Title

"LAND USE LAND COVER ANALYSIS OF NORTH MUMBAI"

By

Ms. DILSHA SARA DANIEL

A DISSERTATION

Submitted To

Department of PG Geography,

Nagindas Khandwala College of Commerce, Arts and Management Studies,

Mumbai- 400064

In partial fulfilment of the requirements for the degree of

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Academic Year – 2021-22

MALAD KANDIVALI EDUCATION SOCIETY'S

NAGINDAS KHANDWALA COLLEGE OF COMMERCE, ARTS & MANAGEMENT STUDIES and

SHANTABEN NAGINDAS KHANDWALA COLLEGE OF SCIENCE

AUTONOMOUS

DEPARTMENT OF PG GEOGRAPHY

Certificate

This is to certify that **Ms. Dilsha Sara Daniel** has successfully completed the Dissertation as a part of the M.sc -II- Semester IV syllabus titled **"Land use Land cover analysis of North Mumbai"** under the guidance of **Dr. Amrita Aggarwal** during the Academic Year 2021-22.

Guiding Teacher

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Date: 22-04-2022

Acknowledgement

This research project "Land use Land cover analysis of North Mumbai" becomes reality with the kind support and help of many individuals. I would like to extend my sincere thanks to all of them.

Foremost, I would like to endeavour to our Lord Almighty for the wisdom he bestowed upon me, the strength, peace of mind and good health in order to finish this research.

I acknowledge the facility extended by Nagindas Khandwala College and I am truly very grateful to our Principal Prof. Dr. (Mrs.) Moushumi Datta. She motivated and helped me to take up this project and I must say it was a remarkable experience.

My gratitude and sincere thanks to Mrs. Dr.Amrita Agarwal who have always been there for me, willing to help in with and any small or big issues so that I can finish my research project on time.

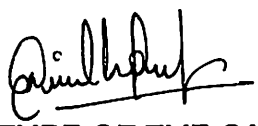
This work would not have been possible without Prof. Dr.Moushumi Datta and Mrs. Dr.Amrita Agarwal for helping me in the timely completion of the study and constantly guiding me. I would also like to thank Prof. Mr. Ashely Fernandes for helping and solving our problems anytime.

Last but not the least; I could never have completed my report without the support of my family members and friends. I would like to express my gratitude towards my family for the encouragement, support and motivation which helped me in completion of this research paper.

Ms. Dilsha Sara Daniel.

DECLARATION

I wish to state that the work embodied in this dissertation titled "**Land Use Land Cover Analysis of North Mumbai**" is my own contribution. The dissertation is carried out under the guidance of **Dr. Amrita Aggarwal** in the academic year 2021-2022.



SIGNATURE OF THE CANDIDATE

PLACE : MUMBAI

DATE : 22-04-2022

Summary

The research study on land use land cover analysis of North Mumbai summarizes the classification or categorization of human activities and natural elements on the land. The changes that have occurred over a period of time have also seen in the research. It also studies the whole background of Mumbai as well as particularly of the study area 'North Mumbai'. Some of the literature review has been taken for the journals of the researcher and the concerned citation is given. Data have been collected from different sources and analysed in the process. Various types of maps have been presented in the research paper for better understanding and analysing of the given subject. A detailed understanding of the maps can be spotted out from the interpretations explained in the research paper.

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Chapter 1 – Introduction

1.1 Background of the study area.

Before we understand the history of North Mumbai deeply, the area that comes under North – Mumbai are: Dahisar, Borivali, Khandivali, Malad and Goregaon. The important part of the city of Mumbai is North Mumbai. Maps of North Mumbai is useful to locate parks, railway stations, roadways and waterbodies. The whole part of North Mumbai is further divided into North central Mumbai and North west Mumbai.

Dahisar was formed by the ten hamlets of village. Later on it became the most popular urban area in the State. **Borivali** was once a group of smaller towns, which later developed into a larger area. It is situated between Dahisar river and Poisar river. The name "Borivali" have been derived from the existence of a lot of lush bushes of sweet fruit called 'borr', in english it means berries. 100 years back Kandivali railway station was built in 1907, was known as Khandolee. This particular village was famous for Earth and stones, from Paran. Thus, dwellings were built for officers and the settlements expanded. Once it was also famous for malad stones due to which many heritage buildings were constructed. Malad lies under the category of suburbs which is located towards the Northern side of Mumbai. Wherein, railway station is situated on the western line. Malad area consisted of many villages, where the community was mainly Bhandaris and Kolis. Goregaon is also a suburb of Mumbai. However, now due to the rapid growth of urbanization and ever increasing population of metropolitan Mumbai, Goregaon is now termed as the crowded suburb of Mumbai.

The physical material on the surface of the earth is termed as land cover. It includes grass, trees, water etc. On the other hand when the land serves for a purpose, it refers to land use. Eg: agriculture, wildlife, habitat, recreation etc. In the form of maps, land use and land cover are considered to be very important criteria for spatial planning management and utilization of land. Since the economic revolution in India, land use has undergone a radical change in the early 1990's. The particular changes that had happened include a series of complex interactions between biophysical and socioeconomic variables. There are some factors that land use land cover include; such as detection and monitoring, water and energy cycle, carbon and biogeochemical cycle, ecosystem and biodiversity. It is seen that there is a rise in demand with

the changing times on the availability of information on land use, land cover. Hence, it is necessary to have a standard classification system, precise definition of land use land cover and its categories. For urban and regional planning, remote sensing has been an important factor. There is a need for land use land cover maps to identify the development of a society which is entirely based on social and economic aspects. At local and reginal levels, LULC maps are very important to manage and plan things out appropriately. Not only this, LULC maps helped to study the what's happening and also the changes that occur in our ecosystem and environment. Land use land cover generally refers to the classification of human activities and natural elements on the landscape within a specific period of time which is based on established scientific and statistical methods of analysis of appropriate source material. Land cover is the physical material at the surface of the earth. Land use is the description of how people utilize the land for socio – economic activities.

1.1.1 Migration

Migration is a historical process which shapes the history of Mumbai. The economic factor played a very important role for the migration in Mumbai. In the late 1990's migration rate was seen to be higher in search of better jobs. Practically, pull factors are those that mostly attract people to Northern Mumbai. Affordable rate of residence, relief from the hustle - bustle life from the city, free from the congested traffic, pollution free environment etc, all come under the category of pull factor.

1.1.2 Why do we need Land use Land cover maps?

Social and economic development totally depends on the growth of a society. This is the main reason why surveys of socio and economic are carried out. In this survey, spatial and non – spatial datasets are included. From the information given of land utilization aspects can be understood easily. Over a period of time it is necessary to look after the ongoing process on land use/land cover pattern to ensure a sustainable development. To use every bit of land in the most rational and optimal way, it would be better enough if the higher authorities linked with urban development initiate some planning models. This is to gain sustainable urban development and reduce the unplanned development of towns and cities. To analyse this, past land use and land cover information of the area are required. The changes that are happening in our ecosystem are

studied with the help of land use land cover maps. Such detailed information would also help to make policies and launch programmes to save our environment.

1.1.3 Land use Land cover classification

LULC are commonly used application under remote sensing. Land use land cover are classified into two approaches which are as follows:

Unsupervised Classification

The classification that is based on the software analysis of an image without the user provided sample classes is called unsupervised classification. This method involves grouping of pixels with common characteristics. In this the computer determines or identifies which pixels are related to groups them into classes. Hence, the individual should have accurate knowledge of the area arranged, such as wetlands, developed areas, coniferous forests etc.

Supervised Classification

The analyst identifies homogenous representative training area of the different surface cover types of interest, in the imagery. The analyst's familiarity with the geographical area and actual knowledge of the surface cover types present in the image are basic for selecting appropriate training areas in the image. The numerical information in all spectral bands for the pixels comprising these areas is used to "train" the computer to recognize spectrally similar areas for each class. Supervised classification are based on the idea that a user can select sample pixels in an image that are representative of specific classes and then direct the image processing software to use these training sites as references for the classification of all over pixels in the image. To group them together the user sets other similar pixels.

1.1.4 PHYSIOGRAPHIC MAPS

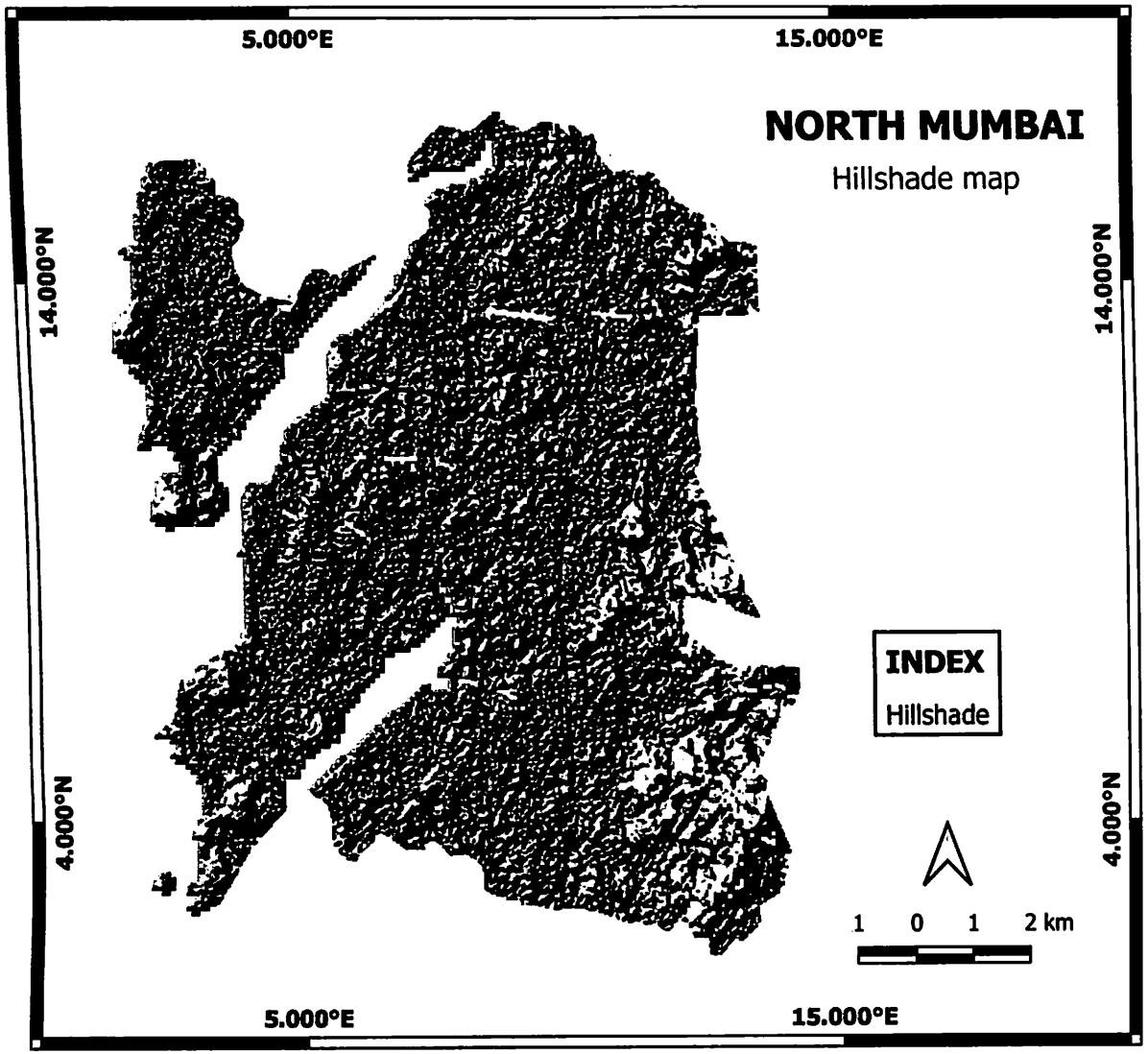


Fig. 1.1 a
***Source Base map-Bhuvan: Created by Researcher**

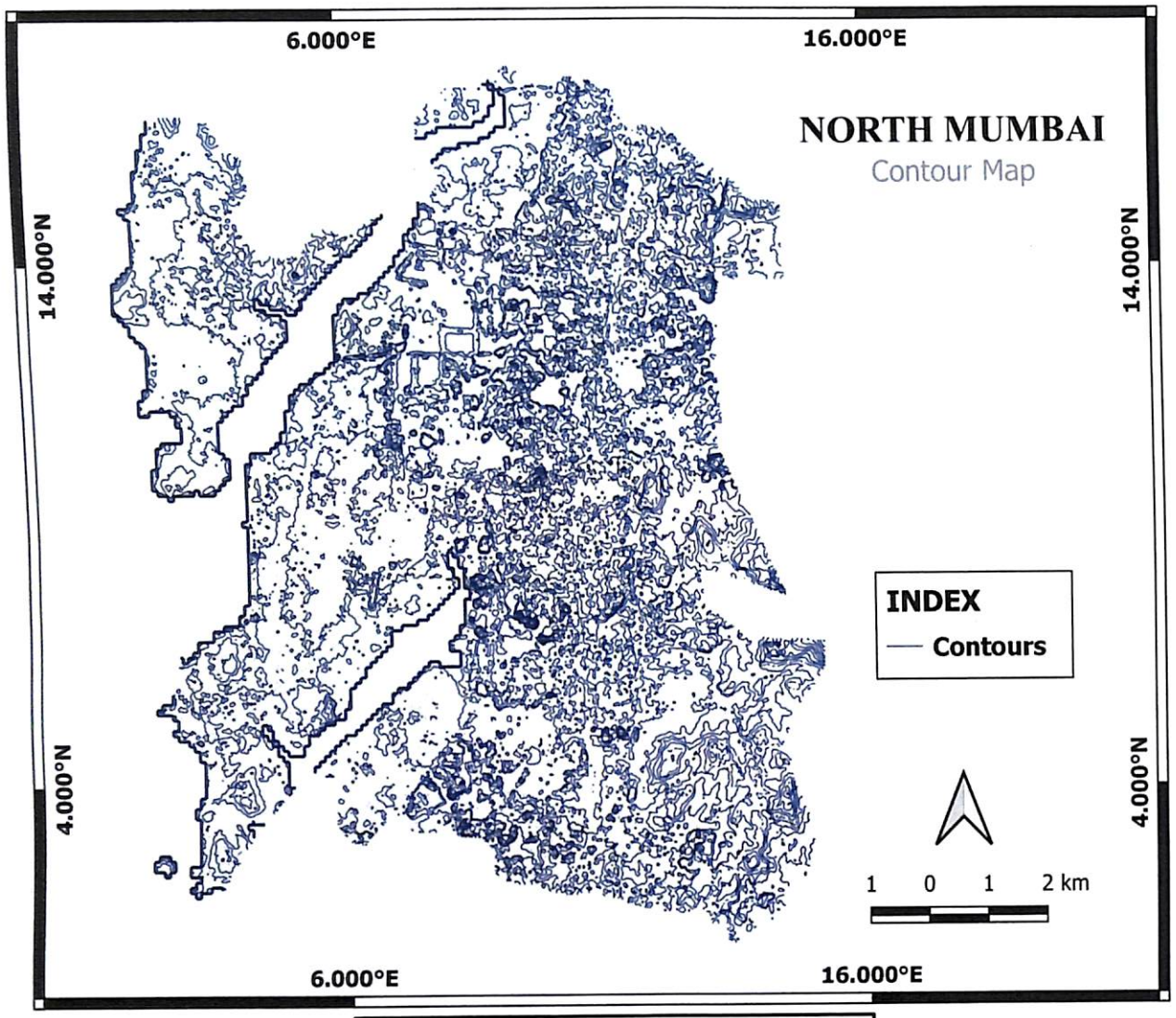


Fig 1.1 b
***Source Base map – Bhuvan: Created by Researcher**

1.2 Review of literature

- (Darshan.A.Sansare and Sumedh .Y. Mhaske, 2020) Researchers in their research article explains how rapid increase in urbanization have given a negative impact worldwide. This has been stated from the year 1973 to 2018 in Mumbai using ArcGIS software. Urbanization has brought a change in the land use land cover (LULC) over the years. It has altered the hydrological process like infiltration, loss of current drainage system, which was caused due to soil erosion and interception and flooding in urban areas.
- (Bhanage Vinayak, 2021) Researcher in their research paper Predicts the future LULC changes over Mumbai and its surrounding area. To gain sustainable development over the region in the year 2050 can be used as a thematic map in various climates, environmental and urban planning models are predicted for LULC.
- (Aman Srivastava , Pennan Chinnasamy, 2021) Researchers in their research article – Which have studied (LULC) changes that have taken place using GIS from the year 2000-2018 for the IIT Bombay Campus, India. Its main aspect was to evaluate hydro – ecological balance inside campus by determining spatial – temporal disparity. This was between ecological components, hydrological parameters etc.
- (Darshan Sansare, Sumedh Mhaske, 2020) Researchers in their research article, states the land cover assessment and socio – economic survey plays a vital role for the development of society. In the past few years, land cover i.e. Water, bare soil, vegetation, urban infrastructure has haphazardly risen. This has become one of the reasons for water – logging in many parts of the city, where the maximum number of water logging is found in the F/North ward. To make up the losses and damages, the decision making governing bodies require accurate information of the affected area for developing appropriate flood protection.
- (Supantha Paul, Subimal Ghosh, Robert Oglesby, Amey Pathak, Anitha Chandrasekharan, RAAJ Ramsankaran , 2016) Researchers in their research article states that weakening of Indian Summer Monsoon Rainfall (ISMR) impact of local changes in land use and land cover are yet to be explored. However, some sensitivity analysis had been performed by the researcher to roughly understand the impact of large – scale deforestation in India on monsoon

precipitation. In the process they found that deforestation is the main cause of weakening of the ISMR.

- (Kumar, 2018) Researcher in his research article highlights about the spatial pattern that changes the land use land cover of built – up area, urban growth and urban sprawl. The quick transformation of cities into metropolitan and mega cities is caused due to a main factor called migration. With the help of satellite imagery, the spatial pattern of land use land cover focusing on built – up area has been analysed with the help of land use land cover maps stating the dynamic accommodation development by replacing the traditional land use design.
- (Rajeev Kumar Jaiswal, Rajesh Saxena, Saumitra Mukherjee , 1999) Researchers in their research article, highlights that remote sensing technology were used to study the changes of land use and land cover over a periods of 30 years in the Shahdol district of Madhya Pradesh in Gohparu. The map of land use and land cover was made of two periods of remotely sensed data by visual interpretation method. Technique used for this purpose was post classification comparison technique. In between the year 1967 and 1996 it was estimated the loss of vegetation cover which ranged upto 22% and the remaining 14% land was converted into waste land. Totally 18% of change was found per year during this period.
- (Harini Nagendra, Darla.K.Munroe, Jane Southworth, 2004) Researchers in their research article states that due to the corporation of landscape ecology and fragmentation analyses within the remote sensing technology. To explore the relationship between the land use and land cover, several papers of this issue on the use of landscape ecological techniques were presented through spatial pattern and processes in an international comparative context. By blending into the process of Geographic Information System (GIS), socio - economic remote sensing techniques, the researchers tried to link spatial pattern to land use with the help of landscape ecological approaches.
- (Pramanik, 2017) Researcher in this research article highlights the different inundation scenarios due to relative sea level rise which was examined in the vicinity of Mumbai, India, by the physical and ecological responses of the coastal areas. However, from the Digital Elevation Model (DEM) with satellite imagery land use/land cover (LULC) was adopted when there was loss of habitat which took place due to the sea level rise. This led to negative impact on LULC categories, coastal features and landforms on some parts of Mumbai. This has also caused

flooding as the drainage system stops functioning during rainstorms and it increases the saltwater into coastal areas leading to intrusion.

- (Jing Jiang, 2010) Researcher in the paper it explains about the growing population and also the rapid urbanization along with it, has led to many environmental problems. Land use has drastically changed and heat islands were developed. To study the research deeply Landsat TM and ETM + image data was taken from the Beijing country on April 9, 1995 and April 30, 2000. Land use land cover classes and the land surface temperature were extracted for the research study, which resulted in an increase in the land surface temperature and drived the importance of changed land use.
- (A.T. Kulkarni, S.S Bodke, E.P Rao, T.I. Eldho, 2014) In the research paper, researcher has explained about hydrological impact of changing land use in Mumbai city in Poisar watershed region. The land use cover maps were made from satellite imagery. The hydrological impact also studied about few rainfall events. The result showed the visibility of rainfall for low, medium and high events.
- (Marathe, 2008) In this paper the dynamic change of LULC was estimated using remote sensing and GIS (Geographical Information System) technology. The main aim of the study was to assess the reason behind the occurrence of the types of land use land cover change in Mumbai from past 28 years. These images were used to classify it into 6 land - use land - cover types such as: forest, wetlands, water, bare land, built-up area etc. Maps were created along with transition matrices were performed. Moreover, the result showed changes in land use and land cover has increased in built - up and high density built - up areas within the period over the study area. Therefore, reforestation occurred in the city.
- (Parsenjit, Subhajit Bandopadhyay, Chandan Kumar, Chandra Mitra., 2020) In the paper Urban Heat Island Intensity (UHII) impact is initiated due to the rapid urban expansion is related with the land use land cover (LULC) change that had resulted in serious environmental issues in India. By using Landsat data, research has been performed through the study. The study mainly focuses on the following points:
  - By using an integrated model land use, land cover of the near - future was predicted through the investigation.
  - Landsat data consists of bands. where one should understand the connection between the band and different LULC classes.

- The LULC maps indicate the temporal relationship between various types of built - up area and Landsat.

These all reasons had led to the expansion of built - up and high built - up area, driving quick attention by the integrated model at such alarming situations.

- (Akshata.S.Pawar, 2018) In the research paper, the water quality is deteriorating due to various land use activities and the changing land use land cover (LULC) in that area. To protect the aquatic ecosystem, surface quality is an important factor. Urbanization is the main reason to affect the Mithi River of Mumbai. Hence, pollution should be prevented at the initial stage, and the pollutant source of the river has to be found. The main aim of the study is to find out the nonpoint sources of water pollution in Mithi river relating to water quality and land use land cover parameters. As the open lands are reducing at an immediate rate, shows negative impact on the quality of water.
- (Chandra.P.Giri, 2012) In the paper it highlights on how remote sensing can be used to analyze land use and land cover from the global scale. Scientists from all over the world have contributed to develop a well - structured volume which will offer technologies , application, international perspective on science and further needs of remote sensing over land use land cover. It shows the relationship between the land use and land cover classification system. However, the art of methods and techniques were used for processing the data, acquisition, interpreting the image, accuracy assessment and characterizing land use land cover by making maps. The study indicates that there is a further need for better change in information of land use and land cover at multiple scales.

1.3 Research Objective

- To undertake land use land cover analysis of the study area 1998 - 2018.
- To understand the reasons for the obtained changes.
- To give applicable solutions for the negative changes.

1.4 Research Methodology

1.4.1 Coverage

Mumbai is a city and capital of Maharashtra and financial capital of India. Previously Mumbai was known as 'Bombay'. People migrate from various countries to this city, for various purpose such as education, employment, medical facilities etc. Mumbai is termed as the developing nation as it is trying to improve from all aspects each and every single day. It is also known as the city that never sleeps. Mumbai is famous for its street foods and shopping malls. As many cultures blend in India is called the land of diversity.

The study area selected for the research is North Mumbai. The research focuses on the land use land cover of North Mumbai. The area that comes under North Mumbai are: Dahisar, Borivali, Khandivali, Malad and Goregaon. The expansion of North Mumbai started occurring due to the reasonable rates of residence in the areas. These areas are similar to a native environment where, people mostly start migrating from the metropolitan cities to village areas. The pleasant environmental condition, act as a pull factor. Now - a - days rail transport are being developed for the public to travel easily to long distance. The North Mumbai are also being developed with all public facilities, but not very well as compared to metropolitan cities like Mumbai.

1.4.2 LOCATION MAP OF STUDY AREA.

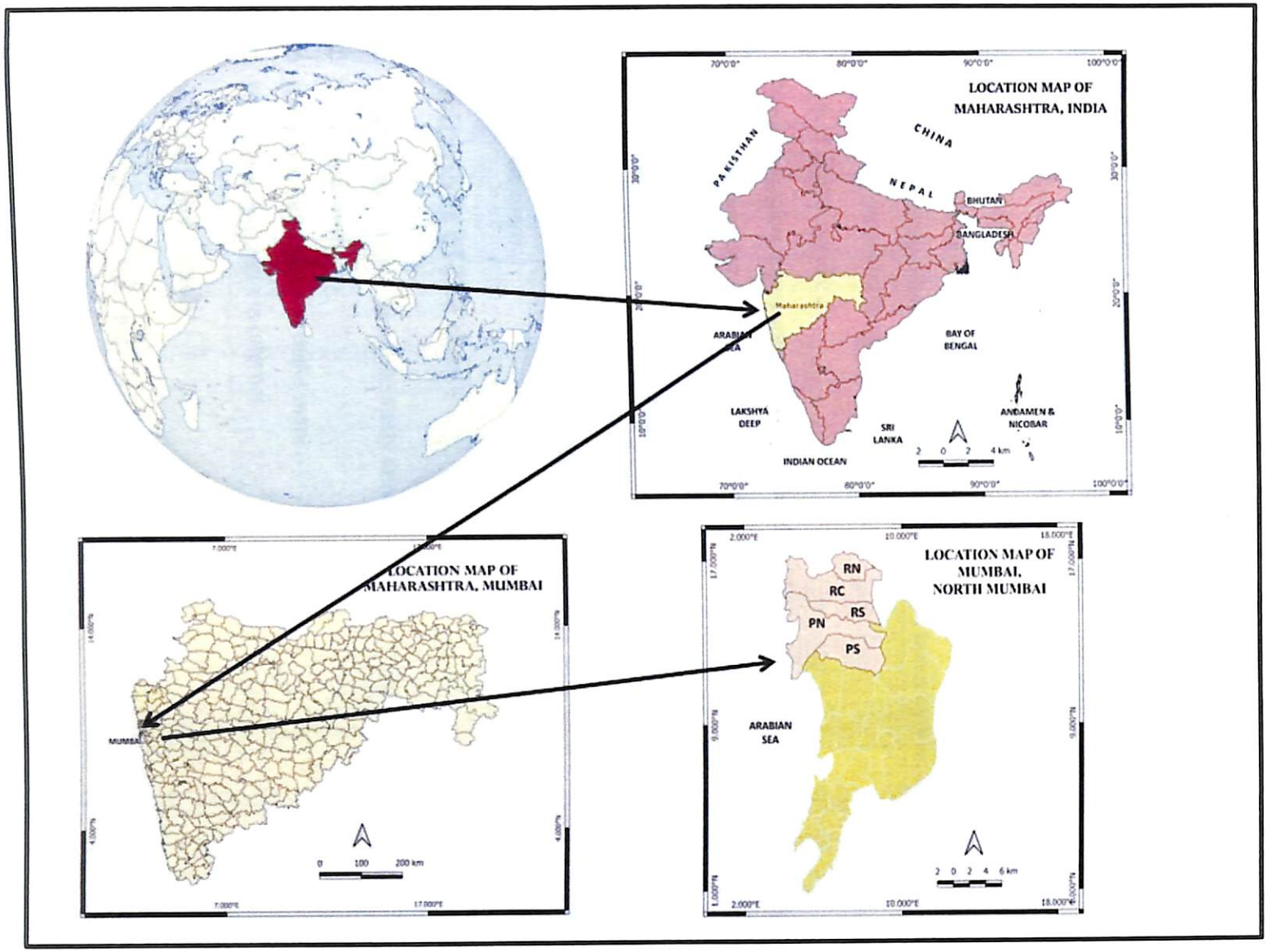


Fig 1.4 a
***Source: Created by Researcher**

1.4.3 Data collection

The data has been collected by primary and secondary method of collecting data. The review of literature was taken from various websites, articles, PDFs, journals through google scholar. The primary data was collected by referring some books from the college library. The base maps for Land use Land cover analysis is taken from the USG earth explorer website, which are the Landsat-8 Satellite imagery. Base maps for demographic analysis showing the choropleth technique was taken from the Bhuvan website which are Satellite imagery. Photographs of the study area were taken by visiting the place which is called as 'Ground truthing'.

1.4. 4 Data analysis

The information taken was typed and stored in Microsoft word. The collected maps were then georeferenced and digitized to make shapefiles. These shapefiles was then projected and modified in the software called QGIS. The process of gathering census data for choropleth maps was derived from the Government of India census data website. These data was then linked to the software and the population of different wards of North Mumbai was shown. The downloaded Landsat imagery were used to analyse the land use land cover maps.

1.5 Limitations of the study

- Limited Information about the study area.
- Time constraint.
- Requirement of skills to make maps.
- Difficult to get data via internet.

1.6 Scope of the study

- The purpose of the study is to analyse Land use Land cover the changes that have occurred over a period of time.
- The geographical location covered in the study area is the North Mumbai.
- To find solution to the rising problems of land use.

- Land use land cover study can reflect upon the pattern of human land use in a region.
- This study is taken into consideration, to cope up with the global climate change and for the sustainable development.
- The land cover data is mainly used as basic information to manage sustainable development.
- Availability of time is the needed for the study of accurate methodology of LULC classification.
- LULC maps helps to study the changes that are occurring in the environment and ecosystem.
- It requires present and past land use land cover information of an area for an accurate study.
- LULC map plays a vital role in planning and monitoring all the various programmes at local, region and national level.
- Remote sensing in the study of land use land cover helps you to get data/information about certain region with being in direct contact with it.
- GIS (Global Information System) technique helps to study and monitor the changes in LULC patterns.

Chapter 2 - Background of the study area.

2.1 Introduction

Mumbai is termed as the 'City of dreams' or 'Islands city' which is located on the western coast of India on the bank of Arabia sea. The capital city of Maharashtra and economic capital of India is Mumbai. As this city is made up of seven Island it is called as 'Islands city'. Mumbai is further divided into two districts which are Mumbai city and Mumbai Suburban. Mumbai has been ranked as the seventh most populous region in the world. Industrialization has led to over population in the state. Not only this, the region also faces many other problems like air, water and noise pollution and lack of space. As there occurs a rapid growth of urbanization, waste management techniques are not functioned systematically.

Taking into consideration about the geographical aspects of Mumbai it is seen that a narrow peninsula located at the western coast of Maharashtra. As Mumbai is composed of seven Islands, many bays can be found out in between the cities. This provides a good network for trade and transportation. To the North of Mumbai, we can see the Vasai creek whereas Thane creek to the East direction and Arabia Sea to the West. It has been studied that many cities in this state are at an elevation from 10 meter – 15 meter above the sea level. 603.4 sq km is the total area of Mumbai, out of which 67.79 sq km area is comprised of Mumbai city and 370 sq km consists of Mumbai Suburban.

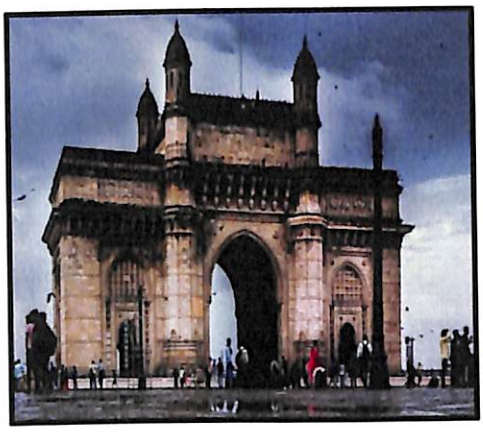
As Mumbai has a tropical climate usually a combination of tropical wet and dry climate is experienced. The rainy season begins in the month of June and ends in the month of September. Winter starts from December and lasts till early February. Summer season is experienced from the month of March – May. At times due to extreme heat, the area is given the signal of heat wave alert.

Mumbai is considered to be the land of diversity due to varied cultural aspects. This diversity is the cause of migration from various parts of the world. The Metropolitan city has diversity in language, religion, fine arts, lifestyle, cuisine, festivals, entertainment etc. Nevertheless, the city also provides variety of mouth – watering in vegetarian and non – vegetarian dishes.

2.2 Historical Background

In the beginning, Mumbai was initially known as Bombay. Which was formed of seven small islands in the Arabian sea until 17th century. The very first group of people, who developed their village and settlements along the coast of Mumbai was the Koli fishermen. They worshiped their goddess whose name was Mumbadevi, which the city eventually received its name Mumbai.

The three religions that ruled greater Bombay were Hindus, Buddhist, and Muslim rulers. Later Vasco da Gama of Portugal landed at Calicut in 1498.



Gateway of India is the famous landmark in Mumbai. This monument is very close to Taj Hotel.
***Source: www.veenaworld.com**

By exchanging the military support, the Portuguese had acquired the 7 islands from the Sultan of Gujarat in 1534.

Islands merged into one Mumbai

Several causeways were constructed, and multiple reclamations were undertaken by the British rulers to connect the islands and bring it together to form one land.



Seven Islands of Bombay
"Source: en.wikipedia.org

Speciality of Mumbai

Mumbai is considered to be an home for three UNESCO World Heritage Sites like the Elephanta caves, Chhatrapati Shivaji Maharaj Terminus. the city's distinctive essemble of Victorian Art Deco buildings and many more. Most commonly you will see food from all parts of India, since Mumbai is a multicultural city consisting of various people from different states staying here.

❖ North Mumbai

Before we understand the history of North Mumbai deeply, the area that comes under North – Mumbai are: Dahisar, Borivali, Khandivali, Malad and Goregaon. The important part of the city of Mumbai is North Mumbai. Maps of North Mumbai is useful to locate parks, railway stations, roadways and waterbodies. The whole part of North Mumbai is further divided into North central Mumbai and North west Mumbai.

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Migration is a historical process which shapes the history of Mumbai. The economic factor played a very important role for the migration in Mumbai. In the late 1990's migration rate was

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2.3 Geographical Development

- ***Hills***

There were 22 hills on the seven islands of Mumbai; some hills still stand today. The hills are inhabited by slums. These hills run parallel to the central railway track. Most of the region is occupied by the Borivali National Park. These hills are seen to be present within the hills. Just near to Ghatkopar station, the Ghatkopar hills are present. Landslides are seen to be a common phenomenon during monsoon season.

- ***Lakes***

Part of the city's drinking water is supplied by the Vihar lake and the Tulsi lake which is present within the National Park.

- ***Bays***

The largest bay in the city is Back Bay. The second largest bay is the Mahim Bay. Along this stretch the marine drive is located. Worli Bay consists of North Marine Drive.

- ***Creeks***

There are many creeks in Mumbai and mangroves along the coastline. The Vasai creek to the north and Thane creek to the east divides Salsette Islands from the mainland.

2.4 Economic growth

Mumbai is termed as the largest economy in India. It is known to be the economic hub. Once upon a time the economy of Mumbai was once dominated by the cotton textile industry in the 19^{th} century, but that industry is now less significant. Although textiles still remain important but city has own industries which include metals, food processing, automobile manufacture,

electronics, etc. This is the main cause of earning revenue. The other major employer in Mumbai is from the entertainment industry. Most of the headquarters of major television and satellite networks are situated in Mumbai as well as it's major publishing houses. Bollywood movie industry are located in Mumbai. The commodities that are exported are jewelry, textiles, engineering goods. Commodities that are important are crude oil, machineries, fertilizers and chemicals. The important sectors that are contributing in the growth of Mumbai's economy are: gems and jewellery, IT and ITES, leather processing, finances. People working under state and central government make up a huge city workforce. It is also seen that Mumbai also includes the blue collar workers which are auto – rickshaw as well as taxi drivers, mechanics, hawkers etc. They fall under the category of unskilled and semi- skilled workers. Other than this Mumbai also serves as a home for the millionaires and billionaires.

2.5 Infrastructure

2.4.1 Education

Apart from being economically, geographically developed, Mumbai is the main center of education. After the University of London in 1857 the University of Mumbai was founded. The literacy rate is high in Mumbai.

Secondary Schools

The municipality of Mumbai runs more than 1,000 primary and secondary schools for the children of the city. The state Language - Marathi is a compulsory subject in municipality schools. Due to the over growing population of children in the city, it makes it difficult for them to get admission in schools. There are three kinds of secondary schools:

1. ***Public School*** - Majority of public schools in Mumbai fall under the category of Maharashtra State Board of Education, which follows the secondary school certificate (SSC) curriculum. After 15 years of schooling, children pass out the 10th standard. They get admission in junior college for 2 years. Once the student completes it, they become eligible to get admission in senior college. This is when

they obtain a graduation degree in the chosen field/stream. The medium of instruction is in the form of English or Marathi.

2. ***Private school*** - Such types of schools are affiliated to ICSE or CBSE boards. The standard of syllabus is much more contemporary, matching the global standards. Instructions are explained in English.

3. ***International school*** - The number of children is lesser in these schools, due to which the teacher can provide more attention to a particular child.

Colleges

The premiere University of India is the Mumbai University. Along with other top universities, Mumbai University has achieved opportunities to be featured in several magazines. They offer courses in streams, such as science, medicine, engineering, fashion designing, art and many other such streams. The best engineering college of India is IIBT. As education is considered to be the most important wealth of every child, their parents would wish to provide the best quality education. And the best quality education is offered in Mumbai. This has led to scarcity of seats in schools and colleges.

2.4.2 Health

The good public - health infrastructure is seen in Mumbai - by far - still it needs to double the medical facilities for the unserved citizens. The infrastructure of Mumbai's health was planned between 1950 - 1980. Most of the people living in Mumbai prefer state - run hospitals as they are affordable. Government hospitals cost somewhere around Rs. 75,000 while the private hospitals charge around Rs. 3 lakh - 3.5 lakh for the same process. Due to the fast growing and dense population in the city Mumbai, the healthcare challenges are provided by the MCGM (Municipal Corporation of Greater Mumbai.) There are three levels run by the MCGM; primary, secondary and tertiary levels.

The North Mumbai i.e. area from Palghar - Goregaon having approximately 25 lakh population has very few Government and multi - speciality hospitals.

2.4.3 Transportation

- ***Railways.***

  The backbone of Mumbai city's transport system is the suburban railway which is known as the locals. Indian railways are usually operated by the central and western railway zones of the Indian railways. Trains are always crowded during working hours. Mumbai railways are widely spread over various routes. To reduce overcrowding Mumbai monorail and Mumbai metro have been built and are being extended. In early June 2014, the first line of Mumbai metro was opened.

- ***Bus***

  The buses that run over all parts of metropolis is 'BEST'. Air condition buses were introduced in 1998 but it's rarely found in North Mumbai. BEST buses are red in color which is similar to Routemaster buses of London. Buses are generally used for commuting short and medium distances. One of the famous tourist bus service is 'Mumbai Darshan' which explores multiple tourist attractions in Mumbai. Although public mostly travels by public transport, Mumbai still struggles with traffic congestion.

- ***Road***

  Mumbai - Pune express highway was the first road route built in Mumbai. Mumbai is served with several National Highways i.e. National Highway 48, National Highway 66, National Highway 160, National Highway 61. In 2013 the Eastern freeway was initiated. The count of private vehicles in Mumbai was about 721,000 in the month of March 2014, 56,459 black and yellow color taxi as of 2005 and 106,000 auto rickshaw as of May 2013.

- ***Air***

  The International airport of Mumbai is named as 'Chhatrapatti Shivaji Maharaj' the second busiest airport of the city. The Juhu aerodrome was India's first airport , and now hosts the Bombay Flying Club and a helicopter operated by state - owned Pawan Hans. Basically, people from North Mumbai travel all the way to the Sahar International Airport.

Chap 3 - Land use Land cover Analysis

3.1 Major Land Use Classes

The land use and land cover classification have further been divided into sixteen major classes as explained below:

1. Agricultural land

This includes all the land parcels that are cultivable and crop fields. Agriculture land is the source of food – fruits and vegetables and many other agriculture products. It helps shape the socio – economic development of a region. Due to ever increasing population, the agricultural land is being exploited and decreasing in size.



Figure 3.1: Agriculture Land in Vasai
***Source: www.99acres.com**

2. Beach

A beach is a coastal strip of land which is covered with lose particles. These particles are made up of weathered rocks and form sand, pebbles, shingles, gravels etc. A beach is mostly used for recreation purpose, however the changes in the area covered under a beach signifies the changes in the local ecological process.



Figure 3.2: Uttan – Bhayandar beach
***Source: Clicked by the researcher**

3. Built up area with vegetation

All the man – made structure are considered as built – up area. It is dense in urban areas and scattered in rural areas. If there is vegetation in between the built structures it is called built – up with vegetation.

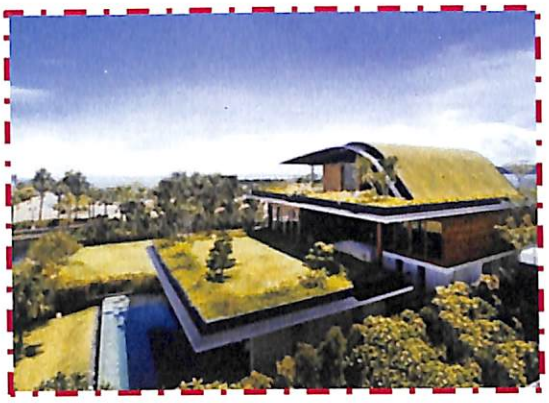


Figure 3.3: Built – up area with vegetation
***Source: https://www.archdaily.com/**

4. Built – up area without vegetation

All the man – made structure is considered as built – up area. It is dense in urban areas and scattered in urban areas. If vegetation is absent in between the built – up structures, it is called built – up without vegetation.

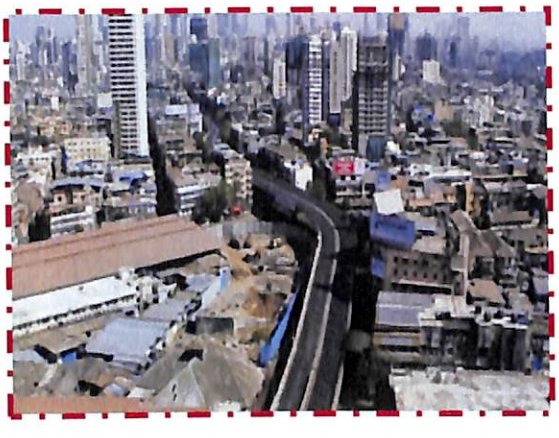


Figure 3.4: Built – up area without vegetation, Mumbai
***Source: https://timesofindia.indiatimes.com/**

5. Fallow land

The arable land which is left unattended for one or more vegetative seasons is called fallow land. It is a technique of cropping used to regain the fertility of land by keeping it bare for some time. The presence of fallow land implies that the land is agriculture but has lost it's fertility to a certain extent which can be regained.



Figure 3.5: Fallow land

***Source: https://en.wikipedia.org/**

6. Highland with vegetation

The area which is high like the plateau, the mountain and other hills are considered highlands. If they are vegetated, they are called highland with vegetation.



Figure 3.6: Highland with vegetation.

***Source: https://pxhere.com/en/photo/**

7. Highland with sparse vegetation

The area which is high like a plateau, the mountains and other hills are considered to be highlands. If they are sparsely vegetated, they are called highland with sparse vegetation.

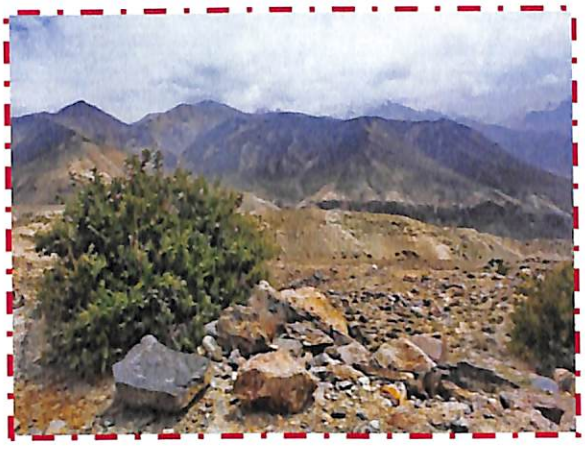


Figure 3.7: Hot highlands with sparse vegetation

***Source: www.dreamstime.com**

8. Industrial area

The land parcels which have been used to construct industries and allied activities, are called as industrial area. It is a common feature in urban areas. It signifies the change in land use because most of the case, vegetation and agriculture are replaced by industries.

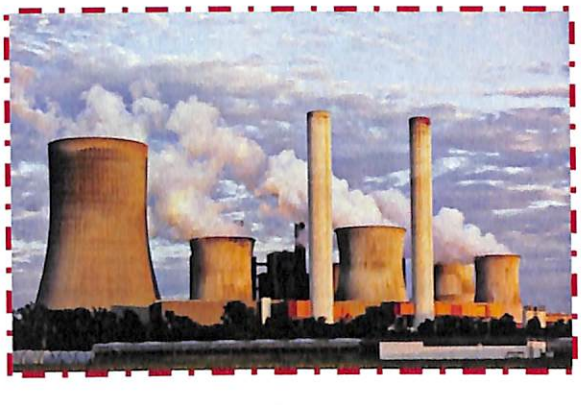


Figure 3.8: TTC, Industrial Area, Navi Mumbai

***Source: www.ascconline.com**

9. Open space

It includes all those land parcels which are either left empty without any human intervention, or are barren lands, or are parks, grounds and other open areas which are accessible to public.



Figure 3.9: Open space
***Source: Clicked by the researcher**

10. Water body

Any water body on the surface of the earth, in any shape size and depth of any origin is called as water body. It is a collective term for any type of water on the earth like lake, pond, river, sea, ocean, stream and alike.



Figure 3.10: Water body – Powai Lake
***Source: https://www.dnaindia.com/**

11. River

A river is a linear water body. It originates in the high mountains and drains down into a large water body i.e. sea or ocean. They are an important part of the ecosystem and a change in their existence can alter the ecosystem and the environment.



Figure 3.11: River

***Source: https://www.collinsdictionary.com/**

12. Sea

It is a large water body of salt water. A sea can be a landlocked water body or it can be a part of the ocean. It plays an important role in the local ecosystem of a place as it provides for the marine ecosystem, wetland ecosystem and scope for disposal of treated sewage. A change in the area under sea represents the impact of climate change and impact of human activities.

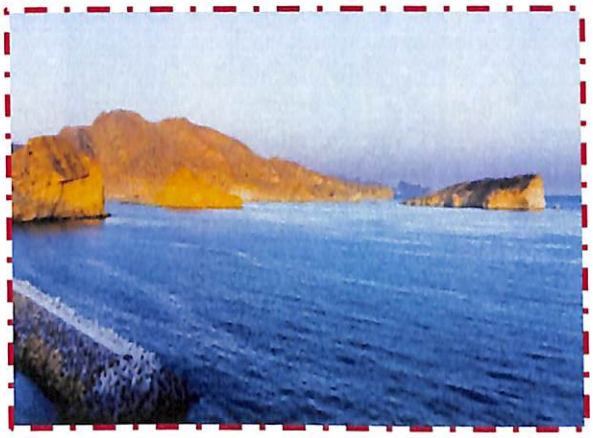


Figure 3.12: Arabian Sea

***Source: https://www.istockphoto.com/photos**

13. Built – up area without agriculture land

] All the man – made structures are considered as built – up area. It is dense in urban areas and scattered in rural areas. If there is absence of agricultural land amidst built structures, it is called built – up without agricultural land. It is common occurrence in the urban areas.



Figure 3.13: Aerial view of Mumbai
***Source: www.businessinsider.in**

14. Slum

The Registrar General of India has adopted the following definitions of slum for the purpose of census of India. 2001(http://mohua.gov.in):



Figure 3.14: Slums of Mumbai
***Source: https://www.hindustantimes.com/**

- All areas notified as slum areas by the local or state administrative authority.
- A compact of at least 300 people or about 60-70 household of poorly built congested tenements, in unhygienic environment usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities.

- The Government of Maharashtra does not give any specific definition of 'slums' in its Maharashtra Slum Areas (Improvement, Clearance and Redevelopment) Act, 1971. However, Section 2(ga) defines 'Slum Area' as:
  - Any declared area by the Competent Authority under sub-section (1) of section 4. According to this, to declare an area as slum area, it must satisfy the following conditions:
  - Any area is or may be a source of danger to health, safety or convenience of the public of that area or of its neighbourhood, by reason of the area having inadequate or no basic amenities, or being insanitary, squalid, overcrowded or otherwise;
  - The buildings in any area, used or intended to be used for human habitation are in any respect, unfit for human habitation; or by reasons of dilapidation, overcrowding, faulty arrangement and design of such building, narrowness or faulty arrangements of streets, lack of ventilation, light or sanitation facilities or any combination of these factors, detrimental to the health, safety or convenience of the public of that area.
  - To decide whether the buildings are fit for the purpose of human habitation, the following should be fulfilled:
    - repairs
    - stability
    - freedom from damp
    - natural light and air
    - provision for water supply

- provision for drainage and sanitary convenience
- facilities for the disposal of wastewater

15. Vegetation

It encompasses the trees either individually or in forest. It also includes gardens. It is the total green cover of the area under study. The area under vegetation helps us to understand the health of the environment.

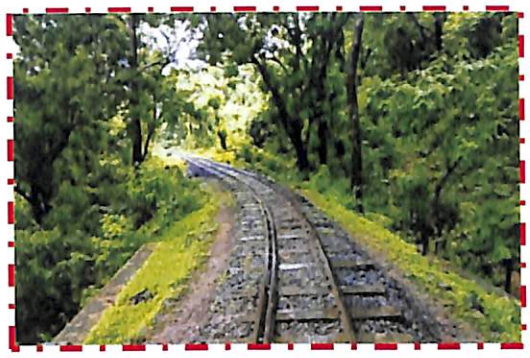


Figure 3.15: Sanjay Gandhi National Park, Borivali
***Source: www.traveloaces.com**

16.Wet Lands

The United Nations Environment protection agency defines wetland as 'areas where water covers the soil or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season.' In short it can be understood as land with marshes and swamps.



Figure 3.16: Wetlands of India
***Source: blog.ipleaders.in**

3.2 Map of Land use Land cover analysis.

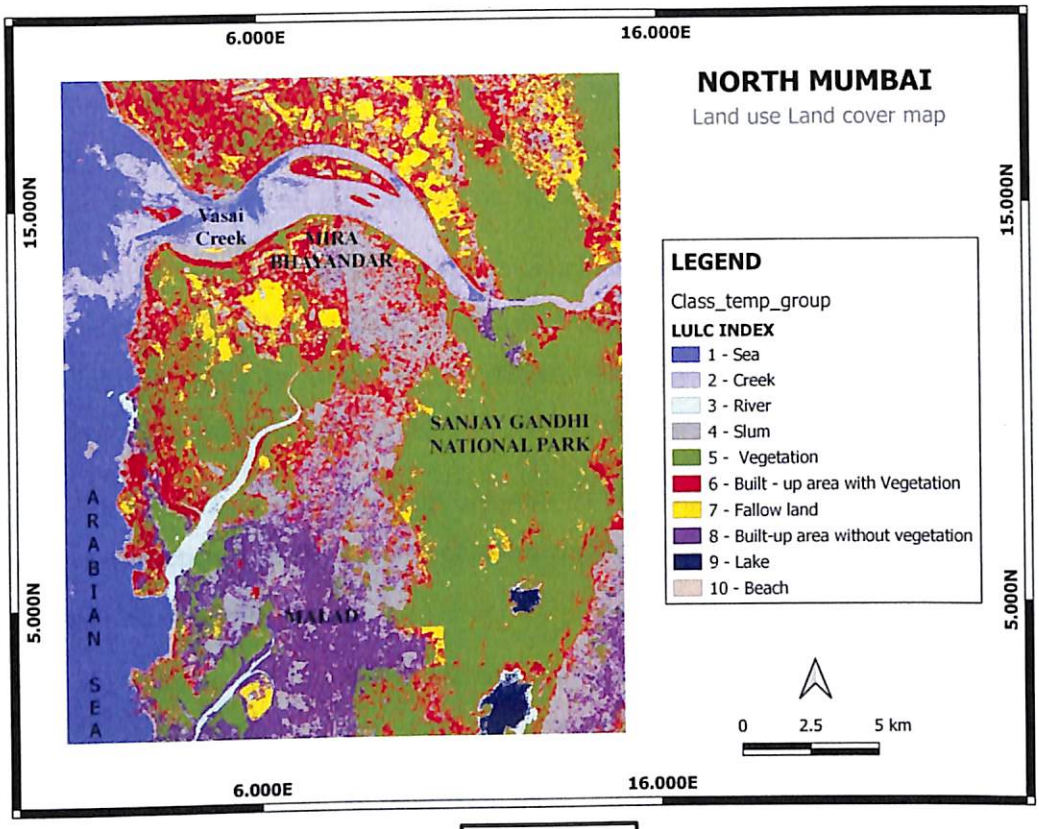


Fig: 3.1

The map in figure 3.1 represents the land use land cover of North Mumbai. The cartographic animation helps to understand the changes occurring in spatial context of a particular region.

The rural areas of North Mumbai have been converted into built up structures due to which the agricultural land has been reduced. This shows a negative impact on the land due to the increasing demand of population. Increase in population growth is the major factor that plays a vital role in conversion of rural areas into urban infrastructure.

Slums are seen to be more in number in the areas of Mira-Bhayandar because of rural – urban migration of all types of people from various parts of the country and it has led to high unemployment. This has leads to unsanitary in the study area because of improper waste disposal and poor drainage system.

Urbanization leads to infertile soil. In some region along with the vegetation and built - up area with vegetation, fallow lands are spotted out in the study area in the recent years.. Fallow lands are lands that are left out barren or uncultivated. Infertile soil. lack of water supply. uneconomical returns from the agriculture and the major factors is climate change. are the reasons for fallow land in North Mumbai. Whereas, the fallow lands are just left for a period of time so that the soil gains all the required nutrients and cops up for the better growth of crops.

Moreover, built – up area with vegetation is seen towards the North Mumbai and lesser towards the Mumbai city area. This because the people living in rural area encourage vegetation around the land they are living in. It can also be derived that due to vegetation the climatic conditions would also be favorable for various agricultural activities.

Mumbai Metropolitan city has a huge amount of built-up area without vegetation due to the concrete construction and the growth of industrialization and many more factors has led to the certain cause in the study area.

As there are rivers in the study area and the vegetation is seen along the banks of river. This is because of fertile soil available and sufficient availability of water for the plants. This encourages the growth of vegetation in the region.

Vasai creek is going to be used for water ways to boost inland and cargo transport as there are settlements on either side of the creek.

Chapter 4 – Demographic Analysis

4.1. Ward wise demographic aspects of the study area

Demographic aspects include information about the population and related aspects in the region. The data will help you to understand the changes in the demographic structure over the last three years i.e. 1991-2011. It will also help to determine the direction of urbanization with the help of census data.

4.1.1 Total distribution of population.

According to the Census of India, 'Population' is defined as the number of people living in an area. The map (4.1) shows the total number of population distribution in the North Wards of Mumbai for the years 1991-2011.

Table 4.1 Distribution of Population by Wards 1991 – 2011

POPULATION			
WARD	**1991**	**2001**	**2011**
P/S	3,50,948	4,37,849	4,63,507
P/N	6,03,877	7,98,775	9,41,366
R/S	3,35,317	5,89,887	6,91,299
R/C	0	5,13,077	5,62,162
R/N	6,19,434	3,63,827	4,31,368

***Source: Census of India, 1991, 2001, 2011**

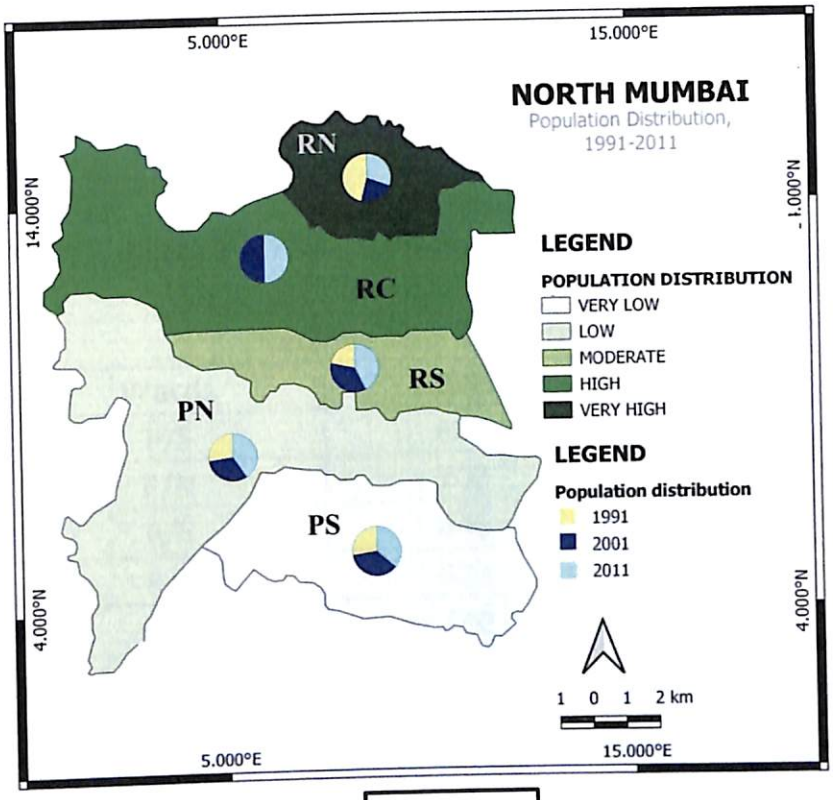


Fig : 4.1

From the above map it is observed that the total distribution of population has been varying from ward to ward. The highest distribution of population is seen in RN ward and the lowest distribution of population in PS ward. Distribution of population must have occurred due to the primary factors such as job opportunities, health facilities, education etc. People started migrating towards the northern region. Almost constant distribution of population is seen in the following years 1991, 2001, 2011 in PS and PN wards of North Mumbai. The reason behind this could be due to favorable climatic condition in the region and also the availability of facilities for settlement at a particular period of time. Moderate distribution of population in RS ward in the year 1991 is seen in scanty amount. This may be because of out- migration of people towards the well developed areas. High distribution of population in RC ward is exactly equal in the years of 2001 and 2011. In the year 1991 the population distribution is highest as compared to 2001 and 2011 years, in the RN ward. Hence, the population distribution differs according to the nature of the area.

4.1.2 Index of relative literacy rate, Mumbai Suburban District 2001-2011

According to the Census of India, 'Literacy rate' is defined by the percentage of given age group that can read and write. The map (4.2) shows the index of relative literacy rate in Mumbai Suburban District for the years 2001 and 2011.

Table 4.2 Index of relative literacy rate

Relative Literacy Rate		
Wards	**2001**	**2011**
P/S	687	788
P/N	702	779
R/S	646	764
R/C	828	917
R/N	730	781

***Source: Census of India, 1991, 2001, 2011**

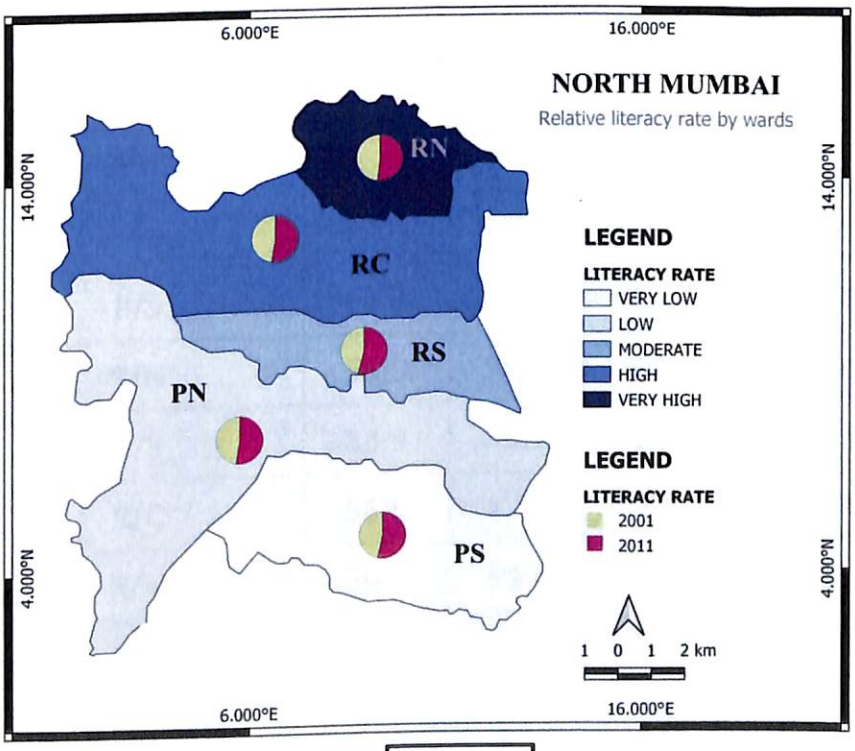


Fig: 4.2

From the above map it is observed that index of relative literacy rate has been varying from ward to ward. The highest literacy rate of North Mumbai is in RN ward which relatively has not much of difference in the year 2001 and 2011. The reason behind the constant rate of literacy rate could be because of the developed education facility available in all the areas of North Mumbai. The literacy rate is seen to be high in RC ward. In the year 2011 the literacy rate was a little bit more that in the year 2001 but there cannot be seen very much difference between the two. Moderate literacy rate is seen in RS ward. Low literacy rate is in the PN ward and the PS ward shows relatively low literacy rate. This is because of out – migration of people mainly towards the Northern wards due to much more better education facility and also job opportunities in the region.

4.1.3 Work participation by sex by wards, Mumbai Suburban 2001-2011

According to the Census of India, 'Work Participation' is defined as the percentage of total workers to the total population. The map (4.3.a and 4.3.b) shows the work participation by sex by wards, Mumbai Suburban 2001 – 2011.

Table 4.3 Work Participation by Gender

Name of the ward	Males		Females	
	2001	2011	2001	2011
P/S	58.2	59.7	13.9	19.8
P/N	56.9	58.6	11.5	20.6
R/S	58.9	59.7	11.2	17.1
R/C	56.5	57.4	15	22.1
R/N	56.8	59.4	13.3	195

***Source: Census of India 2002, 2011**

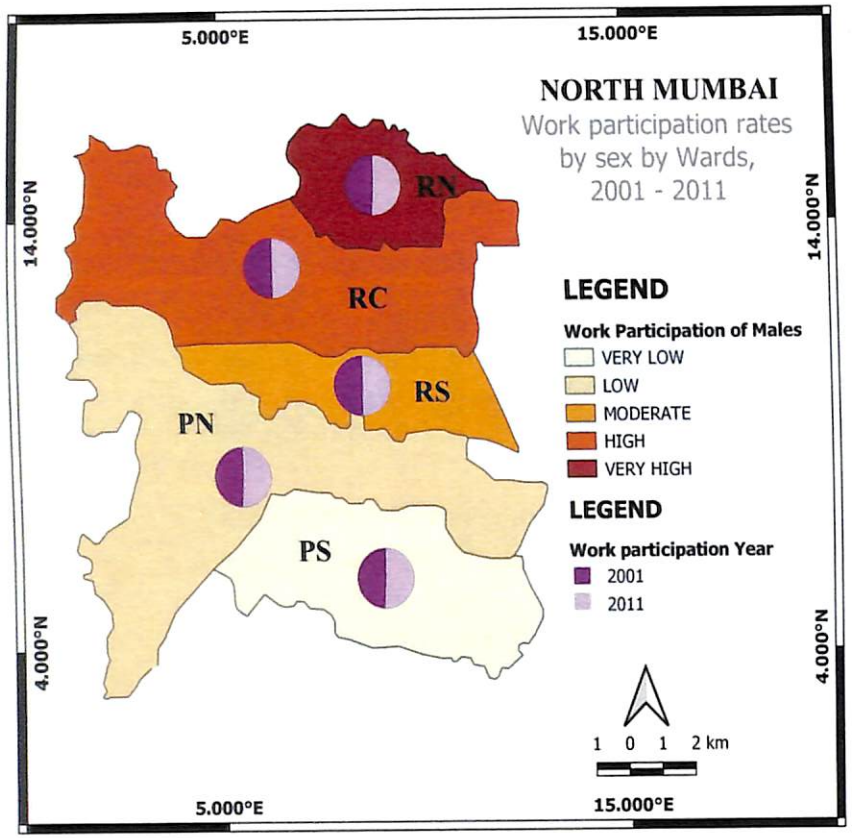


Fig: 4.3.a

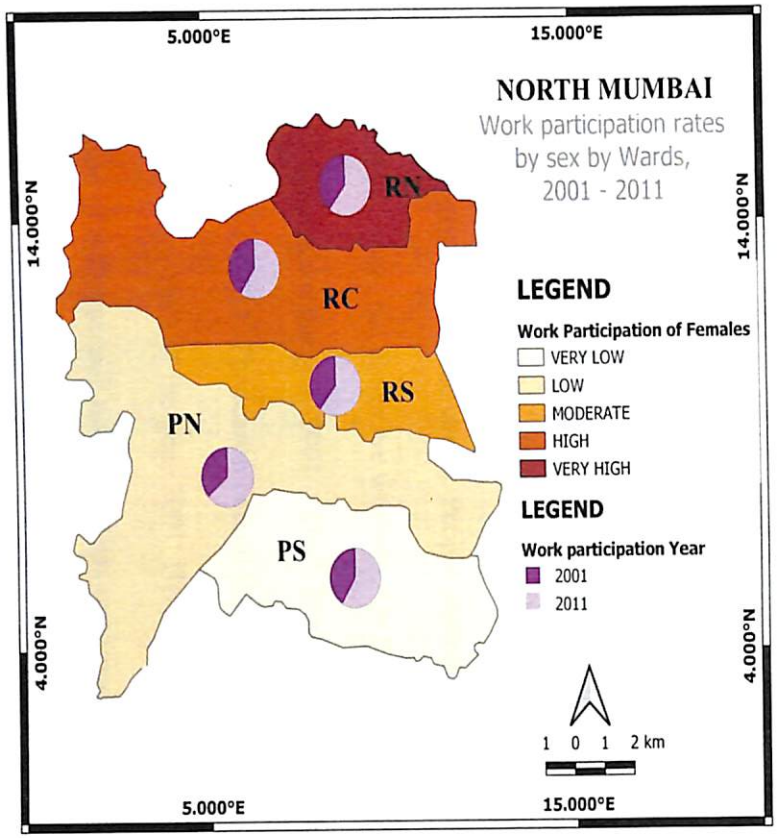


Fig: 4.3.b

From the above map it is observed that Work participation is categorized gender, for the year 2001 – 2011. In both the maps it is observed that there are variations in the work participation rate of male among the wards of North Mumbai. The highest work participation is seen in the RN wards. It shows that in the year 2001 – 2011 the work participation has remained constant which was around 50% over all the wards. People started to migrate more towards the north due to job opportunities, where the males are working. On the other hand, 4.3.b map shows the work participation of females for the year 2001 – 2011. It is clearly seen that more work participation has occurred in the year 2011. The reason behind this could be because of the development in the job field has taken place than of the year 2001. Hence, higher rate of work interest is seen. The work participation of males as well as females has remained moderated in the RS ward. The least amount of work participation is seen in the PS ward for both male and female. This is because of under developed facilities due to which out migration takes place in the area.

Chapter 5 – Major findings, Recommendations, Conclusion

5.1 Major Findings

After reviewing the study major findings have been identified and they are listed below:-

- Built up area is seen to be more than vegetation.
- Urbanization has given rise to decrease in Land cover.
- Slums have spread in major parts of North Mumbai. This has also affected the environmental conditions.
- Ample amount of vegetation are found along the banks of river due to availability of water supply.
- Built – up area are more in number than that of agricultural land.
- Due to increase in urbanization, the growth of population has affected the land use land cover aspects in every way.
- Due to urbanization and poor planning, the North Mumbai area gets flooded during monsoon season.
- Some parts of North Mumbai are protected by land cover due to which certain parts of suburban are filled with natural vegetation.
- Migration of people from all over the world has resulted in over population.
- Mostly North Mumbai has built – up area with vegetation as well as fallow lands.
- The area towards south of Mumbai are mainly cities which consists of built – up area without vegetation.
- A decrease in forested areas is seen due to cutting of tree to build infrastructure.
- Land use land cover mapping makes it easily to study about the change occurring over the years.
- Drainage system is affected in the area of slums.
- Industries are seen to be very less towards North Mumbai.
- Poor sanitation.
- Beaches have reduced.

5.2 Recommendations

- Forestation drive has to be taken into consideration to overcome the problem of deforestations.
- There should be control over population to avoid unemployment.
- Fallow lands have to be provided with fertilizers and cultivated on time.
- Sanitation and hygiene should be maintained all over Mumbai mainly in the areas of slums.
- Drainage system has to be well maintained.
- Built – up area with vegetation has to be encouraged.
- Urbanization has to be controlled to increase lad cover.
- Environmental conditions have to be improved by decreasing pollution.
- Medical, transportation has to be developed towards North Mumbai as the area is seen as rural areas.
- Government should be more concerned about the sustainable development of Land use land cover change over time.
- The youths can include themselves for the growth of land cover in a particular region.
- Cultivation of agriculture along the banks of river should be avoided as soil erosion and loss of fertile soil takes place.
- Agriculture can be encouraged in the area of availability of water supply.

5.3 Conclusion

From the above analysis it can be concluded that Land use Land cover (LULC) mapping is very important to analyze or to deeply study and interpret the changing land cover into land use over a period of time. The study shows that, due to rapidly spreading urbanization is the main cause of over population in the region has led decrease in forested areas. Land use land cover maps are a necessary tool for the development and planning management of the area. From the present study it is observed that the general trend of the area has decreased the forest cover and has given rise to settlements and barren land. Majorly LULC is linked with the growing population and at the same time unending need of natural resources. The growth of population boosted more of infrastructure than that of vegetation in the area. Some village area towards north Mumbai has built – up area with vegetation. The land and the environment conditions are dramatically affected due to the change in the land cover into land use.

Special drives have to be taken to bring an increase in the forestation. This can also promote a pleasant environment. Conversion of land cover into land use not only occurs due to building of infrastructure but also because of mining and other activities which will also lead to air pollution and other health problem to the people.

In the demographic analysis the study area show the total distribution of population is more towards the RN ward in different years. This could be because of developed facilities available in the region. Similarly, the choropleth map shows the literacy rate and work participation by gender over the years in different wards. It mainly shows the fluctuation in various activities that are happening from centuries. The demographic data which are collected are the values of population census of North Mumbai. In the study we can clearly understand the positive and negative impacts and the reasons behind for the cause can be predicted.

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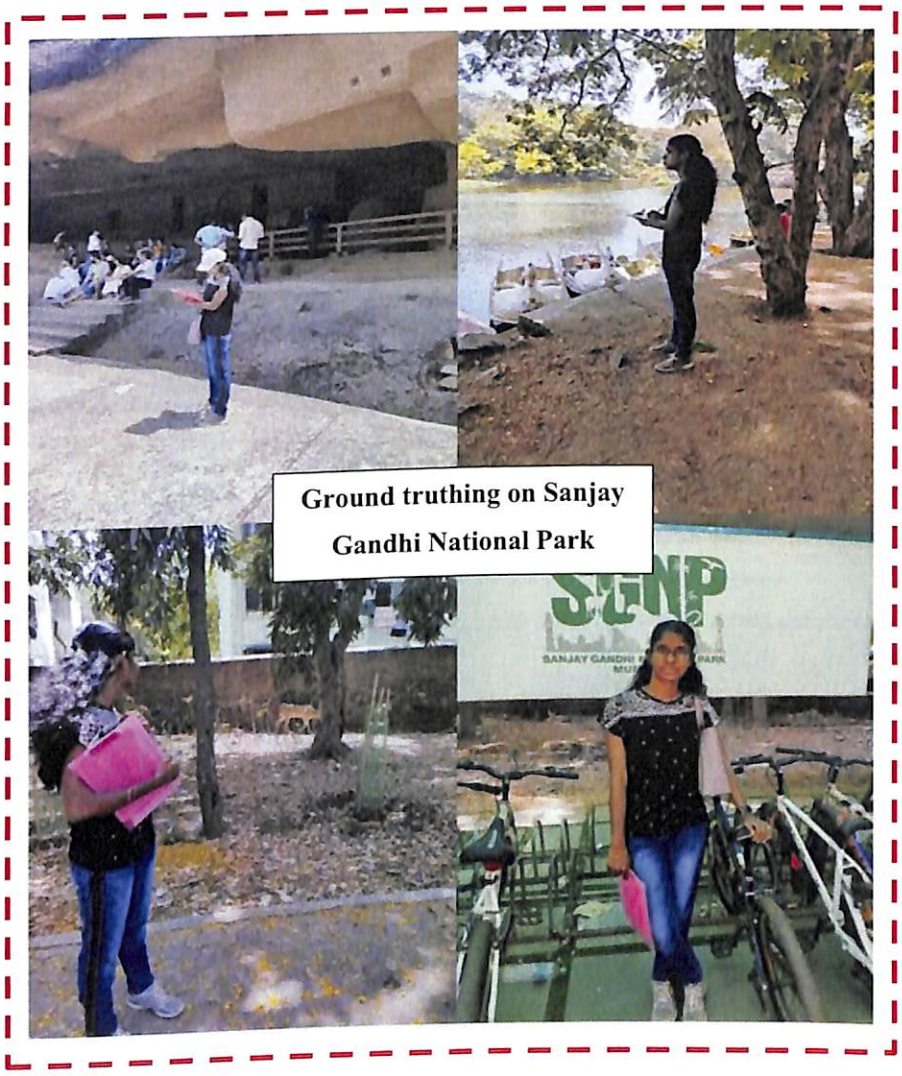
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Annexures

Photographs



Ground truthing on Sanjay Gandhi National Park

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