CHAPTER 3
STUDY AREA AND DATA COLLECTION

3.1 GENERAL

In the present work, Vadodara city was selected as area under the study. Vadodara has suffered due to floods in the years 1974,1976, 1994, 1996 and 2005, not only due to heavy rainfall but also due to changes in land use/ land cover changes.

3.2 STUDY AREA

The study area selected is Vadodara city of Gujarat state in India. Vadodara is located at 22.30°N 73.19°E in western India at an elevation of 34 metres, with an area of 149 square kilometers (as per census 2011). The city sits on the banks of the Vishwamitri River, in Central Gujarat.

Figure 3.1: Location Map of Vadodara City

The city is located on the fertile plain between the Mahi and Narmada rivers. According to the Bureau of Indian Standards, the cosmopolis falls under seismic zone-III, in a scale of I to V (in order of increasing proneness to earthquakes). A wide variety of agricultural crops, both food and non-food, are grown. Food grains like bajra, jowar, maize, paddy, wheat, etc., and pulses make up the main food crops. Fruits, vegetables, and sugarcane are additional food crops. Cotton, ground nut, castor, tobacco, fodder, and other non-food crops are also included.

One of the state's most industrially advanced districts is Vadodara. Its numerous strategic industries are dispersed throughout the Vadodara Taluka, including fertilizers, heavy water projects, petrochemical complexes, and oil refineries. Other significant industries include those that produce metal goods, rubber and plastic, non-metallic mineral products, medicines, and engineering and industrial parts, among others. (http://kvkvadodara.org). In addition to these, the district's Taluka regions contain a large number of industrial notified areas, few of which are created by Gujarat Industrial Development Corporation Ltd. (GIDC Ltd).

3.3 DATA COLLECTION

▪ **Population Data**

The city of Vadodara has witnessed a rapid urban development during the past few decades resulting in enhanced land use change, parallel to the increase in population and economic growth. The city has expanded horizontally in all directions, resulting in large-scale changes in land use. One of the major concerns is the increase in the number of impoverished areas, especially along the banks of river Vishwamitri and its adjoining low-lying areas, which are severely flooded during monsoons, leading to widespread economic loss and impacts on health and environment.

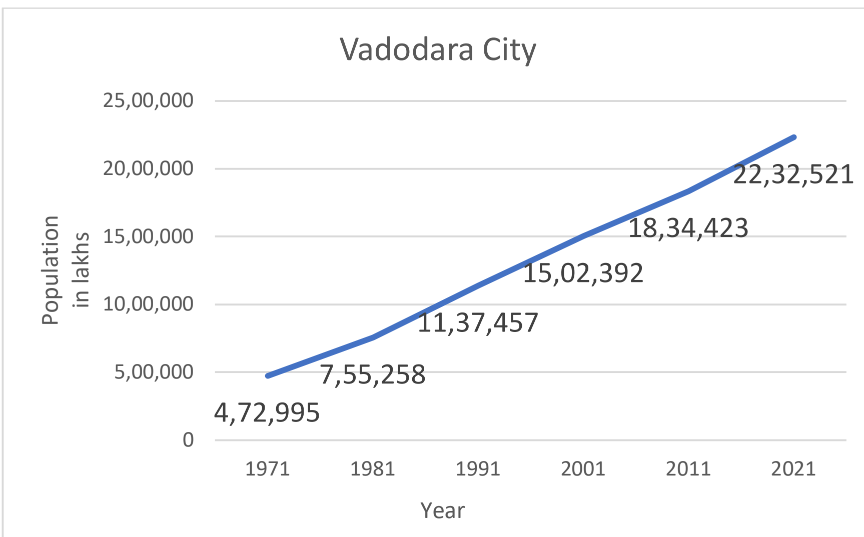

Figure 3.2: Population Growth in Study Area
for the years 1971, 1981, 1991, 2001, 2011 and 2021
(source: https://www.census2011.co.in/census/city/338-vadodara.html)

Fig. 3.2 shows the population data for the years 1971, 1981, 1991, 2001, 2011 and 2021. It shows a decadal increase in the range of 20% to 60%. A minimum of 21% increase from 2001 to 2011 is observed and a maximum 59% increase from 1971 to 1981.

Rainfall Data

The rainfall data for Vadodara city is collected for a rain gauge station available near Vadodara city. Near Vadodara city there is one rain gauge station of which the data is collected. The observed daily rainfall data for a period of 58 years (1961 to 2018) from Vadodara rain gauge station is used in deriving the IDF curves using the equation given by Gumbel and other empirical equations. The hourly rainfall data from 1961 to 2018 of Vadodara rain gauge station is used for deriving the IDF curves by the annual maxima method. The rainfall data has been collected from the State Water Data Centre (SWDC) from year 1961 to 2016 and for the years 2017 and 2018, the data is collected from the website of Indian Meteorological Department (IMD).

The annual maximum rainfall distribution for rainy season i.e., June to October, of Vadodara city for the period from 1961 to 2018 is shown in Fig. 3.3.

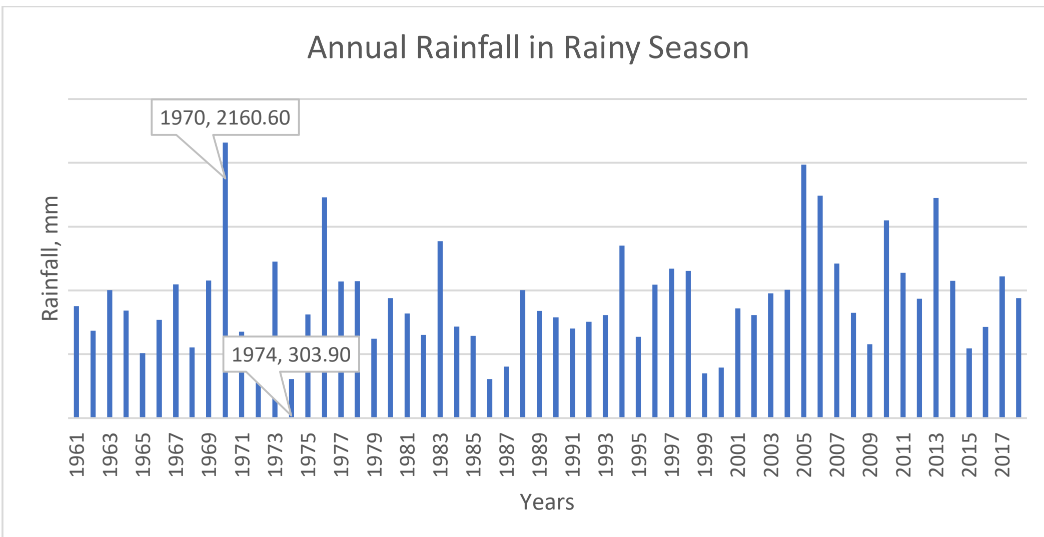

Figure 3.3: Annual Rainfall in the study area

From Fig. 3.3, the maximum annual rainfall is 2160 mm for the year 1977 and minimum annual rainfall is observed as 303.90 mm in the year 1974. The average annual rainfall for the period of 58 years from 1961 to 2018 comes out to be 931.45 mm.

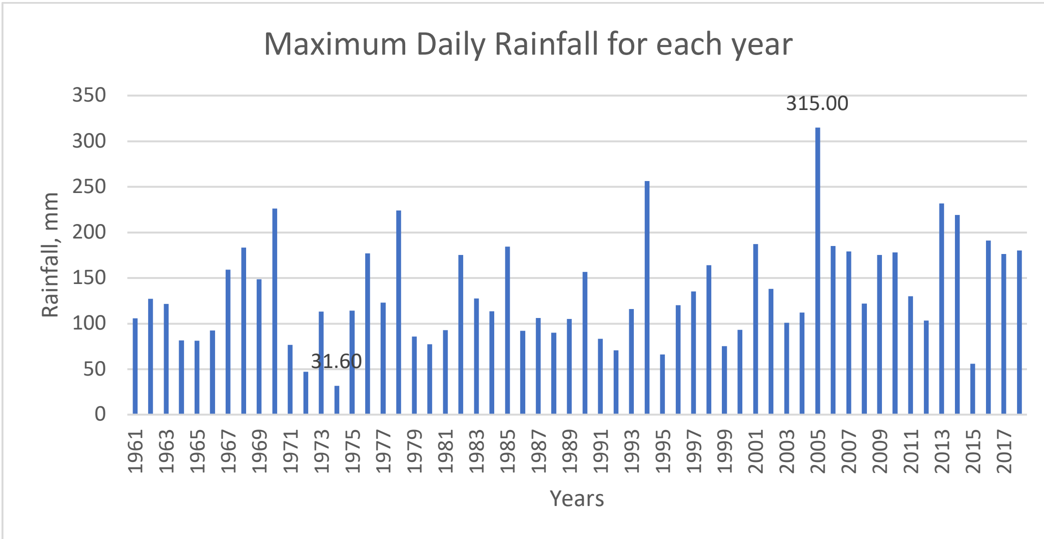

Figure 3.4: Maximum Daily Rainfall from 1961 – 2018

While the average daily rainfall over the area is 134.39 mm, as observed in Fig. 3.4, the actual maximum daily rainfall received ranges from a minimum of 31.60 mm in 1974 to a maximum of 315.00 mm in July 2005, in the period of 58 years.

- **Data for LULC**

Since 1972, Landsat satellites have continuously acquired space-based images of the Earth's land surface, providing uninterrupted data to help land managers and policymakers make informed decisions about our natural resources and the environment. The data are useful to a number of applications including forestry, agriculture, geology, regional planning, and education. Landsat is a joint effort of the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA).

High-resolution satellite images are normally used to monitor the biodiversity loss of an area to distinguish small contrasting areas. LULC analysis is an important technique used by many professionals for proper planning and sustainable management of land resources.

Land cover data documents how much of a region is covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types. Water types include wetlands or open water. Land use shows how people use the landscape – whether for development, conservation, or mixed uses.

LULC assessment can also be applied to monitor the changes of the Earth's terrestrial surface due to climate change, loss in biodiversity, and the impact of pollution on terrestrial and aquatic environments. Land use and land cover change are one of the crucial climate change drivers in expanding cities. The land use conversion which alters physical and thermal properties of land surface has also affected the air quality of the urban atmosphere. Change of land use/cover due to dams and reservoirs is the most common type caused by human-induced activities, and humans build dams as an important way to use water resources and avoid natural challenges in the watershed. These phenomena cause biodiversity loss and alteration of essential natural resources.

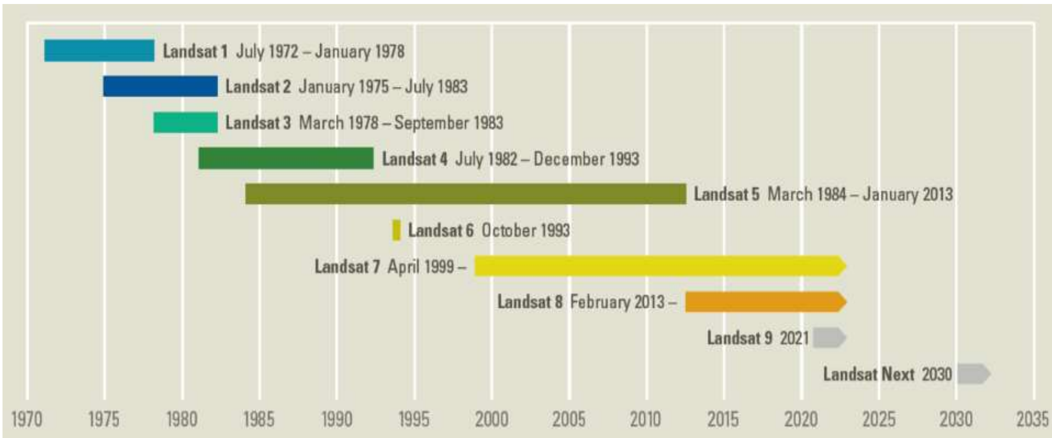

Figure 3.5: Various Landsat launched in different years

Rapid population growth would definitely increase the pressure on land use, but if the implementation of proper planning is executed, its impacts can be mitigated. Remote sensing and GIS provide a fast and efficient method to carry out land use inventory and detect changes. These changes in the city over a period cannot be neglected but require proper monitoring and assessment so that no further deteriorating steps are taken. Remote Sensing and GIS aids in both preparing accurate land use maps and monitoring changes at regular intervals of time. The potential of remote sensing to detect the growth of urban land use changes and determination of statistics has already been proved. This has become a need for Vadodara city as it is facing the grave problem of both urbanization and industrialization.

A GIS is a computer application program that stores Spatial and Non-Spatial information in a digital form. Spatial information for an area is what is traditionally represented in maps which for a region, may broadly be classified as given in the following table. The corresponding source of such data for our country is also indicated.

Table 3.1: Sources of Data

Sr. No.	Spatial features of a region	Obtained from
1	Rainfall Data	State Water Data Centre
2	Soil map	National Bureau of Soil Survey and Land Use Planning
3	Latest information on land-use and land cover, like Vegetation, Water body, Built-up and Barren land	Satellite Imageries

Landsat 8 Operational Land Imager (OLI) image of 2018, Landsat 7 Enhanced Thematic Mapper (ETM+) image of 2008 & 2003, Landsat 5 Thematic Mapper (TM) image of 1998, 1993 & 1988 and Landsat 1 Terrain Precision (TP) image of 1977 with a resolution of 30 m, were utilized in this study to evaluate changes in LULC in the study region during a 41-year period from 1977 to 2018.

Landsat 8 Operational Land Imager (OLI)	2018
Landsat 7 Enhanced Thematic Mapper (ETM+)	2013, 2008 and 2003
Landsat 5 Thematic Mapper (TM)	1998, 1993 and 1988
Landsat 1 Terrain Precision (TP)	1977

Almost, cloud-free Landsat satellite scenes for Path/Row 148/45 from two types of sensors covering the study area were downloaded freely from the United States Geological Survey (USGS) website (http://earthexplorer.usgs.gov/). For easy visibility, the cloud-free imagery used in this study was captured during the month of March. The detailed characteristics of the Landsat images used in this study are presented in Table 3.2.

Table 3.2: Characteristics of Satellite Imageries Considered

Satellite sensor	Path/row	Acquisition date	Number of bands	Spatial resolution (m)	Cloud Cover
L1_TP	159/45	March 10 1977	4	60	0.00
L5_TM	148/45	March 19 1988	7	30	0.00
L5_TM	148/45	March 17 1993	7	30	0.00
L5_TM	148/45	March 15 1998	7	30	0.00

L7 ETM+	148/45	March 05 2003	9	30	1.00
L7 ETM+	148/45	March 18 2008	8	30	0.00
L7 ETM+	148/45	March 16 2013	8	30	0.00
L8 OLI	148/45	March 22 2018	11	30	0.00

Data source: US Geological Survey

3.4 DATA PREPARATION

• The maps of the project are processed and analysed using GIS mapping software mainly ArcMap of ArcGIS and Erdas Imagine; different layers that have the same coordinates and projection systems.

• The statistical parameters of meteorological data considered are calculated in Excel using Excel stats/ curve expert tool is also used.