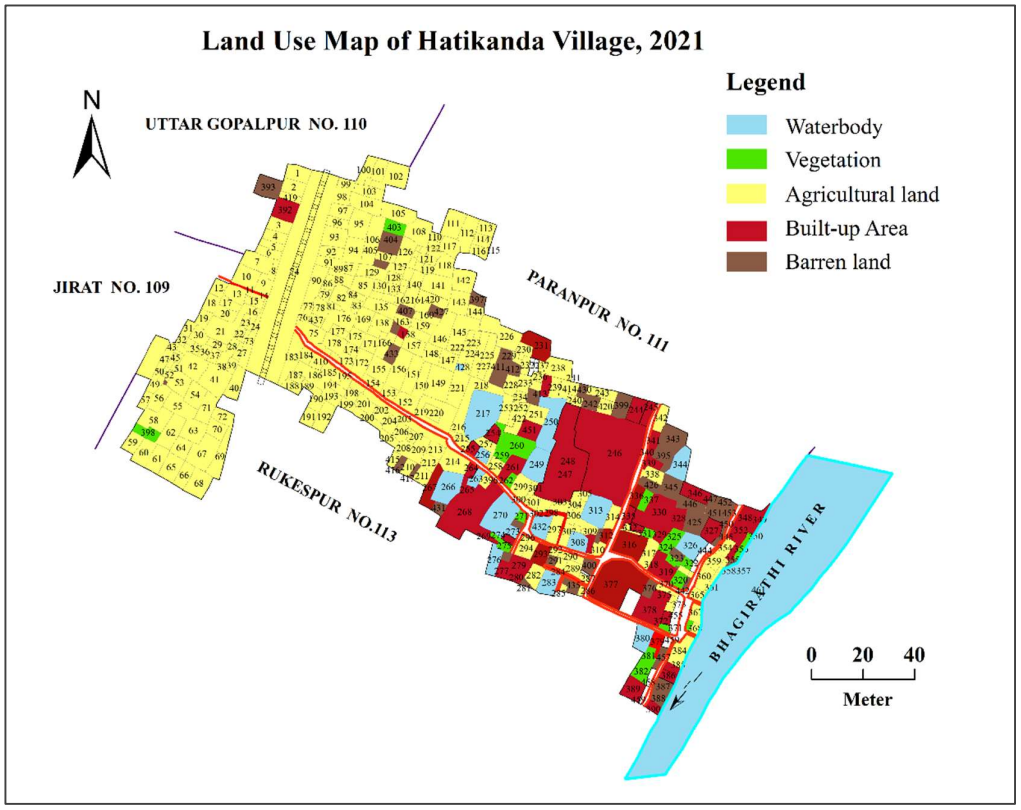


Source: District Land and Land Reform Office, Hugli, West Bengal.

Figure 6.4 depict that land use pattern of 2021 was primarily occupied by Sali land i.e. agricultural land (62.79% out of total area) followed by built up area (22.26%), water body (7.29%), barren land (4.72%) and vegetation (2.83%). There are many small settlement patches developed along the river Bhagirathi. Agricultural land has been found in the north-western portion of the village. Hatikanda village is included in an agrarian economy where 62 percent area is covered by cultivated land and rest of the area remains uncultivated. The total cultivated land is included into more than one crop where rice is grown (both Aus and Aman) and after harvesting rice, this land is used for potato cultivation. Besides this, mustard seeds, khesari, mug, tils are also cultivated here. Main sources of irrigation are submersible shallow tube wells, tanks irrigation etc. During the field investigation it is noticed that most

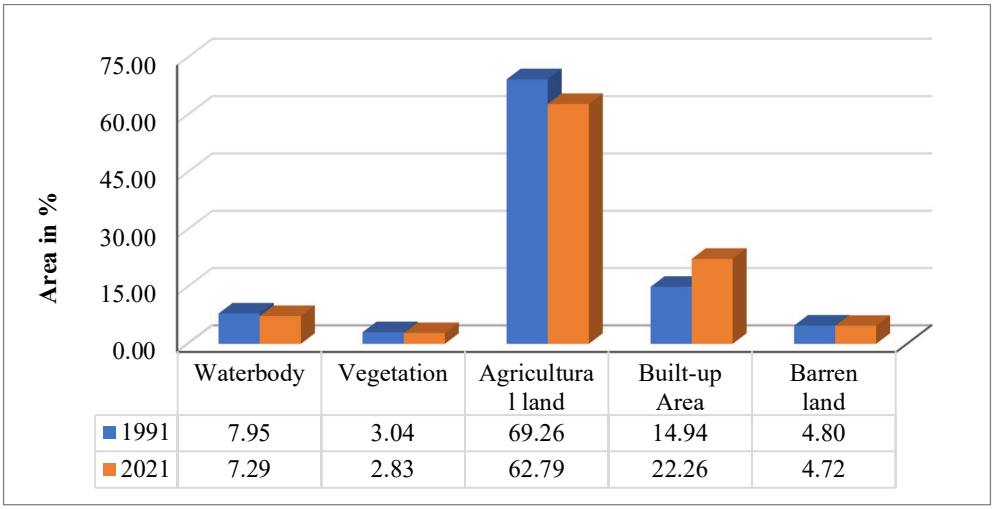
of the agricultural land in the village has now been turned into nurseries. People's income from nursery has increased a lot now.

Figure 6.4: Land use map of Hatikanda Village, 2021



Source: District Land and Land Reform Office, Hugli, West Bengal.

Figure 6.5: Land use pattern of Hatikanda village (1991-2021)



	Waterbody	Vegetation	Agricultural land	Built-up Area	Barren land
1991	7.95	3.04	69.26	14.94	4.80
2021	7.29	2.83	62.79	22.26	4.72

Source: District Land and Land Reform Office, Hugli, West Bengal.

Photograph 6.1: a) Conversion of Agricultural land into Nursery and b) A survey in Hatikanda Village

Source: Captured by the Researcher.

From 1991 to 2021, overall changes of land use pattern of Hatikanda village reveals that there is a decreasing trend of agricultural land. In 1991, the amount of cultivated land was recorded as 68% of the total area of the village (Fig 6.5) but in 2021 this amount reached at 62%. There is an increasing trend of built-up areas has been experienced in Hatikanda village.

6.3.2 Basipota village

- **Location of the village**

Basipota village is located in Serampore Uttarpara C.D block in Hugli District. Raghunathpur is the Gram Panchayet of the Basipota village. It is situated 8.6 km away from Sub- district head quarter Serampore and 25.2 km. away from District Headquarter Chinsurh. The total geographical area of village is 55.41 hectares. Basipota has a total population of 958 peoples, out of which male population is 473 while female population is 485. Literacy rate of Basipota village is 73.80% out of which 75.90% males and 71.75% females are literate. The total households of this village 233.

- **Socio-economic scenario**

Figure 6.6 and 6.7 represent socio-economic profile of Bosipota village. According to the Census data 1991, 7% population of this village were old aged, 23% middle and 18% young

aged. From the field data (2023), it is observed that 8% respondents were old aged category followed by middle (25%) and young aged category (17%) whereas 58% were male respondents. At present (2023), majority of respondents belongs to class v to ix (50%) and upto v (25%) category in their educational achievement. In 1991 majority of population belongs to class v to ix (48%) and upto v (28%) category in their educational achievement. Field study revealed that 67% respondents belong to general caste where 33% were schedule caste. The standard of education in the village is not very good, Raghunathpur Nafar Academy is the only educational institutes near the village. There are no private technical institution or college in this vicinity of the village. Although there is only one health centre inside the village, its service quality is not very good. Village people go to Serampore-Uttarpara for treatment.

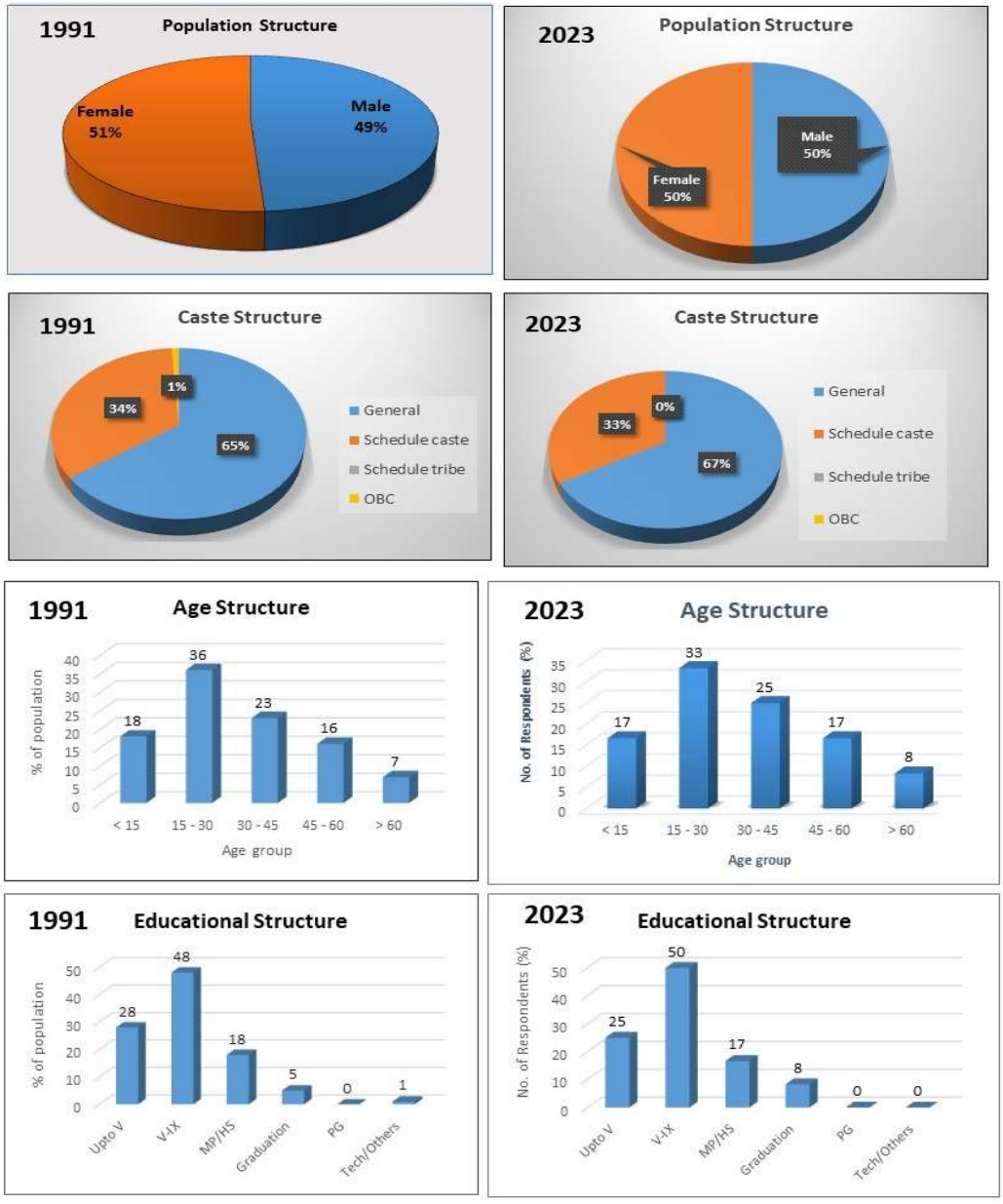
Most of the people in the village earn their living by growing fruits and vegetables from the cultivated land. Nearest vegetable market is Raghunathpur market. Some people work in iron factories, plastic factories, built around Delhi Road for a salary of 8000/- to 10, 000/- .per month. With respect to the monthly income 42% respondents belongs to low level of income group (₹ ≤ 10,000) followed by 33% (₹ 10,000–30,000), 17% (₹ 30,000–70,000), and 8% with high annual income groups (₹ ≥ 70,000) in the year 2023. Compared to 1991, the number of higher income group has increased slightly. Majority of respondents belongs to below poverty level (75%) in 2023. Whereas in 1991, 80% population of this village were belonging to BPL. Number of male working population is high in compare to female working population in this village.

In 2023, majority of respondents (25%) engaged in cultivators followed by agricultural labour (17%), Governmental and private salaried job followed by cultivators (17%), fish cultivation (8%) and non-agricultural wage labour (8%). But in 1991, 30% population engaged in cultivators followed by agricultural labour was 20%, Governmental/private salaried job (12%) and shop keepers (10%) fish cultivation (10%), non-agricultural wage labour (7%) and Livestock farming (5%). In 1991, Basipota village had 65% people living in pucca houses, 25% people living in mixed houses and 10% people living in kuchha houses. In 2023, 83% of people will live in brick houses. The remaining 17% live in mixed households. 58 % respondents having <2 bighas of land holding followed by 33% having 2 to 4 bighas and 8% having 4 to 6 bighas.

There are so many modes of accessibility present in the study area. Among all the modes of accessibility majority of respondents (34%) have avail the facilities of cycle followed by

motor bike (33%), electronic rickshaw (20%) and van (13%). Observing the nature of data, it has been noticed that 58% have used crop residue as domestic fuels. Out of the total respondents 42% respondents have used LPG, 42% have used wood and 8% have used kerosene for their domestic fuel purpose.

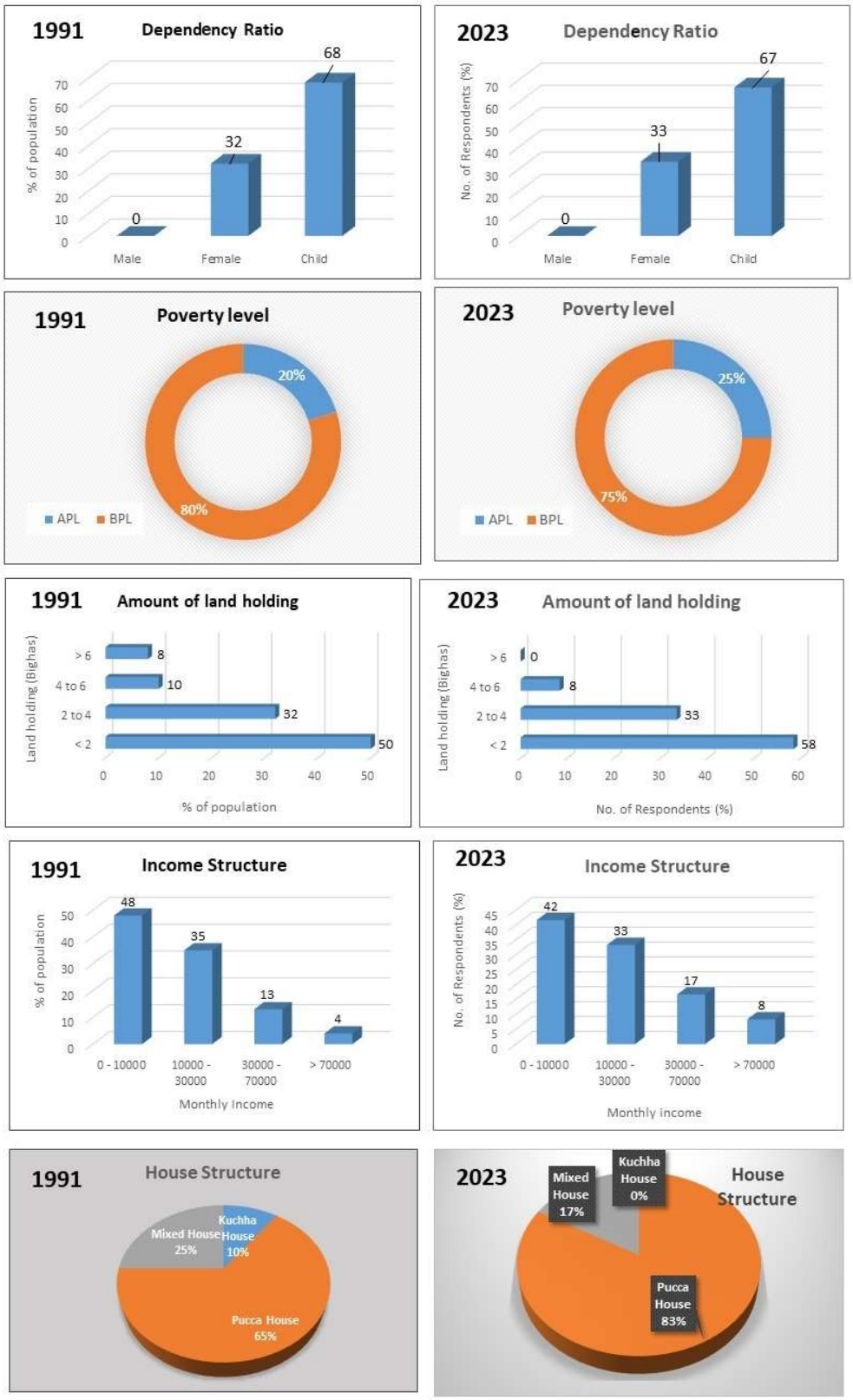
Figure 6.6: Social characteristics of Bosipota village

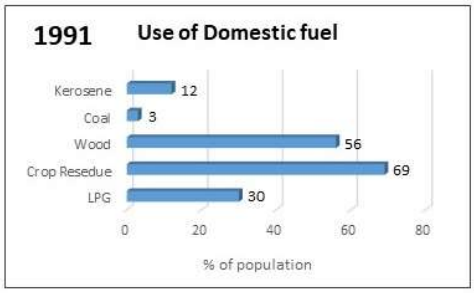


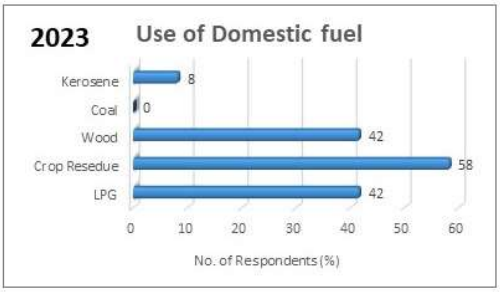
Source: Census of India, 1991 and Field Survey, 2023[3].

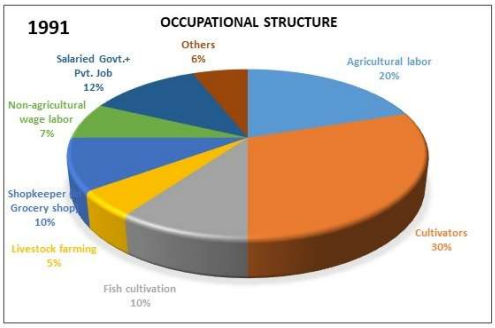
[3] For details, please see Appendix-A (Table No. 6.3)

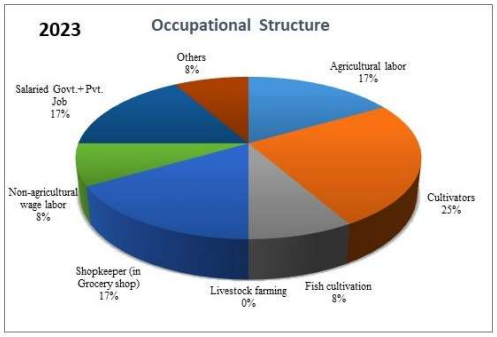
Figure 6.7: Economic characteristics of Bosipota village

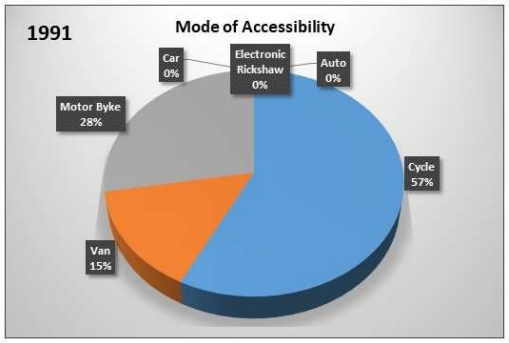


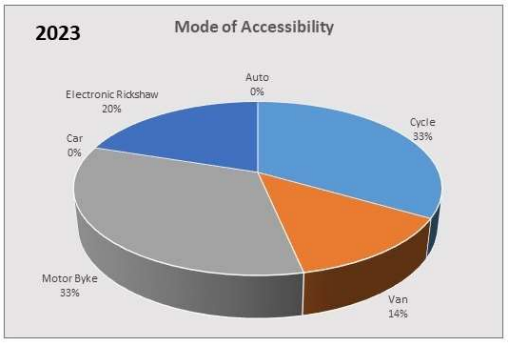












Source: Census of India, 1991 and Field Survey, 2023[4].

There is a shortage of drinking water in the village. Most people drink tap water. Few families buy drinking water. Along with farming, some people raise cows, goats, chickens. Some women grow mushrooms and give dal pills. No vehicles come from the Panchayet to collect garbage from house to house. Electricity available in the village. Most households use wood as fuel for cooking although most households have gas connections. Shriram Company is developing a megacity on an area of about 314 acres in Uttarpara – Konnagar-Risra neighbourhood. As agriculture is not profitable, most of the people of Basipota village, have sold their farming land to this Real Estate Company. As a result, the character of land use in the region is changing.

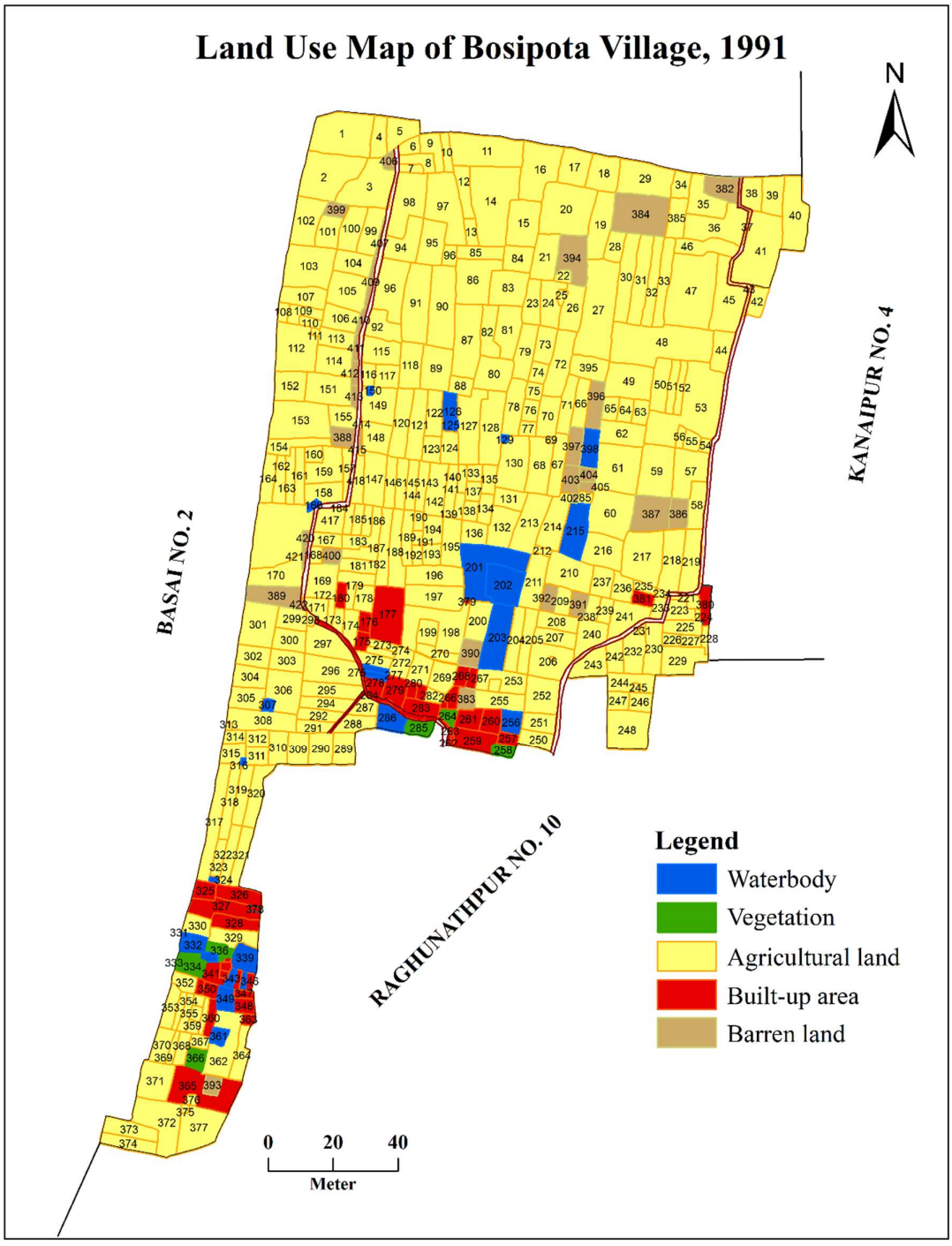
[4] For details, please see Appendix-A (Table No. 6.4)

- **Land use pattern**

On the basis of Census of India, the land use of this village is generally categorized into four types, such as irrigated land, unirrigated land, culturable waste land and area not available for cultivation. About 24.9 hectares land was occupied by irrigated land in 2001 which was only 6.07 hectares in 1991. It was evident that there was an increasing rate of irrigated land by 18.83 hectares from 1991 to 2001 but the irrigated land remained same amounting to 25 hectares in 2011 from 2001. The mode of irrigation system of this village was mainly by tube-well. The amount of unirrigated land was 25.09 hectares in 1991 and it became 14.1 hectares during 1991 - 2001. So, the decline rate of unirrigated land has been noticed. The amount of culturable waste land was increased 5 hectares of land during 1991-2001 and remain same in 2011. The amount of area not available for cultivation was 24.24 hectares in 1991 and it was decreased by 3.84 hectares in 2011.

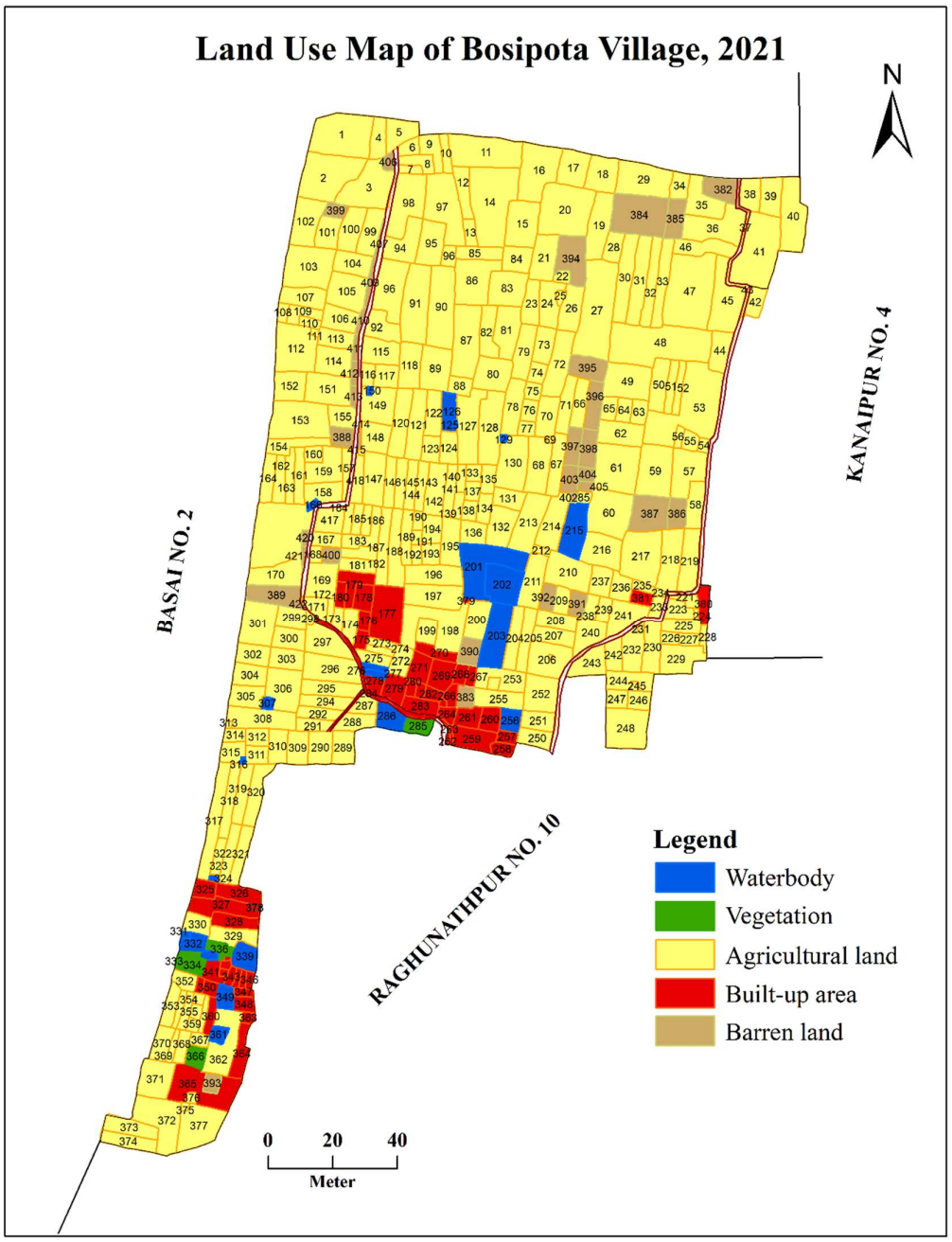
Land use map of Bosipota village (1991) has been prepared to analyse the temporal changes of land use pattern of this village from 1991 to 2021. Based on data provided by District land and land reform office, the highest category was agricultural land (Sali Land) sharing 87.4% of total land area followed by Barren land (4.3%), Water Body (4.2%) and Built-up area (3.4% of total land area), The Figure 6.8 shows the land use pattern of the Bosipota village in 1991. Yellow patches indicate agricultural land which was more prominent in entire village. The red colour indicates settlement which was observed in the southern portion of the village. Beside these, small patches of bata plot were also observed in the north and eastern portion. It has been mentioned that agricultural land utilization has remarkably altered after 1991 due to the improvement of nature of cropping pattern and also the problem of irrigation. Agricultural crops and seasonable vegetable (pumpkin, cucumber, brinjal, and papaya) are being cultivated in most of the cultivated land in 1991. Most of the land irrigated by canal water. The rest of the land was irrigated by tanks. A recent land use map of Bosipota village (2021) has been prepared to analyse the temporal changes of land use pattern of this village from 1991 to 2021. Based on data provided by District land and land reform office, the highest category was agricultural land (Sali Land) sharing 83.8% of total land area followed by settlement/ built up area (6.6% of total land area), barren land (5.38% of total land area), pond/water body (3.5% of total land area) and bamboo garden (0.58% of total land area).

Figure 6.8: Land use Map of Bosipota Village (1991)



Source: District Land and Land Reform Office, Hugli, West Bengal.

Figure 6.9: Land use map of Bosipota Village, 2021

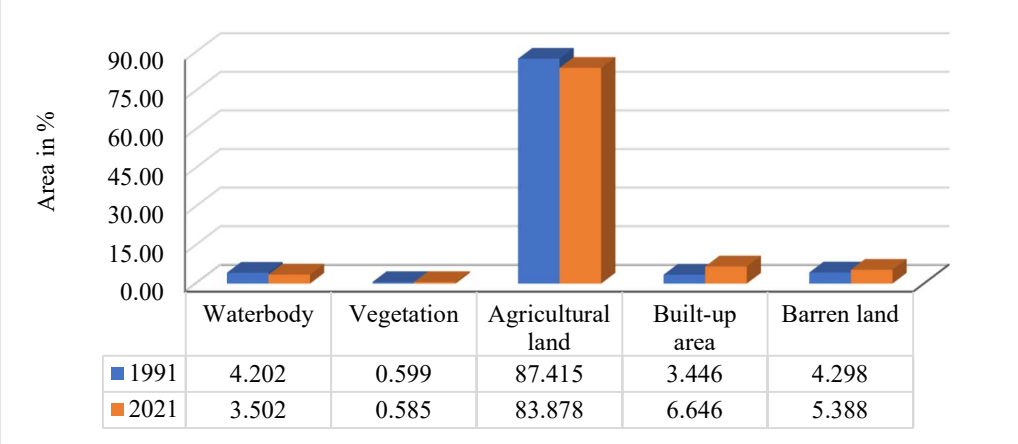


Source: District Land and Land Reform Office, Hugli, West Bengal.

The Figure 6.9 shows the land use pattern of the Bosipota village in 2021. Yellow patches indicate agricultural land which was more prominent in entire village. The red colour indicates settlement which was observed in the southern portion of the village. Beside these, small patches of bata plot were also observed in the north and eastern portion. It has been mentioned that agricultural land utilization has remarkably altered after 1991 due to the

improvement of nature of cropping pattern. Vegetables are being cultivated instead of agricultural crops in most of the cultivated land due to lack of water for farming. Mango, banana, lichees, Sugarcane saffron, shrimp, pumpkin, cucumber, brinjal and some vegetables are being cultivated. The overall study period from 1991 to 2021 experienced a significant change in land use of Bosipota village. Agricultural land has been decreased by 4 percent. In addition to it, area not available for cultivation has gradually decreasing in this village. So, land use changes from 1991 to 2021 showed negative changes in agricultural land utilization.

Figure 6.10: Land use pattern of Bosipota village (1991-2021)



	Waterbody	Vegetation	Agricultural land	Built-up area	Barren land
1991	4.202	0.599	87.415	3.446	4.298
2021	3.502	0.585	83.878	6.646	5.388

Source: District Land and Land Reform Office, Hugli, West Bengal.

Photograph 6.2: a) Bamboo cutting for fuel, b) Researcher with respondent, c) Vegetable Cultivation and d) Banana Garden

Source: Captured by the Researcher.

6.4 Level of Socio-economic development of Hugli District

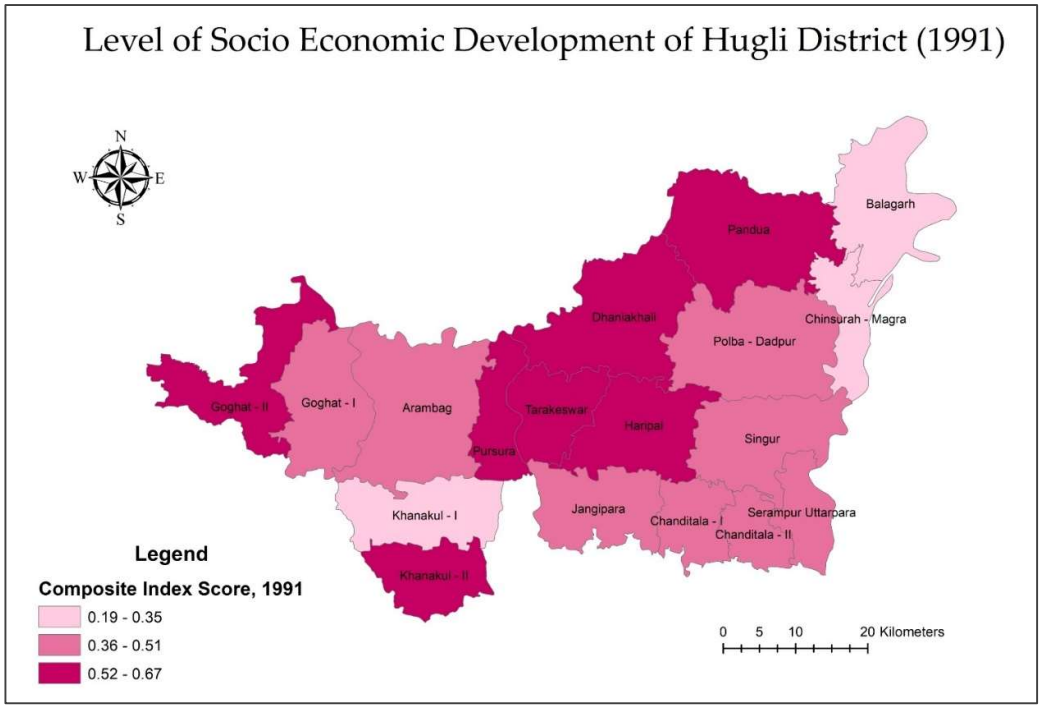
To determine the spatial and temporal variation of socio-economic development in rural areas of Hugli district, eleven variables have been used such as cultivated land, net irrigated area, percentage of agricultural workers, percentage of marginal farmers, percentage of salaried Govt. and private job to the total main workers, literacy rate, percentage of above poverty level, percentage of households having facilities from health care centre, water supply facilities, electricity facilities and transport facilities (Table 6.1). Based on composite index score 18 C.D. Blocks have been categorized into three classes' viz. low, moderate and high to analyse the spatio-temporal variation and level of socio-economic development in the study area. (Figure 6.11 to 6.13).

Table 6.1: List of Selected Variables

SL. No	Variables	Particulars
1	V1	Percentage of cultivated land to the total area
2	V2	Percentage of Net Irrigated area to the gross cropped area
3	V3	Percentage of agricultural workers to the total main workers
4	V4	Percentage of Marginal Farmers to the total workers
5	V5	Percentage of Salaried Govt.+ Pvt. Job to the total main workers
6	V6	Literacy Rate
7	V7	Percentage of above poverty level
8	V8	Percentage of households having facilities from health care centre
9	V9	Percentage of households having water supply facilities on the premises
10	V10	Percentage of households having electricity facilities
11	V11	Percentage of households having transport facilities

In 1991, the composite index score ranges from 0.67 (highest in Pursurah) to 0.19 (lowest in Chinsurah-Magra C.D. Block). Only Balagarh, Chinsurah-Magra, and Singur C.D. Blocks have experienced low level of socio-economic development (0.19 - 0.35). Nine C.D. Blocks fall under moderate category namely Goghat-I, Arambagh, Polba-Dadpur, Jangipara, Chanditala-I, Chanditala-II, Khanakul-I, Serampore-Uttarpara and Haripal where the value lies between 0.36 and 0.51. Remaining six C.D. Blocks namely Goghat-II, Pandua, Dhaniakhali, Tarakeswar, Pursura, and Khanakul-II fall under high category having their composite index score ranging between 0.52 and 0.67 (Table 6.2).

Figure 6.11: Level of Socio-Economic Development using Composite Index Score, Hugli District, 1991



Source: Census of India, 1991[5].

Table 6.2: The spatial pattern of level of Socio-Economic Development of Hugli District, 1991

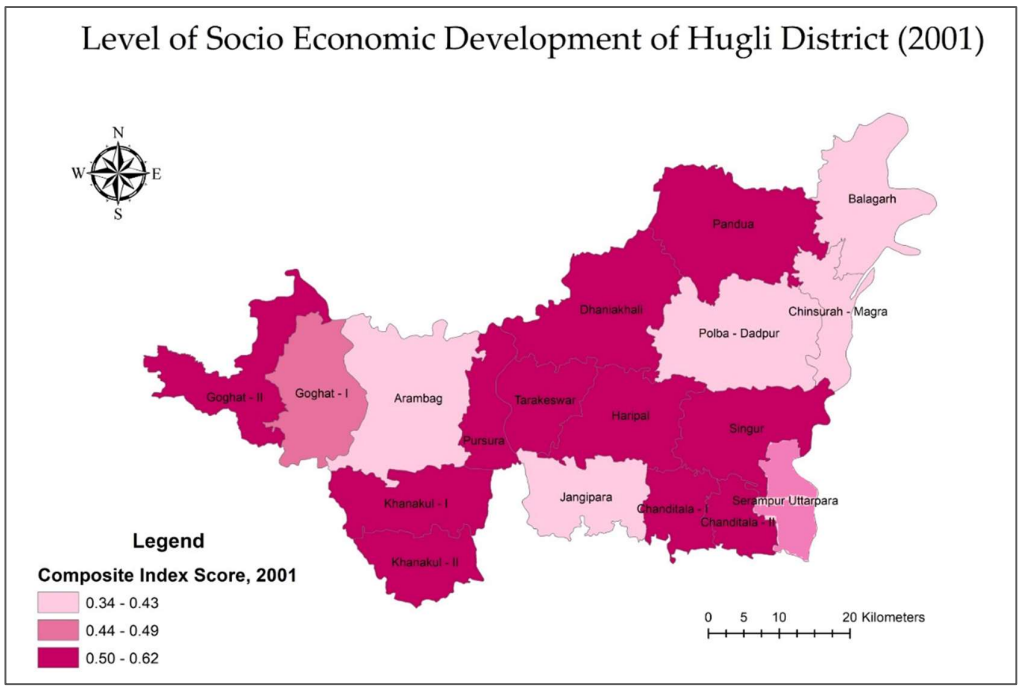
Composite Index Score	Level of Socio-Economic Development	No. of C.D. Block	Name of C.D. Block
0.19 - 0.35	Low	3	Balagarh, Chinsurah-Magra, Singur,
0.36 - 0.51	Moderate	9	Goghat-I, Arambagh, Polba-Dadpur, Jangipara, Chanditala-I, Chanditala-II, Khanakul-I, Haripal, Serampore-Uttarpara
0.52 - 0.67	High	6	Goghat-II, Pandua, Dhaniakhali, Tarakeswar, Pursura, Khanakul-II

Source: Compiled by researcher based on Census of India, 1991[6].

[5]For details, please see Appendix-A (Table No. 6.5)
[6] For details, please see Appendix-A (Table No. 6.5)

In 2001, Singur, Khanakul-I, Chanditala-I, and Chanditala-II C.D. Blocks have upgraded their socio-economic status. There are five C.D. Blocks namely Balagarh, Chinsurah-Magra, Arambagh, Jangipara, and Polba-Dadpur fall under the low developed area where composite index score value lies between 0.34 and 0.43. Moderately developed area experienced in only two C.D. Blocks namely Goghat-I and Serampore-Uttarpara where the composite index score value lies between 0.44 and 0.49. Eleven C.D. blocks namely Goghat-II, Pandua, Dhaniakhali, Tarakeswar, Pursura, Khanakul-I, Khanakul-II, Haripal, Singur, Chanditala-I, and Chanditala-II have been experienced as a high developed area (index score 0.50 - 0.62).

Figure 6.12: Level of Socio-Economic Development using Composite Index Score, Hugli District, 2001



Source: Census of India, 2001[7].

Table 6.3: The spatial pattern of level of Socio-Economic Development of Hugli District, 2001

Composite Index Score	Level of Socio-Economic Development	No. of C.D. Block	Name of C.D. Block
0.34 - 0.43	Low	5	Balagarh, Chinsurah-Magra, Arambagh, Jangipara, Polba-Dadpur

[7] For details, please see Appendix-A (Table No. 6.6)

0.44 - 0.49	Moderate	2	Goghat-I, Serampore-Uttarpara
0.50 - 0.62	High	11	Goghat-II, Pandua, Dhaniakhali, Tarakeswar, Pursura, Khanakul-I, Khanakul-II, Haripal, Singur, Chanditala-I, Chanditala-II

Source: Compiled by researcher based on Census of India, 2001[8].

In 2011, the composite score ranges from 0.70 (highest) in Chanditala-I to 0.34 (lowest) in Chinsurah-Magra. On an aggregate fourteen C.D. Blocks namely, Goghat-II, Arambagh, Pandua, Dhaniakhali, Tarakeswar, Pursura, Khanakul-I, Khanakul-II, Haripal, Polba-Dadpur, Singur, Jangipara, Chanditala-I, and Chanditala-II, which range their composite index score between 0.50 and 0.70, are highly developed region in socio-economic context. High agricultural production, high literacy rate, employment opportunities, having well facilities of drinking water, transportation, electricity and health care centre have triggered to achieve high level of socio-economic development. Two C.D. Blocks fall under moderate category (value ranged from 0.47 to 0.49) namely Goghat-I and Serampore-Uttarpara. Balagarh and Chinsurah-Magra are the only C.D. Blocks that fall under the low category having their composite index score ranging below 0.34 and 0.46.

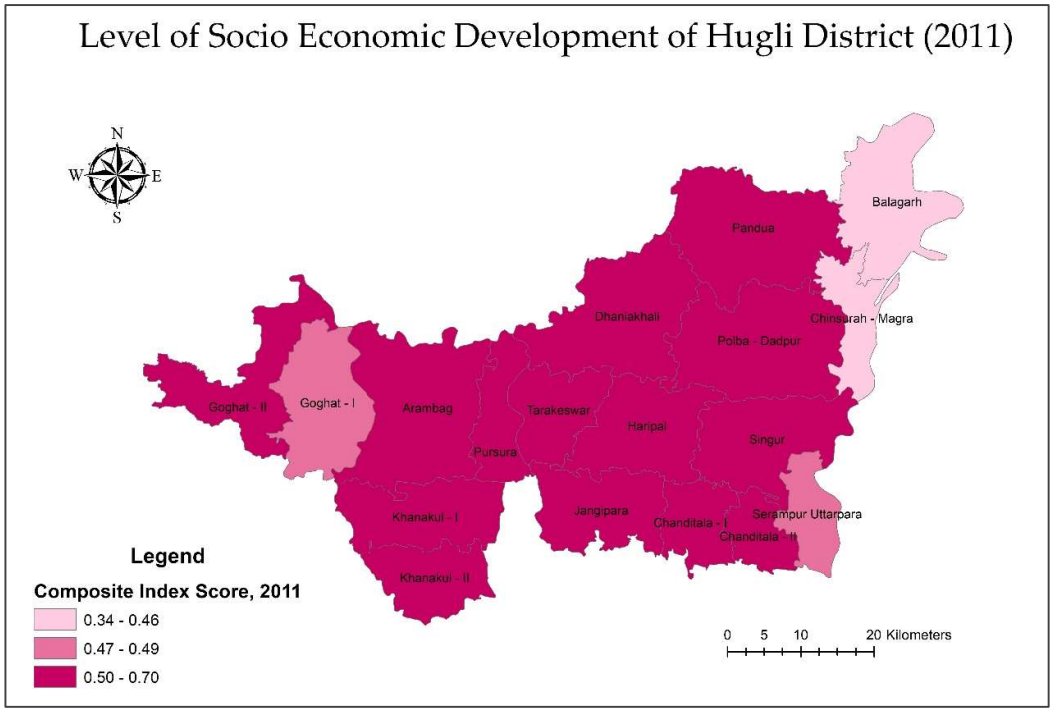
Table 6.4: The spatial pattern of level of Socio-Economic Development of Hugli District, 2011

Composite Index Score	Level of Socio-Economic Development	No. of C.D. Block	Name of C.D. Block
0.34 - 0.46	Low	2	Balagarh, Chinsurah-Magra
0.47 - 0.49	Moderate	2	Goghat-I, Serampore-Uttarpara
0.50 - 0.70	High	14	Goghat-II, Arambagh, Pandua, Dhaniakhali, Tarakeswar, Pursura, Khanakul-I, Khanakul-II, Haripal, Polba-Dadpur, Singur, Jangipara, Chanditala-I, Chanditala-II,

Source: Compiled by researcher based on Census of India, 2011[9].

[8] For details, please see Appendix-A (Table No. 6.6)
[9] For details, please see Appendix-A (Table No. 6.7)

Figure 6.13: Level of Socio-Economic Development using Composite Index Score, Hugli District, 2011



Source: Census of India, 2011[10].

6.5 Conclusion

The socio-economic factors of overall development have shown a great deal of diversity between the C.D. Blocks in the research area (Figure 6.11 to 6.13). In rural areas of Hugli district, Balagarh and Chinsurah-Magra are the least developed C.D. Block. On the other hand, Chanditala-I, Chanditala-II and Singur have outstanding social and economic outcomes. Higher education options are being restricted due to the small number of high schools in Balagarh, Goghat I, and Khanakul-I. Several programs, including the Sarva Siksha Abhiyan (2001), the Mid Day Meal Scheme (1995), and the District Primary Education Programme (1994), have had a positive effect on basic education, particularly in rural areas. Health is the basic and primary need of an individual who makes the nation progress in socio-economic, scientific, literary, and cultural spheres (Singh et. al., 2016). Health care is an important element of well-being, yet it has been one of the most neglected aspects of development in India (Drazee and Sen, 2005). Health status is influenced by socio-economic factors, similarly, health services are shaped by the socio-economic and

[10] For details, please see Appendix-A (Table No. 6.7)

political factors of any region (Baru et. al., 2010). In order to meet the health requirements of the rural population, particularly the most vulnerable segments of society, the Indian government established the National Rural Health Mission (NRHM) in 2005. The extension of health care services, such as the construction of medical infrastructure at CHC, PHC, and Sub-centres, the availability of Anganwadi Workers (AWWs) and Accredited Social Health Activists (ASHA) at every rural based centre, is generally necessary to ensure the health of all human inhabitants of the study area.

The successful and efficient provision of the majority of essential services, including clean drinking water, public lighting, healthcare, education, etc., depends on the availability of energy infrastructure. Furthermore, it facilitates increased household living standards and supports commercial and revenue-generating activities (Samanta, 2015). Village electrification and irrigation pump set energization are the two main components of India's rural electrification initiative. Moreover, various household electrification schemes should be initiated to eradicate the emerging issues of electrification infrastructure in rural India as well as the present study region. Having a motorable road may open new opportunities for residents. Recently improving rural accessibility is a local-level issue. Local Government should emphasize to enhancing rural road connectivity and also provide public and private bus accommodation in remote villages with the nearest urban centres.

Chapter 7

Problems, Suggestions and Conclusion

Chapter 7
Problems, Suggestions and Conclusion

While scanning various aspects of the physiographic, socio-economic aspects, land use patterns, agricultural condition, etc. it is observed that there are quite a large number of problems whose solutions are necessary for the development of the area. All these problems may be grouped into the following:

7.1 Major problems of the study area

7.1.1 Small land holdings and others agricultural problems

The main problems which hinder the development of farming in this district are small land holdings. The average size of land holdings is 0.63 hectares in 2011, which was 0.66 hectares in 1991. Agriculture is becoming unprofitable as lands become fragmented and isolated. Seasonable vegetables are cultivated in segmented land in place of traditional crops by the marginal farmer himself in traditional process.

Photograph 7.1: Small cultivable land converted to settlement

Source: Captured by the Researcher.

Small cultivable land in some villages, not being profitable for crop cultivation, is being sold by marginal farmers at a low price to the migrated people from neighboring countries and others for construction purposes. Agriculture is becoming unprofitable as lands become

fragmented and isolated. In this case, there is no system of providing training to the farmers on how to do farming profitably, either in government or private enterprises. Hatikanda village of Balagarh C.D. block is the only survey village where farmers are trained and where agricultural training is organized by the government. Self-help groups of women are formed like – Basanto, Adwitiya, Trishna, Tiyasa, and Sristi. They regularly participate in agricultural discussions.

7.1.2 Irrigation problem

Depletion of the groundwater table due to excess exploitation of groundwater is a problem in irrigation systems. Due to the lack of water required for crop cultivation, the people of the village (Sankarbati and Bosipota Village) cultivate fruits and vegetables.
Fodders Gama grass is cultivated in abandoned farmland. Paddy fields converted to fisheries due to a lack of groundwater depletion in Mollarber. There is scarcity of irrigation water because the Dankuni canal is polluted by the industrialization of the locality. Most of the agricultural land under Chanditala-II and Serampore-Uttarpara C.D block has lost its fertility because of the polluted water of this canal.

Photograph 7.2: Submersible Pump and Shallow machine, using for irrigation in Bosipota village, Serampore-Uttarpara C.D Block

Source: Captured by the Researcher.

7.1.3 Drinking water problem

Water is an essential aspect of human life. The supply of drinking water remains inadequate. The supply of fresh drinking water is an important factor in any development area. The district has a population of 5520389 (Census of India, 2011). So, the demand for drinking water is very high. Most of the people depend on the hand pump (43.68%) of the study area. Rural inhabitants (60.72%) of the study area are dependent on hand pumps for their drinking water. The Groundwater resource of most of the C.D. block of the district has been overexploited and the groundwater level is declining day by day. It is a serious problem to supply water for drinking and any other agricultural production.

In the Sajaldhara project, water is not available even though the water line has reached from house to house. Some people have Sub Marshal Pump connections in their house; Most of the people drink water from hand pumps and tap water. Poor people have to buy water. During the field survey, the drinking water problem of the village people (Mollarber, Sankarbati, Badpur, Bosipota) was noticed.

Photograph 7.3: Unused Hand Pump in Mollarber Village

Source: Captured by the Researcher.

7.1.4 Unemployment and Poverty

As traditional farming is not profitable, the educated youth community is not willing to take up farming as a livelihood. In the past ten years, the number of educated unemployed has increased due to the decline in employment in agriculture sectors.

During the village survey it was found that in almost every family (of 6/7 members) the entire family is dependent on the income of one person. Landless poor people are making a living by labouring on others land for very low wages. Most of the poor less educated people lead their life as a wage earner.

The extent of poverty and related deprivation significantly affected the development of any region. Poverty levels are associated with poor quality of life, deprivation, mal nutrition, low literacy, UN employment and low human resource development.

The population and the areas have not been properly considered for the purpose of health planning and also the hospital and health centres are not ideally located.

17.55% (2020) people are still illiterate in the district. Although almost all of this generation goes to school, several elderly people in every village remain uneducated.

7.1.5 Problems of Civic Amenities

Low-lying areas get inundated during rains due to improper and inadequate drainage and sewerage facilities. During the field survey, it was observed (Badpur, Bosipota, Bighati village) that no vehicles come from the Panchayet to collect garbage from house to house, no system to collect garbage on the street. Drain water is not regularly discharged directly into water bodies. In the absence of sufficient clean water, the people of the village do household chores in the polluted water of the pond.

Photograph 7.4: Pond water used as household chores in Mollarber village

Source: Captured by the Researcher.

Power failure is a chronic problem. Most of the villages suffer from inadequate civic amenities. They depend on the unfiltered water of tanks.

The distribution of ATM, Bank, Post Office, Sub Post Office, Agricultural Credit Society, Private Courier Facilities, and Birth & Death registration offices, in different blocks of the district is not uniform somewhere is not available. Except for animal driven carts, there are no transportation facilities available inside many villages like Sankarbati, Bandpur in night. The Dankuni Municipality used to farm some pigs to absorb excess waste from the area. They breed and increase in number so much that they spread in different areas of Chanditala-II C.D. Block. All the villages (surveyed village-Thero) in Barijhati Panchayat have been destroyed by the pigs and farming has almost come to a standstill, as reported by Barijhati Panchayet Pradhan.

7.2 Major findings

- The land use pattern of the Hugli district is dominated by **Net sown area** (211.27 ha).
- It has been seen that the maximum **decrease of Irrigated land** took place during 2001 to 2011 for the **Urbanization.**
- **Irrigation problems** have been found in Sankarbati village (Polba-Dadpur), Thero (Chanditala II), and Bosipota village (Serampore–Uttarpara).
- Village people cultivate **fruits and seasonable vegetable**, somewhere fodder in place of traditional crops. Some land has become a wasteland.
- **Barren land is unchanged** in some areas of Singur, Serampore–Uttarpara C.D. block for lack of proper utilization of land.
- The **positive cropping intensity** was recorded in every C.D. block of the district in 2017-18. Cropping intensity of Serampore–Uttarpara and Chanditala C.D. block are little bit slower than others due to its urbanized position.
- Observing the nature of data, it has been noticed that the quantity of the area that has been transformed into **built-up areas** from different land use categories is **significantly high.**
- **Depletion of Ground water Level is a serious problem to supply of water for drinking. Scarcity of Drinking water** found in Sankarbati, Basipota, and Mollarber villages. Poor rural people have to **buy drinking water** which is very alarming for the administration.

- Most people in rural areas **shifted their earnings from an agricultural base to small industry labour, infrastructural labour at low wages**. Many of them took their profession as transport worker (like Electronic Rickshaw, Auto Rickshaw, 'Magic' car).
- **The new generation lose their interest in the agro-based sector due to low profit.** During the Field visit, it was observed that agricultural land usage as a NURSERY, Hatikanda village in Balagarh C.D. Block and FARMHOUSE in Mollarber, Serampore – Uttarpara C.D. Block, in a profitable manner.
- In rural areas of Hugli district, Balagarh and Chinsurah-Magra is the least developed C.D. Block. On the other hand, Chanditala-I, Chanditala-II and Singur have outstanding social and economic outcomes.

7.3 Suggestions

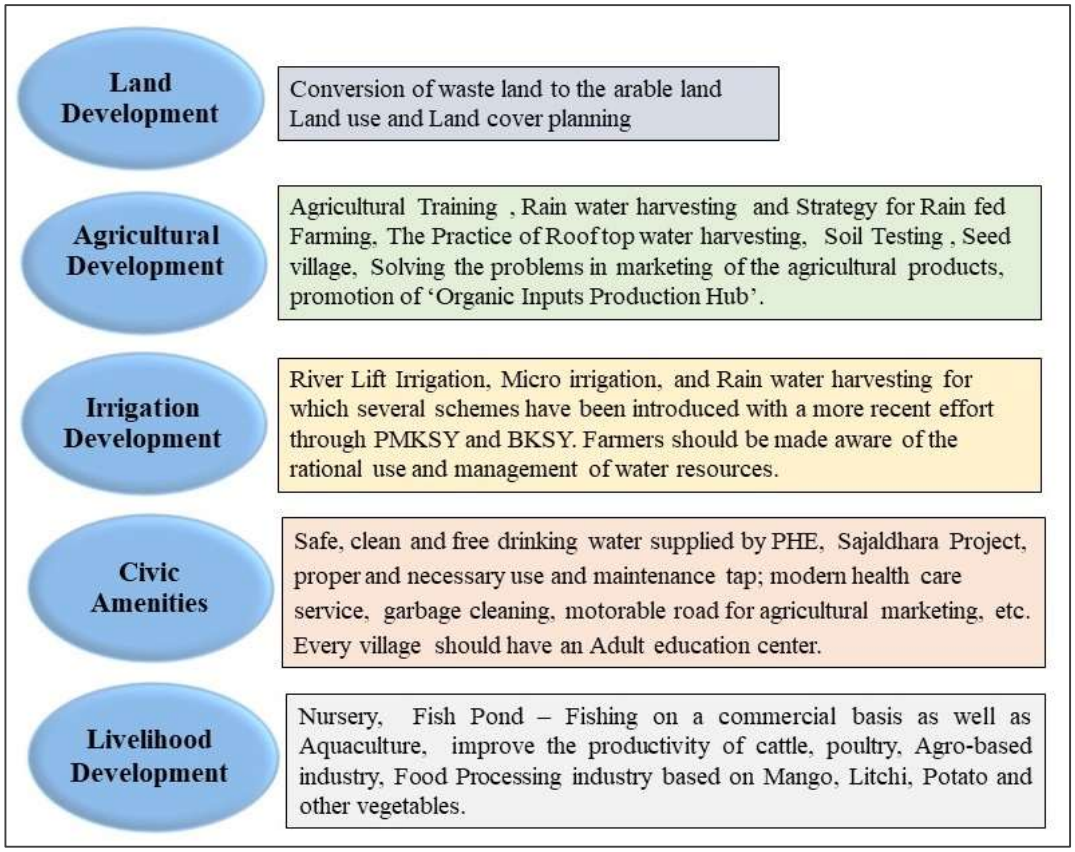
For the development of rural areas central government of India as well as the state government of West Bengal has incorporated different rural development programs such as Krishak Bandhu Scheme since 2019, Fish Farmer's Development Agency (FFDA) since 1974, Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) since 2005, Pradhan Mantri Abas Yojona (PMAY) since 2015, etc.

Model 7.1: Proposed Action Plan

Source: Prepared by researcher.

An action plan has been formulated after the above discussion to develop the socio-economic scenario concerning the land use transformation of the Hugli district. A thematic plan has been proposed for land use planning and a community development program for the overall development of the study area.

Model 7.2: A Thematic plans of land use planning and community development programme



Source: Prepared by researcher.

a) Land Development

- This is because agricultural plots surrounding the settlement area have experienced remarkable change. Whenever there is a need for more houses, they are constructed on the peripheries of the original settlements for reasons of security and community of life. Thus, a house which can be constructed even on a barren land consumed the best land of the village. New settlements may be set up on barren land of the area.
- Destruction of the village's groves and orchards to bring maximum area under crops may cause misuse of land. As a result of this action, several problems have also cropped up. Due to the loss of the village grove, which is primarily the main source of kitchen fuel supply, the fuel problem has sprung up and people are forced to use

cow dung which is used to fertilize the cultivated land. As a result, the fertility of the soil has remarkably deteriorated which is reflected in the gradual decline of yields of different crops. This problem may be solved only when cow-dung is used to produce bio-gas for fuel and the remaining refuse may be used as fertilizer.

- Gram Panchayat wise afforestation programs include a mixture of species suitable for small timber, firewood and fodder like Sishu (Dalbergia Sissoo), and Akashmoni (Acacia Auriculiformis) in the wasteland and barren areas should be promoted through National Rural Employment Guaranty Scheme (NREGS).

b) Strategy of Agricultural development

- Agricultural Training is a must for farmers in all Blocks of the District. Along with agricultural training or seminars, seeds, pesticides, etc. should be distributed among cultivators at a subsidized rate. To increase agricultural productivity, appropriate *ecology-specific and cost-effective technology* has been adopted.
- Better organic input supply through the development of 'Organic Inputs Production Hub' promotion of FYM and vermin composting at farmers 'fields, green manuring promotion through Dhaincha, and brown manuring.
- Development of 'Seed Villages' exclusively for the production of certified seeds of different popular crops." Krishi Samabay Samity" Hugli District has started to implement a Paddy seed processing unit under the RKVY scheme.
- Using informal Channels for technology dissemination through Farmers Club, SHG, and proactive NGOs.
- The occurrence of natural calamities like floods, drought, etc., in particular, is common in a few blocks (Khanakul, Haripal) of Hugli District. So, measures are to be adopted for climate-resilient agriculture.
- The Govt, should pay more attention to research and development of agricultural activities. Otherwise, those infrastructural facilities will not be fulfilled.

c) Irrigation Development

- Evaporation, seepage, and carriage of water loss can be scientifically reduced for better irrigation results. Farmers should be made aware of the rational use and management of water resources.

- To reduce great pressure on ground water use, the possible alternative remains with the use of surface water by **River Lift Irrigation**. To use the flowing water of the river to irrigate the riverside area.
- Rational utilization of groundwater resources through the adoption of micro irrigation and other advanced irrigation systems like Drip and sprinkler systems and promotion of rainwater harvesting structures for groundwater recharging.
- The Practice of **Rooftop water harvesting** provides the scope of conserving water, particularly in the area where groundwater availability is critical.
- **Water Tanks or ponds** are commonly used for rain after harvesting. Large-capacity public tanks may be proposed to be renovated for irrigation purposes.
- Application of **Micro-irrigation** to horticulture and many other crops is very efficient for water use and yield response.

d) Livelihood Development

- The economy of Hugli district depends on mainly agriculture. Our remote sensing data and surveys show that significant changes have taken place in the Hugli district, particularly the decrease of agricultural land with expanding settlements. The most remarkable changes in land use classes occurred from 1991 to 2011. Spatially, most land use change occurred in the western and central part of the study area due to easy access to commercial areas and increased settlement following road improvement and other infrastructure development. Water supplies have been affected by the reduction in forest cover and changes in ecosystems have also been exacerbated by the growth of human settlements. The absence of a strategy for the preservation and use of natural resources has resulted in unsustainable changes in land use, which raises environmental and socioeconomic issues that are not sufficiently addressed by policy solutions.
- The majority of farmers are ignorant about the region's agro-based industries' significance or how to properly manage many crops and agricultural plots. Stalks, husks, bagasse, etc., may be created for use in agro-based enterprises. These could be utilized to make packaging materials, rigid cardboard, etc.
- The Food Processing industry based on Mango, Litchi, Potato and other vegetables are demanding and profitable sector for the district.

- Aquaculture mainly fishing on a commercial basis as well as Lotus, and Water Chestnut production have needed much attention. So, fishing on a commercial basis, though prevalent on a small scale needs much attention through a cooperative society.
- Only the Balagarh C.D. Block in the Hugli District of West Bengal is home to the Boat Making Factory. Those who work in the boat-building sector in Balagarh Srepur Village are suffering greatly as a result of the industry's decline and current state of death. They are unable to access any government facilities or help because there is no government restructuring that would allow them to work as skilled labourers in the boat-making sector.
- Agro-forestry is another important aspect of Hugli district. In Hatikanda village of Balagarh C.D. block, the commercial plant nursery is a new livelihood initiative. Generating biomass, soil conservation, enhancement of soil, agro-based industry promotion, herbal drug manufacture, poultry, piggery, dairy, sericulture, and mushroom cultivation are the primary goals of agro-forestry. These objectives should be popularized among the inhabitants of Hugli district.
- Low-lying Paddy lands, which have become uncultivable, can be made profitable by fish ponds. Due to the proximity to Kolkata, there are huge prospects and scope for ornamental fish breeding and culture in different aquatic resources. Fish Farmer's Development Agency (FFDA) assists the fishermen in the Excavation of tanks and culture of fish through institutional finance.
- To improve the productivity of cattle, follow proper feeding strategy with processed straw, greens, and supplementation of vitamins and mineral mixture.

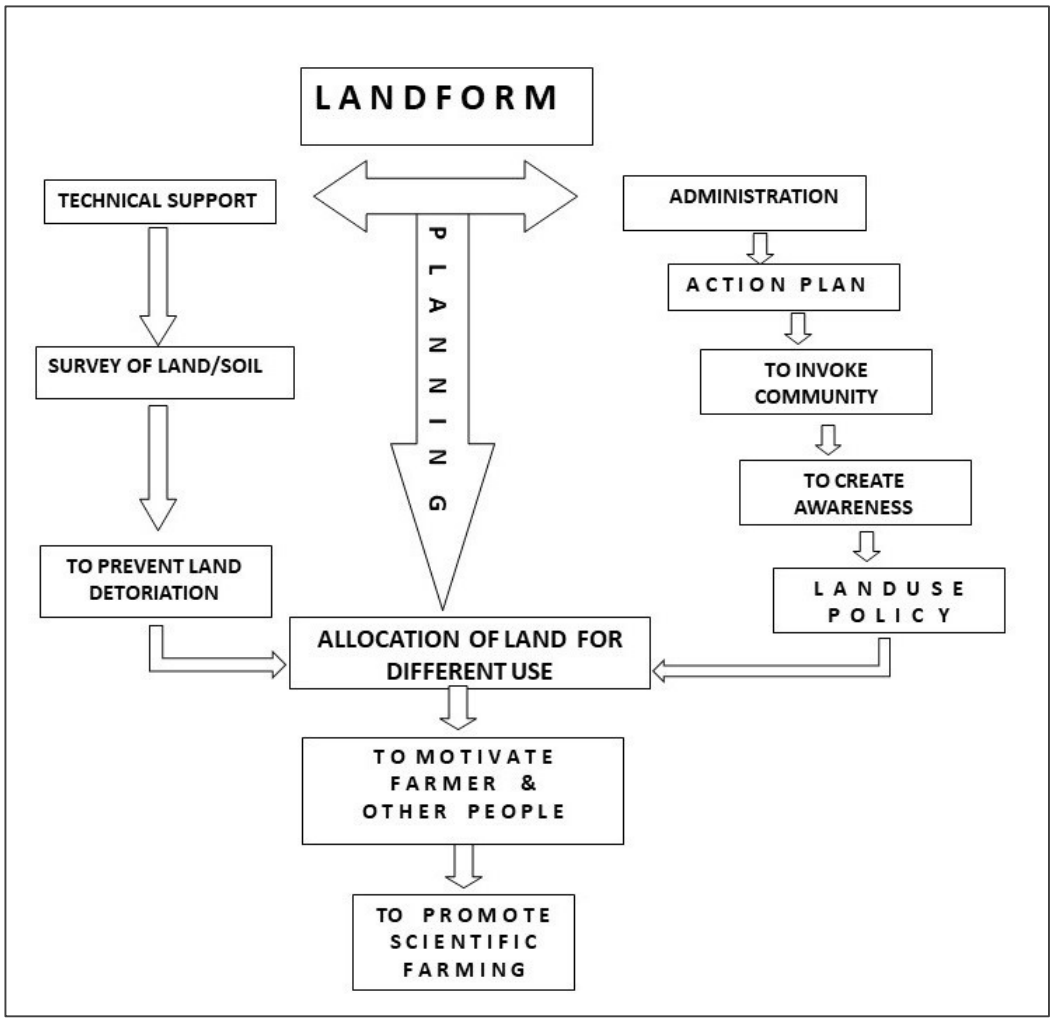
e) Improvement of civic amenities

- Safe, clean, and free drinking water should be supplied by PHE in every house of the district. Every family in the village should take advantage of it.
- Major emphasis has been given on rainwater harvesting for which several schemes have been introduced. In the Sajaldhara project, water taps have been installed, but it is necessary to investigate why water is not available everywhere from them.
- 17.55% (2020) people are still illiterate in the district. Although almost all of this generation goes to school, several elderly people in every village remain uneducated. Every village should have an **adult education center.** Students should be given

concessions on travel expenses. Higher secondary schools, colleges, and technical institutes should be set up with one **Hostel** in each C.D. block, at minimum cost.

- The practice now in place must be replaced by a modern scientific hygienic system of waste disposal.
- Every rural road needs to be connected with block headquarters and highways to speed up socio-economic development.
- The village roads should be improved; they should be possible in monsoon so that the panchayat will be diligent in that regard. Fixed Auto / Toto routes should be introduced for night travel.
- Every village should have at least one Rural Bank and ATM.

Model 7.3: Implementation of the Land Use Planning



Source: Prepared by researcher.

The government is interested in ameliorating the condition of the rural people. Which massive drive has been launched by the Government with the active cooperation of voluntary organisations to eradicate illiteracy and to arouse health consciousness and family planning among the people. The government has allocated sufficient funds for rural development in the current plan period. As a result, various schemes have been undertaken to improve the condition of the rural people, such as a self-employment scheme to uplift the economic condition of the people, the arrangement of drinking water in every village, and the introduction of smokeless chulla for cooking purpose to reduce the health hazards of women of the society, etc. Thus, it can be concluded that through planned land utilization aided by efforts of the Government and voluntary organizations, the economic condition of the rural people can surely be improved, resulting in the social and economic development of the people of the area.

For future development, it is important to systematically evaluate previous patterns and dynamics of land use. Land use change based on time series analysis will provide insight into sustainable resource utilization and conservation.

8.1 Summary

The analysis of research work focuses on the decadal change in land use transformation and socio-economic changes in rural areas of Hugli district. The whole discussion (Chapter 1 to Chapter 7) may be summarized and observed as follows:

The first chapter is the introduction chapter, which provides the basic profile of this research work.

The second chapter also highlights the geo-environmental setup of the study area. The geographical setup is comprised of both physical and socio-economic aspects. In this chapter, it is observed that the district presents an almost homogeneous landscape. The population density of the SC population is very low in the Municipal area and high in the C.D. block area. Literacy rate (88.55% in 2021) above the state level, Female Literacy rate (91.33%) is 6% higher than Male literacy rate (85.35%). Health care service especially in rural areas is still inadequate. The district is electrified. The drinking water supply is not adequate.

To get a clear picture of Land use transformation, three different sources of information have been considered - land use analysis based on Census information and land use analysis based on Satellite imagery, and field investigation also. From the census data analysis (Chapter - 3), it is clear that land use pattern of the Hugli district is dominated by net sown area (211.27 ha). More than 95% of land belongs to small and marginal farmers and the average size of land holdings ranges from 0.66 ha. Cropping intensity (241%) is very high in this area. Out of the total area under cultivation 57% area is covered by irrigation. The main source of irrigation is groundwater. Irrigation intensity is very high in chanditala-I, Chinsurh-Mogra, Polba-Dadpur, and very low in Goghat-I and Chanditala-II.

From the Satellite data analysis (chapter-4), it is clear that Agricultural land has experienced significant changes, indicating the growth of agricultural activities. Settlement areas have expanded over time, reflecting urbanization and the development of residential, commercial, and industrial sectors. Water body areas have generally shown an increase, possibly due to the construction of reservoirs, Fish Pond and conservation efforts. Barren land remains stable. The conversion of Barren land to cropland covering an area of 45.17 sq. km in Arambagh and Dhaniakhali highlights the agricultural development and utilization of unproductive land. Transformation of vegetation to aquaculture for a 7.44 sq km area in Balagarh. The conversion of Cropland to Settlement for 102.34 sq. km. area in Khanakul-I and Goghat-I and 18.61 sq km in Serampore–Uttarpara signifies urban expansion and Population growth.

In the fifth chapter, discussion about land use and socio-economic structures of rural areas, based on field surveys. The present chapter focuses on the socio-economic condition of households. The present chapter also attempts to explain and highlight the land use pattern of sample villages and its spatio-temporal changes. In this chapter socioeconomic scenarios have been highlighted through primary data and the land use pattern of the sample villages has been discussed through census data from 1991, 2001, and 2011.

The focus of the sixth chapter is on the changes in the socio-economic dimensions of the land-use system. This chapter also focuses on the spatio-temporal variation and level of socio-economic development of Hugli District. A case study of two sample villages was also conducted to study the land use transformation and related socio-economic changes in the study area.

The seventh chapter deals with the major problems of the study area with the major findings of the entire study and suggests some ameliorative measures for the overall development of the study area. Summary and conclusion of the entire study have also been given in this chapter.

8.2 Conclusion

Due to the rise in population and rapid urbanization, rural land transformation, especially in developing countries, has become a major concern. India is no exception. More recently, rural land has emerged as a contested territory between public and private agencies. Hugli district of West Bengal displays the image of an agrarian economy. However, the resource potential has not yet been fully utilized. A planned land utilization will contribute a lot to the process of rural development and change in the study area. The increased productivity, production of various crops, and new employment opportunities in the rural sector will bring about tangible changes in the income and living standard of the rural people. It has a direct bearing on the process of rural development. Agro-based industries should be given priority, for which it requires the improvement of transport and communication systems. Optimum utilization of resources and parameters of social well-being should be treated and used thoroughly. The government's cooperation and participation of the local people are urgently needed for the implementation of development plans and programs.

Presenting the case of Hugli district this study forms the basis for future research on land use transformation from primary sectors of the Indian economy. The future scenarios of land transformation in rural region of Hugli district can be modeled to assess rural-urban linkages and socio-economic impacts of land use change. This study also presents some interdisciplinary findings related to social, economic, and environmental implications. Replication of such studies for other areas and a comparative analysis could give useful insights for policy planning and implementation. This research also holds relevance in the context of achieving sustainable development goals, which are vital for a developing economy like India.

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APPENDIX-A (TABLES)

Chapter: 2

Table No. 2.1: Decadal Variation of Population Density in (1901-2011)

Year	Population	Area in sq km.	Density of Population
1991	4355230	3149 .00	1383
2001	5041976	3149 .00	1601
2011	5519145	3149 .00	1753

Source: Census of India (1991-2011).

Table No. 2.2: Population Density of Hugli District in year 1991, 2001 and 2011

Sub-division / C.D. Block / M.C /M	Density of Population (per Sq Km.) in 1991	Density of Population (per Sq Km.) in 2001	Density of Population (per Sq. Km.) in 2011
Dhaniakhali	937	1064	1163
Pandua	851	1028	1144
Balagarh	896	1062	1133
Chinsurah -Mogra	2228	2578	3018
Polba-Dadpur	720	838	923
Tarakeswar	1255	1354	1494
Haripal	1118	1277	1416
Singur	1522	1582	1677
Jangipara	1082	1224	1349
Chanditala-I	1602	1775	1924
Chanditala-II	2504	3035	3602
Serampur-Uttarpara	2200	2821	3399
Goghat-I	581	672	752
Goghat-II	659	754	845
Arambagh	781	942	1059
Khanakul-I	1145	1291	1480
Khanakul-II	1241	1321	1516
Pursurah	1412	1557	1727
District Total	22734	26175	29621
Average Population Density	1263	1454	1646

Source: Census of India 1991, 2001 and 2011.

Table No. 2.3: Religion wise population in Hugli District (1991 - 2011)

Religion	1991		2001		2011	
	Total Population	% of Population	Total Population	% of Population	Total Population	% of Population
Hindu	3696772	84.88%	4216701	83.63%	4574569	82.89%
Muslim	632175	14.52%	763471	15.14%	870204	15.77%
Christion	2222	0.05%	4474	0.09%	7300	0.13%
Sikh	1828	0.04%	2266	0.05%	2662	0.05%
Buddhist	986	0.02%	1319	0.03%	1730	0.03%
Jain	1087	0.03%	2027	0.04%	2160	0.04%
Others	20160	0.46%	49075	0.97%	49050	0.89%
Not stated	NA	NA	2643	0.05%	11470	o.21%

Source: Census of India.

Table No. 2.4: Decadal variation of Male and Female Population Share of District Hugli, (1991-2011)

Name of the C.D Blocks	1991	2001	2011
Arambagh	932	952	950
Khanakul-I	949	962	954
Khanakul-II	978	983	977
Pursurah	937	942	952
Goghat-I	939	961	952
Goghat-II	950	968	949
Chanditala-I	979	941	969
Chanditala-II	938	939	959
Jangipara	943	944	983
Serampore-Uttarpara	882	857	935
Polba-Dadpur	939	938	975
Dhaniakhali	948	946	977
Balagarh	940	940	948
Panduah	962	946	985
Chinsurh-Mogra	898	875	923
Singur	939	902	985
Haripal	942	931	990
Tarakeswar	928	930	952

Source: Computed by Author based on Census of India (1991, 2001 and 2011).

Table No. 2.5: Decadal growth of Urban and Rural Population in the District Hugli (1991-2011)

Year	Urban	Rural	P. C of rural Population to total Population
1991	1358251	2996979	68.81
2001	1687749	3354227	66.53
2011	2128499	3390646	61.43

Source: Statistical Handbook, 2012.

Table No. 2.6: Decadal variation of Scheduled Caste and Scheduled Tribe Population (1991-2011)

Year	Total Population	S C Population	S T Population
1991	4355230	1050280	176401
2001	5041976	1188881	212062
2011	5519145	1344021	229243

Source: Census of India-2011.

Table No. 2.7: Percentage of Literates Population in District Hugli (1991-2011)

Sl No	C.D. Blocks	1991	2001	2011
1	Arambagh	51.85	71.0	79.01

2	Khanakul-I	51.00	69.9	77.73
3	Khanakul-II	49.27	70.5	79.16
4	Pursurah	54.49	75.1	82.12
5	Goghat-I	51.15	70.1	78.70
6	Goghat-II	51.92	68.8	77.24
7	Chanditala-I	52.75	75.7	83.76
8	Chanditala-II	59.63	78.9	84.78
9	Jangipara	50.82	70.2	79.62
10	Serampore-Uttarpara	68.09	84.5	87.33
11	Polba-Dadpur	48.58	65.9	75.14
12	Dhaniakhali	48.55	57.2	75.66
13	Balagarh	50.08	68.9	76.94
14	Panduah	47.34	67.2	75.86
15	Chinsurh-Mogra	56.72	76.9	83.01
16	Singur	60.72	76.7	84.07
17	Haripal	51.27	70.9	78.59
18	Tarakeswar	56.23	74.1	79.96
19	Arambagh(M)	53.60	74.2	81.03
20	Tarakeswar(M)	63.68	79.7	83.09
21	Bansberia(M)	62.91	82.3	85.05
22	Hooghly-Chinsurh (M)	75.33	87.4	91.10
23	Chandannagar (MC)	58.74	84.6	89.66
24	Bhadreswar(M)	55.56	82.3	86.51
25	Champadani(M)	72.17	75.7	81.89
26	Baidyabati(M)	72.17	85.1	88.26
27	Serampore(M)	71.82	83.6	88.73
28	Rishra(M)	63.60	82.2	87.89
29	Konnagar(M)	75.04	87.3	90.84
30	Uttarpara-Kotrang(M)	75.66	86.5	90.65
		58.69	76.1	83.0

Source: Census of India 1991, 2001 and 2011.

Table No. 2.8: General Educational Institutions by type in the district Hugli

year	Primary school	Middle school	High School	Higher Secondary school	College & University	Special & Non Formal School	Technical Schools	Technical Colleges
1992	2993	203	321	115	21	16	02	05
2002	2923	112	474	165	24	3527	12	10
2008	3023	55	345	272	33	5318	22	15
2009	3025	48	339	285	33	5322	22	15
2010	3026	61	318	306	33	7065	22	15
2011	3028	61	319	306	33	6736	22	15
2012	3053	158	322	311	33	6917	22	15
2013	3027	152	291	346	33	6876	22	15
2014	3013	152	292	359	33	6885	19	19

Source: Statistical Hand Book.

Table No. 2.9: Progress in Education scenario in Hugli District

Name of the Blocks	No of Institution in 2001				No of Institution in 2011			
	Primary School	High School	Higher. Secondary School	College	Primary School	High School	Higher .Secondary School	College
Balagarh	155	23	5	1	165	18	8	1
Chinsurh-Mogra	93	13	8	1	150	7	14	1
Polba-Dadpur	200	25	4	-	132	26	8	1
Singur	182	19	10	-	127	16	15	-
Chanditala - I	89	12	5	1	89	8	8	1
Serampur-Uttarpara	78	16	5	1	51	7	8	1
Panduah	182	32	8	1	185	24	14	1
Dhaniakhali	190	29	8	1	199	26	15	1
Haripal	178	17	7	1	187	6	16	1
Jangipara	140	20	7	-	148	11	15	1
Tarakeswar	87	15	3	1	61	7	10	1
Chanditala-II	84	9	6	-	90	8	11	-
Pursurah	99	15	4	-	108	9	8	1
Arambagh	179	45	9	-	180	21	18	1
Khanakul-I	168	19	2	1	188	17	11	1
Khanakul-II	143	16	3	-	137	12	8	-
Goghat-I	63	32	5	-	144	13	9	-
Goghat-II	177	20	2	2	114	16	5	2
	2487	377	101	11	2455	252	201	15

Source: Statistical Hand Book, 2002 & 2012.

Table No. 2.10: Progress of Health Service in Hugli District

Year	Medical institutions	Total Beds	Total Patients	Total no of Doctors
1992	211	3651	1921125	NA
1993	211	3651	1951635	NA
1994	211	3651	2032138	NA
1995	233	3348	2186200	NA
1996	233	3348	2499238	NA
1997	233	3364	2857745	353
1998	778	3651	2296851	364
1999	778	3653	3143439	364
2000	779	3689	3517511	406
2001	813	3768	3291420	406
2002	813	3768	3091504	406
2003	813	3768	2057373	406
2004	813	3768	2130873	406
2005	813	3805	2414759	406
2006	268	5618	3943920	406
2007	251	1946	3933524	283
2008	813 (244)	55159(4159)	5645026	353
2009	254	4228	3683244	319

2010	245	4338	3643565	319
2011	257	4345	6950802	319
2012	257	2202#	3558113	319
2013	252	4611	3783949	337
2014	271	4732	6244103	306

Source: Statistical Hand Book, 1996,2002,2004,2006, 2008, 2009,2012,2014.

Excluding NGO / Private Bodies (Nursing Homes)

Table No. 2.11: Block wise Progress of Health Services in Hugli District

Name of the Blocks	No of Healthcare units			No of Beds		
	1991	2001	2011	1991	2001	2011
Balagarh	16	43	11	16	59	30
Chinsurh-Mogra	14	37	7	14	216	30
Polba-Dadpur	11	53	4	11	33	30
Singur	10	47	12	10	120	60
Chanditala - I	6	42	14	39	29	30
Serampur-Uttarpara	13	28	3	12	8	30
Panduah	12	55	10	12	69	30
Dhaniakhali	10	64	13	10	111	30
Haripal	12	46	10	36	46	30
Jangipara	10	41	9	63	84	60
Tarakeswar	6	36	6	25	68	60
Chanditala-II	10	38	9	40	40	30
Pursurah	6	32	5	15	23	30
Arambagh	14	48	9	22	44	30
Khanakul-I	8	42	8	25	43	30
Khanakul-II	6	33	5	20	28	10
Goghat-I	5	27	2	6	8	-
Goghat-II	9	33	7	23	25	30

Source: Statistical Hand Book, 1996, 2002, 2012.

Excluding Clinic & Dispensaries.

Table No. 2.12: Distribution of Workers in Hugli District in 1991

Name of the Police Station/Block	Cultivators	Agricultural Labourers	Household Industry	Other Workers	Main Worker	Marginal Worker	Total Worker	Non Worker
Sadar Sub Division								
Chinsurh-Mogra	1.87	6.08	0.23	20.33	28.51	0.30	28.81	71.19
Dhaniakhali	10.07	19.45	0.88	7.19	37.59	0.48	38.07	61.93
Panduah	7.00	18.58	0.51	9.48	35.57	0.90	36.47	63.53
Balagarh	8.60	14.30	0.75	9.14	32.79	0.73	33.44	66.48

Polba-Dadpur	10.55	17.25	0.74	7.17	35.71	0.95	36.66	63.34
Chandannagar Subdivision								
Singur	7.75	6.84	0.87	14.69	30.15	0.25	30.4	69.60
Tarakeswar	11.58	10.68	1.01	9.18	32.45	0.27	32.72	67.28
Haripal	9.11	19.35	1.27	8.70	33.03	0.64	33.67	66.33
Serampur Sub-Division								
Jangipara	7.97	11.36	3.43	8.85	31.61	1.42	33.03	66.97
Chanditala - I	5.21	6.79	1.47	13.40	26.89	0.46	27.35	72.65
Chanditala-II	2.38	4.13	2.18	18.67	27.36	0.79	28.15	71.85
Serampore	1.37	2.04	0.26	25.05	28.72	0.50	29.22	70.78
Arambagh Sub Division								
Goghat-I	13.40	10.57	0.87	5.48	30.32	1.06	31.38	68.62
Goghat-II	12.72	8.98	1.59	6.06	29.35	1.44	30.79	69.21
Arambagh	10.05	9.62	1.06	7.78	28.51	0.71	29.22	70.78
Khanakul-I	11.33	7.09	1.63	7.95	28.00	0.64	28.64	71.36
Khanakul-II	10.69	6.52	1.00	8.67	26.89	1.07	27.96	72.04
Pursurah	13.60	7.29	0.82	7.91	29.62	0.65	30.27	69.73

Source: Census of India.

Table No. 2.13: Distribution of Workers in Hugli District in 2001

Name of the Police Station/Block	Cultivators	Agricultural Labourers	Household Industry	Other Workers	Main Worker	Marginak Worker	Total Worker	Non Worker
Sadar Sub Division								
Chinsurh-Mogra	3.6	13.2	3.3	80.0	28.5	4.5	33.0	67.0
Dhaniakhali	19.7	48.0	4.5	27.8	32.0	10.2	42.2	57.8
Panduah	13.9	49.9	3.1	33.1	29.9	10.0	39.9	60.1
Balagarh	19.4	37.4	4.7	38.5	32.5	6.0	38.5	61.5
Polba-Dadpur	19.6	49.1	7.5	23.7	33.3	9.8	43.1	56.9
Chandannagar Subdivision								
Singur	15.9	16.6	9.4	58.1	32.0	4.1	36.1	63.9
Tarakeswar	26.9	34.7	3.7	34.7	31.0	5.5	36.5	63.5
Haripal	18.5	37.3	7.3	36.9	27.9	10.4	38.3	61.7
Serampur Sub-Division								
Jangipara	16.3	29.8	10.0	43.9	34.2	12.3	46.5	53.5
Chanditala - I	13.0	19.9	9.3	57.8	27.5	6.9	34.4	65.6
Chanditala-II	3.1	7.4	9.8	79.7	28.5	4.0	32.5	67.5
Serampore	2.9	6.3	4.5	86.3	29.0	4.6	33.6	66.4
Arambagh Sub Division								

Goghat-I	36.7	33.3	3.3	26.8	33.7	9.8	43.5	56.5
Goghat-II	36.2	31.7	5.3	26.8	32.9	16.3	49.2	50.8
Arambagh	22.5	36.1	4.5	36.9	25.5	6.4	31.9	68.1
Khanakul-I	27.4	25.1	9.5	38.0	28.6	8.3	36.9	63.1
Khanakul-II	30.8	28.5	6.1	34.6	27.3	11.7	39.0	61.0
Pursurah	32.3	27.7	3.5	36.6	28.8	4.0	32.8	67.3

Source: Census of India.

Table No. 2.14: Distribution of Workers in Hugli District in 2011

Name of the Police Station/Block	Cultivators	Agricultural Labourers	Household Industry	Other Workers	Main Worker	Marginal Worker	Total Worker	Non-Worker
Sadar Sub Division								
Chinsurh-Mogra	3.73	12.70	3.79	79.78	34.32	8.16	37.79	62.21
Dhaniakhali	17.50	53.71	3.80	25.00	31.63	13.32	44.95	55.05
Panduah	11.82	51.33	3.80	33.05	30.43	14.87	45.31	54.69
Balagarh	15.95	42.99	4.34	36.72	33.03	8.45	41.49	58.51
Polba-Dadpur	17.76	54.89	4.24	23.10	34.41	11.34	45.75	54.25
Chandannagar Subdivision								
Singur	16.40	16.34	8.11	59.15	32.85	5.06	37.92	62.08
Tarakeswar	19.55	38.09	5.19	37.17	29.16	13.00	42.16	57.84
Haripal	17.13	40.05	5.92	36.90	31.21	8.84	40.05	59.95
Serampur Sub-Division								
Jangipara	14.13	34.77	14.86	36.24	32.39	9.50	41.89	58.11
Chanditala - I	9.24	18.10	10.41	62.25	30.84	4.82	35.66	64.34
Chanditala-II	4.18	6.31	12.01	77.50	32.47	4.62	37.10	62.90
Serampore	2.41	3.57	4.94	89.08	32.41	5.09	37.50	62.50
Arambagh Sub Division								
Goghat-I	27.87	41.68	3.18	27.28	32.32	6.15	38.47	61.53
Goghat-II	39.33	29.00	4.51	4.11	30.20	9.13	39.33	60.67
Arambagh	17.38	42.74	5.13	34.75	25.53	11.71	37.24	62.76
Khanakul-I	19.61	34.83	9.43	36.14	26.99	9.21	36.20	63.80
Khanakul-II	19.14	29.25	7.68	43.93	27.27	9.36	36.33	63.37
Pursurah	26.52	33.83	3.78	35.88	28.99	8.52	37.51	62.49

Source: Census of India.

Chapter: 3

Table No. 3.1: Land use pattern of Hugli District (1991, 2001 and 2011)

Land use data of 1991 from Census report (Area in Hectare)

Name of the C.D. blocks	Area under non agricultural use	Culturable waste land	Total Irrigated land	Total Un-irrigated land	Net shown area	Forest
Arambagh	7605.35	140.44	12662.04	8078.81	20740.85	
Khanakul-I	4484	264.36	5163.08	7290.98	12454.06	
Khanakul-II	3329	99.51	7921.25	676.88	8598.13	
Pursurah	1028.92	194.34	5037.01	3810.56	8847.57	
Goghat-I	2863.52	1302.95	10416.4	4110.6	14527	
Goghat-II	3016.42	1325.42	11073.58	3222.97	14296.55	39.66
Chanditala-I	2459.94	73.66	4331.19	2329.74	6660.93	
Chanditala-II	1752.72	440.65	1011.05	2342.22	3353.27	
Jangipara	3329.53	261.1	6160.51	7132.57	13293.08	40
Serampore-Uttarpara	1073.1	0	189.08	1986.54	2175.62	
Polba-Dadpur	6267	558.8	16813.42	4928.5	21741.92	
Dhaniakhali	6021.95		20385.54	682.68	21068.22	
Balagarh	6874.95	185.06	6188.82	6475.39	12664.21	
Panduah	4854	10	16320	7091	23411	
Chinsurh-Mogra	2210	382	2268	1214	3482	
Singur	4522.3	249.75	6181.2	5628	11809.2	
Haripal	5364.32	0	8507.88	4563.52	13071.4	
Tarakeswar	3635.93	0	6478.18	1780.13	8258.31	

Land use data of 200 1 from Census report (Area in %)

Name of the blocks	**Total area**	**% of Area under non agricultural use**	**% of Culturable waste land**	**% of Total Irregated land**	**% of Total Un-irregated land**	**Net Shown Area**	**% of Forest Area**
Arambagh	26930.6	21.05	2.59	54.92	21.44	76.35	
Khanakul-I	17191.7	27.21	3.99	28.05	40.75	68.79	
Khanakul-II	12182.9	12.46	2.8	51.72	33.03	84.75	
Pursurah	10042	14.7	0.67	80.96	3.66	84.62	
Goghat-I	18632.2	13.65	6.71	58.58	18.38	76.96	8.1
Goghat-II	19003	14.04	7.12	50.72	25.36	76.07	2.7
Chanditala-I	9345.4	25.94	0.21	46.46	26.21	72.67	
Chanditala-II	5208	33.52	5.61	37.61	22.81	60.42	22.2
Jangipara	16422.6	20.35	1.68	36.36	41.04	77.40	62.8

Serampore-Uttarpara	2920.9	36.74	8.79	27.41	26.03	53.45	
Polba-Dadpur	28568.6	21.94	1.96	58.85	17.25	76.10	
Dhaniakhali	27568.2	19.27	0.71	72.00	6.40	78.41	9.3
Balagarh	20110.7	26.32	3.17	54.02	16.17	70.20	5.9
Panduah	27268.1	17.8	1.62	59.85	17.77	77.63	9.6
Chinsurh-Mogra	6198	35.66	2.58	42.18	19.59	61.77	
Singur	15844.7	28.21	3.84	47.33	20.61	67.94	0.9
Haripal	18441.7	25.12	1.3	55.03	18.48	73.51	3.9
Tarakeswar	11992.6	30.98	0.51	53.06	14.91	67.98	64.8

Land use data of 2011 from Census report (Area in %)

Name of the C.D. blocks	**Total area**	**Forest**	**% of Area under non agricultural use**	**% of Culturable wasteland**	**% of Net area Shown**	**% of Irrigated land**	**% of Un-irrigated land**
Arambagh	26931.3		20.09	2.96	76.94	55.39	21.55
Khanakul-I	17191.7		29.12	3.66	67.23	30.20	37.02
Khanakul-II	12182		10.32	2.64	87.04	73.44	13.61
Pursurah	10042.3		13.64	1.25	85.1	82.66	2.44
Goghat-I	18632.2	40.4	12.14	9.51	78.13	64.60	13.53
Goghat-II	19002.8	8.1	11.04	7.22	81.69	63.17	18.52
Chanditala-I	6262.4		24.06	1.42	74.52	52.41	22.11
Chanditala-II	2248.8		22.59	9.34	68.05	52.64	15.41
Jangipara	15837	32.5	15.40	3.96	80.43	47.93	32.50
Serampore-Uttarpara	2063		30.89	10.01	59.1	28.88	30.22
Polba-Dadpur	28569.2		19.60	4	76.39	59.48	16.91
Dhaniakhali	27568.7	442	15.86	2.29	80.23	72.41	7.82
Balagarh	19260.5	0.7	19.19	4.91	75.9	66.57	9.32
Panduah	26788.2	132.6	18.38	2.63	78.5	66.96	11.53
Chinsurh-Mogra	5570.1		33.46	3.68	62.86	46.24	16.62
Singur	13813.3		24.67	7.69	67.63	49.81	17.81
Haripal	18317.4		18.68	2.99	78.34	66.36	11.98
Tarakeswar	11992.2	65.3	0.08	3	72.25	56.39	15.87

Source: Census of India.

Table No. 3.2: Production (in '000 mt.) of different types of crops in the C.D Blocks of Hugli for the year 1991-92, 2001-02 and 2011-12

No of C.D Blocks	Aman Production			Variation of Aman Production	Boro Production			Variation of Boro Production
	1992	2002	2012		1992	2002	2012	
Dhaniakhali	550.81	495.7	574.52	76.29	197.64	154.0	133.92	-63.72
Panduah	460.18	590.0	624.15	163.97	285.43	404.1	309.96	24.53
Balagarh	260.63	412.0	318.17	57.54	181.18	216.8	147.19	-33.99
Chinsurh - Mogra	93.47	89.6	76.40	-17.07	79.79	61.8	26.96	-49.83
Polba-Dadpur	433.67	458.9	511.92	78.25	210.19	368.0	208.05	-2.14
Tarakeswar	235.86	237.6	290.62	54.76	13.52	86.2	17.27	3.75
Haripal	392.20	407.4	301.94	-90.26	97.74	166.6	128.81	31.07
Singur	28.47	272.7	189.77	161.3	43.74	143.7	29.80	-13.94
Jangipara	297.97	404.7	278.41	-19.56	10.82	196.1	98.54	87.72
Chanditala-I	154.05.	177.9	169.83	15.78	51.14	72.1	82.89	31.75
Chanditala-II	43.55	86.1	49.82	6.27	21.15	72.7	33.48	12.33
Srerampur-Uttarpara	28.53	23.9	03.74	-24.79	9.78.	22.3	07.16	-2.62
Goghat-I	401.01.	241.5	370.22	-30.79	89.67	167.7	284.63	194.96
Goghat-II		365.6	396.68			106.7	206.38	116.71
Arambagh	336.36	511.0	720.93	384.57	228.97	315.4	415.33	186.36
Khanakul-I	318.09	302.9	289.34	-28.75	120.32		129.82	9.5
Khanakul-II	113.00	127.3	11.98		238.75		227.96	-10.79
Pursurah	234.69	164.0	257.90	23.21	2.83	51.0	-	

Source: Compiled by author based on CDAP Hugli.

Table No. 3.3: Production (in '000 mt.) of Potato in the C.D Blocks of Hugli for the year 1991-92, 2001-02 and 2011-12

Name of C.D Blocks	Potato Production			Production Variation from 1992-2012
	1992	2002	2012	
Dhaniakhali	2538.32	1978.5	1982.96	-555.36
Panduah	656.57	1183.6	2230.46	1573.89
Balagarh	116.15	320	382.17	266.02
Chinsurh - Mogra	264.48	107.8	47.48	-217
Polba-Dadpur	1095.84	1236.3	1248.44	152.6
Tarakeswar	1990.53	2534.1	1336.26	-654.27
Haripal	1976.55	2331	1839.46	-137.09
Singur	608.48	1821.1	1518.96	910.48
Jangipara	1803.43	1307	1452.35	-350.07
Chanditala-I	143.33	246.7	509.4	366.07

Chanditala-II	118.69	213.1	252.02	133.33
Srerampur-Uttarpara	17.22	2	17.73	0.51
Goghat-I	1090.97	577.2	1472.77	386.8
Goghat-II		2365.5	2939.56	1848.59
Arambagh	1657.67	1609.3	3520.07	1862.4
Khanakul-I	1117.44	2605.5	1050.48	-66.96
Khanakul-II	393.03	671.9	296.88	96.15
Pursurah	2173.24	2453.3	2301.93	128.69

Source: CDAP Hugli, 2017-18

Table No. 3.4: Production (in '000 mt.) of Jute and Mustard in the C.D Blocks of Hugli for the year 1991-92, 2001-02 and 2011-12

Name of the C.D. Block	Jute Production			Production Variation from 1992-2012	Mustard Production			Production Variation from 1992-2012
	1992	2002	2012		1992	2002	2012	
Dhaniakhali	140.2	189.4	294.53	154.33	11.63	11.4	14.22	2.59
Panduah	10.9	3.7	3.2	-7.7	6.38	5.3	2.53	-3.85
Balagarh	331.9	534	675.66	343.76	2.22	2.7	11.94	9.72
Chinsurh - Mogra	22.3	24.3	25.21	2.91	1.34	0.6	0.48	-0.86
Polba-Dadpur	176.3	232	85.64	-90.66	13.32	12.5	4.91	-8.41
Tarakeswar	526.5	781.1	654.44	127.94	0.29	(b)	0.24	-0.05
Haripal	207.4	347.6	311.43	104.03	3.46	3.8	1.69	-1.77
Singur	438.4	284.1	555.57	117.17	1.08	11.1	0.54	-0.54
Jangipara	464.2	877.2	208.38	-255.82	13.55	0.9	28.05	14.55
Chanditala-I	117.2	91.4	223	105.8	0.59	0.2	0.94	0.35
Chanditala-II	219.5	77.2	31.36	-188.14	1.01	1.2	0.3	-0.71
Srerampur-Uttarpara	28.3	11	10.69	-17.61	0.14	(b)	0.1	-0.04
Goghat-I	0.2	39			13.7	1.3	5.8	-7.9
Goghat-II		No			2	9.1	8.08	6.8
Arambagh	167.5	347.6	146.76	-20.74	13.72	6.1	13.28	-0.44
Khanakul-I	403.5	1131.4	500.69	97.19	32.74	5.6	10.78	-21.92
Khanakul-II	70.8	501.4	485.74	414.94	3.54	6.2	9.51	5.97
Pursurah	684.7	475.8	232.65	-452.05	0.9	0.1	0.09	-0.81

Source: CDAP Hugli, 2017-18

Table No. 3.5: The present status of farm mechanization in the district Hugli

Sl . No	Machinery / Implements	
	Type	Number
1	Tractors	224
2	Power Tillers	4955
3	Peddle threshers	22996
4	Power threshers	200
5	Drum Seeders	25
6	Power Sprayers	1000

Source: CDAP, Hugli, 2017-18.

Table No. 3.6: Fertilizer Consumed in the District of Hugli (Thousand tons)

Year	Nitrogen(N)	Phosphate(P)	Potash(K)	Total
1991-92	44.3	21.8	8.3	74.4
1992-93	44.8	18.0	12.4	75.2
1993-94	47.0	17.5	10.4	74.9
1994-95	49.6	19.0	11.7	80.3
1995-96	50.8	21.2	12.1	84.1
2000-01	57.1	26.1	19.1	102.3
2001-02	58.3	27.7	21.1	107.1
2002-03	57.1	28.5	21.0	106.4
2004-05	58.6	26.7	19.4	104.7
2010-11	54.6	54.4	45.6	154.6
2011-12	54.5	57.0	42.9	154.4
2012-13	66.3	36.7	33.4	136.4
2012-13	61.9	52.6	39.1	153.6
2013-14	47.4	28.5	31.9	107.8

Source: Directorate of Agriculture Govt of West Bengal.

Chapter: 4

Table No. 4.1: Land use change matrix statistics of Arambagh C. D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	3.72	0	0	3.72
Vegetation	1.48	0	26.81	52.87	0.74	81.9
Agricultural Land	14.89	5.21	0	111.71	5.21	137.02
Settlement	0	0.74	9.68	0	0	10.42
Barren Land	0.74	0	40.21	0	0	40.95
Total	17.11	5.95	80.42	164.58	5.95	274.01

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.2: Land use change matrix statistics of Balagarh C. D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0.74	5.21	2.97	0	8.92
Vegetation	7.44	0	27.55	32.02	0	67.01
Agricultural Land	5.95	16.38	0	37.98	1.48	61.79
Settlement	0	3.72	5.21	0	0	8.93
Barren Land	2.23	2.97	5.95	3.72	0	14.87
Total	15.62	23.81	43.92	76.69	1.48	161.52

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.3: Land use change matrix statistics of Chanditala-I C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	0	0	0	0
Vegetation	0	0	14.89	17.23	0	32.12
Agricultural Land	4.68	0	0	28.53	0	33.21
Settlement	0	0	6.82	0	0	6.82
Barren Land	1.52	0	0	10.25	0	11.77
Total	6.2	0	21.71	56.01	0	83.92

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.4: Land use change matrix statistics of Chanditala-II C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	0.44	2.34	0	2.78
Vegetation	0	0	5.13	14.50	0	19.63
Agricultural Land	0	4.89	0	30.88	0.37	36.14
Settlement	0	2.79	3.23	0	0	6.02
Barren Land	1.34	0	0	4.89	0	6.23
Total	1.34	7.68	8.80	52.61	0.37	70.80

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.5: Land use change matrix statistics of Chinsurah Mogra C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	0.74	6.7	0	7.44
Vegetation	0.74	0	5.21	17.87	0	23.82
Agricultural Land	3.72	5.21	0	17.12	0	26.05
Settlement	0	0.74	4.46	0	0.74	5.94
Barren Land	0	0.74	5.21	5.21	0	11.16
Total	4.46	6.69	15.62	46.9	0.74	74.41

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.6: Land use change matrix statistics of Dhaniakhali C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0.74	2.23	0	0	2.97
Vegetation	2.23	0	28.3	23.08	0	53.61
Agricultural Land	10.42	5.21	0	63.3	0	78.93
Settlement	2.97	1.48	29.79	0	0.74	34.98
Barren Land	0	2.23	2.97	0	0	5.2
Total	15.62	9.66	63.29	86.38	0.74	175.69

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.7: Land use change matrix statistics of Goghat-I C. D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	2.23	1.48	0	3.71
Vegetation	0	0	7.44	12.66	0.74	20.84
Agricultural Land	1.48	3.72	0	67.77	14.15	87.12
Settlement	0	0	11.91	0	0	11.91
Barren Land	0	0	7.44	0.74	0	8.18
Total	1.48	3.72	29.02	82.65	14.89	131.76

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.8: Land use change matrix statistics of Goghat-II C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	2.13	14.89	0	17.02
Vegetation	0	0	26.61	7.03	0	33.64
Agricultural Land	1.92	2.34	0	25.61	0	29.87
Settlement	0	0	15.61	0	0	15.61
Barren Land	0	0	7.03	37.23	0	44.26
Total	1.92	2.34	51.38	84.76	0	140.4

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.9: Land use change matrix statistics of Haripal C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	0.74	0.74	0	1.48
Vegetation	0	0	11.91	23.08	0	34.99
Agricultural Land	1.48	0	0	40.96	0	42.44
Settlement	2.23	0.74	26.81	0	0	29.78
Barren Land	0	0	2.97	0	0	2.97
Total	3.71	0.74	42.43	64.78	0	111.66

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.10: Land use change matrix statistics of Jangipara C.D Block (in sq. km)

1991	2021				
	Waterbody	Vegetation	Agricultural Land	Settlement	Total
Waterbody	0.00	0.74	2.98	0.74	4.47
Vegetation	0.74	0.00	10.43	15.64	26.81
Agricultural Land	2.23	0.00	0.00	39.47	41.71
Settlement	0.00	1.49	16.39	0.00	17.87
Total	2.98	2.23	29.79	55.86	90.86

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.11: Land use change matrix statistics of Khanakhul-I C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	0.74	0	0.74	1.48

Vegetation	2.23	0	17.12	52.87	0	72.22
Agricultural Land	13.4	8.19	0	81.18	0.74	103.51
Settlement	0	2.97	8.93	0	0	11.9
Barren Land	0	0	1.48	0	0	1.48
Total	15.63	11.16	28.27	134.05	1.48	190.59

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.12: Land use change matrix statistics of Khanakhul-II C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	2.97	0.74	0	3.71
Vegetation	0.74	0	9.68	29.79	0	40.21
Agricultural Land	1.48	7.44	0	20.1	0.74	29.76
Settlement	0	7.44	4.46	0	0	11.9
Barren Land	0.74	0	2.23	0	0	2.97
Total	2.96	14.88	19.34	50.63	0.74	88.55

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.13: Land use change matrix statistics of Pandua C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	5.95	2.97	0	8.92
Vegetation	0	0	7.44	4.46	0	11.9
Agricultural Land	0.74	0.74	0	46.17	1.48	49.13
Settlement	1.48	0	19.36	0	0	20.84
Barren Land	0	0	0.74	0	0	0.74
Total	2.22	0.74	33.49	53.6	1.48	91.53

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.14: Land use change matrix statistics of Polba Dadpur C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agriculture Land	Settlement	Barren Land	Total
Waterbody	0	0.14	0.67	0.14	0	0.95
Vegetation	0.14	0	2.01	3.94	0	6.09
Agriculture Land	0.96	0.07	0	6.47	0	7.5

Settlement	0.07	0	1.41	0	0	1.48
Barren Land	0	0	0.14	0	0	0.14
Total	1.17	0.21	4.23	10.55	0	16.16

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.15: Land use change matrix statistics of Pursura C.D Block

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	0.74	0	0	0.74
Vegetation	0.74	0	5.95	32.02	0	38.71
Agricultural Land	1.48	0	0	48.41	0	49.89
Settlement	0.74	0.74	7.44	0	0	8.92
Barren Land	0	0	4.46	0.74	0	5.2
Total	2.96	0.74	18.59	81.17	0	103.46

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.16: Land use change matrix statistics of Serampore-Uttarpara C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0	0.74	0.74	0	1.48
Vegetation	0.74	0	2.23	11.17	2.97	17.11
Agricultural Land	32.02	1.48	0	18.61	12.66	64.77
Settlement	1.48	0.74	0.74	0	1.48	4.44
Barren Land	2.23	1.48	3.72	7.44	0	14.87
Total	36.47	3.7	7.43	37.96	17.11	102.67

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.17: Land use change matrix statistics of Singur C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0.74	7.44	3.72	0.74	12.64
Vegetation	3.72	0	26.81	64.05	0	94.58
Agricultural Land	7.44	5.21	0	46.17	6.7	65.52
Settlement	0.74	0	14.89	0	0	15.63

Barren Land	1.48	0	2.97	2.97	0	7.42
Total	13.38	5.95	52.11	116.91	7.44	195.79

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Table No. 4.18: Land use change matrix statistics of Tarakeshwar C.D Block (in sq. km)

1991	2021					
	Waterbody	Vegetation	Agricultural Land	Settlement	Barren Land	Total
Waterbody	0	0.74	0.74	1.48	0	2.96
Vegetation	0	0	11.17	13.4	0	24.57
Agricultural Land	2.97	0.74	0	24.57	0	28.28
Settlement	0.74	0.74	16.38	0	0	17.86
Barren Land	0	0	0	1.48	0	1.48
Total	3.71	2.22	28.29	40.93	0	75.15

Source: Compiled by researcher based on Landsat Imageries & Google Earth.

Chapter: 5

Table No. 5.1: Mode of Accessibility among the respondents

Mode of Accessibility	No of Respondents	%
Cycle	189	47.25
Van	27	6.75
Motor Bike	83	20.75
Car	4	1
electronic rickshaw	58	14.5
Auto	7	1.75

Source: Field survey, 2022 to 2023.

Table No. 5.2: Domestic Fuels used by the respondents

Use of Domestic Fuels	No of Respondents	%
LPG	299	74.75
Crop Residue	207	51.75
Wood	171	42.75
Coal	0	0
Kerosene	26	6.5

Source: Field survey, 2022 to 2023.

Chapter: 6

Table No. 6.1: Social characteristics of Hatikanda village

No. of Respondents (%)	1991	2023		No. of Respondents (%)	1991	2023
Population Structure				Caste Structure		
Male	52	51		General	75	78
Female	48	49		Schedule caste	23	22
Educational Structure				Schedule tribe	0	0
Upto V	32	0		OBC	2	0
V-IX	18	11		Age Structure		
MP/HS	21	33		< 15	35	33
Graduation	15	33		15 - 30	23	22
PG	6	11		30 - 45	20	22
Tech/Others	8	11		45 - 60	12	11
				> 60	10	11

Source: Field survey, 2022 to 2023.

Table No. 6.2: Economic characteristics of Hatikanda village

No. of Respondents (%)	1991	2023		No. of Respondents (%)	1991	2023
Dependency Ratio				House Structure		
Male	0	0		Kuchha House	19	0
Female	24	22		Pucca House	54	78
Child	38	33		Mixed House	27	22
Occupation				Mode of Accessibility		
Agricultural labour	49	44		Cycle	50	22
Cultivators	25	22		Van	8	11
Fish cultivation	3	0		Motor Byke	36	44
Livestock farming	0	0		Car	6	11
Shopkeeper (in Grocery shop)	0	0		Electronic Rickshaw	0	11
Non-agricultural wage labour	7	11		Auto	0	0
Salaried Govt.+ Pvt. Job	14	22		Use of Domestic Fuel		
Others	2	0		LPG	54	89
Income Structure				Crop Residue	45	33
0 - 10000	22	11		Wood	59	44
10000 - 30000	15	11		Coal	2	0
30000 - 70000	24	33		Kerosene	15	0
> 70000	39	44		Land Status		

Poverty Level						
APL	34	56		< 2	20	22
BPL	66	44		2 to 4	34	33
				4 to 6	38	33
				> 6	8	11

Source: Field survey, 2022 to 2023.

Table No. 6.3: Social characteristics of Bosipota village

No. of Respondents (%)	1991	2023		No. of Respondents (%)	1991	2023
Population Structure				Caste Structure		
Male	49	50		General	65	67
Female	51	50		Schedule caste	34	33
Educational Structure				Schedule tribe	0	0
Upto V	28	25		OBC	1	0
V-IX	48	50		Age Structure		
MP/HS	18	17		< 15	18	17
Graduation	5	8		15 - 30	36	33
PG	0	0		30 - 45	23	25
Tech/Others	1	0		45 - 60	16	17
				> 60	7	8

Source: Field survey, 2022 to 2023.

Table No. 6.4: Economic characteristics of Bosipota village

No. of Respondents (%)	1991	2023		No. of Respondents (%)	1991	2023
Dependency Ratio				Income Structure		
Male	0	0		0 - 10000	48	42
Female	32	22		10000 - 30000	35	33
Child	68	33		30000 - 70000	13	17
Workforce				> 70000	4	8
Workforce (Male)	85	83		Mode of Accessibility		
Workforce (Female)	15	17		Cycle	58	42
Workforce (Child)	0	0		Van	15	17
Occupation				Motor Byke	28	42
Agricultural labour	20	17		Car	0	0
Cultivators	30	25		Electronic Rickshaw	0	25

Fish cultivation	10	8		Auto	0	0
Livestock farming	5	0		Poverty Level		
Shopkeeper (in Grocery shop)	10	17		APL	20	25
Non-agricultural wage labour	7	8		BPL	80	75
Salaried Govt.+ Pvt. Job	12	17		Use of Domestic Fuel		
Others	6	8		LPG	30	42
Land Status				Crop Residue	69	58
< 2	50	58		Wood	56	42
2 to 4	32	33		Coal	3	0
4 to 6	10	8		Kerosene	12	8
> 6	8	0		House Structure		
				Kuchha House	10	0
				Pucca House	65	83
				Mixed House	25	17

Source: Field survey, 2022 to 2023.

Table No. 6.5: Level of Socio-Economic Development using Composite Index Score, Hugli District, 1991

SL_NO	C.D. Block	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	Composite Score
1	Arambagh	0.00	0.53	0.43	0.82	0.38	0.45	0.19	0.21	0.31	0.50	0.24	0.37
2	Balagarh	0.61	0.89	0.50	0.16	0.33	0.06	0.15	0.17	0.00	0.11	0.18	0.29
3	Chanditala-I	0.07	0.87	1.00	1.00	0.50	0.06	0.36	0.01	0.12	0.21	0.00	0.38
4	Chanditala-II	0.83	0.88	0.81	0.07	0.13	0.00	0.02	0.37	0.39	0.00	0.63	0.37
5	Mogra-Chuchura	0.20	0.42	0.03	0.00	0.53	0.13	0.00	0.02	0.18	0.03	0.60	0.19
6	Dhaniakhali	0.47	0.53	0.24	0.61	0.63	0.64	0.11	0.89	0.42	0.96	0.45	0.54
7	Goghat-I	0.44	0.68	0.00	0.61	1.00	0.19	0.32	0.56	0.30	0.76	0.39	0.48
8	Goghat-II	0.38	0.81	0.04	0.35	0.50	0.43	0.57	0.40	1.00	0.50	0.87	0.53
9	Haripal	0.77	0.53	0.57	0.67	0.41	0.17	0.48	0.00	0.56	1.00	0.64	0.53
10	Jangipara	0.45	0.68	0.38	0.45	0.50	0.26	0.19	0.45	0.16	0.66	0.21	0.40
11	Khanakul-I	0.23	0.22	0.97	0.25	0.31	0.59	0.04	0.04	0.39	0.21	0.04	0.30
12	Khanakul-II	0.56	0.00	0.40	0.16	0.78	1.00	0.80	0.84	0.65	0.57	1.00	0.61
13	Pandua	0.67	0.84	0.77	0.82	1.00	0.18	0.21	0.05	0.42	0.79	0.44	0.56
14	Polba-Dadpur	0.58	0.88	0.40	0.16	0.10	0.22	0.10	0.91	0.27	0.07	0.32	0.37
15	Pursurah	0.64	0.69	0.92	1.00	0.38	0.22	1.00	0.69	0.89	0.16	0.78	0.67
16	Serampur-Uttarpara	0.49	0.61	0.22	0.07	0.44	0.18	0.45	0.50	0.54	0.16	0.53	0.38
17	Singur	0.43	1.00	0.88	0.25	0.00	0.09	0.27	1.00	0.34	0.39	0.72	0.49
18	Tarakeswar	1.00	0.75	0.63	0.39	0.03	0.34	0.09	0.88	0.56	0.77	0.58	0.55

Source: Census of India, 1991.

Table No. 6.6: Level of Socio-Economic Development using Composite Index Score, Hugli District, 2001

SL_NO	C.D. Block	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	Composite score
1	Arambagh	0.26	0.28	0.92	0.39	0.41	0.72	0.01	0.10	0.53	1.00	0.07	0.43
2	Balagarh	0.72	0.59	0.46	0.18	0.10	0.32	0.00	0.67	0.37	0.87	0.43	0.43
3	Chanditala-I	0.80	0.83	1.00	0.16	0.51	0.00	1.00	0.55	0.00	0.91	1.00	0.61
4	Chanditala-II	0.77	0.61	0.53	0.82	0.12	0.37	0.36	0.88	0.83	1.00	0.07	0.58
5	Mogra-Chuchura	0.53	0.50	0.34	0.16	0.18	0.43	0.08	0.45	0.25	0.89	0.70	0.41
6	Dhaniakhali	0.46	0.37	0.44	1.00	0.59	0.71	0.33	0.74	0.75	1.00	0.10	0.59
7	Goghat-I	0.64	0.52	0.29	0.07	0.54	0.50	0.21	0.54	0.83	0.97	0.35	0.49
8	Goghat-II	0.46	0.48	0.00	0.00	0.35	0.62	0.87	0.84	1.00	0.95	0.73	0.57
9	Haripal	0.77	0.17	0.74	0.53	0.18	0.48	0.36	0.16	0.79	0.96	0.51	0.51
10	Jangipara	0.61	0.36	0.28	0.35	0.45	0.68	0.09	0.00	0.59	1.00	0.11	0.41
11	Khanakul-I	0.61	0.36	0.87	0.67	0.00	0.79	0.16	0.83	0.48	1.00	0.25	0.55
12	Khanakul-II	0.00	0.00	0.21	0.45	1.00	1.00	0.92	1.00	0.34	1.00	0.37	0.57
13	Pandua	0.75	0.58	0.83	0.25	0.72	0.47	0.41	0.31	0.49	0.33	0.35	0.50
14	Polba-Dadpur	0.72	0.44	0.72	0.36	0.16	0.42	0.25	0.63	0.02	0.00	0.00	0.34
15	Pursurah	0.73	0.51	0.47	0.18	0.78	0.51	0.89	0.33	0.93	1.00	0.35	0.61
16	Serampur-Uttarpara	0.49	0.63	0.17	0.18	0.43	0.47	0.40	0.04	0.84	0.57	0.64	0.44
17	Singur	1.00	0.45	0.60	0.61	0.65	0.49	0.09	0.63	0.91	0.81	0.03	0.57
18	Tarakeswar	1.00	1.00	0.42	0.35	0.10	0.66	0.53	1.00	0.34	0.90	0.52	0.62

Source: Census of India, 2001.

Table No. 6.7: Level of Socio-Economic Development using Composite Index Score, Hugli District, 2011

SL_NO	C.D. Block	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	Composite score
1	Arambagh	0.15	0.32	0.87	0.82	0.56	0.65	0.33	0.40	0.00	1.00	0.67	0.52
2	Balagarh	0.67	0.57	0.60	0.00	0.28	0.00	0.42	0.32	0.28	1.00	0.46	0.42
3	Chanditala-I	0.82	0.81	1.00	1.00	0.65	0.04	0.82	0.03	0.92	1.00	0.61	0.70
4	Chanditala-II	0.75	0.71	0.52	0.68	0.00	0.06	0.23	0.31	0.54	1.00	0.80	0.51
5	Mogra-Chuchura	0.65	0.70	0.17	0.33	0.06	0.15	0.05	0.23	0.18	1.00	0.24	0.34
6	Dhaniakhali	0.33	0.39	0.23	0.94	0.40	0.73	0.29	0.60	0.82	1.00	0.00	0.52
7	Goghat-I	0.74	0.70	0.38	0.62	0.50	0.28	0.12	0.47	0.43	1.00	0.06	0.48
8	Goghat-II	0.51	0.51	0.00	0.50	0.83	0.40	0.73	0.74	0.54	1.00	0.87	0.60

9	Haripal	0.82	0.35	0.73	0.52	0.06	0.37	0.20	0.43	0.39	1.00	0.67	0.50
10	Jangipara	0.60	0.44	0.20	1.00	0.40	0.71	0.00	0.96	0.80	1.00	0.59	0.61
11	Khanakul-I	0.35	0.44	0.76	0.68	0.28	0.79	0.16	0.43	0.59	1.00	0.31	0.53
12	Khanakul-II	0.00	0.00	0.10	0.62	1.00	1.00	0.93	1.00	0.96	1.00	1.00	0.69
13	Pandua	0.73	0.66	0.91	0.29	0.67	0.29	0.71	0.47	0.35	1.00	0.31	0.58
14	Polba-Dadpur	0.87	0.64	0.65	0.52	0.00	0.17	0.50	0.32	0.60	1.00	0.43	0.52
15	Pursurah	0.69	0.49	0.37	0.27	0.73	0.32	1.00	0.00	1.00	1.00	0.91	0.62
16	Serampur-Uttarpara	0.31	0.59	0.16	0.25	0.31	0.21	0.24	0.52	0.85	1.00	0.65	0.46
17	Singur	0.98	0.83	0.83	0.08	0.65	0.32	0.32	0.75	0.54	0.00	0.80	0.55
18	Tarakeswar	1.00	1.00	0.50	0.21	0.00	0.57	0.34	0.90	0.63	0.00	0.17	0.48

Source: Census of India, 2011.

APPENDIX-B (Questionnaire**)**

SOCIO - ECONOMIC SURVEY OF VILLAGE

Name of the respondent:

Panchayat:

Village:

1. Sex: male /female

2. Age:

3. Religion:

4.Caste:

5. Do you have phone: smart/ keypad? Give no:_____

6. Education of the respondent:

7. Occupation of the respondent:

8. How many family members are going jobs?

9. Number of dependent:

10. Mode of transport do you use for job?

11. Electricity in your house? Y / N

12. Type of house: (Kacha / Pucca)

13. Source of drinking water:

14. What type of cooking fuel do you use:

15. What toilet arrangement do you have: private /common/ open field or others: specify.

16. Currently are you member of a self help group?

17: if yes, indicate name of the group:

18. Is the group holding regular meeting:

19. Does the group have a bank account:

20. B.P.L / A.P.L / Red Card :

21. Do you receive a newspaper at home: Y / N .

22. Do you have TV : Colour/ Black and white

23. Do you have radio:

24. Do you receive any magazine at home? Y / N

25. Do you have internet connection? Y/ N

26. What TV channels do you watch most name three most watched channels?

* News/ Entertainment/ others.

27. Which type of program would you like to participate in?

Music /Health /theatre/ environment /education/ radio jockey/ agriculture rural development /others.

28.

a Distance from drinking water source (km).

b. Distance to collect fuel food or cow dungs?

c. Distance from hospital (km)?

d. Distance from school (kms)?

e. Distance from market distance from bus or train point (km)?

f. Distance from place of worship?

g. Distance from court or administrative area?

h. Distance from police station?

i. Minimum distance between your place of working and residence (kms)?

29. Landless households:

* Local

*Migrant

* Household having less than 1 bigha

* House having 6 to 10 bigha

*House hold having 10 to 20 bigha

* Household having 20 to 50 bigha

* Household having 50-100 bigha.

30. How many times in sold your land?

31. No of cows?

* Number of buffaloes?

* Number of goat ?

* Number of hen ?

*Number of ducks?

32.Land Status: Agricultural land / Barren land / Orchard / Area sown more than once / Area for pond / Grazing land.

33. Irrigated (Type of irrigation)/ Un-irrigated:

34. Name of the crop cultivated?

34. Did you get hundred days of work? Y / N

35. Any allowance from govt. received?

APPENDIX-C (IMPORTANT OFFICES)

SL No.	Name Of the Offices
1	Office of the District Magistrate, Hugli, West Bengal
2	Office of the Block Development Officer, Balagarh, Hugli
3	Sija Kamalpur Gram Panchayet, Balagarh, Hugli
4	Office of the Block Development Officer, Serampore-Uttarpara
5	Rishra Gram Panchayat Office
6	Office of the Block Development Officer, Chanditala-I
7	Aniya Gram Panchayet Office
8	Office of the Block Development Officer -II
9	Barijhati Gram Panchayet Office
10	Office of the Block Development Officer-Goghat-II
11	D. L. & L.R.O. Office, Hugli
12	Office of the Director of Land Records and surveys
13	Rishra Gram Panchayat Office, Serampore, Hugli
14	Office of the Block Development Officer, Arambagh
15	Aniya Gram Panchayet Office, Chanditala, Hugli
16	Office of the Block Development Office, Polba- Dadpur

APPENDIX-D (WEBLIOGRAPHY**)**

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