Land use Change and its Impact on Surrounding Environment

"A case study on Kamrangirchar Thana Dhaka Metropalitan area"

Report submitted to the Department of Geography and Environment, Jahangirnagar University, Savar, Dhaka, in partial fulfillment of requirements for the Bachelor of Science degree

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CERTIFICATE OF APPROVAL

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DECLARATION

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ABSTRACT

This research was conducted to analyze the land use changes of Kamrangirchar Thana Dhaka Metropolitan area. Dhaka is one of the densely populated city in the world, At present, the population of Dhaka city is 19.5 million and here about 63600 peoples live in per square kilometer. It is the 15th megacity and 1st Build up urban area in the world. Dhaka being a mega city has been challenged by numerous difficulties like unplanned urbanization, traffic congestion, water logging, Load shedding, Pollution, Housing and Settlement, overpopulation etc. Land use classification and analysis is performed using a GIS and Remote sensing technique is used to sustainable urbanization model the land use change and uses this techniques to examine the process, pattern and direction of land use change Kamrangirchar Thana, Dhaka metropolitan area.

The first step of the study was acquisition of temporal data in order to detect the changes over the time. For this purpose satellite images (Landsat, TM, ETM and OLI) have been used from (USGS) server. In order to acquire data from satellite images object oriented image classification and analytical method have been used. To observe the success of the classification accuracy assessment has been done by comparing the control points with the classification results and measured using GPS point. The 2nd step was to observe the changes between the defined years in the study area. In order to observe the changes land use maps belongs to different years compared with cross tabulation and overlay methods, according to the results it has been observed that the main changes in the study area were the transformation of wetland , bare soil and settlement areas. Every 5 years around 50000 sq. m area of wetland and water body were transformed to urban. After detecting the changes in the study for the future has been performed a controlling statement and propose better land use model.

Key words: Land Use, Landsat, Remote sensing, GIS, , Supervised Classification, Unsupervised Classification, USGS, Change Detection.

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(Al Jubaer)

DEDICATIONS

This Research is dedicated to my parents. Their uninterrupted inspiration, support, guidance made this effort possible.

LIST OF ABBREVIATIONS

DCC	: Dhaka City Corporation
LU	: Land Use
DWASA	: Dhaka Water and Sewerage Authority
WDB	: Water Development Board
WASA	: Water and Sewerage Authority
BBS	: Bangladesh Bureau of Statistics
SOB	: Survey of Bangladesh
RAJUK	: Rajdhani Unnoyon Corporation
DMP	: Dhaka Metropolitan Police
LGED	: Local Government Engineering Department
M	: Meter
Sq.	: Square
GDP	: Gross Domestic Product
CBD	: Central Business District
GIS	: Geographic Information System
RS	: Remote Sensing
LULC	: Land Use and Land Cover
UAP	: Urban Area Plan
NGO	: Non Government Organization
JICA	: Japan International Co-operation Authority
FGD	: Focus Group Discussion
KII	: Key Informant Interview
ETM	: Enhanced Thematic Mapper
TM	: Thematic Mapper
OLI	: Operational Land Imager

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1.1 Background and Present status of the problem

Land use change is one of the most important indicators in understanding the interaction between man and environment with their various activities. Although some natural and artificial/anthropogenic factors are responsible for land use change, the human being is adjustment in land use round the world has recently appeared as unparalleled, intensely affecting the earth's ecological systems("IDENTIFYING THE DEFICIENCIES OF LANDUSETRANSPORT DEVELOPMENT IN DHAKA CIT," n.d.). This phenomenon is particularly common in developing countries, where widespread land use change driven by socio-economic development, environmental degradation, particularly landscape fragmentation. Urban Land use change due to the human activities. In addition to urbanization causes substantial reduction of arable lands habitat destruction, species and habitat extinction, the reduction of net primary productivity, and landscape degradation by patch fragmentation and ecological change(Abd El-Kawy, Rød, Ismail, & Suliman, 2011). Like many other cities area in Dhaka, Kamrangirchar is focal point of Dhaka south city corporation, is also the outcome of spontaneous rapid growth without any prior or systematic planning(Dhaka, n.d.). As the growth of population in Kamrangirchar is taking place at an exceptionally rapid rate, it has become one of the most populous urban growth areas in the Dhaka city.

Kamrangirchar has undergone radical changes in its physical form, not only in its vast territorial expansion, but also through internal physical transformations over the last decades(Islam, Taher, & Khan, 2013). These have created entirely new kinds of urban fabric. In the process of urbanization, the physical characteristics of Kamrangirchar area are gradually changing as plots and open spaces have been transformed into building areas, open squares into car parks, low land and water bodies into reclaimed built-up lands etc.

This urban structure is to be analyzed to understand the changes that have lead to its creation(Hasan & Mulamoottil, 1994). Therefore it is necessary to track the changes of modern Kamrangirchar urban area which mainly includes the changes in the physical form of the city.

Land use classification and analysis is performed using a GIS and Remote sensing technique is used to sustainable urbanization model the land use change and use this techniques to examine the process, pattern and direction of land use change Kamrangirchar Thana, Dhaka metropolitan area.

1.2 Justification of the Research

The main purpose of this report is to study the land use change analysis and classification with showing impact of land use change environment this report defines urbanization as a major driver of land use change, which causes environmental problems(Mohan, Pathan, Narendrareddy, Kandya, & Pandey, 2011). There are unlimited numbers of urbanization induced environmental problems of many scales issues of air and water quality at the local scale and the issue of global warming and climate change at the global scale. This Report does not involve in the discussion of all of these issues. Instead, it focuses on the immediate and noticeable impacts of urbanization on our natural environment, that is, the loss of land and its resources such as wetlands, biodiversity, etc.

1.3 Aim and Objectives of the research

1.3.1 Aim

The aim of this research to identify the changes of Land use from 1998 to 2017 in Kamrangirchar thana, Dhaka Metropolitan area.

1.3.2 Objectives

- To identity the land use changes from 1998 to 2017 in Kamrangirchar thana.
- To investigate the driver of land use changes the study area.
- To demonstrate the impact of land use change on surrounding environment on research field.

1.4 Research Questions

Based on the aim and objective of the study, the report attempts to answer the following questions:

1. How to identify land use change that has taken place from 1998 to 2017 Kamrangirchar?
2. What are the drivers of land use change the study area?
3. How to demonstrate the impact of land use change on research field?

1.5 Organization of the research

This report is arranged in seven different chapters with a number of sections and sub-sections, bibliography and appendix that's follow the chronological development of the study.

Chapter 1: Introduction: This chapter contains the general background and present status of the problem, scope of the study, objectives of the study and the research organization.

Chapter 2: Literature Review: The relevant literatures on land use change. land use classification, signature editor, change detection, supervised and unsupervised classification and different parameter .

Chapter 3: Methodology and Data Collection: In this chapter, outlines the overall design of the study and research methodology that were followed for this thesis is presented here. The tasks include the process of data collection, sources and sectors of data and data analysis procedure are also described in this chapter.

Chapter 4: Study Area: This chapter summarized driver of land use change in different parameter.

Chapters 5: Land use change from 1998 to 2017 : In this chapter, the overall landuse scenario and landuse development at macro and micro levels.

Chapter 6: Driver of Land use change in urban area perspective

Chapter 7: Impact of Land use change in man and Environment

Chapter 8: Limitation, Conclusions and Recommendations: This chapter summarized the outcomes of the study. Some recommendations for improving the land use planning and model. And management system in Kamrangirchar area. Limitation of the study and the problem face during the data collection has been expressed.

1.7 Overview

In this chapter, a general statement regarding the research work has been provided. The existing scenario of the city transport system and the magnitude of the problem have been highlighted. The objectives of this study and the scope of the research work have also been pointed out. Finally, the structure of the thesis documentation work is presented.

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2.1 Introduction

Methodology outlines here the techniques for the collection of data and the procedures applied for the execution of the study. It expresses a systematic way through which any study can be done in a fruitful way. This chapter outlines the overall design of the study and research methodologies that have been followed to achieve the objectives set out in Chapter 1. It also describes data collection procedures at different stage of the research work. Data analysis procedures and techniques are also presented here(Urban & Planning, 1996). Finally, the difficulties or problems faced during the data collection process and the limitation of the study has been illustrated.

2.2 Data Sources

There are two types of data sources. Such as; primary and secondary source. In this survey primary sources is field survey and secondary source is supplied maps and data. It is needed to develop a database to detect the land use change in two different years. For this purpose both primary and secondary data sources are used in this work. In addition, data should be obtained following good practice guidelines using appropriate method and for a reasonable length of time to allow long-term trends to be evaluated.

2.2.1 Primary sources

Primary data are those which are collected for report, directly from the field of enquiry and hence are original in character. In order to achieve the aims and objects of this research, various types of primary data will be collected from the field by using questionnaire survey. Primary sources refers to direct field survey which will be conducted into following ways-

2.2.2 Secondary Sources

Secondary data, in a word is the storage of primary data. These data may be collected from any publication, journal, newspaper, survey report, annual report of any institution etc. Statistical data is the best example of secondary data. The past record of this study is mainly based on secondary information. Secondary data are collected from maps and publications and questionnaire survey.

- ✓ Thesis, report, record, journal, Books, Internet, library etc.
- ✓ Books, texts and publication and research Reports.
- ✓ Councilor office, LGED, RAJUK, DCC etc.
- ✓ Maps from different organizations and online server
- ✓ Internet

2.3 Methodology of the Study

In this research, five data preprocesses were operated which were band combination, image clip, image enhancement, image classification and post classification. Through these preprocesses, the qualities of the original image data of year 1998, 2003, 2007, 2013 and 2017 were improved. After then, three major data processes should be completed. They were urban change detection. Through these processes, the final results could be obtained. Based on the introductions above, the methods used in this research can be divided into three subchapters. The first subchapter is data preprocessing which is explaining the detailed steps of each technique of preprocessing, classification and analysis with images. The second subchapter is image preparation which is the first major process in this thesis and post classification which is employed to improve the quality of classified images. The accuracy of results from post classification is estimated in next subchapter. In the final subchapter, the second major process which is change detection is introduced in three parts as mentioned before.

Various secondary data was used for this research and several procedures have been maintained, such as; at first identification problem and topic selection, conceptualization, study the aim and objectives, collection of maps, Field survey, field observation etc. The whole methodology we depict through the following chart: Detail procedure and aspects of the data collection has been described

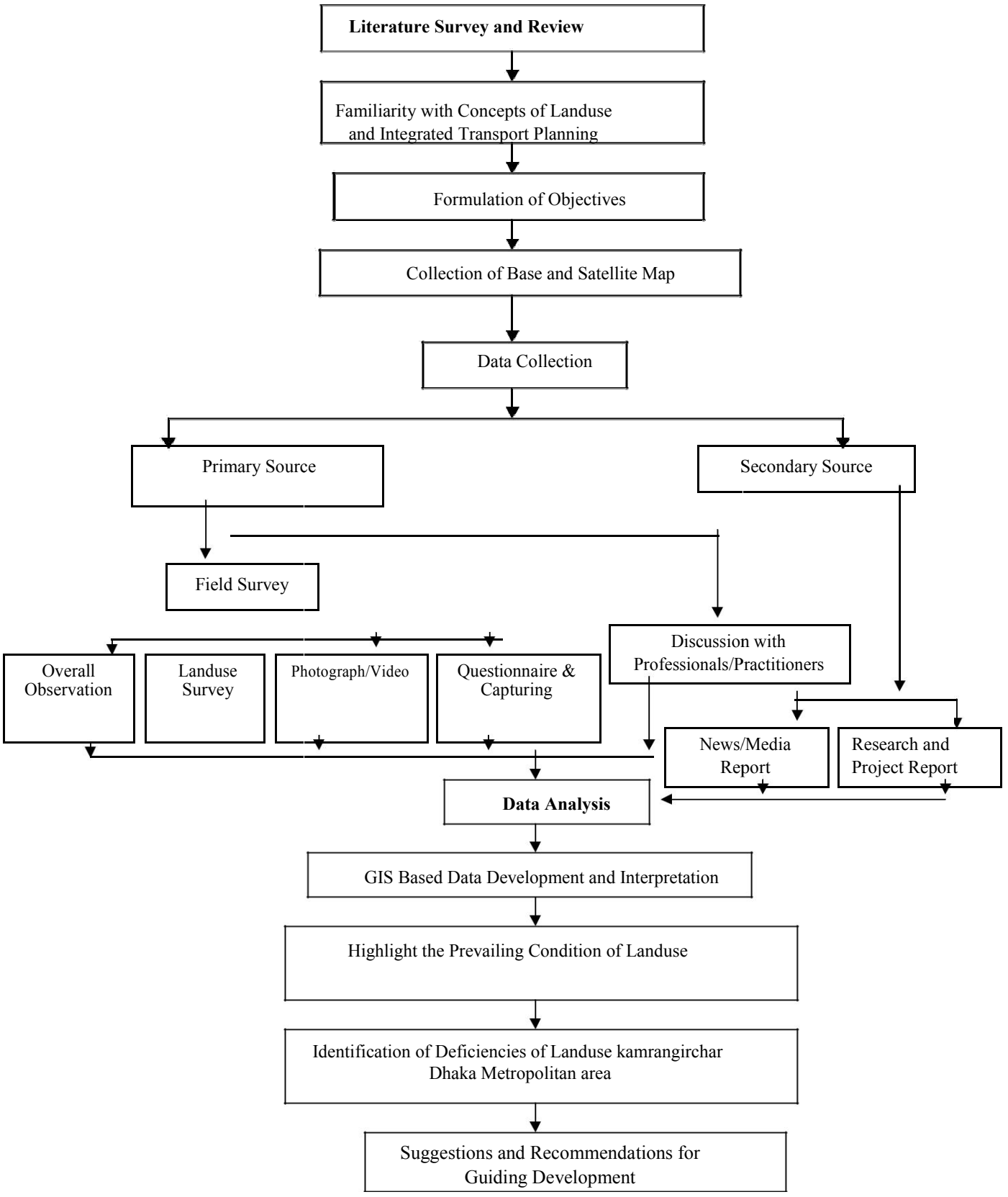


Figure 3.1: Flow chart of the study methodology

2.4 Data collection

Research Objectives	Research Questions	Data Source		Data Collection Methods/ Technique		Data Analysis Tools
		Primary data source	Secondary Data Source	Qualitative	Quantitative	
To identity the land use change from 1998 to 2017 in Kamrangir Char.	a) How to identify land use change that has taken place from 1998 to 2017 Kamrangirchar ?	Observation Field Paper study	Rajuk Dhaka South City corporation Glovis and earth explorer USGS Server EOS data landcover	Survey Experiment Observation	FGD (Focus Group Discussion) KII (Key Informant Interviews) Questionnaire survey	Arc GIS Erdas Imagine Arc Scene SPSS MS Excel Google Earth USGS Earth Explorer
To Investigate the causes of the massive land use change the study area.	b) What are the causes massive land use change the study area.	Questionnaire FGD Observation	Newspaper Journals Internet NGO	Survey Experiment Observation	FGD (Focus Group Discussion) KII (Key Informant Interviews) Questionnaire survey	Microsoft office Excel SPSS Arc GIS Adobe Photoshop Adobe Illustrator Google Earth
To Demonstrate the impact of land use change on surrounding Man and Environment on research field.	c) How to demonstrate the impact of land use change on research field.	Questionnaire FGD Observation	Newspaper Journals Internet NGO	Survey Experiment Observation	FGD (Focus Group Discussion) KII (Key Informant Interviews) Questionnaire survey	Arc GIS Erdas Imagine Adobe Photoshope Adobe Illustrator Arc Scene Google Earth USGS Earth Explorer

2.4.1 Collection of Published Data

An extensive literature review has been done in search of relevant data. Purchasing of different books and reports containing the socio-economic data and along with these associated maps has been collected from different published sources such as

Different published source are

- Rajdhani Unnoyon Corporation (Rajuk)
- Dhaka South City Corporation (DCC)
- Local Government Engineering Department (LGED)
- Center for Environmental and Geographical Information Services (CEGIS)
- Bangladesh Space Research and Remote Sensing Organization (SPARRSO)
- Ward Council Office

2.4.2 Scanning and Digitization

After the collection of raw hard copy maps from different published sources the researcher have to scan each of the maps and then digitize them to convert in to a usable format (i.e., in digital format which has been converted in to GIS coverage).

2.5 Data analysis

Data analyses are one of the important parts of research work. We have got several types of data from the study area. Then we have made data table with each different field using Microsoft office excel. Using these data table we have made some maps on the basis of different database information's. In data table we have showed different parameter related to education sector and disaster oriented. In GIS there are a lot of ways to analyses data on the basis of spatial arrangements.

2.5.1 Multi Temporal and Multispectral Data (Landsat Images)

For the land change detection and modeling the initial step is the data acquisition and the most common sources are the remote sensing sources, because the acquisition of the vector data is expensive and time consuming, finding the multi temporal data in order to detect the changes is not easy, especially in developing countries. For the study area the multi temporal vector data was CORINE which was prepared in 25 ha minimum mapping unit. But this resolution was not detailed enough because of that satellite images have been used. The summer period Landsat images selected for preparation of land use/cover data. The reason of using the summer period was to distinguish the other agriculture from orchards and to observe the transformation from urban area to these classes separately. In order to have better accuracy in classification the cloud free Landsat images used; for this reason in the year 1990 the month for the image is June and the sensor is ETM+ and for 2000 and 2010 the month is July and the sensor is TM.

2.5.1.1 The Landsat Thematic Mapper (TM)

The Landsat Thematic Mapper (TM) sensor was carried on Landsat 4 and Landsat 5, and images consist of six spectral bands with a spatial resolution of 30 meters for Bands 1-5 and 7, and one thermal band (Band 6). The approximate scene size is 170 km north-south by 183 km east-west (106 mi by 114 mi).

Table 3.1 Landsat TM data information

	Bands	Wavelength (micrometers)	Resolution (meters)
Landsat 5 Thematic Mapper (TM)	Band 1 - Blue	0.45-0.52	30
	Band 2 - Green	0.52-0.60	30
	Band 3 - Red	0.63-0.69	30
	Band 4 - Near Infrared (NIR)	0.76-0.90	30
	Band 5 - Shortwave Infrared (SWIR) 1	1.55-1.75	30
	Band 6 - Thermal	10.40-12.50	120* (30)
	Band 7 - Shortwave Infrared (SWIR) 2	2.08-2.35	30

Source: USGS server

TM Band 6 was acquired at 120-meter resolution, but products are resampled to 30-meter pixels.

3.5.1.2 The Landsat Enhanced Thematic Mapper Plus (ETM+)

The Landsat Enhanced Thematic Mapper Plus (ETM+) sensor is carried on Landsat 7, and images consist of seven spectral bands with a spatial resolution of 30 meters for Bands 1-5, and 7. The resolution for Band 8 (panchromatic) is 15 meters. All bands can collect one of two gain settings (low or high) for increased radiometric sensitivity and dynamic range, while Band 6 collects both low and high gain (Bands 61 and 62, respectively) for all scenes. The approximate scene size is 170 km north-south by 183 km east-west (106 mi by 114 mi).

Table 3.2 : The Landsat Enhanced Thematic Mapper Plus (ETM+)

Landsat 7 Enhanced Thematic Mapper Plus (ETM+)	Bands	Wavelength (micrometers)	Resolution (meters)
	Band 1 - Blue	0.45-0.52	30
	Band 2 - Green	0.52-0.60	30
	Band 3 - Red	0.63-0.69	30
	Band 4 - Near Infrared (NIR)	0.77-0.90	30
	Band 5 - Shortwave Infrared (SWIR) 1	1.55-1.75	30
	Band 6 - Thermal	10.40-12.50	60 * (30)
	Band 7 - Shortwave Infrared (SWIR) 2	2.09-2.35	30
	Band 8 - Panchromatic	.52-.90	15

Source: USGS server

* ETM+ Band 6 is acquired at 60-meter resolution, but products are resample to 30-meter pixels.

3.5.1.3 Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)

Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) images consist of nine spectral bands with a spatial resolution of 30 meters for Bands 1 to 7 and 9. The ultra blue Band 1 is useful for coastal and aerosol studies. Band 9 is useful for cirrus cloud detection. The resolution for Band 8 (panchromatic) is 15 meters. Thermal bands 10 and 11 are useful in providing more accurate surface temperatures

and are collected at 100 meters. The approximate scene size is 170 km north-south by 183 km east-west (106 mi by 114 mi).

Table 3.3 Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)

Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)	Bands	Wavelength (micrometers)	Resolution (meters)
	Band 1 - Ultra Blue (coastal/aerosol)	0.435 - 0.451	30
	Band 2 - Blue	0.452 - 0.512	30
	Band 3 - Green	0.533 - 0.590	30
	Band 4 - Red	0.636 - 0.673	30
	Band 5 - Near Infrared (NIR)	0.851 - 0.879	30
	Band 6 - Shortwave Infrared (SWIR) 1	1.566 - 1.651	30
	Band 7 - Shortwave Infrared (SWIR) 2	2.107 - 2.294	30
	Band 8 - Panchromatic	0.503 - 0.676	15
	Band 9 - Cirrus	1.363 - 1.384	30
	Band 10 - Thermal Infrared (TIRS) 1	10.60 - 11.19	100 * (30)
	Band 11 - Thermal Infrared (TIRS) 2	11.50 - 12.51	100 * (30)

Source: USGS server

* TIRS bands are acquired at 100 meter resolution, but are resampled to 30 meter in delivered data product.

2.3 Accuracy Assessment

The accuracy of each change detection technique was assessed and evaluated using aerial photos and high resolution satellite images as reference data. The accuracy assessment involves thorough comparison of the classified images in each year with high resolution aerial photography to find whether a particular urban change detection technique was be able to accurately classify areas of urban regions and changes. A cluster of check points was randomly produced in the study area that is covered by aerial photos for each site. Such random check points perform as a statistical sample to assess the accuracy of each urban change detection technique, as assessing every pixel

in the study area is not practical or essential. In this research, 200 random sample points were selected across each change image using the Accuracy Assessment tool in Erdas Imagine or Arc GIS. There are three distribution options for selecting random check points: Random, Stratified, and Equalization Random(Baysal, 2013).

The Random option produces points randomly with no rules to their selection. The Stratified option produces points randomly in each defined class, and the number of points generated in each class is proportional to the class area. The Equalization Random option creates equal numbers of random points in each defined class. The Random option was chosen in this study to assess the accuracy of each urban change detection technique for two reasons(Habiba, Haider, Ishtiaque, Mahmud, & Masrur, 2011). First, the random check points could be used for assessing the accuracy of both urban change detection techniques, and classes generated in each technique were not identical, which would result in a bias of placing check points on one technique over 32 the other. The second reason is that aerial photos only cover the central area of the cities, where most changes occurred on the edges.

The accuracy assessment of random check points was executed in ESRI's ArcGIS software, which provides useful tools to assist the accuracy assessment procedure including displaying aerial photos and change images to identify whether any changes occurred or not, and documenting the observations in the attribute table for later analysis. First, easting and northing coordinates of random check points generated in Erdas Imagine were exported to a text file, and then a point shapefile was created in ArcGIS with new fields to accommodate the results of urban change detection techniques and ground truth information(Mohan, Pathan, Narendrareddy, Kandya, & Pandey, 2011). Each check point was then individually analyzed and the results were documented in the attribute table. Results of accuracy assessment in ArcGIS were then documented in an Excel spreadsheet to produce an error matrix for each urban change detection technique and calculate certain accuracy statistics. Overall accuracy was calculated by dividing the total number of accurately classified pixels by the total number of check points.

Producer's accuracy estimates errors of omission and specifies how accurately the reference pixels of each class were classified. Producer's accuracy was calculated by dividing the number of accurately classified reference pixels in each class by the total number of reference pixels truly in that class based on aerial photos. User's accuracy estimates errors of commission, and was calculated by dividing the number of accurately classified reference pixels in each class by the total number of reference pixels distributed on that class(Gong & Liu, 2013).

2.4 Other Data Sources

The LU changes can be predicted using the multi temporal land use/cover data but also other data sources needed for the improvement of the study. For this purpose other data related to the study area has been collected from the Firat Development Agency (they have been prepared by different institutions) and processed with GIS software. The other data sources are;

- ✓ Roads: Main road network of the study area prepared by Ministry of Transportation in national level.
- ✓ Water bodies: Lakes and dams in the study area.
- ✓ Protection Areas and: These are including the naturally protected and it has been prepared by Ministry of Culture and Tourism.
- ✓ Approved Development Plan: This data is including the approved development plan for the study area prepared by municipality of the study area in the year 2017.
- ✓ DEM: Digital elevation model for the study area (30m resolution) from USGS SRTM data 2017.

2.4.2 Tools

The tools have been used for the study varies, main tools used for the development of the research are;

- ✓ ArcGIS 10.6 used for image and vector data preprocessing.
- ✓ Erdas Imagine used for classification, accuracy assessment of classification, change detection and modeling.

2.5 Data presentation

We have presented the latest vulnerability map using GIS and Remote Sensing techniques on the basis of information gathered from the field survey. Then we have analyzed the impact of natural disaster by composing maps and tables of Kamrangirchar thana, Dhaka Metropolitan area. We have tried to find out the possible reasons behind it.

2.6 Techniques of Analysis

Geographic Information System (GIS) and Remote Sensing are used as tools for analyzing the land use, its pattern and land use change mapping. The Google Earth image is used for validation of the work.

- ***Statistical techniques*** will be performed by computer based programmed to show the chart and table. After collecting data, a various techniques will be processed manually and by using computer to manipulate the data accordance with the objectives and guidelines of the research.
- The maps also will be produced by using ***Arc Map, Erdas Imagine, Google Earth Engine*** and **Google Earth Pro** by the help of computer.

2.6.1: Geo- correction and Geo-referencing

This procedure is thus imperative to data modeling in the field of geographic information systems (GIS) and other cartographic methods. When data from different sources need to be combined and then used in a GIS application, it becomes essential to have a common referencing system. This is brought about by using various georeferencing techniques. Georeferencing tasks are undertaken to produce a map or because to link two or more different datasets together by virtue of the fact that they relate to the same geographic locations.

2.6.3 Field Visit and Survey

The researcher has conducted an in-depth reconnaissance survey in the study area for the better understanding of the physical features and about the socio-economic status of the local peoples that was essential to build a theoretical frame work for conducting the research work. Among the methods the 'Transact Work was be helpful to familiarize the local environment and community in depth..

2.6.5 Interview

Unlike with questionnaire surveys, the interviewer has the opportunity to probe or ask follow-up questions. The researcher has conduct interview with the local Ward Councilor, Member and local administrative bodies. They were interviewed few basic questions about the local environmental, Landuse impact their concepts and comments were summarized to understand the present situation intervention for the impact reduce in the study area.

2.6.6 FGD

A focus group is more than a group discussion and interview because of the community interest shared by the group and the use of participants' interaction as research data. Focus groups are a rich source of qualitative data for the social science researcher and as such are an attractive and popular method of data collection. A FGD is a qualitative method. Its purpose is to obtain in-depth information on concepts, perceptions and ideas of a group. A FGD aims to be more than a question-answer interaction. The idea is that group members discuss the topic among themselves, with guidance from the facilitator.

2.6.7 Remote Sensing

Remote Sensing is the science of acquiring information about the earth surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information.

The Google Earth Image (2017) of the study area has been analyzed here. The analysis of these images has revealed the spatial distribution of physical and social features of the study area.

2.6.8 Geo-referencing the Google Earth Image

To geo-reference the Google Earth Image the researcher first established control points, input the known geographic co-ordinates of these control points, choose the coordinate system and other projection parameters and then minimize residuals using Arc Map, Image Analysis. Residuals are the difference between the actual co-ordinates of the control points and the coordinates predicted by the geographic model created using the control points. They provide a method of determining the level of accuracy of the geo-referencing process.

2.6.9. Buffer Analyses

Buffering is a feature class that has features covering a large region, or you are using a very large buffer distance, distortion in the projection can cause inaccurate buffers to be produced. You can completely avoid distortion when buffering by using a feature class that has a geographic coordinate system and specifying a Buffer Distance in linear units (meters, feet, and so forth, as opposed to angular units such as degrees)

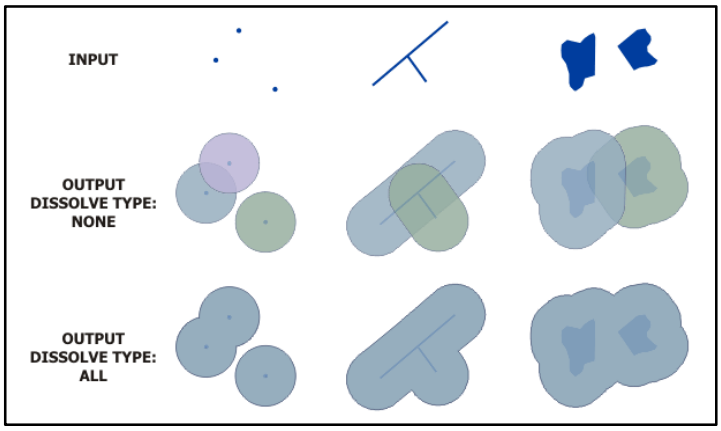


Figure 3.1 - Different type of Buffer analyses

2.7 Conclusion

The systematic data collection, the plan of research and the problems and prospects are the main subject matter of discussion in the methodology. The significance of the research rest upon the smooth expression and interpretation of the events ((Byomkesh, Nakagoshi, & Dewan, 2012)).Data sources and methodology is the most essential and significance approach leading to penetrate in to the problem and solution in the entire research work. It is the structural framework of the study. It guides how to operate the study, interpret and analyze the research work from the beginning to ending. Research methodology provides the methods, systems and process of data collection, the logic behind the selection of the study area and some hypothetical assumptions to facilitate the study(Korecha & Barnston, 2007).

2.1 Introduction

Literature review is a description, concise summary and critical analysis of the relevant reference research works in the field related to a particular research topic. In brief, it is a process of surveying scholarly literature, such as books, scholarly articles and any other sources, analyzing and documenting of what is already known about a particular topic, area of research or theory. Literature review conducted for any purpose either as a part of an academic dissertation or for constituting the background part of a research article or in the context of a standalone research reviews. In the context of land use change driver scientific article and research are available but in Bangladesh on these particular topics good books and journals are not available.

2.2. Define Land Use

Land use can be defined as the purpose to which humans put land. Land use can also be defined as the human activities that are directly related to land, making use of its resources or having an impact on it through interference in ecological process that determine functioning of land cover(Dewan & Yamaguchi, 2009). Defined land uses any kind of permanent or cyclic human intervention to satisfy human needs, either material or spiritual or both, from the complex of natural and artificial resources that together are called “land”.

Land use is a basic human life. Urban and rural uses are major factors in living standards, environmental quality and civilization itself(Byomkesh, Nakagoshi, & Dewan, 2012). a surprisingly large proportion of the world’s problems spring from the misuse, disuse, overuse, under use or abuse of land, and wiser policies are constantly being sought have pointed out that inappropriate land use has led to serious problems as degradation of tropical forests, deforestation of arable land, and so forth, which concern the survival of human beings.

2.3. Land Use Change

Changes in the land use, and management of the land cover have occurred throughout history in most parts of the world as population has changed and human civilizations have risen and fallen(Griffiths, Hostert, Gruebner, & der Linden, 2010). Land use change is generally shown in terms of a change in area for a particular land use or cover class over a specific period of time. Two important drifts are evident over the century: the total land area dedicated to human uses has grown dramatically, and increase production of goods and services has intensified both use and control of the land.

2.4. Drivers of Land Use Change

The many ways that people have used and managed throughout the history have emerged as a primary cause of land cover change around the world. Thus, land use and land management increasingly represent a fundamental change in the Global environment(Dhaka, n.d.). Land use change is driven by a combination of socio-economic, political and biophysical factors, the so called land use drivers explained that the major determinants of land use and land use change are physical, climatic and demographic factors, level of poverty, and economic and institutional structure of the resource use(Habiba, Haider, Ishtiaque, Mahmud, & Masrur, 2011). Also pointed out that human economic and social conditions influence pattern of land use, and that technological innovation affect how land is managed. These all are changing facets of human societies that the way land is used for the benefit of individual owners or for the members of the society.

2.5 Impact of Land Use Change

Changes in land use reflect the history of mankind. Economic development, population growth, technology and environmental change are directly linked with land use change. Rate of land use changes are often parallel rates of population growth during the past several thousand years, human have taken an increasingly large role in modification of the global environment. In last few decades, the effects

of land use change have became global, not only in the sense that changes in land use is a dynamic process, which changes over time due to some factors, such as increasing population, income, changes in farming system, technology and general structure of the overall economy. Population is undoubtedly one driver of land use change; it's positively associated with two other variables: technological capacity and levels of consumption(Gao, Zhang, Chen, Pal, & Giorgi, 2007).

In developing countries population growth, the major barrier to development is found to be the major driving force on land use change. Population increases always demand more food and this result in more land under cultivation. As the country gradually advances towards technology and development consumption per capita also increases and thereby increases the need for more production that ultimately results in more agricultural land and enhance land use changes. In the North pressures for land conversion derives from qualitative changes as well as quantitative increases in consumption(Tang, Engel, Pijanowski, & Lim, 2005).

On the other hand, in the South this pressure comes mainly from the demand for basic requirements, such as food, shelter and clothing. So, the effect of land use change can be considered as a combined effect of social, political and economic conditions of a region or a country(Saha, Gupta, & Arora, 2002).

2.6 Land use expansion of Dhaka city and Kamrangirchar

In kamrangirchar urbanization process increase for the reason of populations pressure in Dhaka city. In the period of 1975 to 2005 there was rapid urbanization manifested in Dhaka city. In this period many agricultural land, vegetation cover area, and water bodies highly fragmented as a result of rapid increase of unbanning activities(Dewan, Yamaguchi, & Rahman, 2012). For this consequent sharp changed in landscape pattern and composition in the sub-urban part of the Dhaka cities. As a nearest part of Dhaka city, Kamrangirchar expended as an urban area in a short time. Before 1980 this area was fully an island. Population, industrial expansion, economic growth are main driver of land use change in the peripheral part of a

city(Hassan & Nazem, 2016). Previous research on megacity Delhi has showed, there was a massive change of peripheral region of this city. In the same way, in the surrounding part of Dhaka megacity's landscape changing for its expansion of area, population pressure, commercial development and demand of additional natural resources, there by a massive scale landscapechanged in the Kamrangirchar Island (Mohan, Pathan, Narendrareddy, Kandya, & Pandey, 2011).

In the development context land use change has provided many social and economic benefits, but it has come at a cost of natural environment. In the united states in Michigan's area, the Lake Muskegon hampered by the rapid urbanization process. Runoff, water quality and habitant of this lake damaged.

In our study area Kamrangirchar was an island, now that was nothing but a history. There have no signed to identify that was an island(Tang et al., 2005). Decreasing of wetland is the main reason of environmental degradations in Dhaka city as well as nearby area. Researcher showed from 1998 to 2009 there have a great changed of wetland, mainly Rivers and Khals (Habiba et al., 2011). One of the objective of this study demonstrates the impact of land use on surrounding man environment. Unplanned urbanization is the main anthropogenic causes of environmental degradation.

Kamrangirchar is an area where settlement develops in a short time, for the high house rent poor and lower class society of Dhaka cities developed this island illegally. Recently this area has included in Dhaka South City Corporation, but there have no signed of cities development yet. All of the garbage point and sewerage line linked with nearby River(Kalnay & Ming, 2003). Dhaka cities is the fastest growing megacities of the world so land use of Dhaka city consuming development.

2.7 Change Detection Techniques

There are four main components of change detection for observing environmental resources: identifying if the change has occurred, classifying the nature of change, calculating the areal magnitude of the change, and analyzing the spatial pattern of

the change (MacLeod and Congalton, 1998). Lambin and Strahler (1994b) indicated five types of influence that lead to changes in land cover. The first three types are related to natural changes: long-term climate change due to astronomical causes, short-term geomorphologic processes, and ecological processes such as vegetation succession and soil erosion. The other types are associated with human activities: direct alterations of land cover, such as deforestation and urbanization, and indirect influences through human-induced climatic change such as the greenhouse effect.

2.8 Modern Urbanization trend analysis based on Dhaka city

This study presents an integrated study of urbanization trends in Kamrangirchar, Thana by using Geographical Information Systems (GIS) and Remote Sensing (RS). This study explores the land use change pattern of Kamrangirchar over 1998-2017, through interactive supervised land cover classification using Landsat images by ArcGIS 10.3. The remotely detected land use/cover change from 1998 to 2017 shows that Kamrangirchar is gradually changing as vegetative cover and open spaces have been transformed into building areas, low land and water bodies into reclaimed built up lands(Mamun, Mahmood, & Rahman, 2013).

Growth of urban and impact of human activities disrupted the natural ecological balanced. Basically damaged of Buriganga. Buriganga is the bio-hub of the Dhaka cities, Kamrangirchar along with this Reiver, but present situation show main channel of the River fill-up by the garbage of this areas, all of the bio component degraded for the illegal settlement process (Wu, Ye, Qi, & Zhang, 2013).

In the history of urbanization most of the city grows up on the bank of the River Dhaka cities also developed on the bank of the River Buriganga, Poor law enforcement authority and urban land management system is responsible for lower quality urbanizing processes. Industrial waste, chemical waste and household garbage changed the River water quality (Solaimani, Arekhi, Tamartash, Miryaghobzadeh, & Sari-iran, 2010). In our increasingly urbanized world, monitoring and mapping of urban growth and thereby induced land use and land-cover change (LULCC) is of emergent

importance Remote sensing can reveal spatio-temporal growth trajectories of cities, which again allow a thorough understanding of the impacts of urbanization on ecosystems and ecosystem services.

However, the mapping of urban areas remains one of the most challenging tasks of remote sensing data analysis. This paper presents an approach to map urban growth from multi-sensorial data, exemplified for the Dhaka megacity region in Bangladesh between 1990 and 2006.The approach is globally applicable and can facilitate regional urban growth maps in arbitrary complex and dynamic environments. Dhaka's deified urban landscape, its deltaic locality and the highly dynamic monsoon-related phonology call for a sophisticated analysis approach that is able to separate intra-annual land-cover variations from actual urbanization.

Imagery from the Landsat series of satellites is a great asset for such an analysis due to its synoptic coverage of large urban areas as well as its unique historical archives (Grif, Hostert, Gruebner, & Linden, 2010).It is very difficult to predict land use change, Dhaka as a capital city of Bangladesh after the liberation this city were the main hub of business, industry, occupational, commercial, administrative office, educational and many other activities. It was showed that the land of Dhaka city changing rapidly but it cannot be control.

As a nearest area of the city Kamrangirchar urbanized in short time without any respect of urban policy and processes(Veldkamp & Lambin, 2001). For the rapid urbanization this area is over populated, that is why this area expended vertically all of the building multistoried and those are very risky at earth quake. For disrupting the ecological component, air is very dusty, temperature is very hot and humid in this area. Simulated the land use changes effected on the total climate of the study area(Xuejie, Zongci, & Giorgi, 2003).The changes of this land form is particularly indispensable for proper functioning of the ecosystem in an urban environment.

This study was an attempt dynamically changes Kamrangirchar, Dhaka, Bangladesh. Both primary and secondary data were acquired to document the spatial–temporal

dynamics of the changes in the study area. Using a supervised classification algorithm, multi-temporal land use/cover data were extracted from asset of satellite images.

A number of spatial metrics were employed to understand the landscape condition in a multi temporal manner. In addition, 50 key informants along with focus group discussion and observation techniques were used to document existing management(Byomkesh et al., 2012).

2.9 Land use change history of urban area

Humans have been altering the earth's surface to produce food through agricultural activities for centuries and increasingly contributing towards modification of global environment. Population pressure increasing scarcity of agricultural land and has led to both planned and unplanned migration into tropical forest areas. Usually, land conversion due to unplanned agricultural colonization substantially exceeds the land subject to government-induced migration programmes, such as "Grow More Food" campaign in India, "Land for the Landless" programme in Dhaka.

From an economic point of view there is a difference in development of land use between densely populated countries (e.g. Western Europe) and those with much sparser populations (e.g. the USA), because of available labor and consequently labor costs. In Europe production per hectare is important where in USA it is very important production per man. In less than one century these countries, which once were agriculture, have been transformed into industrialized countries, where agriculture has become a less important sector of the economy (Buringh and Dudal, 1987).

2.10 Application of remote sensing for land use change

There is significant variation between various sensor instruments' capability and wealth of information captured and also the applicability depends on the objective of the intended study. There is also clear variation in the spatial and spectral properties of satellite images acquired by different versions of a particular sensor instrument. Landsat instruments can be taken as a good example of showing

continuous improvement in radiometric and spectral property of images enabling better understanding of land resources.

Since 1972, the Landsat satellites have provided repetitive, synoptic, global coverage of high-resolution multispectral imagery. Their long history and reliability have made them a popular source for documenting changes in land cover and use over time (Turner et al., 2003) and their evolution is further marked by the launch of Landsat 7 by the US government in 1999. Multispectral Scanner (MSS) data from the U.S. Geological Survey's (USGS) EROS Data Center (EDC) has provided a historical record of the Earth's land surface from the early 1970s to the early 1990s. The MSS and TM sensors primarily detected reflected radiation from the Earth's surface in the visible and IR wavelengths, but the TM sensor provides more radiometric information than the MSS sensor.

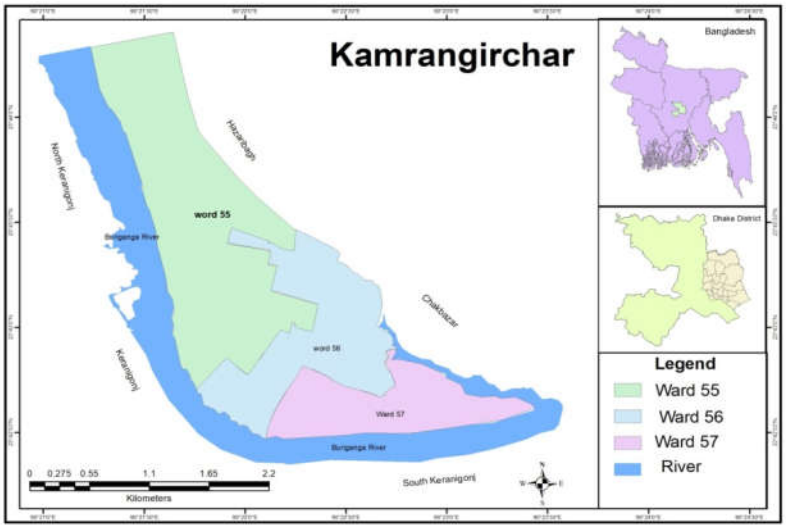
The wavelength range for the TM sensor is from the visible (blue), through the mid-IR, into the thermal-IR portion of the electromagnetic spectrum and it has a spatial resolution of 30 meters for the visible, near-IR, and mid-IR wavelengths and a spatial resolution of 120 meters for the thermal-IR band. Each pixel of Landsat TM images contains a wealth of information about the surface materials that reflect light from that pixel to the satellite sensors. Each band in a TM image represents a separate piece of data whose value ranges from 0 to 255 enabling the whole image to contain 2565 (approximately 1.1 billion) different possible spectral combinations. However, it does not mean that each one of these combinations represents a different type of land cover and most of these variations represent very small and, to us, "unseeable" differences in surface reflectance. ETM+ instrument measures upwelling radiance in the same seven bands as the TM, and has an additional 15 m resolution panchromatic band (Mather, 2004). The spatial resolution of the thermal infrared channel is 60 m rather than the 120 m of the TM thermal band and this instrument has substantially the same operational characteristics as Landsat-4 and Landsat-5. All the Landsat image archives used for this study were acquired from ILIR’s information database.

2.11 Conclusion

Various research were conducted on Dhaka city and Dhaka region but on this study area very few research were conducted in the particular title, but no research accumulated land use change's drivers, impact on surrounding man and environment and possible solutions of those problems. This study accumulate various factors of land use change, impact of unplanned urbanization on surrounding environment and also find out possible way to reduce the impacts on physical environment and human of the island.

4.1 Introduction

Kamrangirchar is my study area. Kamrangirchar Thana (Dhaka metropolitan) area 3.63 sq km, located in between 23°42' and 23°43' north latitudes and in between 90°21' and 90°23' east longitudes. It is bounded by hazaribagh and lalbagh thanas on the north, Lalbagh and chawkbazar model thanas on the east, keraniganj upazila on the south and west and this area reverie bounded by the Old Buriganga in the North and Buriganga river in the South and administrative boundary bounded by hazaribagh and lalbagh thanas on the north, Lalbagh and chawkbazar model thanas on the east, keraniganj upazila on the south and west. Kamrangirchar Thana Kamrangirchar Thana (Dhaka metropolitan) area 3.63 sq km,



Map 4.1 : Study area showing Kamrangirchar and its surrounding (Source: Compile by Author)

Table 4.1 : Ward and Moholla information

Thana				
Ward	Mohalla	Population	Density (per sq km)	Literacy rate (%)
				Urban
3	12	143208	39452	38.46

Table 4.2 : Union information

Ward				
Name number of Ward	Area (sq km)	Population		Literacy rate (%)
		Male	Female	
Sultanganj Union 51	3.63	76325	66883	38.46

Sources: Councilor office(Kamrangirchar)

Table 4.3: Religious institutions

Religious Institutions	Number	Religious Institutions	Number
Mosque	85	Sacred Place	5
Temple	6	Buddihist Math	8
Church	2		

Sources: Councilor office(Kamrangirchar)

4.3 General Information about Study Area

Table 4.4: Profile of My Study Area: At a Glance

Name of the study area	Kamrangirchar
Total Area	3.63 sq. k.m
Word	03
Union	01
Village	10
Mouza	09
Elevation	8 meters above mean sea level.

Sources: Councilor office(Kamrangirchar)

4.4. Major Occupations

Occupational pattern of population of the Kamrangirchar area is mainly urban based that include salary earning jobs and business. About 15% are either underaged or students and about 23% are involved in household works. About 54% are engaged in some sort of income earning activities and 8% are unemployed. About 7% work in government/private/autonomous organizations, 30% are involved in business, 5% belonging to day labouring activities and 1% are land owner farmers. The remaining

11% are involved in other activities like industrial labourers, skilled/unskilled professions, etc.

Table 4.5: Occupational Status of the Surveyed Area's People.

Occupation Category	Kamrangirchar (%)
Household work	**23**
Bussiness	**30**
Unemployment	**8**
Job	**7**
Student	**15**
Labour	**16**
Total	**100**

Source: Councilor office

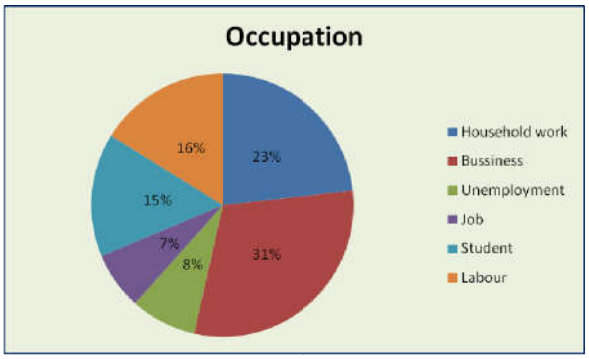


Figure 4.1 Occupational status

4.5 Cultural Group and Population status

There is huge difference of cultural group of Kamrangirchar. Here a variation can be easily visible after representing the data table. Kamrangirchar is dominant in Muslim community. Male female ratio has some large difference. Male female ratio and other cultural variation can be easily seen through this table. A small number of Hindu and Cristan community live here.The religious practice are also different for different religion.

Table 4.6 Cultural group Status of the Surveyed Area's People.

Types	Kamrangirchar (%)
Male	56
Female	44
Total Population	200229 (P)
Muslim	92
Hindu	6
Cristian	1.5
Buddhist	0.2
Other	0.3

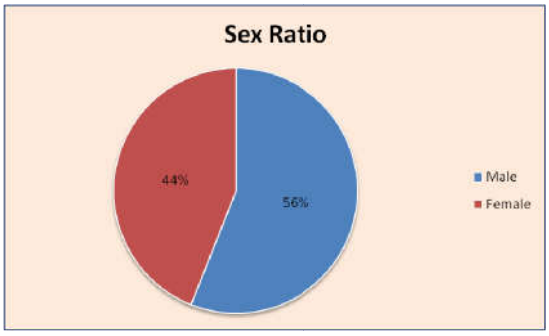
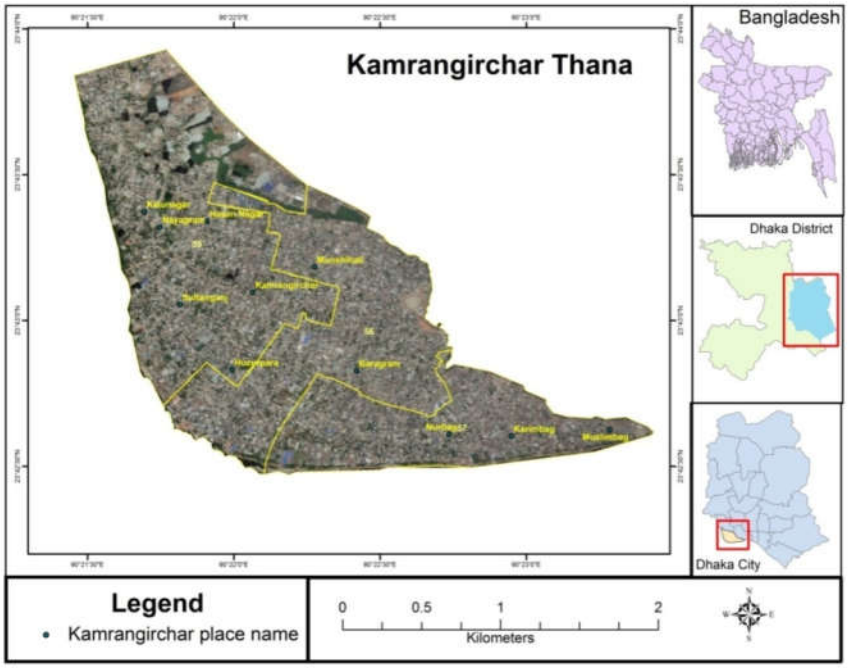


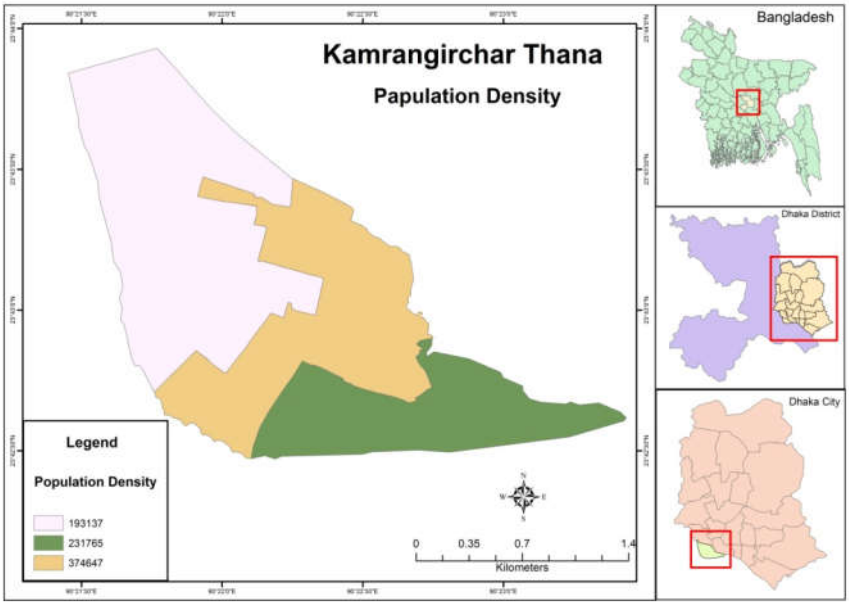
Figure 4.1 Sex Ratoio

Source: Councilor offce 2017

4.6 Study area Satellite Image



Map 4.2 : Satellite View of Kamrangirchar



Map 4.3 : Population Density map of Kamrangirchar

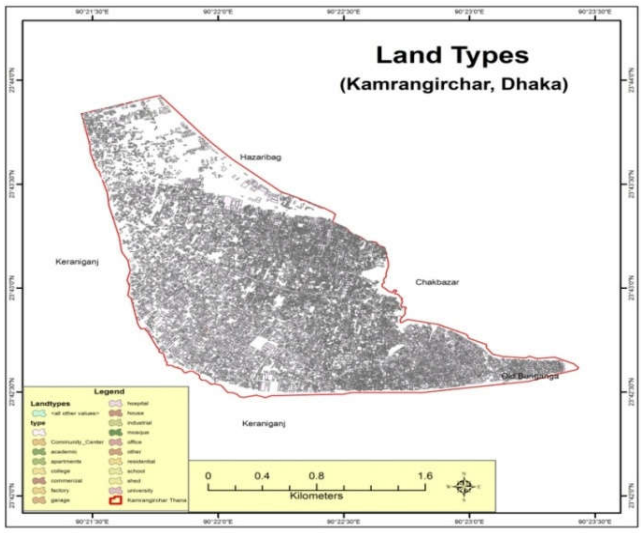
4.6 Physical Settings

4.6.1 Physiographic

Physiographic is a description of the physical nature (form, substance, arrangement, changes) of objects, especially of natural features. Physiographic region/unit refers to a region of which all parts are similar in terms of physical characteristics and which have consequently had a uniform geomorphic history, and whose pattern of topographical features or landforms differs significantly from that of adjacent regions. In the context of Physiographic, Bangladesh may be classified into three distinct regions (a) The Recent flood Plains (b) The Terraces of Pleistocene Period and (c) Hills of Tertiary Age, each having distinguishing characteristics of its own. The overall Physiography of the country has been divided into 24 sub-regions and 54 units. My study area is covered with Ganges-Brahmaputra deltaic Flood plain under the recent flood plain physiographic regions.

4.6.2 Land Use and Land Condition

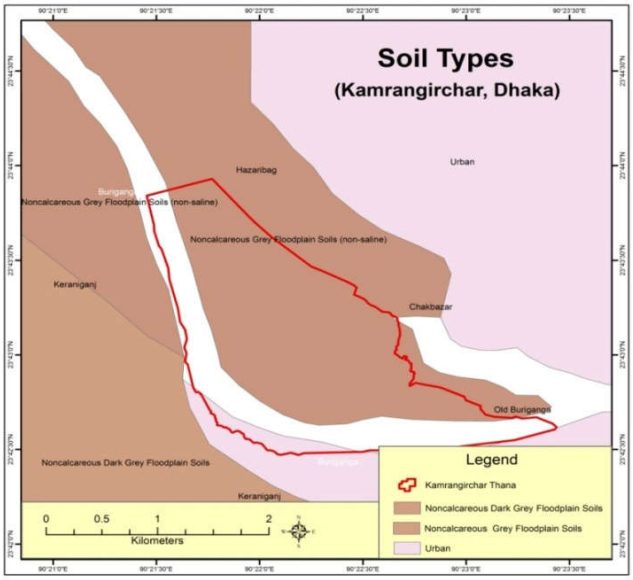
Land is a very essential element of ecosystem and land use and land cover is very important ecological activities of any area. Land is varied physically into medium high land, medium land and low land in the study area and this identified in the prior of land use survey. Different types of land use are observed in the study area and information is collected its transformation process according to time.



Map 4.4: Land Types map of Kamrangirchar *(Source: Compile by Author)*

4.6.3 Geology and Soil

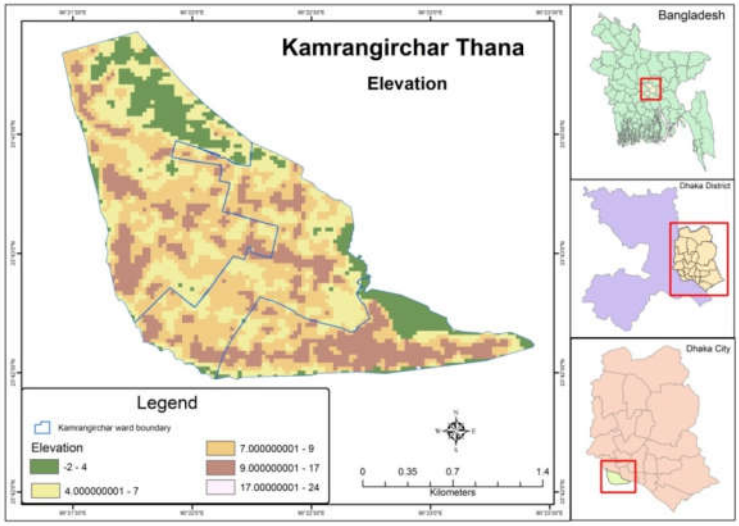
Dhaka City and its surrounding areas are covered with Pleistocene Madhupur Clay and Holocene sediments belonging to the Ganges-Brahmaputra flood plain. The western part of the investigated area lies in the Madhupur Tract having highly oxidized Pleistocene sediments which are represent Noncalcarous gray flood plain. To the east, the area is covered with recent flood plain deposits.



Map-4.5: Soil Types map of the Study Area *(Source: Compile by Author)*

4.6.4 Topography

The research area is characterized by high undulated land surface. The comparatively developed area, that is, the western part of the area has the higher land surface, while the eastern part is low land and falls in the retention pond designated in DMDP Structure Plan. But most of these low lands have been filled up for residential development. The area is generally low. Most parts are inundated by normal flood every year. During serious flooding, even the highest road goes under 2/3 feet of water. The area falls just outside the Dhaka flood embankment and floodwall and is therefore exposed to regular flooding, discouraging from people to settle there.The 10 feet high Dhaka City (Flood) Protection Embankment runs by the north of the planning area.



Map-4.6: Elevation map of the Study Area *(Source: Compile by Author)*

4.6.5 Climate

Like other parts of Bangladesh, the study area is also influenced by tropical monsoons climate. Mainly three seasons are seen in the study area. One is the rainy season during May to October, about 91% rainfall occurs during the rainy season. Second is winter season includes November to February and it is almost dry and cool and last is the pre-monsoon (or hot) season from March to April has the highest temperatures and evaporation rates of the year and during which occasional thunder showers fall.

4.6.5.1 Temperature

Remarkable changes in temperature can be found with the changes of seasons in Kamrangirchar. The mean annual temperature of the project area is about 25.5°C with peaks of over 27. °C in May. The temperature in winter can fall to 10°C in January. However, Kamrangirchar area shows a mild summer than of inland areas, northern part of Dhaka city, where summer temperature sometimes exceeds 38°C. (Meteorological Dept. Dhaka, 2017).

4.6.5.2 Rainfall

The mean annual rainfall of the project area is about 2022 mm due to tropical monsoon climate.Approximately 80% of total rainfall occurs during the monsoon season. Winter is the dry period with little or nearly no rainfall. However, during the months of December and January little rainfall is recorded (Meteorological Dept. Dhaka, 2017).

4.6.6 River Network

The internal transportation system of Bangladesh has developed through the Rivers, Khal and Lakes. River plays the most important role in the internal transportation system. Due to the presence of large number of rivers, Bangladesh is called a country of Rivers. The Kamrangirchar has been growing in a linear shape following the Buriganga river course. The Buriganga , originating from the Dhaleshwari , flows south ward. In study areas, there found two river systems. Such as: Buriganga River System and Turag River System.

4.6.7.1 Buriganga River System

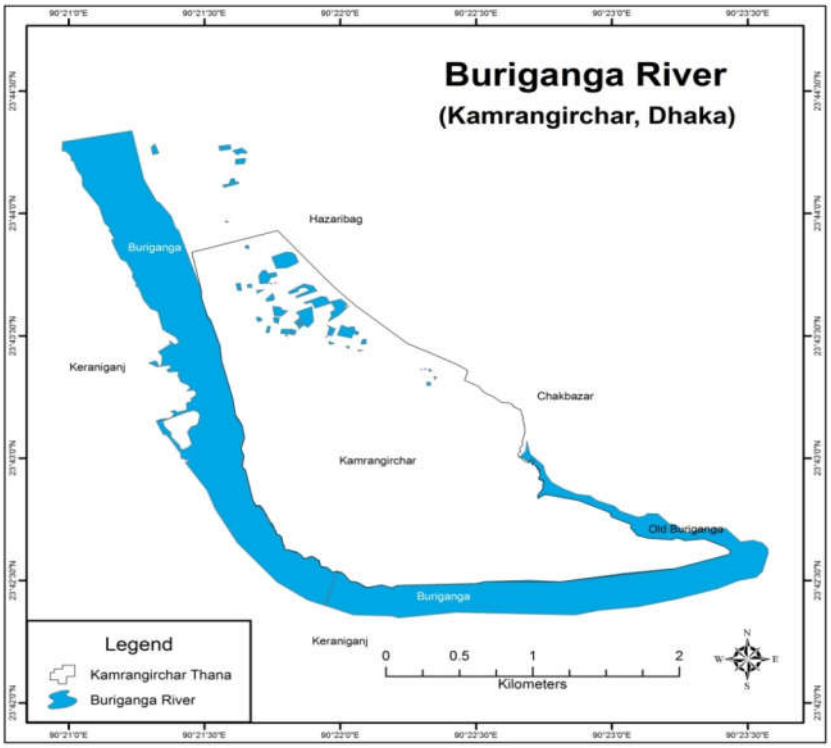
Buriganga River a tide-influenced river passing through west and south of Dhaka City. There is a traditional story behind naming it. In ancient times one course of the ganges used to reach the bay of bengal through dhaleshwari. This course gradually shifted and ultimately lost its link with the main channel of the Ganges and was renamed as the Buriganga. The water levels during high and low tides in this river astonished the Mughals.

The Buriganga originated from the Dhaleshwari near Kalatia. Its average width and depth are 400m and 10m respectively. This river is only 27 km long. The turag has joined the Buriganga at Kamrangirchar of Dhaka City. In fact, the main flow of the Buriganga comes from the Turag. It meets with the Dhaleshwari at munshiganj. The present head of the Buriganga near Chhaglakandi has silted up and opens only during floods, but the lower part is still open

throughout the year. The downstream junction with the Dhaleshwari fluctuates from time to time according to changes in the position of the latter river; at present it lies about 3.22 km southwest of Fatullah. Its course by Dhaka is stable, fixed by the resistant clays marking the southern edge of the madhupur tract.

The Buriganga is of great economic importance to Dhaka. It provides river connection by launch and country boats. Large steamers can no longer ascend the river in the dry season.

Water pollution in the River Buriganga is as its highest. The most significant source of pollution appears to be from tanneries in the Hazaribagh area. In the dry season, the dissolved oxygen level becomes very low or non-existent and the river becomes toxic



Map 4.7 : River Network Map of Kamrangirchar *(Source: Compile by Author)*

4.7 Conclusion

Study area is an important factor in the case of research conduction. The study area of present research was a suitable for this study. As this research was about different aspects of types, uses, sources of water resources in the study area. People of the study area directly or indirectly are depended on these water resources in different way.

Land use Change from 1998 to 2017

5.1 Introduction

Urbanization is one the most prevalent anthropogenic causes of the loss of water body, arable land/bare land, habitat destruction, and the decline in natural vegetation cover. The conversion of rural areas into urban areas through development is currently occurring at an unprecedented rate in recent human history and is having a marked effect on the natural functioning of ecosystems). Although urban areas currently cover only 3% of the Earth's land surface, they have marked effects on environmental conditions at both local and global scales, including climate change. Since ecosystems in urban areas are strongly influenced by anthropogenic activities, considerably more attention is currently being directed towards monitoring changes in urban land use. Such studies are particularly important because the spatial characteristics of LU are useful for understanding the various impacts of human activity on the overall ecological condition of the urban environment.

Land use change due to human activities is currently proceeding more quickly in developing countries than in the developed world, and it has been projected that by the year 2020, most of the world's mega cities will be in developing countries. Increasing population in developing cities has caused rapid changes in Land use and increased environmental degradation. The effect of population is particularly relevant given that the global urban population is projected to almost double by 2050. mitigate the detrimental effects associated with urban growth on the environment and to maintain optimal ecosystem functioning), spatial and temporal LU patterns, and the factors affecting these changes), are considerably important in developing rational economic, social and environmental policies.

5.2 Map Preparation and Accuracy Assessment

This chapter deals with explaining the procedure of preparing the base maps for analysis and the accuracy assessment , Land use change from 1998 to 2017 of the study area. The collected Landsat satellite images (1998, 2003, 2007, 2013 and 2017) have been used for preparing the base maps for land cover change detection. The basic steps for preparing the base maps are as follows

5.3 Image Enhancement

Image enhancement is a kind of image modification that enables the capabilities of human vision to identify and select regions of interests. Composite generation technique has been performed for this particular research.

5.4 Composite Generation

Landsat TM (Thematic Mapper) records 7 spectral bands. For visual purpose any 3 bands are combined that are acting a False Color Composite (FCC). Figure 3.1 shows several composites using different band combinations from the same TM images.

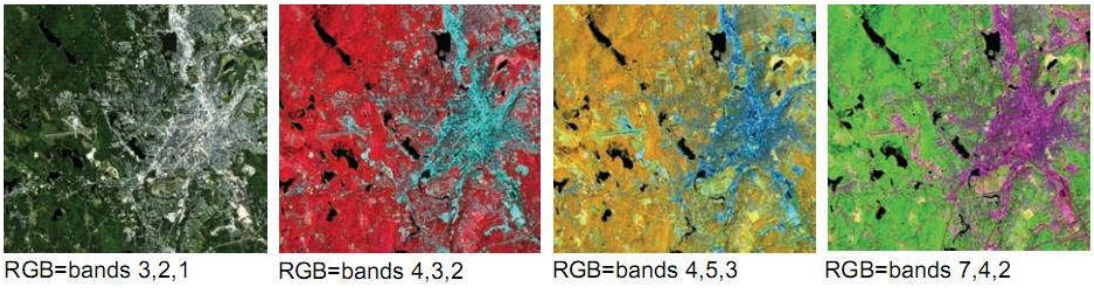


Figure 5.1: Composites Using Different Band Combinations

Using the basic colours red, green and blue (RGB) it is possible to prepare different FCC images. These FCC images are useful to distinguish between different cover types or ground objects like Settlement, Water body, bare land and vegetation.

The FCC of RGB= bands 4, 3 and 2 has been chosen for this research. This combination normally makes urban areas appear blue, vegetation red, water bodies from dark blue to black, soils with no vegetation from white to brown. Figure 3.2 shows the FCC (RGB= bands 4, 3 and 2) image of the study area for different time periods.



Figure 5.2: False Color Composite (RGB=4, 3 and 2) Maps of the Study Area

The study area is selected by choosing the same geographic position of all 7 bands for the same time period. This helps to maintain the same number of rows and column. The properties of each image are described in Table 3.1

5.5 Image Classification

Image classification refers to grouping image pixels into categories or classes to produce a thematic representation. Image classification comprehends various operations that can be applied to photographic or image data. These include image restoration, image pre-processing, enhancement, compression, spatial filtering, and pattern recognition and so on. There are two basic methods of image classification: supervised and unsupervised. Supervised classification relies on the priori knowledge of the study area. Therefore, for this research, a supervised classification method has been used.

Supervised classification can be defined as: "A procedure for identifying spectrally similar areas on an image by identifying 'training' sites of known targets and then extrapolating those spectral signatures to other areas of unknown targets" [39].

In case of supervised classification, the user develops statistical description for various known land cover types that is called signature development. Then a procedure is used to identify the similar pixels/signature for different land cover types for the whole image. The steps that are followed for this supervised classification are as follows:

Table 5.2: Details of the Land Cover Type

Land Cover Type	Description
Built-up Area	All residential, commercial and industrial areas, villages, Settlements and transportation infrastructure.
Water Body	River, permanent open water, lakes, ponds, canals and reservoirs.
Vegetation	Trees, shrub lands and semi natural vegetation, and mixed forest, palms, , herbs, climbers, gardens, inner-city recreational areas, parks and playgrounds, grass land and vegetable lands.
Wetland and Low land	Permanent and seasonal wetlands, low-lying areas, marshy land, rills and gully, swamps, mudflats, all cultivated areas including urban agriculture; crop fields and rice-paddies.

5.6 Signature Editor

This is the stage of creating the spectral signature for each type of land cover. This is done by analyzing the pixels of the training sites [36]. When the digitization of training sites is finished, the statistical characterizations of each land cover class are needed. These are called signatures.

Signatures are developed incorporating the vector files containing training sites and the bands used for analysis. These signature files contain statistical information about the reflectance values of the pixels of the training sites for each land cover type [36].

5.7 Classification

After developing signature files for all land cover classes the next step is to classify the images based on these signature files. This can be done by two ways: hard or soft classifiers. These are kind of statistical techniques to classify the whole image pixel by pixel based on each known type particular signature.

In case of hard classifications, each pixel is assigned in a way that has the most similar signature for a particular land cover type. On the other hand, soft classifications take into consideration the degree of membership of the pixel in all classes.

5.8 Generalization

After image classification, sometimes many isolated pixels may be found. These isolated pixels may belong to one or more classes that differ from surrounding pixels. Therefore it is necessary to generalize the image and remove the isolated pixels. Filtering is the solution for this type of problem. In RS analysis, filtering refers to the removal of certain spectral or spatial frequencies to highlight features in the remaining image. Mode filters are good for filling gaps between polygons after a vector-to-raster conversion.

5.9 Results and Discussion

The assessment of classification accuracy of the land cover maps (1998, 2003, 2007, 2013 and 2017) has been carried out using various methods.

User‟s accuracy measures the proportion of each land cover class which is correct. On the other hand, producer‟s accuracy measures the proportion of the land base which is correctly classified. Producer‟s and User‟s accuracy are also found consistently high ranging from 71%-100% for all the years. Therefore, higher values of producer‟s and user‟s accuracy indicate that the prepared base maps are quite good enough for further analysis.

It means few misclassifications have been observed in the classified land cover maps of Kamrangirchar. This may be because of the same spectral characteristics of some land cover types. For example, in case of 1998 base map, certain built-up areas were misclassified as fallow land. Again, in most cases it was really difficult to separate water bodies and low/cultivable lands categories. The reasons may be the seasonal variations of the satellite images for different years and the similar spectral properties of land covers in some cases.

The different techniques and spatial metrics that have been implemented for change of landuse from 1998 to 2017 analysis are described in this chapter.

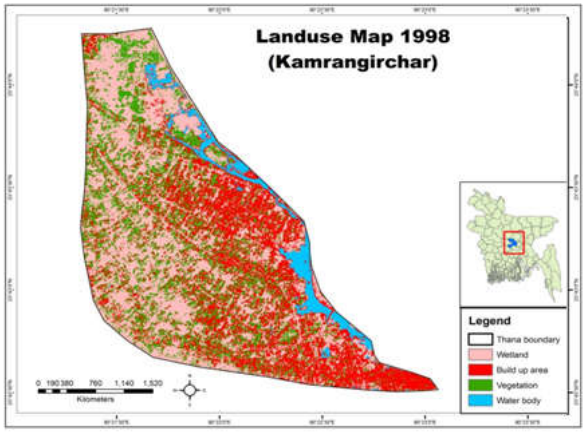
5.10 Land use Change or Change Detection

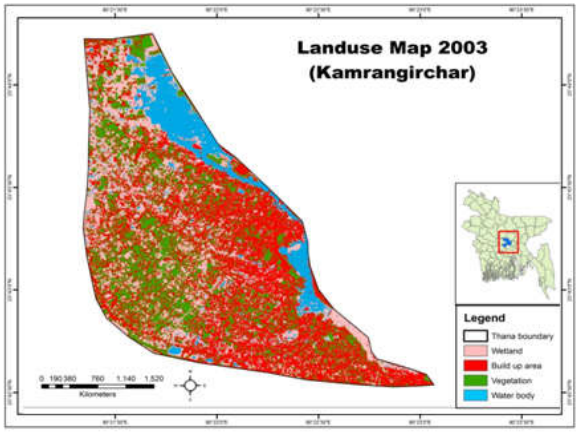
Urban area is highly dynamic. Numerous factors put impact on the growth or changing pattern for a particular city. Therefore, understanding the urban dynamics is a complex task while planning for a planned and sustainable urban development. To predict the future change of highly dynamic urban areas like Dhaka city, it is necessary to assess and monitor the urban land cover change on a regular basis. In remote sensing, ‘Change Detection’ is defined as the process of determining and monitoring the changes in the land cover types in different time periods. It provides the quantitative analysis of the spatial distribution in the area of interest. Change detection is important because it helps the researcher to understand and monitor the land cover change pattern within the study area.

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh, 1989). The land change can be resulted by many factors, in order investigate these factors we need to analyze the changes. By change detection method transitions from one category to other ones can be observed, which can help to understand the interaction between the categories. There are many techniques for change detection.

5.12 Land use Change analysis from 1998 to 2017

5.12.1 Land use changes between 1998-2003





Map 5.1 : Land use map 1998 Source: Compile by Author Map 5.2 : Land use map 2003

Spatial pattern of land use change in the Kamrangirchar area for 1998, 2003, 2007, 2013 and 2017 is 1998 and the direction of urban development to the north of the area. However in 1998, built-up land cover replaced most of the water bodies and depressions within the city and cultivated land of the then fringe zone. The propensity of urban development extended to further north and north-west direction between 1998 and 2003, when road transportation from Dhaka to the hinterland was provided by constructing bridges on the rivers. Current map shows that the built-up category is fast becoming the dominant cover while rural lands started to disappear concurrently since the demand for urban land dramatically increased in recent years.

Table 5.2: Land use change from 1998 to 2003

Land use	1998(Sq. m)	Percentage(1998)	2003(Sq. m)	Percentage(2003)
Water body	90900	23%	43474	11%
Vegetation	55390	14%	39522	10%
Build up	142279	36%	276654	70%
Wetland	106709	27%	35569	9%

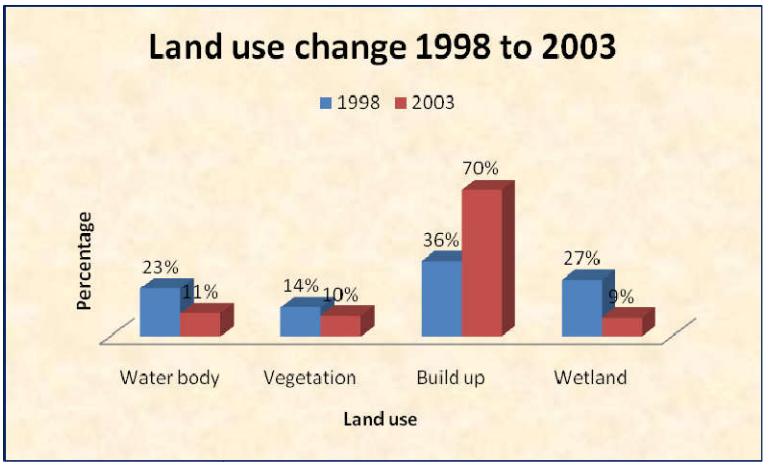
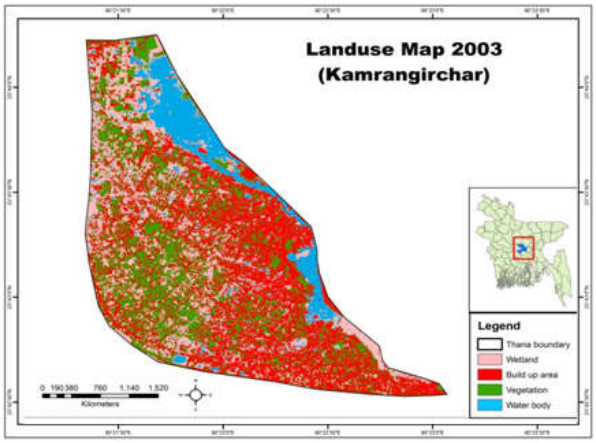


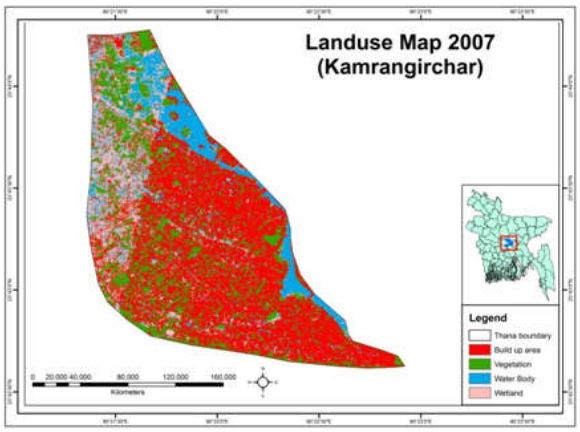
Fig 5.3: Land use change 1998 to 2003

To evaluate the results of land use/cover conversion, a land use transition matrix was calculated and shown in Table 3. These results indicated that an increase in urban areas mainly resulted from cultivated land and water bodies during 1998–2003. The analysis of the land use conversion matrix revealed that 3.63 sq of water bodies and 90900 sq. m cultivated land was converted to urban built-up category between 1998 and 2003. Further analysis of land use change showed that wetland (106709 sq. m) and Water body (90900 sq. m) comprised the major land covers followed by vegetation (55390 sq. m) and Build up area (142279 sq. m) in 1998, totaling 395278 sq m of the study area. Conversely, built up area was merely 276354 sq. m In 2003, significant expansion in built-up area was noticed and its areal growth doubled from 36 percent (142279 sq. m) to 70 percent (276354), a gain of more than 92% within 20-years (1998–2017).

5.12.2 Land use changes between 2003- 2007

Based on Table 5.4 A similar pattern of land use change was found between 2003 and 2007. However, the built-up area in this period witnessed a steady growth. Interestingly, cultivated land and water bodies experienced relatively subtle conversion compared to wetland and





Map 5.3 : Land use map 2003 Source: Compile by Author **Map 5.4 : Land use map 2007**

Vegetation land use/cover categories. The total loss of vegetation and wetland between 2003 and 2007 was 35569 sq. m and 27665 sq m, respectively. Many vegetative covers were cleared and trans- formed to urban land during this time, indicating a gain of 7% of urban land. In addition, wetland areas also reduced markedly in response to the increase landfill activity during 2003–2007.

Table 5.4: Land use change from 2003 to 2007

Land use	2003(Sq. m)	Percentage(2003)	2007 (Sq. m)	Percentage(2007)
Water body	43474	11%	31617	8%
Vegetation	39522	10%	31617	8%
Build up	276654	70%	304319	77%
Wetland	35569	9%	27665	7%

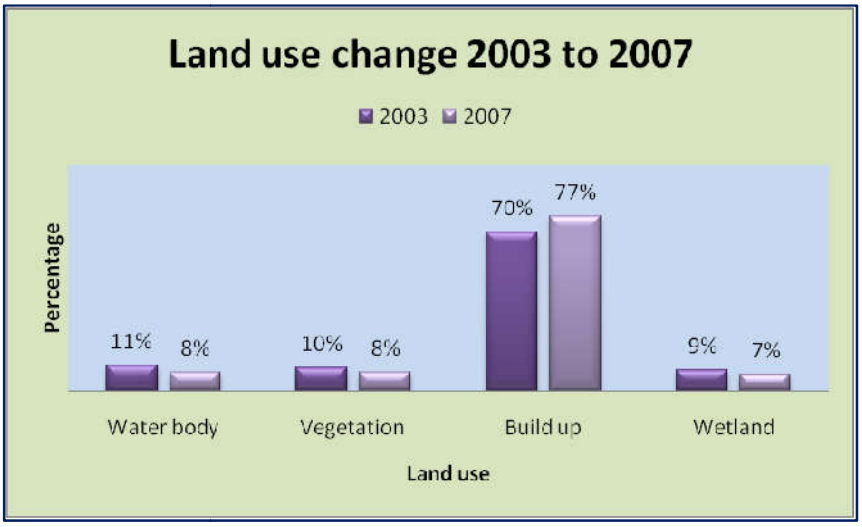
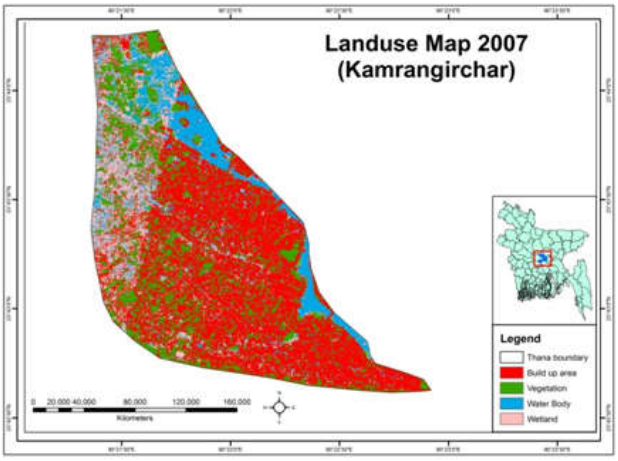
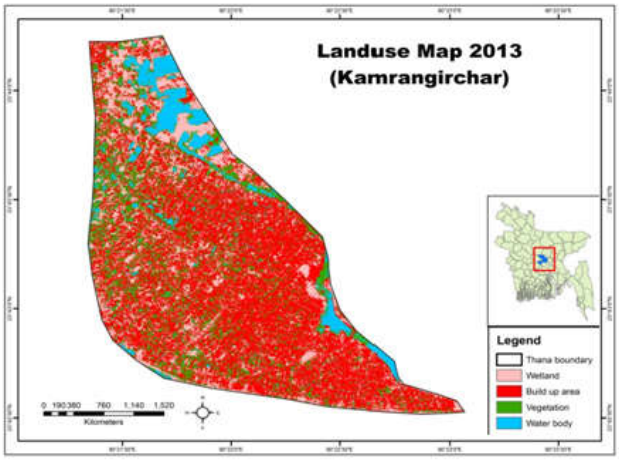


Fig 5.4: Land use change from 2003 to 2007

5.12.3 Land use changes between 2007-2013





Map 5.5 : Land use map 2007 **Source: Compile by Author** **Map5.6 : Land use map 2013**

Based on Table 5.5 Between 2007 and 2013, a further expansion in built-up areas was observed which outpaced the growth rate of 2003–2007. On the contrary, the dominance of cultivated land, wetland and vegetation cover dramatically declined from 27665 sq m (2007) to 26655 (in 2013). During 2007–2013, wetland/ lowland category primarily converted to built-up category, resulted in wetland 4% ad vegetation cover 4%, highest during the study period. The built-up category further expanded to 77% during 2007 of which 85% of 2013 which very large change over all situation the land use change.

Table: 5.5 : Land use change 2007 to 2013

Land use	2007 (Sq. m)	Percentage(2007)	2013(Sq. m)	Percentage(2013)
Water body	31617	8%	15808	4%
Vegetation	31617	8%	15808	4%
Build up	304319	77%	335937	85%
Wetland	27665	7%	27655	7%

As lands were getting scarce for urban expansion, wetlands became the target for urban development in this time period.. It was noticed during field visits that land filling by sand and earth is a common practice in Kamrangirhcar to offset the flood vulnerability. vegetation cover are again loss which are change from 8% of 2007 and 2013 function are losses to converted 4%. The gain in Build up area is 7% was largely attributed to the increase of urbanization.

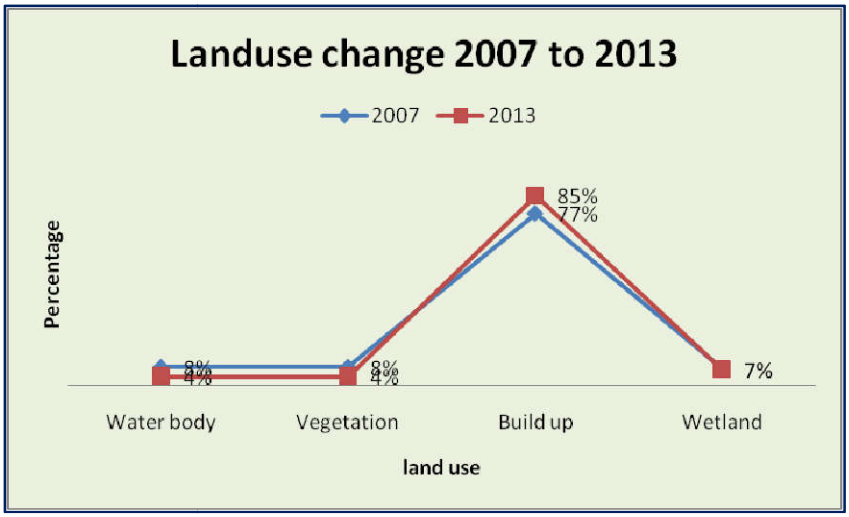
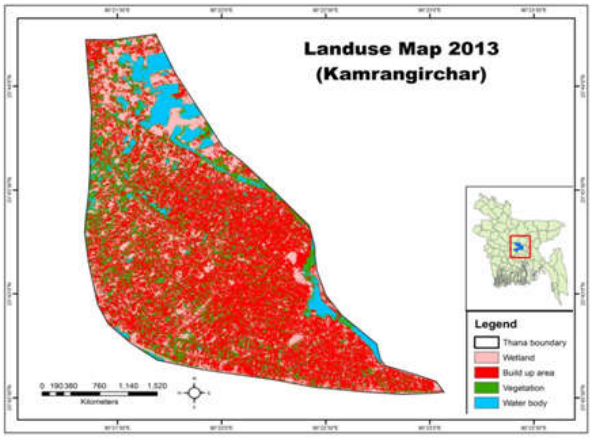
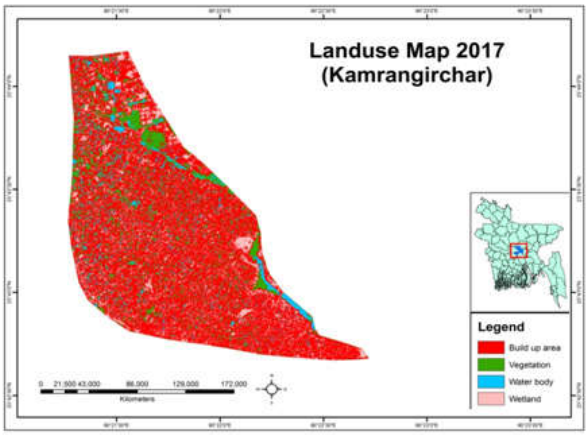


Fig 5.5: Land use map 2007 to 2013

5.12.4 Land use changes between 2013-2017





Map 5.7 : Land use map 2013 Source: Compile by Author Map 5.8 : Land use map 2017

Based on Table 5.6 Between 2013 and 2017, a further expansion in built-up areas was observed which outpaced the growth rate of 2013–2017. On the contrary, the dominance of cultivated land, wetland and vegetation cover dramatically declined from 396354 sq. m (in 2013) to 396318 sq. m (in 2017). During 2013–2017, wetland/ lowland category primarily converted to built-up category resulted in 5% loss, highest during the study period. The built-up category further expanded to 363602 sq. m during 2017 of which 335937 sq.m in 2013 which are came from wetlands 5% and vegetation cover 2% total 7 percent gain.

Table: 5.6: Land use change 2013 to 2017

Land use	2013(Sq. m)	Percentage(2013)	2017(Sq. m)	Percentage(2017)
Water body	15808	4%	15808	4%
Vegetation	15808	4%	7904	2%
Build up	335937	85%	363602	92%
Wetland	27655	7%	7904	2%

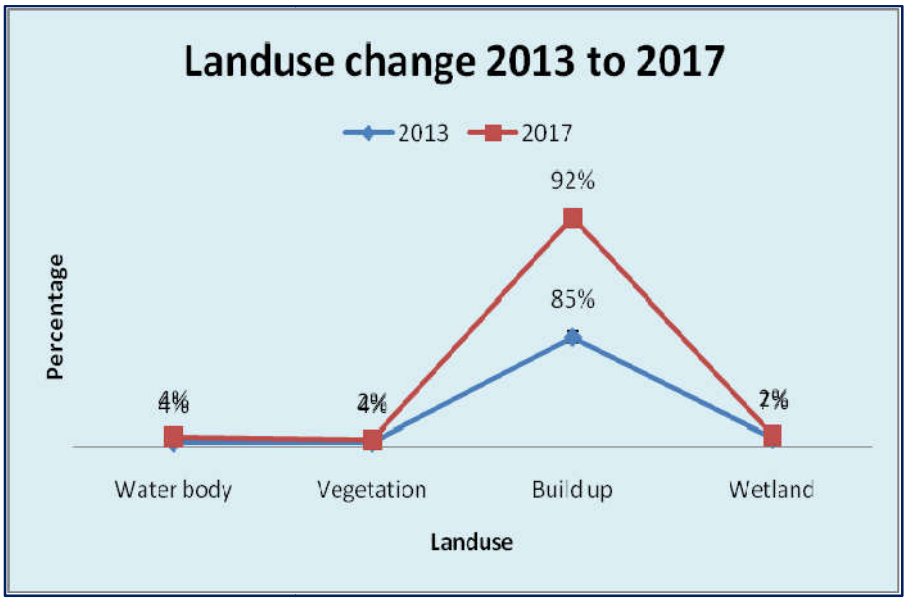


Fig 5.6 : Land use change 2013 to 2017

Based on Table 5.7 The examination of land use changes during last 20 years period (1998–2017) revealed significant reduction of natural lands and consequent increase in urban land. The analysis of the nature of change showed that built-up areas grew by 65% from 27% to increase 92% which area follow up 1998 to 2017. Similarly, the increment of urban area was 363602. the below table show gain and loss of land use variation which are showing every 5 year 1st 5 year land use change are slow but next 5 year means 2003-2007 are gradually increasing urban build up area, on the other hand another land use for example vegetation, wetland and water body gradually loss and decreases. after all we show here normally every 5 year build up area are gradually increase and another land use decrease. the over population are depend on the land use expansion. Table 5.7 and 5.8 show over all land use expansion of built-up areas between 1998 and 2017, the growth of human landscape and subsequent reduction of natural landscape, which clearly implies the magnitude of anthropogenic activities.

Table 5.7: Land use change from 1998 to 2017 (difference between year)

Land use	1998(Sq. m)	Percentage	2003(Sq. m)	Percentage	Difference between 1998 and 2003	Difference	2007(Sq. m)	Percentage	Difference between 2003and 2007	Difference	2013(Sq. m)	Percentage	Differencebetween 2007 and 2013	Difference	2017(Sq. m)	Percentage	Differ2017	Difference
Water body	90900	23	43474	11	-11.9964961	-47426	31617	8	-3.00008856	-11857	15808	4	-3.99996964	-15809	15808	4	-0.00010121	0
Vegetation	55390	14	39522	10	-4.01289725	-15868	31617	8	-2.00013663	-7905	15808	4	-3.99996964	-15809	7904	2	-2.00001012	-7904
Build up	142279	36	276654	70	34.00551007	134375	304319	77	7.000111331	27665	335937	85	8.002292471	31618	363602	92	6.997783436	27665
Wetland	106709	27	35569	9	-17.9961167	-71140	27665	7	-1.99988614	-7904	27655	7	-0.00235319	-10	7904	2	-4.99767211	-19751

Table 5.8 : Land use change from 1998 to 2017 (show percentage)

Land use	1998(Sq. m)	Percentage	2003(Sq. m)	Percentage	2007 (Sq. m)	Percentage	2013(Sq. m)	Percentage	2017(Sq. m)	Percentage
Water body	90900	23%	43474	11%	31617	8%	15808	4%	15808	4%
Vegetation	55390	14%	39522	10%	31617	8%	15808	4%	7904	2%
Build up	142279	36%	276654	70%	304319	77%	335937	85%	363602	92%
Wetland	106709	27%	35569	9%	27665	7%	27655	7%	7904	2%

Over all Land use Change Situation

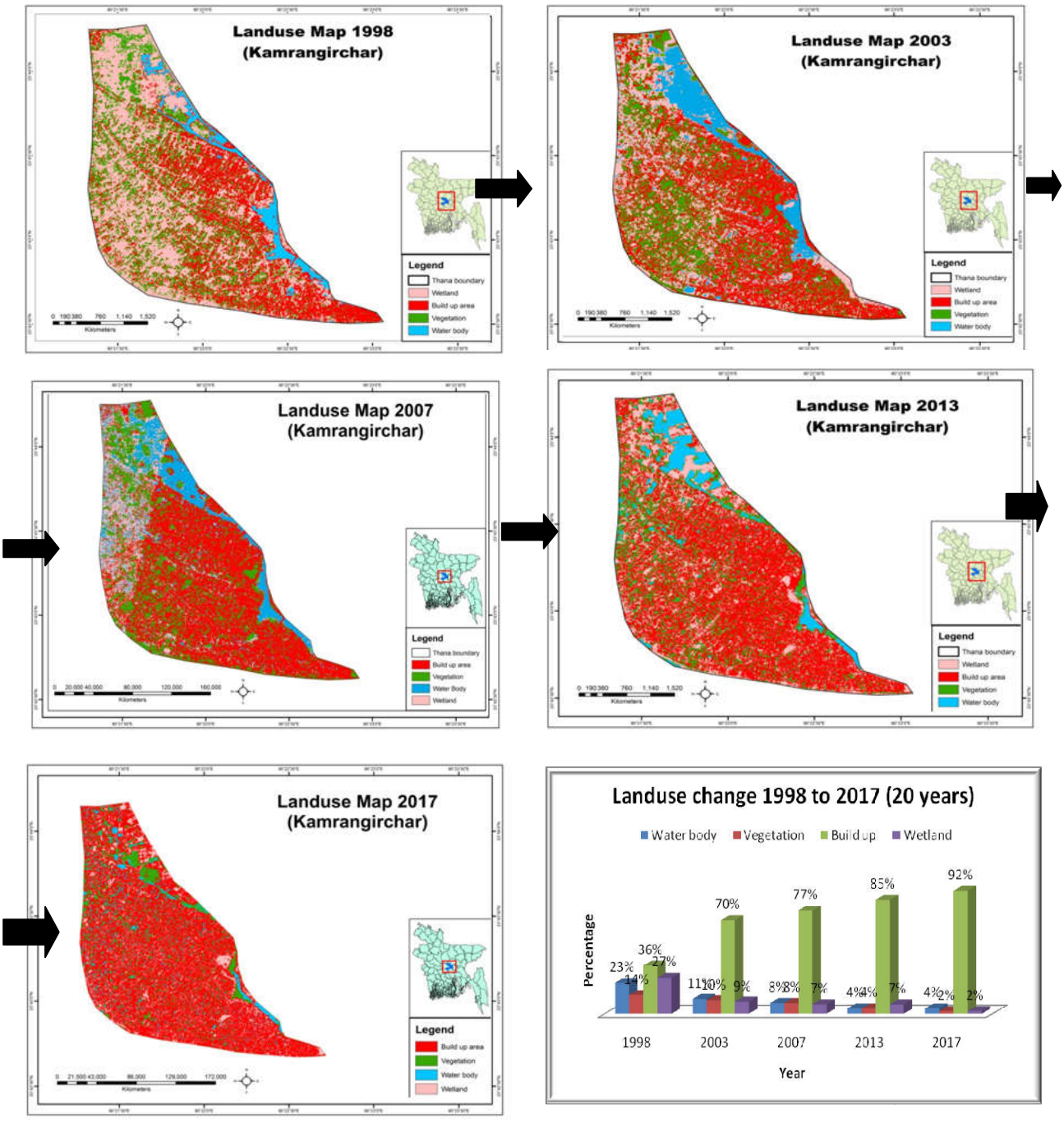


Fig 5.6 : Land use change 1998 to 2017

The GIS analysis also revealed that the area occupied by water bodies decreased by 10%, wetlands by 25%, and vegetation by 12% between 1998 and 2017. Another significant change was the decline in wetlands and vegetation from 1992 to 2017. In 1998, wetlands and vegetation occupied 28% and 13.7% of the total study area, but by 2003, these areas had declined to 21.7% and 5.5%, respectively. Conversely, built-up areas increased in size by 37.9% in the period from 1998 to 2017. A slight increase in cultivated land (6.7%) was also observed in this period. The decline of vegetation and wetlands was clearly due to intensification of urban development in the kamrangirchar area, particularly through the process of suburban development. As shown in Table 5.8, there has been a marked change in LU over the 20-year study period. The post-classification comparison of change detection was carried out using GIS, producing change maps for understanding the spatial pattern of change between years (Fig.5.1). Table 5.7 shows a summary of the major LU conversions, namely information, which occurred during the study period. As indicated, the majority of urban land was acquired by converting areas that were previously agricultural land, vegetation, water bodies or low-lying areas, suggesting the existence of increased pressure on natural resources in research area to meet the increasing demand for urban land. The study revealed that the urban expansion in Kamrangirchar has been relatively rapid and has resulted in widespread environmental degradation.

5.14 Conclusion

Bangladesh has experienced rapid urban population growth in recent decades; the population numbered 14.1 million in 1981, 22.5 million in 1991, 31.1 million in 2001 (BBS, 2001) and 35 million in 2005). Rapid urbanization has led to the transformation of rural areas into developed areas, and it has been estimated that more than 809 km2 of agricultural land is converted to cities, roads and infrastructure annually (BBS, 1996). The decrease in agricultural activities, the largest sector of the Bangladeshi economy, and the concomitant loss of cultivated land is likely to contribute to landlessness, food shortages and jeopardize the economy (Ahmad, 2005). Dhaka, the capital of Bangladesh, is expected to be the third largest city in the world by 2020 (World Bank, 2007) and the rapid urban

growth experienced by the city in recent decades is one of the highest in the world (Islam, 1999, 2005). Urban expansion of Dhaka was slow in the 1950s, but strong growth followed the independence of Bangladesh in 1971 (Chowdhury & Faruqui, 1989). The considerable growth observed in the population of Dhaka is thought to have occurred in response to large-scale rural–urban migration, which has contributed, significantly to the increased rate of urbanization (Islam, 1996).

Driver of Land use change

6.1 Introduction

The many ways that people have used and managed throughout the history have emerged as a primary cause of land cover change around the world. Thus, land use and land management increasingly represent a fundamental change in the Global environment. Land use change is driven by a combination of socio-economic (e.g. income levels, infrastructure, demographic structure), political and biophysical (e.g. soil and climate characteristics) factors(Hasan & Mulamoottil, 1994), the so called land use drivers explained that the major determinants of land use and land use change are physical, climatic and demographic factors, level of poverty, and economic and institutional structure of the resource use. Usher (1992) also pointed out that human economic and social conditions influence pattern of land use, and that technological innovation affect how land is managed.

These all are changing facets of human societies that the way land is used for the benefit of individual owners or for the members of the society. Land cover modification and conversion are driven by the interaction in space and time between biophysical and human dimension Social and economic forces often dictate how land is used. Human use is the important factor in land cover modification and conversion than natural change.

Change of population is often investigated as one of the driving forces of global land use change (Heilig, 1994). Many land use change and its ultimate causes directly responsible for population growth (Dale et al., 2000). Demographic effects can be aggravated or dampened by the effect of other forces driving global land use change, such as technological innovation, change of lifestyle or political decisions.

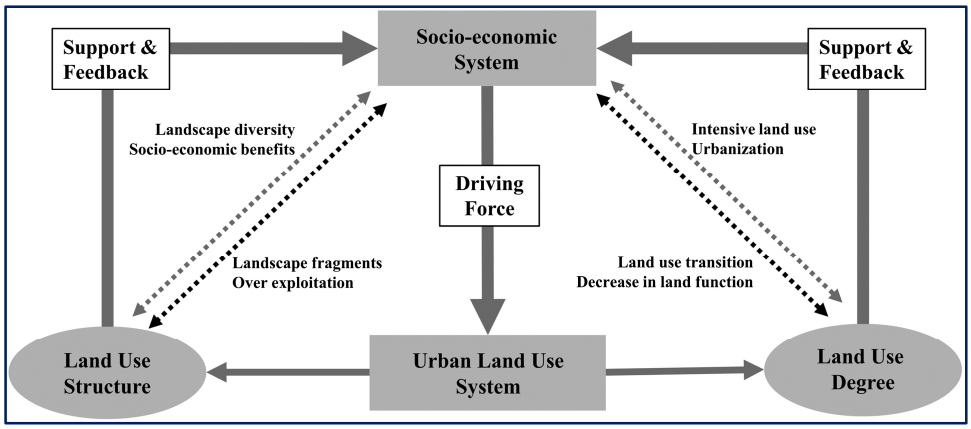


Fig 6.1: Driving force of land use change ***Source: ASCE Library***

6.2 Existing land use pattern and activities

Existing land-use patterns cannot be considered of driving forces, but have a very dominant influence on future land use. The time dynamics of the changes in land-use are very slow and therefore the existing land use is a very important given for future land use. Further the likelihood that a land use change occurs at a location depends on the existing land use. It is, for example, rather unlikely that existing areas which are highly valued, either ecologically or economically (high sunk costs), will easily transform their functionality. This situation is often represented as geographical inertia. Secondly, existing ecological, cultural, water and transport networks strongly influence the choice of location for new developments, as do residential and commercial activities. However, with the expanding stocks of residential and commercial buildings, over the years, dynamics increasingly take place in the way of changes or transformations within building stocks at existing locations.

6.3 Driving forces of land-use change sector wise explain

Within the research area and overview of the drivers of land-use change, per sector, was presented in sector-specific notes written by leading experts in the field. The short descriptions in this section are based on these notes, for more detail we refer to :-

- ✓ Driving forces of land use change behind housing demand and residential land use
- ✓ Driving forces of land use change behind land-use for employment
- ✓ Driving forces of land use change behind future land use for agriculture
- ✓ Driving forces of land use change behind changes in land use for nature and use of land for water

6.3.1 Driving forces of land-use change in housing

Historically, housing market developments are largely explained in connection to demographic developments, such as birth rate, life expectancy, household formation and dissolution, and international migration. The variety in types of households is increasing due to factors, such as individualisation and an increasingly multi-ethnic society. A rather recent phenomenon in some Dutch regions is demographic shrinkage instead of growth as a driver of possible land-use change. These developments call for increased detailed information on the types of households, to address differences in their preferences, and increased regionalisation, to address the differences in the regional challenges (such as pressure on the housing market due to growth around Amsterdam, versus shrinkage in some areas in the periphery).

Another set of increasingly important driving factors are economic and financial drivers, such as income (including an increase in double-income households) and capital development. Many of the housing policy options of the government are also financial instruments, such as taxation on housing transfer, fiscal support (tax deductions) for house owners, liberalising rents, shift in housing subsidies for people on low incomes, from rental housing only, towards all housing. To create a model simulation of these drivers, the financial position of households, housing prices and financial interference of the government must all be explicitly entered into the model.

Changes within the existing housing stock are becoming increasingly important, such as urban renewal or gentrification, and urban facilities and qualities. In addition, the relationship between supply and demand is changing and becoming more complex, as a result of increased ownership of second homes, an unclear distinction between houses

with a purely temporary, recreational function and regular houses, and a more short-term occupation of houses (for example, seasonal or short- term workers from Dhaka city).

6.3.2 Driving forces of land-use change in Wetland and Fellow land

The changes in wetland use can be distinguished as:

1. Conversions from wetland to urban land or nature areas
2. Changes in type of wetland variations
3. Changes towards multi-functional land use, such as wetland use for business or pleasure, combined with recreational or nature functions.

In general, conversions of wet or bare land are driven by exogenous developments outside the urban sector, such as urbanization or nature development. The changes in agricultural production are driven by worldwide developments on the market for economic products, environmental regulations and technological innovations. The change towards multi-functional bare land use varies per region, and is driven by regulations and subsidies for nature and landscape management, and by the attractiveness of different opportunities for farmers to increase their incomes.

Demographic and economic developments in the Dhaka city result in a need for more urban land, which is won through the conversion of crop land, mainly affecting crop farming and cattle farms. Worldwide demographic and, especially, economic developments (for example, rising incomes in Dhaka and Chittagong) result in a growing demand for crop products. A worldwide increase in welfare may also result in an increasing demand for horticultural products. However, the amount of additional land needed in this sector will be modest, as horticultural productivity per hectare is very high, and is still increasing.

6.3.3 Driving forces of land-use change in employment

In the analyses, land use related employment was divided in two components which are influenced by driving forces differently, namely the spatial distribution of employment and the land use per worker. For the five economic sectors, the spatial distribution and density

of employment differentiates strongly. Table 3 presents the differences in land use per economic sector. The agricultural sector is not included, as it has already been discussed in the previous section.

The land-use characteristics of the sectors show that a change in economic structure, for example, from industry to final or public services, affects the density and location of employment. At the local level, many sectoral processes of concentration and de-concentration occur driven by different locational factors, such as accessibility and environmental regulations.

6.3.4 Driving forces of land-use change in nature

The driving forces behind changes in land use have been grouped into societal, economic and physical drivers, and policy drivers (see Table 6 for a detailed overview of the drivers). The demographic and societal changes affect the size, composition and behaviour of the population, from which the demand for nature areas stems. An important driving force is the increasing demand for nature areas to be used for outdoor leisure activities or for short stays (e.g. camping). This trend offers opportunities for nature, as more agricultural land may be converted into it. However, this increasing human activity may reduce the quality of nature land use, for example, through overcrowding or loss in biodiversity.

Changes in the agricultural sector have a large impact on the size and quality of nature areas. In this sector, economically driven scale increases negatively affect the size of nature areas, as small natural elements in the landscape disappear, and larger barriers are created between nature areas. Urbanisation, driven by economic and demographic developments (as economic growth and reduced household sizes), is contributing to further fragmentation of nature areas. Even stronger is the impact of infrastructural construction, as it confines and cuts off nature areas, which leads to further deterioriation of habitats. In addition, both urbanisation and transport contribute to noise, air and light pollution in these areas, which may affect biodiversity.

6.3.5 Driving forces of land-use change for water

The underlying driving forces behind land use for water (namely societal, economic, physical and policy drivers) are similar to those for nature, see Table 7 for a detailed overview of the drivers. The interaction between land use and water consist of direct impacts on land use, such as areas reserved for rivers or water storage, and indirect impacts of water affecting land use via hydrological systems. Hydrological conditions support certain types of land use (ecological systems) and these downstream conditions can be protected by upstream regulations.

Appreciation of water for recreational purposes in residential environments and as landscape elements is increasing, which results in increasing use of land for water. For example, housing prices increase near the waterfront. Such trends can be combined with the demand for additional water storage from intensified local rainfall in and around urban areas. Economic and population growth in regions, increasing the potential flood damages, can result in stricter guidelines for water safety to protect these regions.

6.3.6 Urban Growth with Population increases status

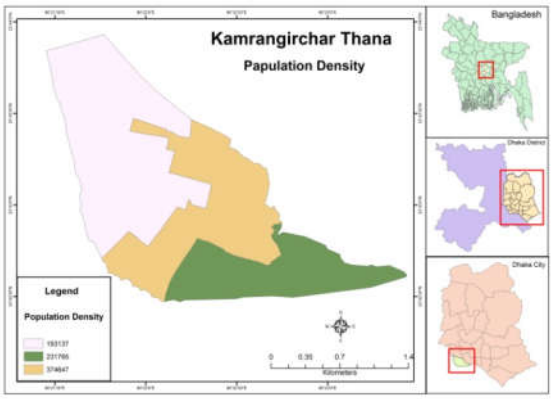
To explore the associated drivers for urban growth, population data were selected because population is a very active factor in urban development. Population data in census years close to the available Landsat data acquisition dates were obtained from Statistics Dhaka. Census population is showed in Table 6.1. Seven years of population data were analyzed from 1971 to 2017 (Statistic Bangladesh, 2011) and the 2017 population was estimated based on the 2017 population (Statistics Bangladesh, 2017. The percentage of population change between two adjacent census dates 133 was calculated by subtracting population in adjacent census dates divided by the population of earlier census date.

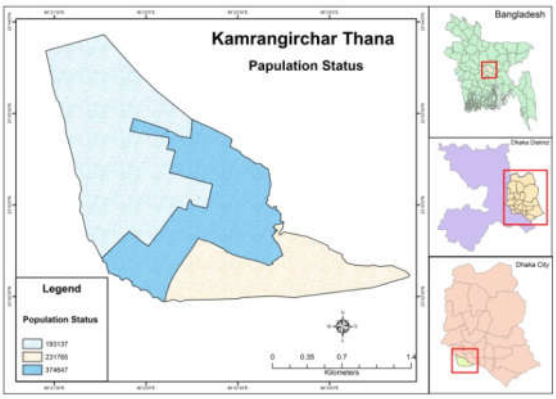
Table 6.1 Population change from 1974 to 2017

Year	Population	Density
1974	45500	12534
1981	95250	28322
1991	180350	49683
2001	270200	74735
2011	380450	140807
2014	520450	143374
2017	772550	212823

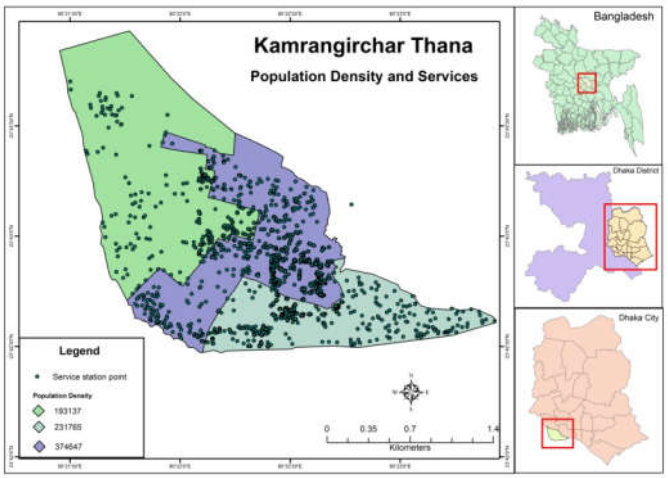
Sources: Council office and BBS

The census dates do not completely coincide with the Landsat imagery dates. In order to associate urban change with census population change, the amount yearly new development was selected to correspond with the nearest percentage of population change. During the census interval from 1974 to 1981, the closest urban changes are change from 1974 to 1981 and change from 19781 to 1991. The yearly new developed (annual growth) is calculated from total amount of new developed from these two intervals divided by the period from 1974 to 1991. From 1981 to 1991, the urban change interval from 1981 to 1991 is closest to the census dates. Yearly new development from 1981 to 1991 was associated with both the census interval from 1991 to 2001 and the census interval from 1991 to 2001. The association between population change and yearly new developed is shown in.





Map 6.1: Population Density (*Sources: compile by Author)* **Map 6.2: Population Status *compile by Author***



Map 6.3: Population Density and Services (*Sources: compile by Author)*

6.3.7 Driver of Land use change in Kamrangirchar



Fig 6.2: Driving force/Causes the land use change kamrangirchar

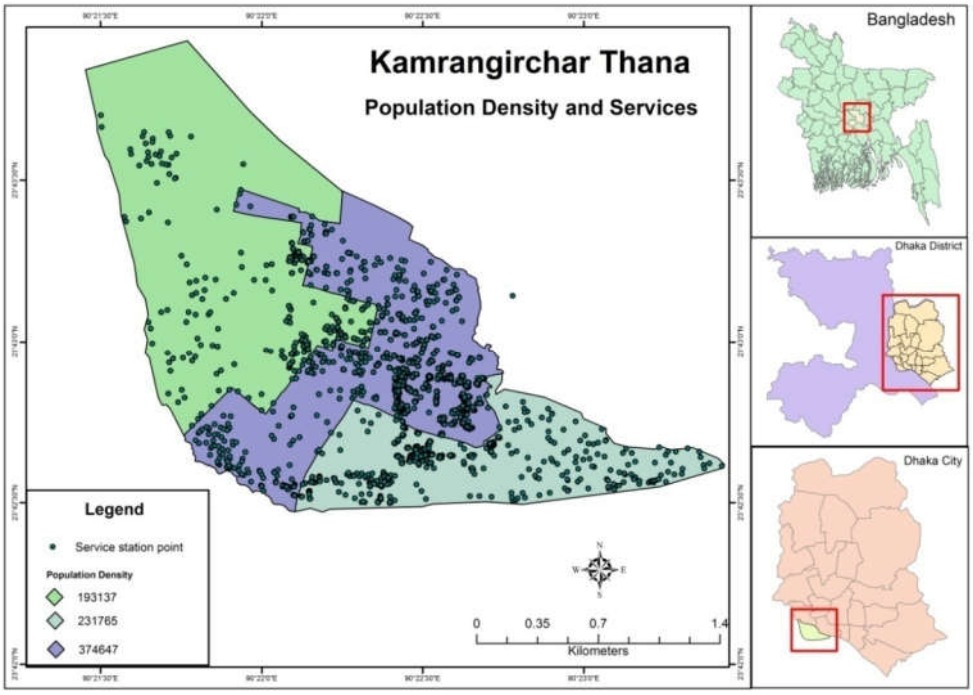
(Sources: picture online and edit compile by Author)

6.4 Driving Forces behind Urbanization

The research area shows a rapid increase of population with increase of net population density. The factor acting behind is the scarcity of land in the core city. Especially, low income people find accommodation here at cheaper rent and close vicinity to their work places. Land price is still lower here compared to core city due to flood risk and unavailability of municipal services and access of the poor to the main city. As a consequence lower and lower middle income people can afford small plots here.

6.4.1 Spontaneous Development and low living cost

Some major land filling projects have undertaken within the project area. Haphazard land filling increasing the frictional surface and further reduce the velocity of flow. As a consequence, this is creating the problem of drainage congestion especially during the



Map 6.1: Services station with population Density (*Sources: compile by Author)*

Rainy season. Land grabbers are sometime filling the natural drainage channels and khans not keeping in mind about the drainage congestion. This illegal land filling is aggravating the situation.

Development control function is very poor in the project area. With present capacity RAJUK cannot

Oversee or pro-act to guide and steer development in desired areas of urban expansion. This resulted in:

- Un-necessary invasion of agricultural land by urbanization.
- Non-conforming uses are found everywhere.
- Residential areas are being invaded by industries.

6.4.2 Transportation

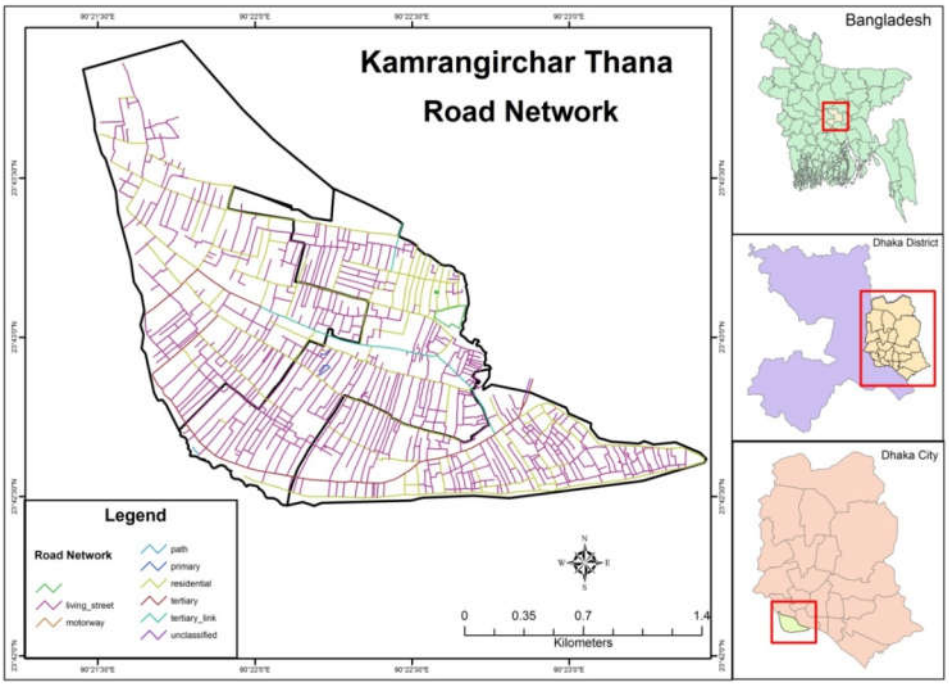
a. Road

The entire area lacks systematic and planned road network. No road network plan was ever drawn up for this high intensity development area. As a result narrow and unplanned meandering roads have been developed spontaneously by the community efforts. If this trend continues then there will be no scope for future intervention. Due to high demand for land by a fast growing economy, rapid development is taking place in the area without considering the suitability of road network and quality. Since the investors have little or no option, they are forced to choose lands on narrow and low standard road. Many existing roads have been found to be narrow and meandering that poses as impediments in smooth movement of vehicular traffic.

Table – 6.1 : Road Standard for kamrangirchar

SL No.	Road Category	Type	Length Meter
1	Primary Road	Type-1	5010.82
2	Primary Road	Type-2	3090.63
3	Primary Road	Type-3	3200.48
4	Secondary Road	Type-1	2450.39

Sources: Rajuk Yearly report 2016



Map 6.2: Road Network Kamrangirchar (*Sources: compile by Author)*

b. Transportation Problem versus Urban Land Use

The plan would not be successful if there is no balance between land use and transport planning. Many of the transportation problems is emanating from the conflict in the landuse. It is found that congestions are created due to the land use along the side of the major roads. Moreover, linear development along the major road substantially reduces the efficiency of a road. Roads are also constructed with complete disregard to the projected generation of trips. Conflicting land uses also result in unnecessary congestion which could be otherwise avoided. Commercial land use should not be allowed along the major roads as they generate traffic congestion.



Fig: 6.3: Transportation problem Kamrangirchar *Sources: oguevisitarem*

6.4.3 Utility Services

In the study area are very limited utility services are available. Utility services such as water, gas, and sewerage and garbage disposal are available only in the areas belonging to the eastern part of the embankment. The western part of the embankment is deprived of most of the utility services.

a. Electricity

From the survey and discuss, it was found that 40% of households do not have any electricity. 60% households have electricity, but the service is not very good. Only 2% households reported to have good service, whereas majority (85%) reported the service to be of medium quality followed by 9% who considered the service as bad.

b. Water Supply

Only a small part of the planning area has tap water supply, the rest depend on hand tube-wells. Water scarcity severely affects the area particularly during the dry season. From the survey, it was found that 40% households termed the water supply service as absent, followed by 7% who consider the service as of medium quality.

c. Gas Supply

Only a small part of the study area has gas connection. Very recently gas pipes have been laid to bring the middle part (Char Kamrangi and Bagh Chand Kha mouzas) of the area under gas coverage. The non-existence of the service in the area has been revealed by our survey where 93.5% households termed the service as absent followed by 5% who regarded the service as good and 1.6% who considered the service as medium quality.

d. Sanitation

Shortage of sanitation facilities is another major problem of the area. From household survey, it is found that 30% households have pucca sanitary arrangements followed by 40% who have kutcha sanitary facilities and the rest 30% have none, which is a possible source of health hazard.

e. Drainage

In the study area, drainage is a serious problem because there is no organised and planned drainage system. From household survey, it is gathered that only 35% households have some drainage facility and the rest 65% have no such facility. Of those having the drainage facility, only 210% have pucca drains.

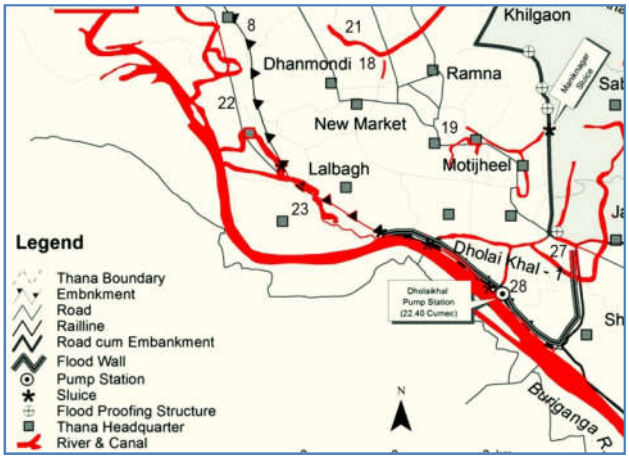


Fig: 6.4: Drainge and Canal of Kamrangirchar ***Sources: The daily sun***

f. Solid Waste Disposal

According to the survey results, the waste management facility in the project area is not encouraging. No organised waste management facilities have been found in the project area even in the DCC part. About 85% of the households dump their household wastes just outside the household and 10.88% households dump in dustbin nearby. Only 5.12% household's get community based collection facilities



Fig: 6.5: Kamrangirchar solid waste disposal ***Sources: The daily observer***

6.4.4 Amenities and Services

a. Educational Facilities

i. No public or private university
ii. No medical college
iii. No national level school/college

b. Market Facilities

No hat and bazaar has been found in the study area formally provided by authority. Only few small daily kitchen markets have been found in planning area.

c. Community Facilities

There exist several religious facilities in the Location-2 area but there is great dearth of community facilities like Hospital/Clinic, fire service station, post office, police station, power plant, and refueling station etc are also available in the project area. Problems of community facilities are summarized below:

6.4.5 Environmental Concern

a. Water bodies

There are plenty of water bodies like pond, ditch, marshy land and khal in study area. With urbanization and industrialization through this project, many ponds and ditches will be lost for land filling by the owners for increasing land value due to human pressure, settlement and development.

c. Bio-diversity

Urbanization like roads, infrastructure development, housing, commercial places, industrialization etc. will replace the existing green natural environment to man made environment. Trees will be cut down, water bodies will be filled up and polluted; birds and fishes will lose their habitats and as a result a big loss of biodiversity will happen for urbanization process in the project area.

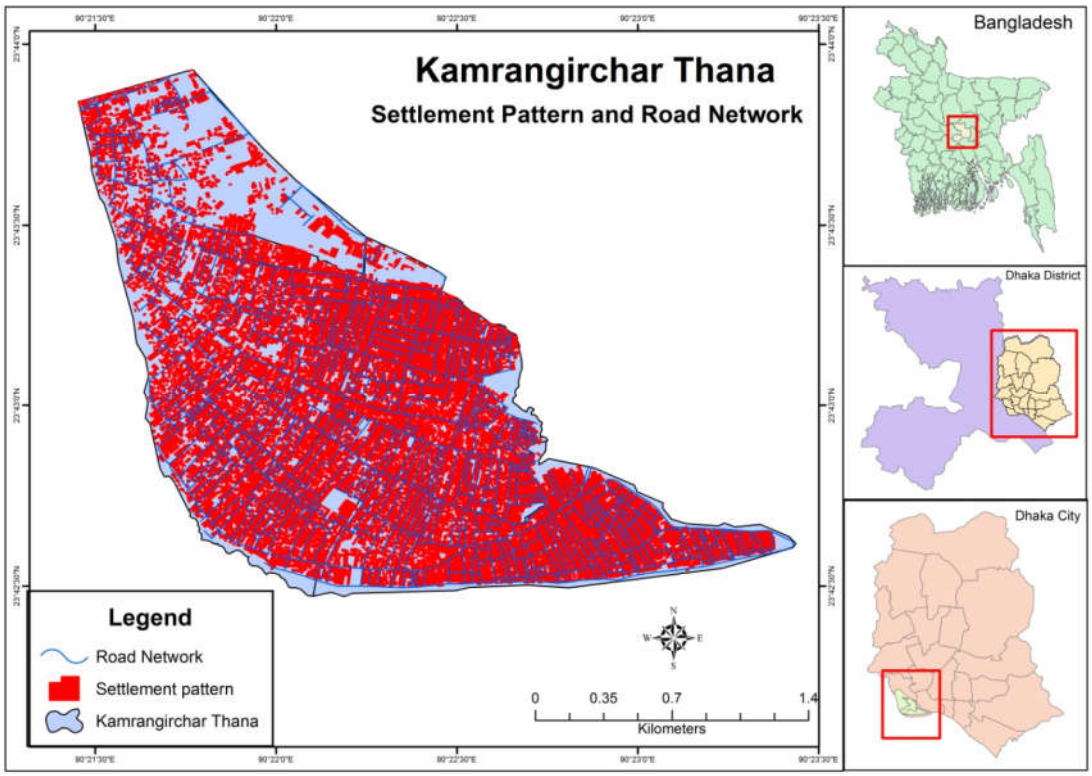
d. Potential Hazards

Groundwater is replenished or recharged through surface water seeping from lands surface, streams or lakes into the ground or through precipitation percolating into the

ground. For the groundwater table to stay at the same level, the amount of recharge must equal the amount of discharge. It is reprehensible that vested quarters or groups all over the planning area make offence by diminishing the arable lands, grabbing lands by filling low lying areas, encroaching rivers, lakes, khals, etc. Indiscriminate exploitation of ground water by dyeing industries is resulting in the lowering of ground water table which will have negative impact on environment It is not worth mentioning that urbanization poses a threat to our groundwater supply.

6.4.6 Shelter and Settlement

Owing to ineffective development control measure, indiscriminate and unplanned growth of Settlements has become a common phenomenon. It has been found that new areas are brought under settlements without adequate provision of infrastructure and services. On the other hand, it has become very difficult to provide secured shelter to the urban poor at their affordable prices. The majority of the people of the project area are grouped in the middle and low income range and they are unable to buy land in the established urban areas. As a result, they are finding shelters in remote areas without basic services including access facilities.



Map 6.3: Settlement Pattern of Kamrangirchar ***Sources: Compile by Author***

6.5 Main challenges for the new land-use control

So far, this paper has given an overview of the driving forces behind land-use change for the main land-consuming sectors. As was the research objective, this effort was part of a larger designing process resulting in the specifications for a new Dutch land-use model for the Netherlands Environmental Assessment Agency (PBL). This final section discusses the main challenges for a new land-use model, reflecting the main and upcoming driving forces and current state of practice in these models.

Based on a review of the driving forces, the list below summarizes the main challenges for a new land-use model:

- Shifting focus from modeling quantity (houses, office space, etc) towards quality. Such a shift includes more attention for modeling of existing built-up areas and processes of transformations or renewal within these areas. Traditionally, land-use models at PBL focus on green field developments. In addition, more attributes will have to be modeled, for example, ownership;
- Increasing regional diversification, as it is expected that in the coming decades the Netherlands will face a pattern of growing and shrinking regions, in terms of population and employment. These processes will also have an impact on the functionality of areas, as they affect the potential for large-scale agriculture, nature development, recreation (day recreation, and holiday homes) and services. Traditionally, land-use models focus on growth, and diverse land-use claims are allocated to scarce land resources;
- Modeling land use (e.g. residential), objects (e.g. houses) and actors (e.g. households) in a much more integrated way. Especially, more attention for the modeling of actors is needed, as many driving forces mentioned in this paper influence the segments or behavior of households, companies and farmers. For example, the composition of households and companies is influenced by (company) demographic processes and changes in economic structure, while their behavior is influenced by income developments, financial incentives and taxes, and societal values. Changes in the

segments or behavior of the actors will be reflected in different land-use demands, densities of land use (e.g. number of households per hectare) and changes at different locations (e.g. suburban vs. urban neighborhoods);

- Climate changes affect physical conditions (e.g. rising sea levels, periods of intensified rainfall and drought, increasing seepage of salt water) in Netherlands, and, therewith, land use (quantity and quality) of nature water and agriculture and flood risks for urbanized regions along coasts and rivers. The water system plays a crucial role when calculating the impacts of climate change or addressing the effectiveness of adaptation strategies. Therefore, the interactions between water and land use should be included much more in a new land-use model;
- Energy transition, driven by climate change mitigation policies and high energy prices, is an important and sensitive scenario variable, affecting land use of different sectors in diverse ways. Land can be used directly to produce energy (windmills, biofuels, etc.) and to distribute it. The indirect impacts of changes in energy, for example through mobility or housing costs, can potentially be large, because it

6.6 Conclusion

Using a GIS and RS tools, this study quantitatively analyzed the spatial changes of land use characteristics as well as their differences and driving forces in Kamrangirchar. From 1998 to 2017 rapid urbanization contributed to great land use changes for cropland, wetland, vegetation. These changes were related to the level of economic development, public policy that was carried out, and people's recognition of the importance of land resources. In Kamrangirchar, the most active land use change was in Dhaka city, followed by others area of Dhaka city. Both area were located in prime geographical locations, which were favorable for receiving Dhaka capital city and for economic development. To some extent, land reclamation research have contributed to a decrease in water body area.

7.1 Introduction

Land and its uses are essential to all human communities. This is particularly so for urban communities, where many people are directly dependent on land for their livelihood, and the way land is used has a central role in defining the identity of an area and its community. Changes in land use change can have a profound impact on the personal, family, work and social lives of people living in urban communities, as well as those living in urban and regional towns. Many rural regions across Dhaka have experienced rapid land use change in recent decades. The region extending from the 'Kamrangirchar' in Southern part of Dhaka city. is no exception, with multiple types of land use change occurring in recent decades. These have included expansion of plantation forestry, increase in rural residential properties, increase in cropping, and decrease in wool production in some areas, increase in prime lamb production, and a range of changes to the dairy industry in different parts of the region.

7.2 Impact on Land use change

Major land use changes have occurred in the Kamrangirchar during the past 20 years. The total area covered bare land, water body and vegetation which are decreased from 1998 to 2003; however the total area of developed land increased by 100 acres or 10%. What is the potential economic, social, and environmental impact of land use changes

7.3 Socio-economic Impact

Land is one of three major factors of production in classical economics and an essential input for housing and food production. Land use is the backbone of agricultural economies and it provides substantial economic and social benefits. Land use change is necessary and essential for economic development and social progress. Land use change, however, does not come without costs. Conversion of farmland and forests to urban development reduces the amount of lands available for food production; Soil

erosion and other soil degradations associated with intensive agriculture and deforestation reduce the quality of land resources and future agricultural productivity.

Urbanization presents many challenges for farmers on the urban fringe. These benefits will disappear when neighboring farms are converted to development. List down the socio economic impact on land use change:-

7.3.1 Forest Reduce for urban development

Conversion of forests to urban development reduces the amount of land available for food production. Land-use change can be a factor in CO2 (carbon dioxide) atmospheric concentration, and is thus a contributor to global climate change. IPCC estimates that land-use change (e.g. conversion of forest into agricultural land) contributes a net 1.6 ± 0.8 Gt carbon per year to the atmosphere. For comparison, the major source of CO2, namely emissions from fossil fuel combustion and cement production amount to 6.3 ± 0.6 Gt carbon per year.



Fig 7.1 : Land cover image ***Sources: Google Earth (Compile by Author)***

7.3.2 Soil erosion and soil degradations

Soil is the earth's fragile skin that anchors all life on Earth. It is comprised of countless species that create a dynamic and complex ecosystem and is among the most precious resources to humans. Increased demand for agriculture commodities generates incentives to convert forests and grasslands to farm fields and pastures. The transition to agriculture from natural vegetation often cannot hold onto the soil and many of these plants, such as coffee, cotton, palm oil, soybean and wheat, can actually increase

soil erosion beyond the soil's ability to maintain itself. Half of the topsoil on the planet has been lost in the last 150 years. In addition to erosion, soil quality is affected by other aspects of agriculture. These impacts include compaction, loss of soil structure, nutrient degradation, and soil salinity. These are very real and at times severe issues. Soil erosion and soil degradation associated with agricultural, building construction and deforestation reduce land quality.



Fig 7.2: Soil Erosion Sources: *slideshare.net*

7.3.3. Open space growing down

As urbanization leads to rapid decline in open spaces across our cities, a rethink leading to enhancement of urban biodiversity and maintenance of essential ecosystem services is a must to ensure a sustainable future for all. Urbanization is ever increasing - urban sprawls are eating away much of open spaces and environmental degradation continues to be a major problem in many cities as the open spaces available per capita are decreasing. By 2030 more than 60% of the world's population is expected to live in urban areas with the figure expected to touch 70% by 2050 (United Nations, 2016). Consequently urban sustainability will be a critical challenge, particularly for developing nations like Dhaka city. Conversions of forests to urban development reduce the amount of open space and environmental amenities for local residents.

7.3.4 Point out some socio economic impact of land use change

- Urban development patterns not only affect the lives of individuals, but also the ways in which society, community and organization.

- Urban development has encroached upon some rural communities to such an extent that the community's identify has been lost.
- Suburbanization intensifies income segregation and economic disparities among communities
- Excessive land use control, however, may hinder the function of market forces
- Land use regulations that aim at curbing land development will raise housing prices, making housing less affordable to middle– and low–income house- holds
- Land use regulation must a balance between private property rights and the public interest ion.

As urbanization intensifies, agricultural and nonagricultural 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 labor from nonagricultural sectors may raise farmers' labor costs. When the total amount of farmland falls below a critical mass, the local agricultural economy may collapse as all agricultural supporting sectors disappear.

Urbanization also presents important opportunities to farmers. Emergence of a new customer base provides farmers new opportunities for selling higher value crops. Urbanization has changed rural communities in many places. In some rural areas, urban sprawl has encroached to such an extent that the community itself has been lost. In other areas, the lack of opportunities has turned once viable communities into ghost towns. Urban sprawl in- testifies income segregation and economic disparities between urban and suburban communities.

Suburbanization brings urban and rural people and problems together. Most land areas are rural, most watersheds are in rural places, and most of the atmosphere exists above

rural space. Urbanites and agencies have legitimate concerns about the use and condition of rural natural resources, just as rural populations have legitimate concerns about urban–based pressures on the natural world. These shared interests in the natural environment have important economic, social, and political implications, which may profoundly impact society in the future.

7.3 Environmental Impacts

Land use change is arguably the most pervasive socioeconomic force driving changes and degradation of ecosystems. Deforestation, urban development, agriculture, and other human activities have substantially altered the Earth landscape. Such disturbance of the land affects important ecosystem processes and services, which can have wide–ranging and long–term consequences.

Farmland provides open space and valuable habitat for many wildlife species. However, intensive agriculture has potentially severe ecosystem consequences. For example, it has long been recognized that agricultural land use and practices can cause water pollution and the effect is influenced by government policies. Runoff from agricultural lands is a leading source of water pollution both in inland and coastal waters. Conversions of wet- lands to crop production and irrigation water diversions have brought many wildlife species to the verge of extinction.

Forests provide many ecosystem services. They support biodiversity, providing critical habitat for wildlife, remove carbon dioxide from the atmosphere, intercept precipitation, slow down surface runoff, and reduce soil erosion and flooding. These important ecosystem services will be reduced or destroyed when forests are converted to agriculture or urban development. For example, deforestation, along with urban sprawl, agriculture, and other human activities, has substantially altered and fragmented the Earth's vegetative cover. Such disturbance can change the global atmospheric concentration of carbon dioxide, the principal heat–trapping gas, as well as affect local, regional, and global climate by changing the energy balance on Earth's surface.

Urban development has been linked to many environmental problems, including air pollution, water pollution, and loss of wildlife habitat. Urban runoff often contains nutrients, sediment and toxic contaminants, and can cause not only water pollution but also large variation in stream flow and temperatures.

Habitat destruction, fragmentation, and alteration associated with urban development have been identified as the leading causes of biodiversity de- cline and species extinctions. Urban development and intensive agriculture in coastal areas and further inland are a major threat to the health, productivity, and bio- diversity of the marine environment throughout the world.

Private trusts and nonprofit organizations play an important role in land conservation. For example, the American Farmland Trust claims that it has helped to protect more than one million acres of America's best farm and ranch land. The Nature Conservancy has protected more than 117 million acres of ecologically important lands. How- ever, some has questioned whether private conservation efforts crowd out or complement public efforts for land conservation.

Land use and land management practices have a major impact on natural resources including:-

1. Water Pollution

Water pollution is one of the significant dangers to general wellbeing in Bangladesh. Drinking water quality is inadequately overseen and checked. Bangladesh positions at number 86 among 142 countries with respect to drinking water quality. Drinking water sources, both surface and groundwater are debased with harmful metals and pesticides all through the nation. Different drinking water quality parameters set by WHO are every now and again damaged. Human exercises like uncalled for transfer of civil and mechanical effluents and aimless utilizations of agrochemicals in agribusiness are the principle factors adding to the crumbling of water quality. Microbial and substance contaminations are the primary elements mindful solely or in mix for

different general medical issues. This paper presents a detailed layout of water quality in Bangladesh with unique accentuation on significant poisons, sources and causes of pollution. The information introduced in this paper are extracted from different surveys and reports distributed in national and global journals.



Fig 7.3: Water Pollution buriganga river

2. soil Pollution

Soil pollution is defined as the build-up in soils of determined toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.



Fig 7.4: Soil Pollution buriganga river

3. Air Pollution

Air pollution is a mixture of solid particles and gases in the air. Car emissions, chemicals from factories, dust, pollen and mold spores may be suspended as particles. Ozone, a gas, is a major part of air pollution in cities. When ozone forms air pollution, it's also called smog.

Some air pollutants are poisonous. Inhaling them can increase the chance you'll have health problems. People with heart or lung disease, older adults and children are at greater risk from air pollution. Air pollution isn't just outside - the air inside buildings can also be polluted and affect your health.



Fig 7.5 : Air Pollution Source: The daily star

4. impact on plants and animals

7.3 Point out some Environmental impact of land use change

- Runoff from irrigation and household water is a leading source of water pollution both River and lake water.
- Draining wetlands for crop production and irrigation water diversions has had a negative impact on many wildlife species
- Irrigated agriculture has changed the water cycle and caused groundwater levels to decline in many parts of the world
- Intensive farming and deforestation may cause

1. soil erosion

2. soil degradations

- Deforestation adds to the greenhouse effect, destroys habitats that support biodiversity, affects the hydrological cycle and increases soil erosion, runoff, flooding.



Fig7.6 : urban flood, dhaka Source: the daily observer

- Habitat destruction, fragmentation, and alteration associated with urban development are a leading cause of biodiversity decline and species extinctions Land use regulation can take many different forms. The traditional command and control approach often involves zoning, density regulation, and other direct land use controls. Al- though these policies can be quite effective as regulatory tools, they could lead to substantial social welfare loss in the form of higher housing prices, smaller houses, and inefficient land use patterns.

  While federal spending on land– related conservation programs has increased substantially over the last twenty five years, the federal government has yet to articulate a clear vision of how land use should be managed. Most land use controls are in the hands of local governments in the United States, and the level of control varies considerably across counties and municipalities. Some local governments have few land use controls, while others are actively involved in land use planning and regulation.

  Land use regulation is a contentious issue in many communities, particularly those facing rapid urbanization. Proponents argue that land use planning protects farmland,

forests, water quality, open space, and wildlife habitat and, at the same time, increases property value and human health. Conversely, uncontrolled development will destroy the natural environment and long term economic growth. Critics of land use regulation call those fears overblown. They argue that urban development is an orderly market process that al- locates land from agriculture to urban use, and that governments tend to over regulate because they rarely bear the costs of regulation. The stakes are high in this debate. Any policy measures that aim at curbing urban development will ultimately affect a key element of the American way of life, that is, the ability to consume a large amount of living space at affordable prices. Policymakers must resist the temptation to attribute all “irregular” land use patterns to market failures and impose stringent land use regulations that may hinder the function of market forces. They should try to identify the sources of market failures that cause "excessive development" and address problems at their roots. Land use regulation must strike a balance between private property rights and the public interest.

7.5 Conclusion

This study integrates information from remote sensing, GIS and studies of environmental variables (e.g. land cover/use change, river flow, water quality, fecal and total counts and the incidence of geospatial indicaotor) to understand the environmental impacts of urban growth in Arequipa city, based upon many direct and indirect influences in the environment. Land use regulation can take many different forms. The traditional command and control approach often involves zoning, density regulation, and other direct land use controls. Al- though these policies can be quite effective as regulatory tools, they could lead to substantial social welfare loss in the form of higher housing prices, smaller houses, and inefficient land use patterns (Cheshire and Sheppard 2002; Walsh 2007).

9.1 Limitation of the Research

9.1.1 Collection of Satellite Images

To perform this type of Spatio-temporal analysis, it is important to select the satellite images of the same time interval. Again the spatial resolution of the images is important. For this research purpose, Landsat satellite images have been chosen that are only commercially available but can be found in free public-domain. Another reason for choosing these images is that the time interval is found equal 10 years of interval (1989, 1999, and 2009). The main problem of working with Landsat images is low resolution. The spatial resolution of Landsat Image is 30 meter [21]. IKONOS, QuickBird or other satellite images with higher resolution can be better option, but those images are commercial. Therefore due to limitations of resources, only free public-domain data have been used for this research.

9.1.2 Seasonal Variation

Another important point, while selecting satellite images, is seasonal variation. Seasonal variation is an important aspect for tropical countries like Bangladesh. The change in vegetation, wet land, low land and water body land cove types are evident due to different seasons. Therefore, in an ideal situation, satellite images of the same season are selected for this kind of research. But there exist some sorts of seasonal variation for Landsat satellite images collected for this research. The images collected for 1999 (November) and 2009 (October) are from the same winter season. But the image of 1989 (February) is from another season, summer. This kind of variation creates problems while preparing base maps for analysis.

9.1.3 Collection of Reference Data

The next limitation regarding this research is the collection of reference data or maps. The reference data are necessary for ground truthing purpose of the base maps (1989, 1999 and 2009) that have been prepared from the Landsat satellite images. But

reference maps of the respective years (1989, 1999 and 2009) are not available. Therefore the base maps of Dhaka city of the years 1987, 1995 and 2001, collected from Survey of Bangladesh (SoB), have been used for referencing purpose. Google Earth images (2010) are used as reference data for ground truthing the base map of 2009.

The present study is constrained by the lack of sufficient information and statistics. The present study some problem were faced. But this documentary data is not available. Satellite imageries are not also available and the price of digital copy of it is very high for a researcher.

9.1.4 The main limitations of my study are as follows.

- It has been difficult and expensive for students to collect data from the respective field.
- This data collected from various disaster sectors need a vast time and more expenses which is not possible for a student.
- It has been difficult to get exact information from relative institute. Data have been difficult to analysis.
- Our warning and forecasting system is weak and old technology dependent.
- Our shelter construction is poor to accommodate our hazard affected people
- Lack of proper awareness of Natural Hazard
- We have failed to proper institutional arrangements up to grassroots level.

9.2 Findings

9.2.1 Introduction

The major findings, limitation, Recommendation and evaluation system consists of asset of impact/outcome indicators, derived from the program immediate and mid-term goals and objectives to ensure effective assessment of progress and provide timely feedback for possible changes that might be required in the course of implementation due to unforeseen changes in the socio-economic context, as well as program strategy for Disaster Management. Input and output indicators in each sub-sector, crops, fisheries, forestry and livestock, community infrastructures, communication systems will enhance regular findings and evaluation of program performance, including identification of potential problems, limitation, and recommendation.

9.2.2 Findings

The prime aim of present study was to determine land use changing of the Kamrangirchar using remotely sensed data for the year of 1998, 2003, 2007, 2013 and 2017. For this study Landsat TM , ETM and OLI image and vector map (LGED and RAJUK) have been used. Based on the study, following remarks can be made.

The results of this research can be categorized as follows:

1) The research area experienced a series of new urban development periods with varied growth rates. Two peak new development periods occurred between 2007 and 2013 and between 2013 and 2017. Two periods with lower new urban development rates occurred from 1998 to 2003 and from 2003 to2007. Over the last 10 years, a relatively High urban growth rate in new urban development has occurred.
2) Kamrangirchar yearly new urban development periods seemed to be synchronized with the time of urban development backfill whereas the slower growth periods seem synchronized with times of outward urban expansion. The period of new urban

development and expansion appeared to be the period of urban scheme.
3) Urban development demonstrated a distinctly uneven spatial distribution in the stud area. Chak bazaar and Kamrangirchar regions account for most of the urban growth in the study, in which northern part of kamrangirchar is Keranigonj which are the most active and fastest growing areas.
4) Changes in population over different historical periods are associated with the speed of new urban development quite well. This indicates that population is an important driving force in urban development(Kalnay & Ming, 2003).

9.4 Recommendations

Development of Kamrangirchar should be regulated and steered to planned developments. A Detailed Area Plan to steer development in a prepared manner should be taken up and the area should be brought under Dhaka City Corporation. The Detailed Area build up Plan should include schemes to:-

1. Accommodated middle and low income people in planned residential neibourhoods
2. Improve existing areas through community based development and government participation
3. Provide protection against external floods (embankments & retention pond).

A Detailed Area Plan is needed for Hazaribagh tannery area and for development of this area-when tanneries will be shifted to a new location

1. Construction of a road on the western embankment should be considered to provide another access from the west to the old city area of Dhaka.

2. The zone needs a sub area supplemented by a number of community action plans for the slums, the squatter settlements and new spontaneous areas. Detailed Area Plan should include access, assessment of utility requirements and their delivery alternatives.

APPENDIX A

Photographs: Some Existing Land use Problems within Kamrangirchar













APPENDIX B

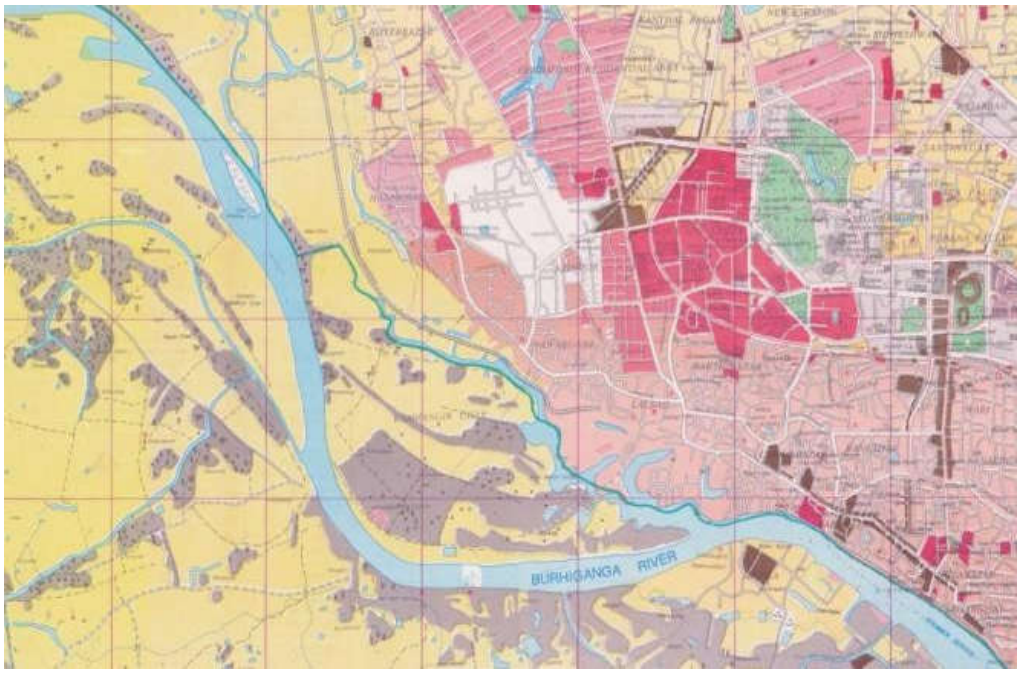
Reference Maps

Kamrangirchar Map (1998)



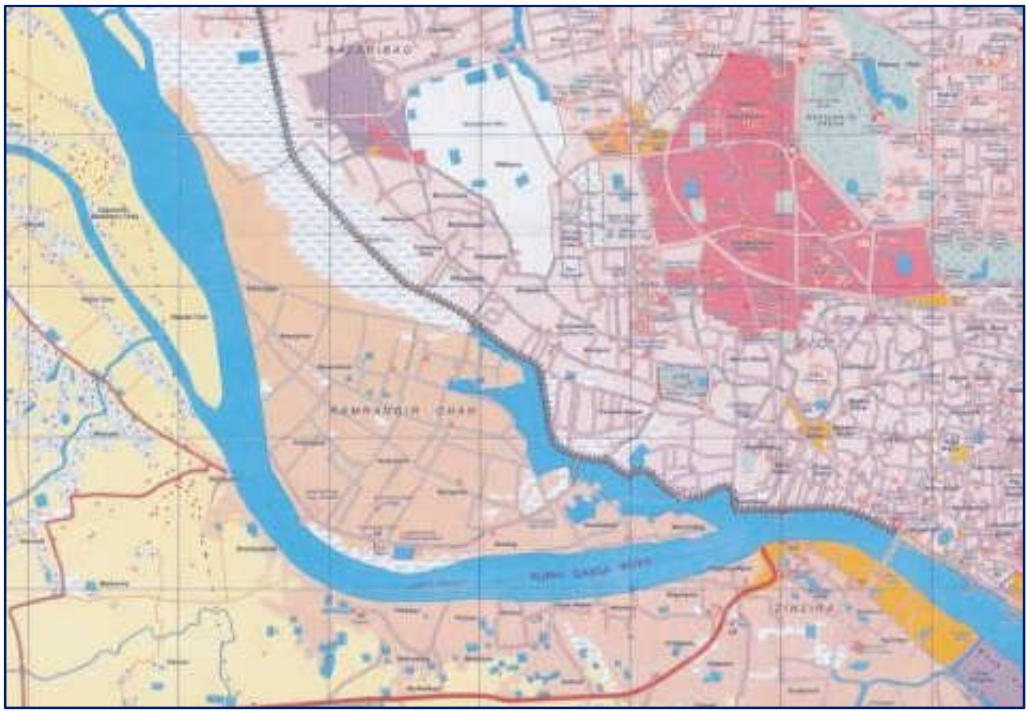


Kamrangirchar Map (2007)





Dhaka City Guide Map (20013)





APPENDIX D

Quantitative Values of Spatial Metrics for Change Detection Analysis

Land Cover Type/ Spatial Metrics	Builtup Area	Water Body	Vegetation	Wetland
NP	1198	2079	3132	1334
LPI	3.4551	4.0222	3.5120	3.3454
ED	21.0155	38.5187	68.1446	26.2272
CPLAND	1.2407	1.6939	2.2958	3.4103
ENN_MN	162.0899	137.0132	101.1428	153.7087
FRAC_MN	1.0439	1.0425	1.0558	1.0431

Land Cover Type/ Spatial Metrics	Builtup Area	Water Body	Vegetation	Wetland
NP	1861	549	1553	320
LPI	15.0426	2.7725	4.7579	4.2360
ED	54.1470	15.4297	38.0826	13.5453
CPLAND	5.6707	2.8383	5.0149	5.0204
ENN_MN	116.3086	196.2941	132.6763	198.6695
FRAC_MN	1.0494	1.0483	1.0454	1.0500

Land Cover Type/ Spatial Metrics	Builtup Area	Water Body	Vegetation	Wetland
NP	2096	658	1586	425
LPI	27.6267	1.9408	4.4650	3.7163
ED	77.8558	15.4560	37.1452	15.4459
CPLAND	11.6378	1.6657	3.7745	4.3154
ENN_MN	89.4140	184.1595	127.4179	163.8193
FRAC_MN	1.0502	1.0501	1.0509	1.0502

APPENDIX E

Summary of Land Cover Classification Statistics (1998 - 2017)

Table 5.3: Land use change from 1998 to 2003

Land use	1998(Sq. m)	Percentage(1998)	2003(Sq. m)	Percentage(2003)	Increase	Decrease
Water body	90900	23%	43474	11%		
Vegetation	55390	14%	39522	10%		
Build up	142279	36%	276654	70%		
Wetland	106709	27%	35569	9%		

Table 5.4: Land use change from 2003 to 2007

Land use	2003(Sq. m)	Percentage(2003)	2007 (Sq. m)	Percentage(2007)	Increase	Decrease
Water body	43474	11%	31617	8%		
Vegetation	39522	10%	31617	8%		
Build up	276654	70%	304319	77%		
Wetland	35569	9%	27665	7%		

Table: 5.5: Land use change 2007 to 2013

Land use	2007 (Sq. m)	Percentage(2007)	2013(Sq. m)	Percentage(2013)	Increase	Decrease
Water body	31617	8%	15808	4%		
Vegetation	31617	8%	15808	4%		
Build up	304319	77%	335937	85%		
Wetland	27665	7%	27655	7%		

Table: 5.6: Land use change 2013 to 2017

Land use	2013(Sq. m)	Percentage(2013)	2017(Sq. m)	Percentage(2017)	Increase	Decrease
Water body	15808	4%	15808	4%		
Vegetation	15808	4%	7904	2%		
Build up	335937	85%	363602	92%		
Wetland	27655	7%	7904	2%		

APPENDIX F

Socio Economic Status of Kamrangirchar Thana, Dhaka Metropolitan area

Table 4.1 : Ward and Moholla information

Thana				
Ward	Mohalla	Population	Density (per sq km)	Literacy rate (%)
				Urban
3	12	143208	39452	38.46

Table 4.2 : Union information

Ward				
Name number of Ward	Area (sq km)	Population		Literacy rate (%)
		Male	Female	
Sultanganj Union 51	3.63	76325	66883	38.46

Table 4.3: Religious institutions

Religious Institutions	Number	Religious Institutions	Number
Mosque	85	Sacred Place	5
Temple	6	Buddihist Math	8
Church	2		

4.3 General Information about Study Area

Table 4.4: Profile of My Study Area: At a Glance

Name of the study area	Kamrangirchar
Total Area	3.63 sq. k.m
Word	03
Union	01
Village	10
Mouza	09
Elevation	8 meters above mean sea level.

4.4 Occupational Status

Occupation Category	Kamrangirchar (%)
Household work	**23**
Bussiness	**30**
Unemployment	**8**
Job	**7**
Student	**15**
Labour	**16**
Total	**100**

4.5 Cultural Group

Types	Kamrangirchar (%)
Male	56
Female	44
Total Population	200229 (P)
Muslim	92
Hindu	6
Cristian	1.5
Buddhist	0.2
Other	0.3

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