GEO

Vigyan

SUMMER PROJECT 2022

TOPICS INCLUDED

- Image Classification
- Using Supervised Algorithm
- Atmospheric Correction
- Raster To Vector Conversion
- Lulc Analysis

Submitted by:

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SUMMER INTERNSHIP REPORT
GEOVIGYAN

APPLICATION OF ML IN

RS AND GIS

SUBMITTED BY

Nitish

BS in Earth Science
IIT kanpur

Under the Supervision of

Internship Supervisor

Ms. Dhruv Nanda mam
Senior Research Fellow
IIT, Bhubaneswar

Internship Coordinator

Mr. Shubham Badola
Secretary GeoVigyan

CERTIFICATE

This is to certify that the Virtual Summer Internship work entitled "**Supervised Machine Learning application for determining LULC change of Porbandar city, Gujarat**"is an authentic work done by Nitish Shankar, Under Graduate in BS in Earth Science IIT kanpur, during 1 June 2022 – 30 June 2022, at GeoVigyan, Dehradun under my supervision and guidance. During the period of training, her conduct and discipline was very good.

Date: 31/07/2022

Supervisor

Ms. Dhruv Nanda

Senior Research Fellow

IIT Bhubaneswar

CERTIFICATE

I certify that the report entitled "**Supervised Machine Learning application for determining LULC change of Porbandar city, Gujarat**" submitted by Nitish is the record of research work carried out by her during 1 June 2022 – 30 June 2022 under my coordination, and this work has not formed the basis for the award of any degree, diploma, associateship, fellowship or other titles in this university or any other university or Institution of higher learning.

Date: 31/07/2022

Coordinator

Mr. Shubham Badola

Secretary GeoVigyan

DECLARATION

I hereby declare that the work, which is being presented in this Virtual Summer Internship, entitled "Supervised Machine Learning application for determining LULC change of Porbandar city, Gujarat" by Nitish submitted to the GeoVigyan, Dehradun, is an authentic record of my own work carried out under the guidance of Ms. Dhruv Nanda, Senior Research Fellow, IIT, Bhubaneswar, during 1 June 2022 – 30 June 2022.

Date: 31/07/2022

Nitish

BS in Earth Science
IIT kanpur, IN

ACKNOWLEDGEMENT

I express my solemn gratitude to my internship supervisor, Ms. Dhruv Nanda, Senior Research Fellow, IIT, Bhubaneswar, for her guidance, moral support, positive cooperation and providing all facilities for carrying out the entire report work. The words fail me in expressing their continuous co-operation and valuable time. She has nurtured my ideas, with his knowledge and patience and gave me
full freedom to work on the topic. I am thankful to her for guidance, active participation and instructions in my report.

I have no words to express my gratitude and gratefulness to my internship coordinator, Mr. Shubham Badola, Secretary, Geovigyan, who coordinated this summer camp so smoothly and with patience, for
suggesting this endeavour and his valuable guidance and constant encouragement throughout the period of this study.
I consider myself extremely fortunate to have worked with them, since I found every discussion inspiring and enlightening. I am thankful to him for his active participation and instructions in my report.
Last but not the least I express my indebtedness to the authorities of Geovigyan, for providing me a chance to do this Virtual Summer Internship and necessary environment for the successful completion
of the course. I once again thank all who helped me in the successful completion of the course.

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ABSTRACT

Urbanisation is important aspect of development. It is increasing day by day. This is mainly seen in developing countries. Population increase is directly related to urbanisation. People tend to move towards towns in search of work. Efforts need to be made for well urbanisation.. Land use Land change analysis can play key role in todays urbanisation pattern. Some quantitative techniques can help in the assessment of land-use dynamics. Land use Land cover is directly affected by the oversize of the population. The present works mainly focus on Land use dynamics and how it impacts the ecosystem services. This study is based on machine learning that can use supervised algorithms to assess Land use dynamics and other phenomena.

In this project, there is the use of Landsat8 data set for further analysis. After downloading data from the Earthexplorer i do atmospheric Correction on all the data including for further assessment. Then prepare a training sample for supervised classification with the help of a quantum geographical information system.

The main objective of the study is to understand the Land cover and ecosystem services by using a machine learning algorithm.

Keywords

Machine Learning, Land use Dynamics, Ecosystem services, Lulc Change Analysis .

Introduction

Urbanization is an emerging subject mainly in developing countries like India. It occurs when people moving towards urban centers due to the availability of sources. The urban land use pattern in Indian cities has a complex urban form, design, and function due to unplanned urban developments (Chadchan & Shankar, 2012; Kotharkar, et al., 2014). People mainly shifted from rural areas to urban areas for better living standards. It led to an increase in the population of an urban center. Rapid and uncontrolled growth in population along with economic and industrial development, in particular in developing countries, have multiplied changes of land-use and land cover (LULC) rate in the late 20th and early 21st centuries (Talukdar, S., et al.,2020).

It is also one of the main problems that led imbalance between population and natural resources. Due to the number of industries, there is also a change in the land use pattern of the urban center. People started to exploit resources for the sake of interest. Due to the exploitation of natural resources, there is a negative effect on ecological services. It is mainly occurring due to the non-availability of basic amenities like health, sanitation, education, etc in the rural areas. Every resource has some saturation level that should be balanced with the population size. Due to rising demand for various things by the migrated people causes some dangerous issues. In short, the government should plan and organize the society so that it cannot affect the natural resources as well as ecological services provided by the nature.

Changing land use during the urbanization process has significant impacts on the value of ecosystem services (Sun, W. et al., 2018), and regional differences in per capita GDP, population density, and urbanization rate affect spatial and temporal differences in the value of ecosystem services (Xu, X et al., 2019). Furthermore, land use and regional economic development have a well-linked, harmonious relationship and mutual effect (Chen, D et al., 2018).

At present, 55% of the world population lives in urban areas of the world and it will increase to 68% by 2050 (UN DESA, 2018). It describes that the gradual shift of the human population from rural to urban areas and the overall growth will increase by 2.5 billion by 2050. Among these continents, Asia and Africa face a 90% increase in urbanization. It is projected that India will have 416 million urban populations by 2050. (UN DESA, 2018). In India, one-third of the population lived in cities. There are 53 cities in India with a population of a million or more than a million. This number will increase to 87 by 2013. The main reasons behind urbanization are the opportunities for sustainable development that will provide by urban areas (United Nations University). Oxford economies say that between 2019 and 2035 cities are growing that 17 of the 20 fastest cities in the world are from India.

Land-use classification is different from land-cover classification. Land use focuses on natural attributes, while land use focuses more on social attributes. In urban areas, more emphasis is

placed on land-use patterns and conditions in urban areas of the world (Mao et al.,2020). Land use is associated with human activities on land. On the other hand, the land cover represents the feature on the surface of the land. It includes vegetation and human construction that covers the land surface. Land use is important in various forms and directly linked with human beings. The present study is about the land use and ecological services of the Porbandar cityLand use dynamics is an important subject that helps the various fields to understand
and plan. These fields are geography, urban planning, and other sciences. It helps to understand the land use pattern of the particular area. It also helps to under the social condition of the society. By understanding spatial patterns, a planner can make the best decision for society. This study is done by using machine learning to classify the land use pattern of the study area.
There are various technologies to access the land-use change and its impact on the ecosystem services. Some methods are based on the classification and will help to map the land use of the study area. There are some new earth satellites like sentinel-2 and Landsat-8 that provide their data to the public. Among these, machine learning is the important medium to understand the land-use pattern and change concerning ecosystem services.
A machine learning algorithm is a process that is used to fit a model to a data-set, through training or learning (S. Willcock et al., 2018). Machine learning algorithms may generally be divided into two main groups, supervised and unsupervised, learning separated by using explicit feedback in the learning process (Blum and Langley, 1997; Russell and Norvig, 2003; Tarca et al., 2007).
There are many algorithms in machine learning that can be used for both classification and regression purposes. A common example of this type of algorithm is Random forest that can be used with continuous and categorical variables. So, a random forest can be used for land use and another modeling the earth science application. RF was compared with classification trees, which are also known as decision trees, (Rodriguez-Galliano et al. 2012) who found that RF produced a high accuracy of 92%, thereby outperforming classification trees. The accuracy of the random forest is based on the decision tree that is based on the training data set. Support vector machines (SVM) are very useful for complex data sets. A Landsat-8 study of six Land-Cover classes has shown that SVM achieves a relatively high precision of about 88% overall SVM (Goodin, et al., 2015). Decision Tree has the potential for land cover and land use mapping. Decision Tree Classifiers have various advantages for remote sensing applications and other phenomena.

Steps Involved in Classification:

- **Study Area**

1. General Characteristics of the District

- **Location & Geographical Area**

Porbandar district consists of 3 talukas viz. Kutiyana, Porbandar and Ranavav. Porbandar district is situated in the south west corner of the sautashtra peninsuala between 21.15° and 21.50° North Latitude and 69.55° and 70°.25 East Latitude. Total Geographical area of the district is 2272 sq. Kms.

- **Topography**

The annual normal average rainfall of the district is 1242 M.M.The district receives rains from south west MONSOON FROM June to September. The district falls In Agroclimate zone . The climate is humid along the coastal belt.

- **Availability of Mineral**

Porbandar district abounds in mineral resources. The minerals found in the district are limestone and building lime stone.

- **Administrative Setup**

Head quarter of the district is Porbandar. There are three tehsils in the district namely porbandar, ranavav & kutiyana. There are two nagar palika's and two nagar panchayats. There are 151 gram panchayats in the district.

Porbandar, the historical port city of India, is famous for many reasons but the most important reason is that Mahatma Gandhi was born here. The people in Porbandar are warm and nice. They boast of a very rich cultural heritage and their festivals are a visual treat. The Porbandar is land of Sant(Divine Souls), Shura(Brave Souls), Sati(Holy Mothers) and Sevak(Selfless servants of the people) and literacy Geniuses. Porbandar in Gujarat, India is famous all over the world as the birthplace of Mahatma Gandhi, the Father of the Nation. People and culture of Porbandar makes the city even more special since it has adhered to its culture and traditions and has carried forward the legacy, which was bestowed upon it by people like Mahatma Gandhi.


Jammu and Kashmir
Himachal Pradesh
Punjab
Harvana
Rajasthan
Uttar Pradesh
Sikkim
Arunachal Pradesh
Assam
Nagaland
Meghalaya
Manipur
Tripura
Mizoram
Bihar
West Bengal
Guiarat
Madhva Pradesh
Orissa
Maharashtra
Andhra Pradesh
Karnataka
Kerala
Tamil Nadu

Porbandar City

DYNAMICS OF LAND USE-LAND CHANGE

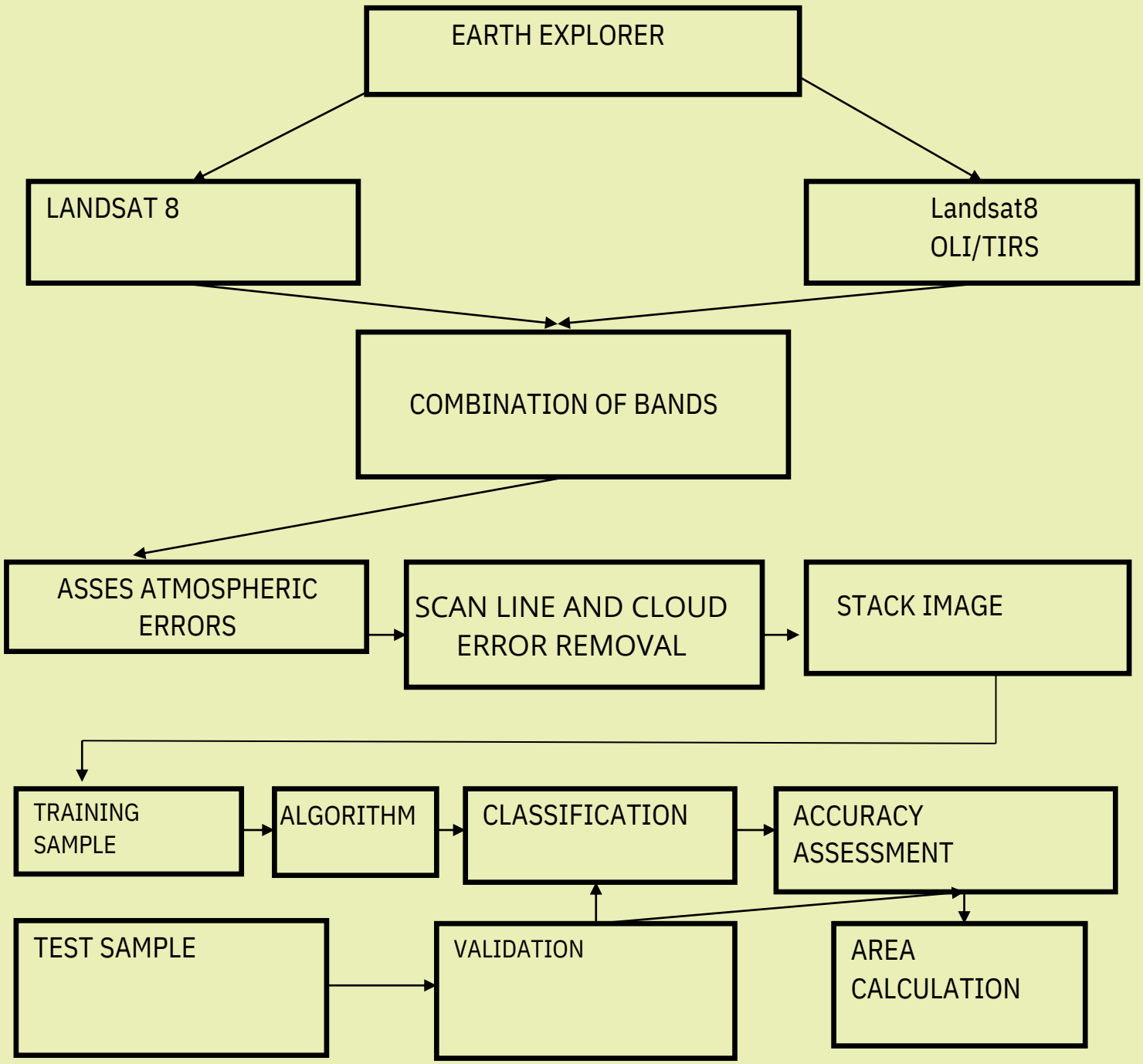
Land-use change is driven by synergetic factor combinations of resource scarcity leading to an increase in the pressure of production on resources, changing opportunities created by markets, outside policy intervention, loss of adaptive capacity, and changes in social organization and attitudes. The changes in ecosystem goods and services that result from land-use change feed back on the drivers of land-use change. A restricted set of dominant pathways of land-use change is identified. Land-use change can be understood using the concepts of complex adaptive systems and transitions. Integrated, place-based research on land-use/land-cover change requires a combination of the agent-based systems and narrative perspectives of understanding. We argue in this paper that a systematic analysis of local-scale land-use change studies, conducted over a range of timescales, helps to uncover general principles that provide an explanation and prediction of new land-use changes.

- **Research Procedure**

The present study is assessing the dynamics of Land use with the help of a machine learning algorithm. This study used the Landsat 8 imagery for assessing the dynamics of land use and ecosystem services. After that, the image is combined into bands for calculating the Composite Bands. I then did remove error for more analysis. Then take a training sample for the supervised classification with the help of a machine learning algorithm. I also use a test sample for the validation and at the end, we calculated area by conversion from raster to verctor polygon

There are no optimal training samples and the training sample size should not be less than ten to thirty-fold as many bands for each class (Li et al., 2014). To set the spatial autocorrelation, various samples were used for machine learning algorithms that were selected through the visual interpretation of satellite imagery.

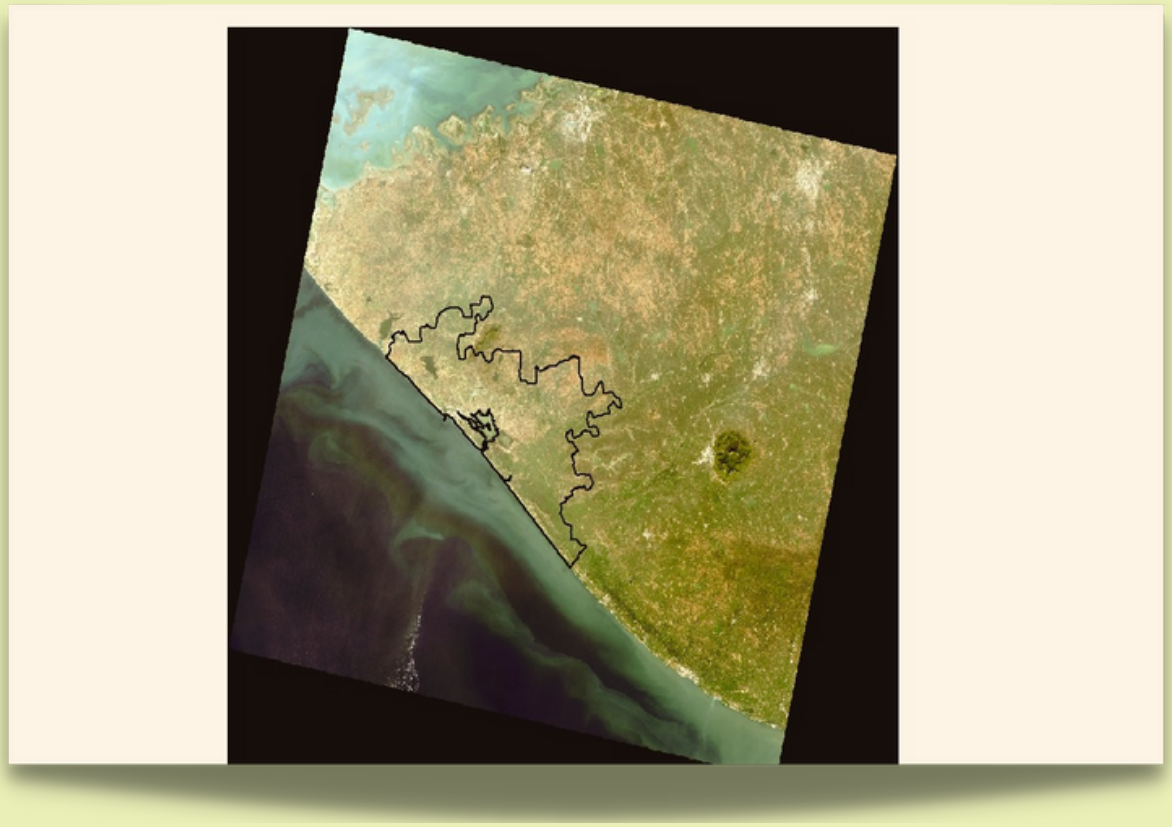
Image fusion can be used to improve the ability of users to detect, recognize and identify objects in an image from different wavelengths at the same time (Wald, 1999). Specifically, high spectral resolution can generally help in the discrimination between LULC types as far as spatial and spectral resolution is concerned, whereas high spatial resolution can benefit from identifying field characteristics and structures (Tso & Mather, 2016). To obtain the spectral information for the fused image, the higher resolution multi-spectral bands must be fused to produce the same geometric information from lower resolution (Ballester et al., 2006; Gasparovic, M., & Jogun, 2017; He et al., 2012).

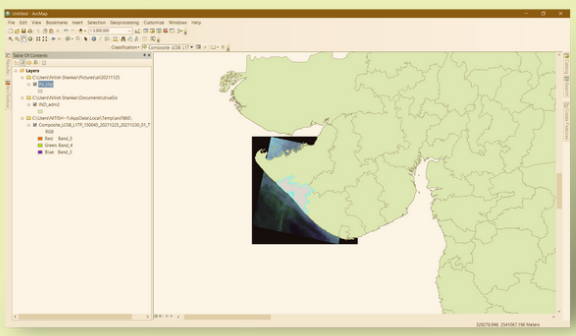


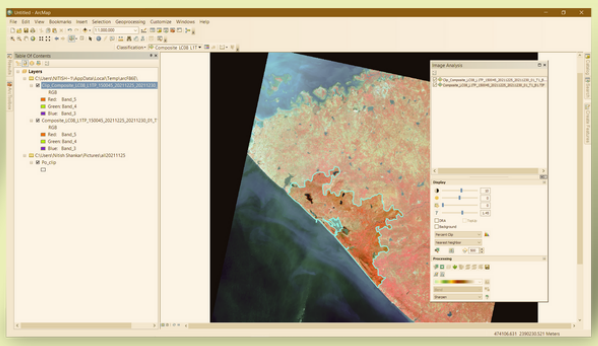
The above flowchart shows the materials and methods that have been used in the land-use dynamics of the cit. In this study, Landsat 8 imagery has been used for assessing the land-use dynamics ofPorbandar city. Spectral Landsat data are often used in the LUCC regional scale classification (Abdullah et al., 2015; Jimenez et al., 2018; Satir and Erdogan, 2016) because of its free access, widespread coverage, and higher archive frequency. Landsat 8 satellite imagery is used for one decade. . The satellite imageries have been downloaded from the EarthExplorer that is a very important source for satellite imagery. Further, the Arc GIS software has been used for further analysis of the study. After downloading the data, export it to the arcGIS software and then then combine multispectral images into different bands. Then, I have calculated the LULC and LULC chane analysis for these years

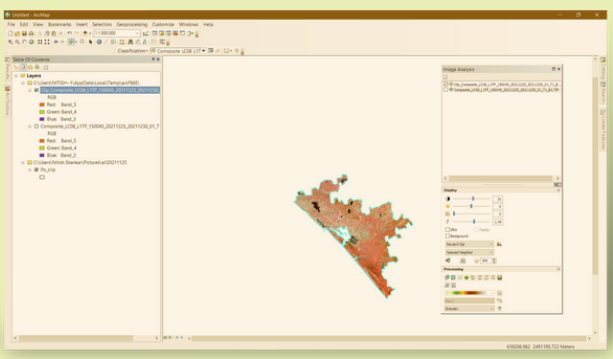
The present study is based on the machine learning algorithms that are used for the assessment of land-use dynamics of the city. Training samples have been from all areas in the city and then perform the machine learning algorithms for assessing the land use pattern of the Porbandar city. In last, perform an change analysis with the help of the calculated area for each class.

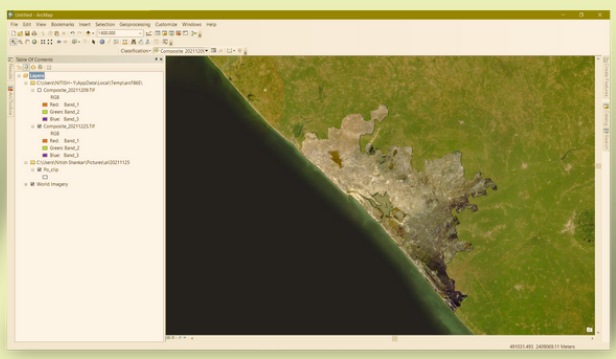
- **Area of Interest(AOI)**











Clipping AOI

- ## Bands Used

Landsat -8 Satellite Data is used in the classification purposes and LULC change assesment. Landsat 8 is an Earth observation satellite built, launched and operated by a collaboration of NASA and USGS. Data survey is performed by two main sensors which are adjusted into prescribed bands. The satellite operates in visible light, near InfraRed; ShortWave InfraRed to Thermal (LongWave) infrared. The bands are pre-set to 11 bands in total differed by the wavelength of their vision.

Started in 2014, Landsat data helps us in many useful way, through this band images we can easily classify features and do Urban Planning, coastal and aerosol studies. cirrus cloud detection surface temperatures measurements. Which further leads to Good governance and public programme planning .

Landsat 8 (formerly the Landsat Data Continuity Mission, or LDCM) was launched on an Atlas-V rocket from Vandenberg Air Force Base, California. Since its launch on Feb11, 2013 Landsat -8 has made RS GIS more easier, fruitful and effective.

The satellite carries the **Operational Land Imager (OLI)** and the **Thermal Infrared Sensor (TIRS)** instruments.

1.Operational Land Imager (OLI) uses 9 bands in the spectrum of visible light, Near Infrared and shortwave infrared portions (VNIR, NIR, and SWIR) of the spectrum.
2.Thermal InfraRed Sensor (TIRS) operates in the range of the Infrared frequencies – Longwave InfraRed Light.The TIRS measures land surface temperature in two thermal bands with a new technology that applies quantum physics to detect heat.

The satellite provides images with a moderate resolution which varies in different bands from 15 m per pixel in the most accurate to 100 m in the LongWave Infrared where accuracy is not vital. Landsat 8 images have 15-meter panchromatic and 30-meter multi-spectral spatial resolutions along a 185 km (115 mi) swath.

While monitoring the land cover it is possible to select one or several bands in order to create a clearer picture due to the specific needs for different kinds of researches it is possible to use False Color Images for enhancing the visual appearance of the data. The opportunity given is to substitute the true color of the image with the color required.

Landsat 8 Satellite Orbit Features

- Orbits the Earth in a sun-synchronous, near-polar orbit (98.2 degrees inclination)
- Achieved an altitude of 705 km (438 mi)
- Completes one Earth orbit every 99 minutes
- Has a 16-day repeat cycle with an equatorial crossing time of 10:00 a.m. +/- 15 minutes
- Acquires about 740 scenes a day on the Worldwide Reference System-2 (WRS-2) path/row system, with a swath overlap (or sidelap) varying from 7 percent at the equator to a maximum of approximately 85 percent at extreme latitudes

Landsat 8 Instruments

Landsat 8 carries two sensors. The Operational Land Imager sensor is built by Ball Aerospace & Technologies Corporation. The Thermal Infrared Sensor is built by NASA Goddard Space Flight Center.

- ## Dataset Used- OLI/TLI

1.Operational Land Imager (OLI)

Nine spectral bands, including a pan band:

- Band 1 Coastal Aerosol (0.43 - 0.45 µm) 30 m
- Band 2 Blue (0.450 - 0.51 µm) 30 m
- Band 3 Green (0.53 - 0.59 µm) 30 m
- Band 4 Red (0.64 - 0.67 µm) 30 m
- Band 5 Near-Infrared (0.85 - 0.88 µm) 30 m
- Band 6 SWIR 1(1.57 - 1.65 µm) 30 m
- Band 7 SWIR 2 (2.11 - 2.29 µm) 30 m
- Band 8 Panchromatic (PAN) (0.50 - 0.68 µm) 15 m
- Band 9 Cirrus (1.36 - 1.38 µm) 30 m

OLI captures data with improved radiometric precision over a 12-bit dynamic range, which improves overall signal to noise ratio. This translates into 4096 potential grey levels, compared with only 256 grey levels in Landsat 1-7 8-bit instruments. Improved signal to noise performance enables improved characterization of land cover state and condition.

The 12-bit data are scaled to 16-bit integers and delivered in the Level-1 data products. Products are scaled to 55,000 grey levels, and can be rescaled to the Top of Atmosphere (TOA) reflectance and/or radiance using radiometric rescaling coefficients provided in the product metadata file (MTL file).

2.Thermal Infrared Sensor (TIRS)

Two spectral bands:

- Band 10 TIRS 1 (10.6 - 11.19 µm) 100 m
- Band 11 TIRS 2 (11.5 - 12.51 µm) 100 m

Landsat 8 Spacecraft Features

- Built by Orbital Science Corporation
- 3.14 terabit solid-state data recorder
- Power provided by a single 9 x 0.4 meter solar array and one 125 Ampere-Hour (AHr), Nickel-Hydrogen (NiH2) battery
- Weight: 2,071 kg (4,566 lbs) fully loaded with fuel (without instruments)
- Length: 3 m (9.8 ft)
- Diameter: 2.4 m (7.9 ft)
- Direct Downlink with Solid State Recorders (SSR)

Data rate: 384 Mbps on X-band frequency; 260.92 Mbps on S-band frequency
Landsat 8 Data Products
Landsat 8 data products are consistent with all Landsat standard Level-1 data products, using the specifications described on the Landsat Processing Details page.

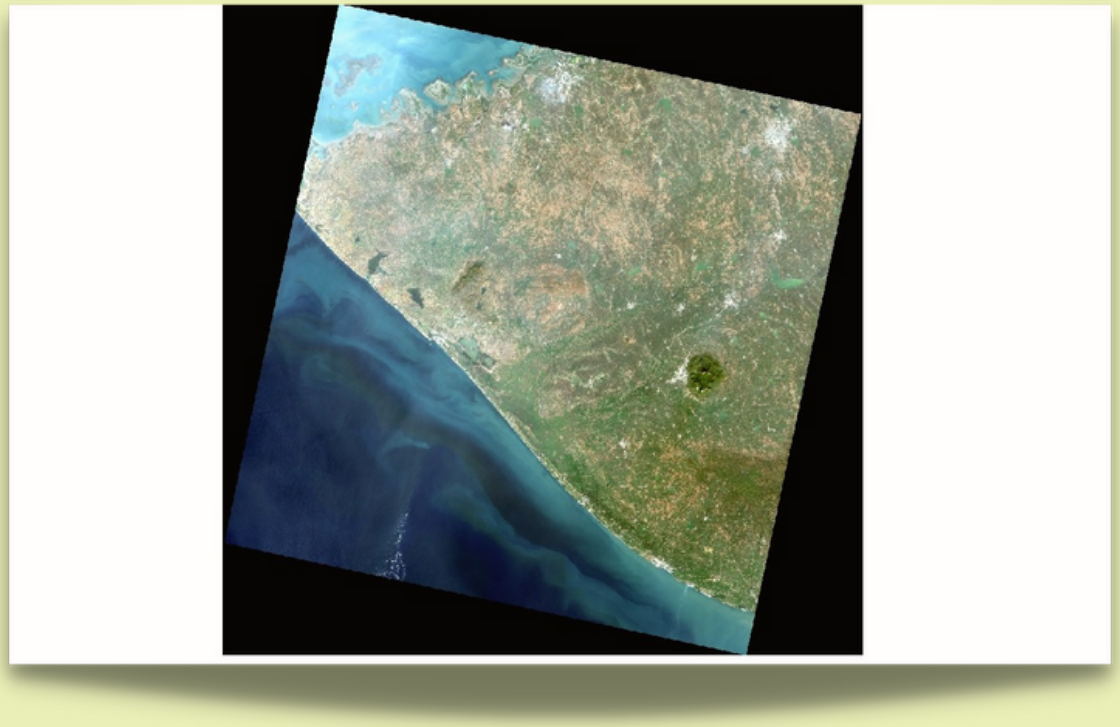
Landsat 8 Pre-WRS-2 Data Products
Nearly 10,000 scenes were acquired by OLI/TIRS after launch (February 11, 2013) through April 10, 2013, when the satellite achieved operational orbit (WRS-2). The earliest images are TIRS data only. These data are also visible and can be downloaded from EarthExplorer or GloVis.

While these data meet the quality standards and have the same geometric precision as data acquired on and after April 11, 2013, the geographic extents of each scene may differ. Most data are processed to the highest level possible, however there may be some differences in the spatial resolution of the early TIRS images due to telescope temperature changes, but they should be within +/- 1 percent.

- ## Bands Combinations used

Natural Color (4, 3, 2)

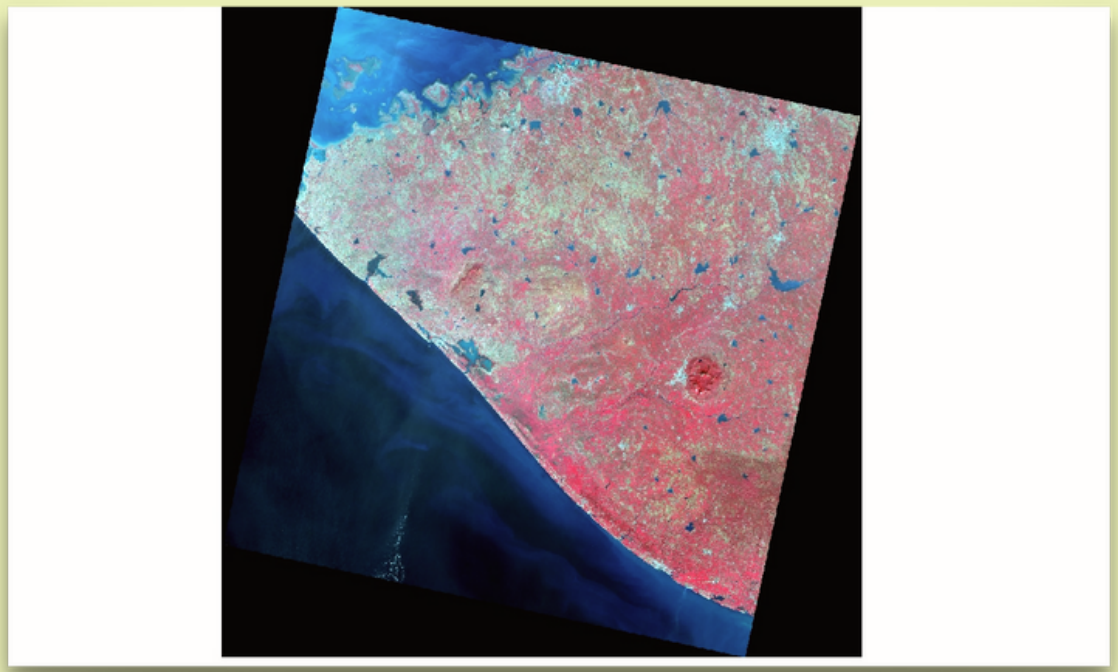
Landsat Natural Color
The natural color composite uses a band combination of red (4), green (3), and blue (2). It replicates close to what our human eyes can see. While healthy vegetation is green, unhealthy flora is brown. Urban features appear white and grey and water is dark blue or black.



Color Infrared (5, 4, 3)

Landsat Color Infrared

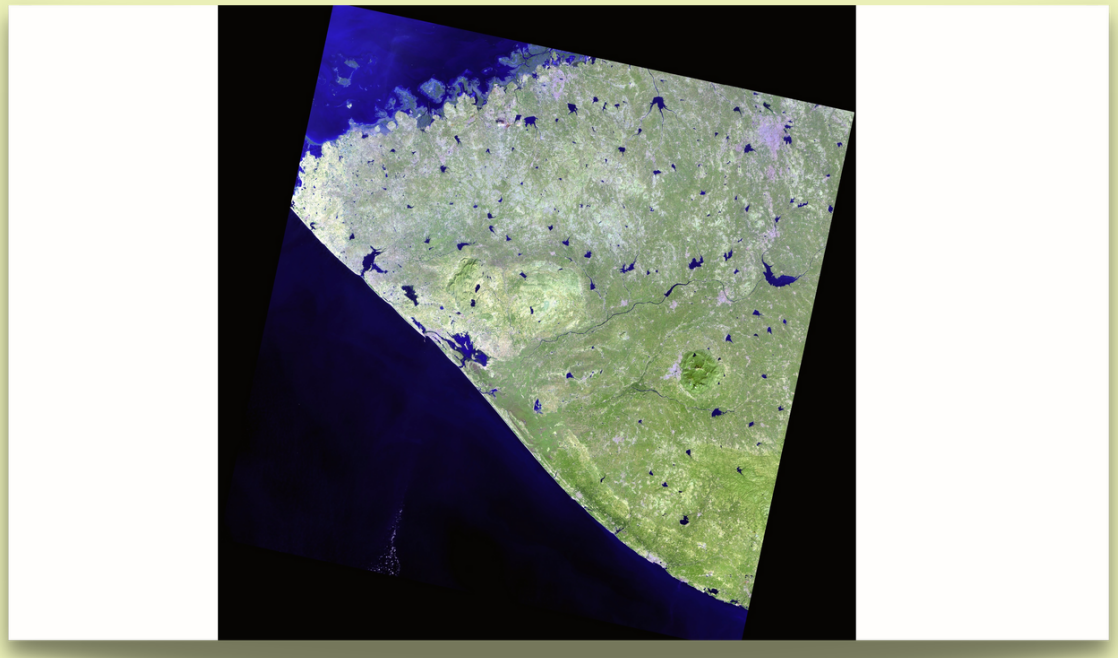
This band combination is also called the near-infrared (NIR) composite. It uses near-infrared (5), red (4), and green (3). Because chlorophyll reflects near-infrared light, this band composition is useful for analyzing vegetation. In particular, areas in red have better vegetation health. Dark areas are water and urban areas are white.



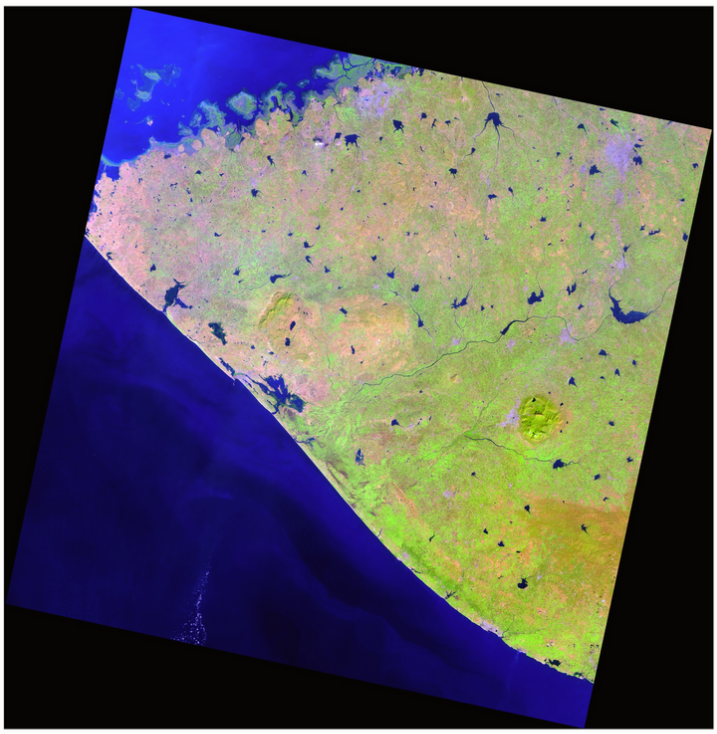
Short-Wave Infrared (7, 6 4)

Landsat Shortwave Infrared

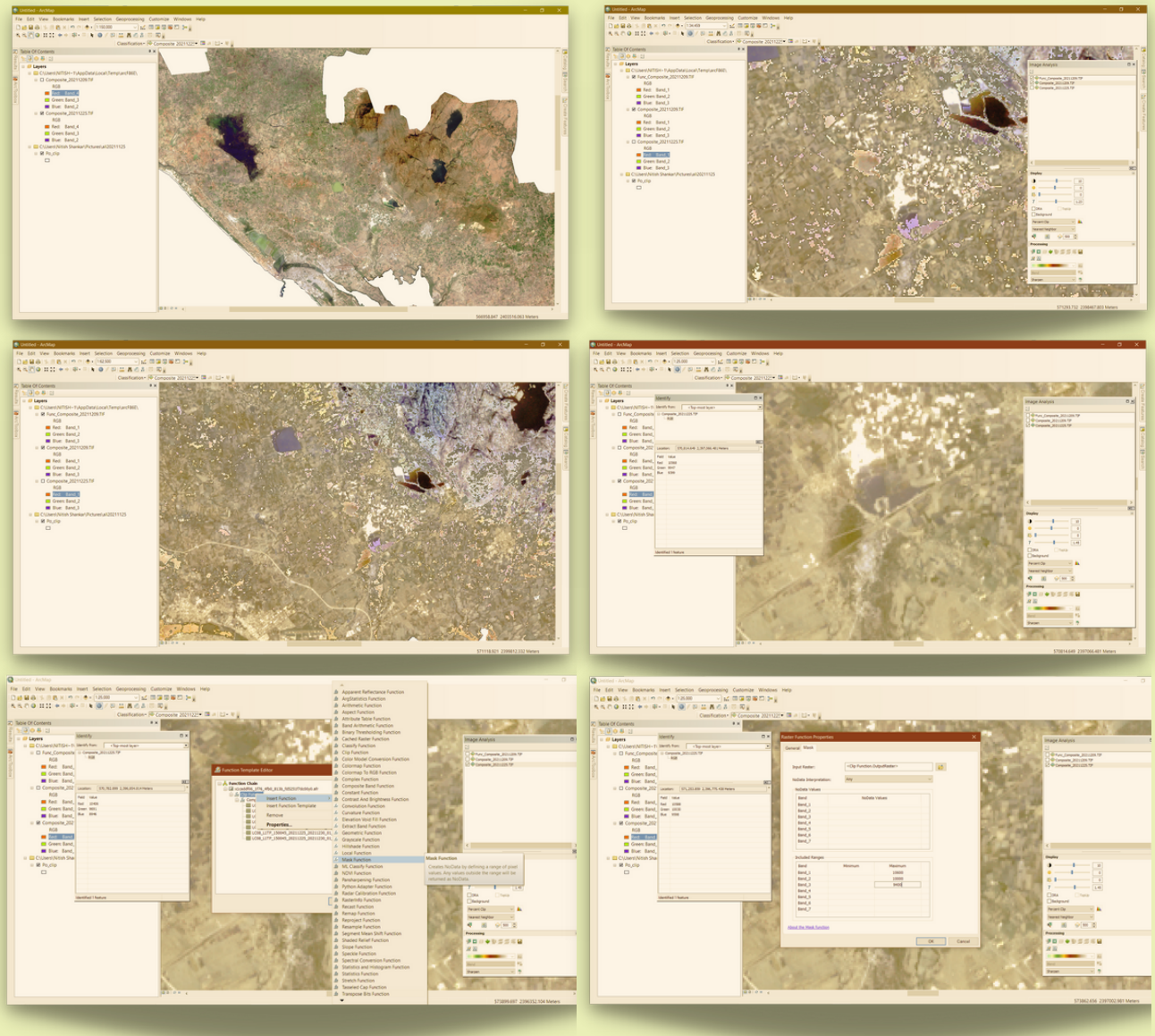
The short-wave infrared band combination uses SWIR-2 (7), SWIR-1 (6), and red (4). This composite displays vegetation in shades of green. While darker shades of green indicate denser vegetation, sparse vegetation has lighter shades. Urban areas are blue and soils have various shades of brown.



Agriculture (6, 5, 2)
Landsat Agriculture
This band combination uses SWIR-1 (6), near-infrared (5), and blue (2). It's commonly used for crop monitoring because of the use of short-wave and near-infrared. Healthy vegetation appears dark green. But bare earth has a magenta hue.

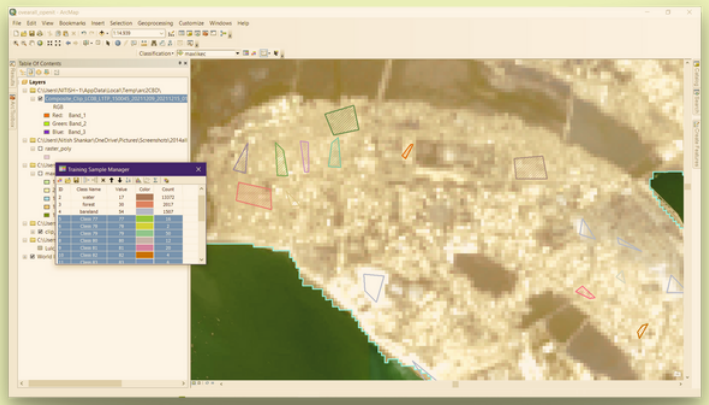


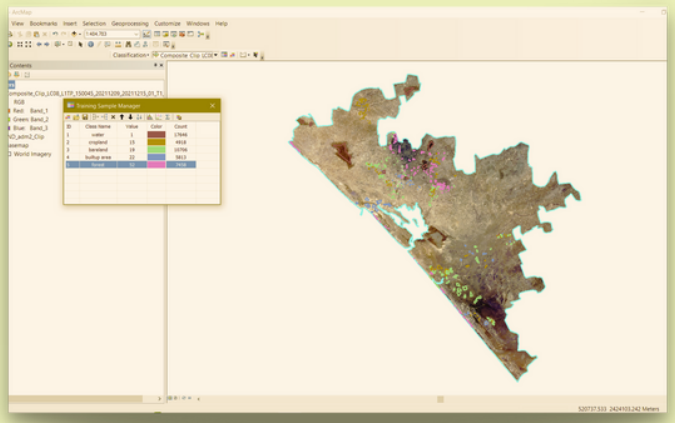
- **Cloud Presence And Cloud Removal**

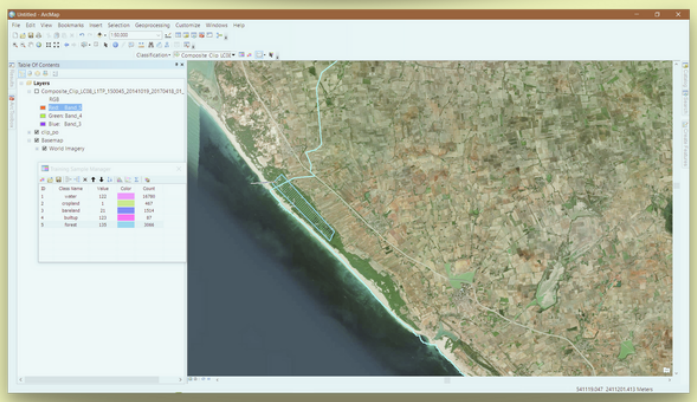


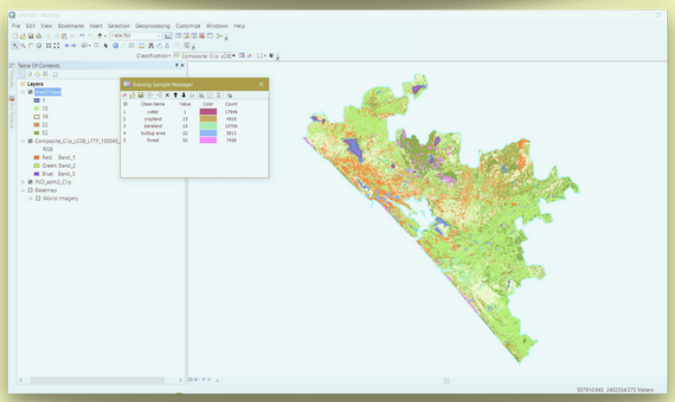
Atmospheric Correction Such as Scan Line error, Cloud removal, And Sun elevation Shadow removal are necessary data preprocessing steps involved before Data analysis and interpretation.
Atmospheric interaction distorts the surface signal received by a space-borne instrument. Images derived from visible channels appear often too bright and with reduced contrast.
Could Removal process was applied and cloud free images was acquired as a result of atmospheric preprocessing correction step

- **Marking Training Samples**

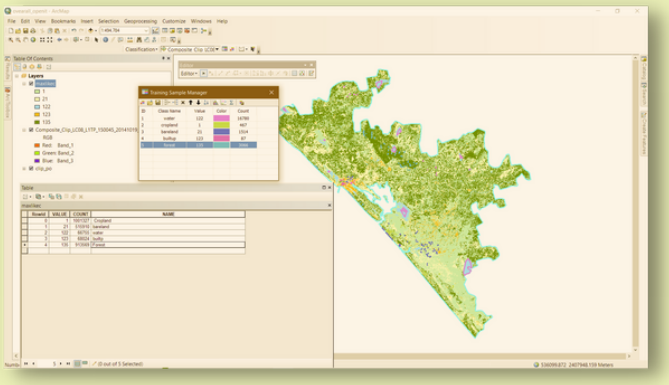


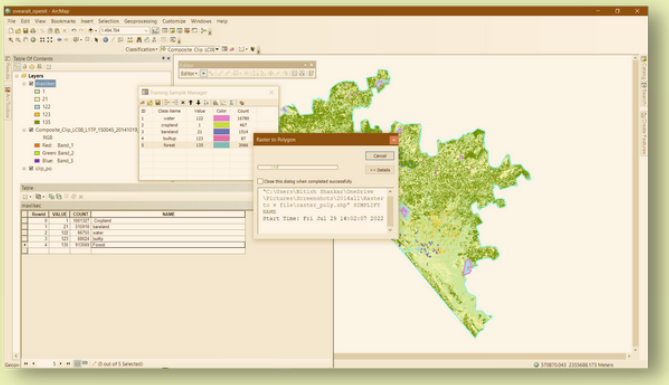


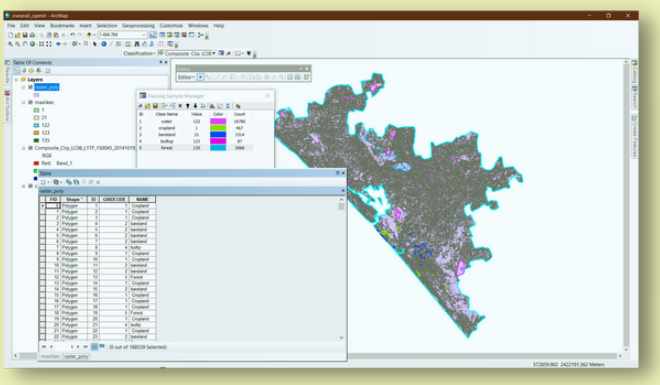


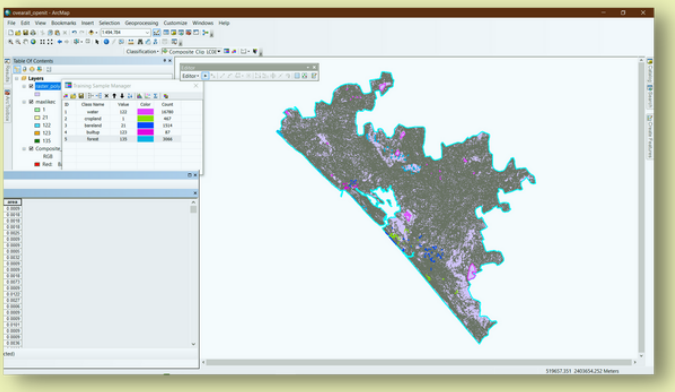


- **Conversion of Raster To Vector Polygon**









- **Application Of ML Algorithm in classification and Feature extraction**

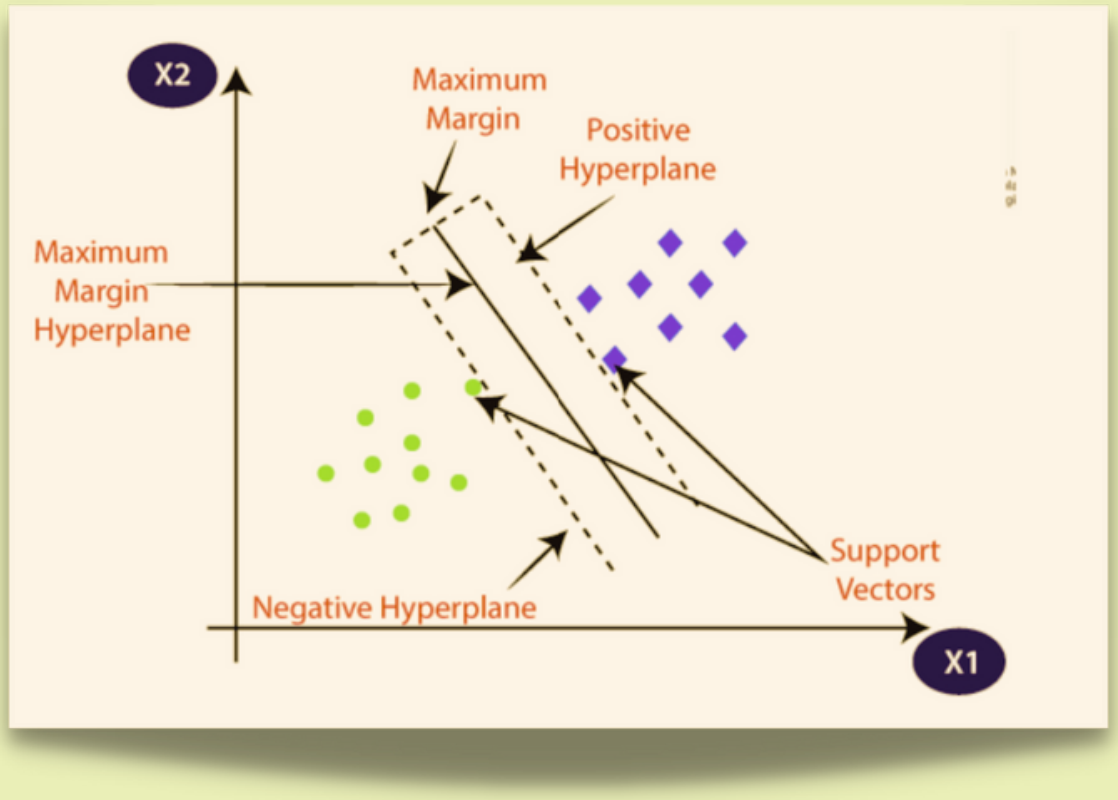
Machine Learning Algorithm

Support Vector Machine .

Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for Classification problems in Machine Learning.

The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane.

SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector Machine. Consider the below diagram in which there are two different categories that are classified using a decision boundary or hyperplane



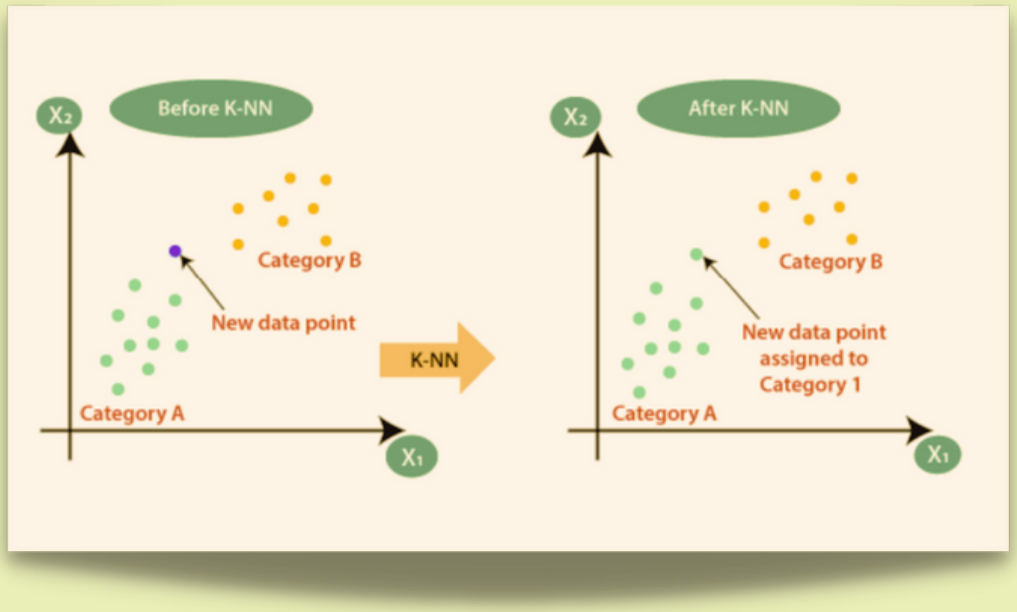
Types of SVM
SVM can be of two types:

- **Linear SVM:** Linear SVM is used for linearly separable data, which means if a dataset can be classified into two classes by using a single straight line, then such data is termed as linearly separable data, and classifier is used called as Linear SVM classifier.

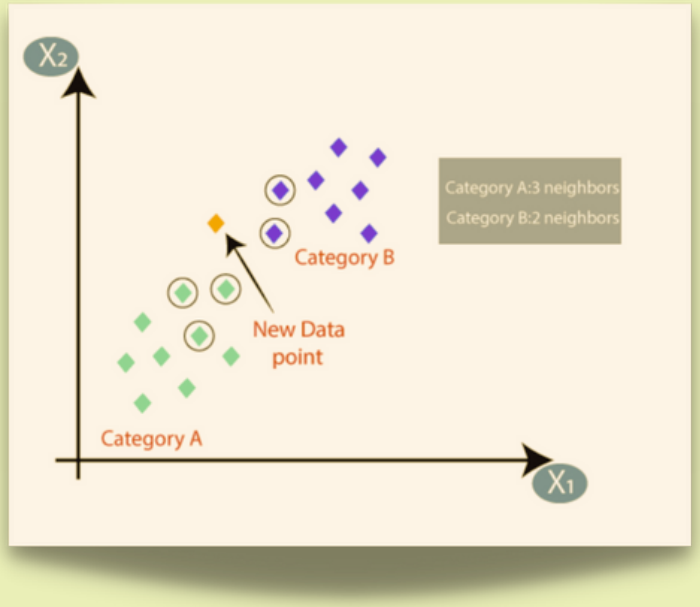
- **Non-linear SVM:** Non-Linear SVM is used for non-linearly separated data, which means if a dataset cannot be classified by using a straight line, then such data is termed as non-linear data and classifier used is called as Non-linear SVM classifier.

K-Nearest Neighbor(KNN)

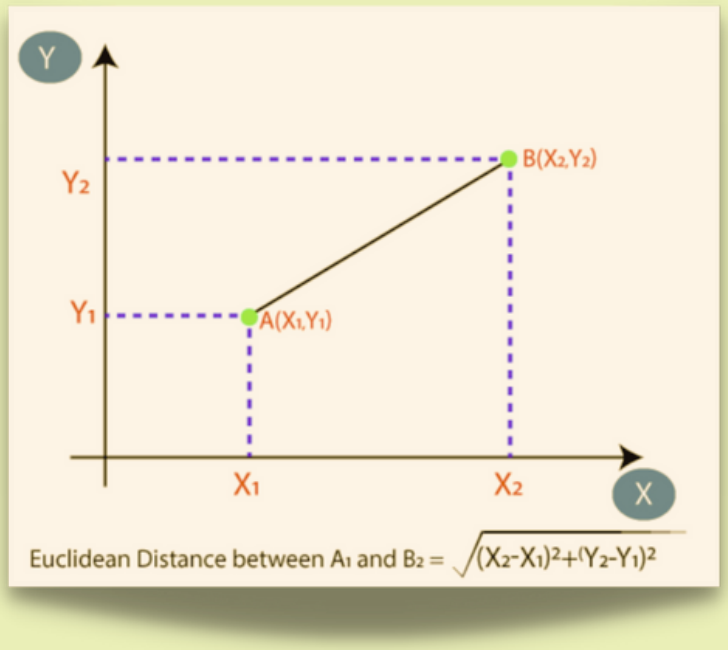
- K-Nearest Neighbour is one of the simplest Machine Learning algorithms based on Supervised Learning technique.
- K-NN algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories.
- K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using K- NN algorithm.
- K-NN algorithm can be used for Regression as well as for Classification but mostly it is used for the Classification problems.
- K-NN is a non-parametric algorithm, which means it does not make any assumption on underlying data.
- It is also called a lazy learner algorithm because it does not learn from the training set immediately instead it stores the dataset and at the time of classification, it performs an action on the dataset.
- KNN algorithm at the training phase just stores the dataset and when it gets new data, then it classifies that data into a category that is much similar to the new data.



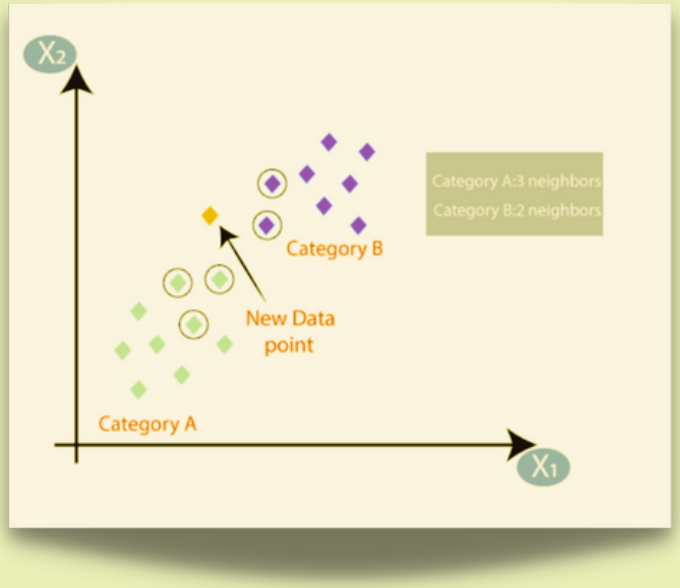
Suppose we have a new data point and we need to put it in the required category. Consider the below image:



- Firstly, we will choose the number of neighbors, so we will choose the k=5.
- Next, we will calculate the Euclidean distance between the data points. The Euclidean distance is the distance between two points, which we have already studied in geometry. It can be calculated as:



- By calculating the Euclidean distance we got the nearest neighbors, as three nearest neighbors in category A and two nearest neighbors in category B. Consider the below image:



- As we can see the 3 nearest neighbors are from category A, hence this new data point must belong to category A.

Advantages of KNN Algorithm:

- It is simple to implement.
- It is robust to the noisy training data
- It can be more effective if the training data is large.

Disadvantages of KNN Algorithm:

- Always needs to determine the value of K which may be complex some time.
- The computation cost is high because of calculating the distance between the data points for all the training samples.

Random Forest

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

As the name suggests, "Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset." Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output.

The greater number of trees in the forest leads to higher accuracy and prevents the problem of overfitting.

The below diagram explains the working of the Random Forest algorithm:

Applications of Random Forest

There are mainly **four** sectors where Random forest mostly used:

Banking: Banking sector mostly uses this algorithm for the identification of loan risk.

Medicine: With the help of this algorithm, disease trends and risks of the disease can be identified.

Land Use: We can identify the areas of similar land use by this algorithm.

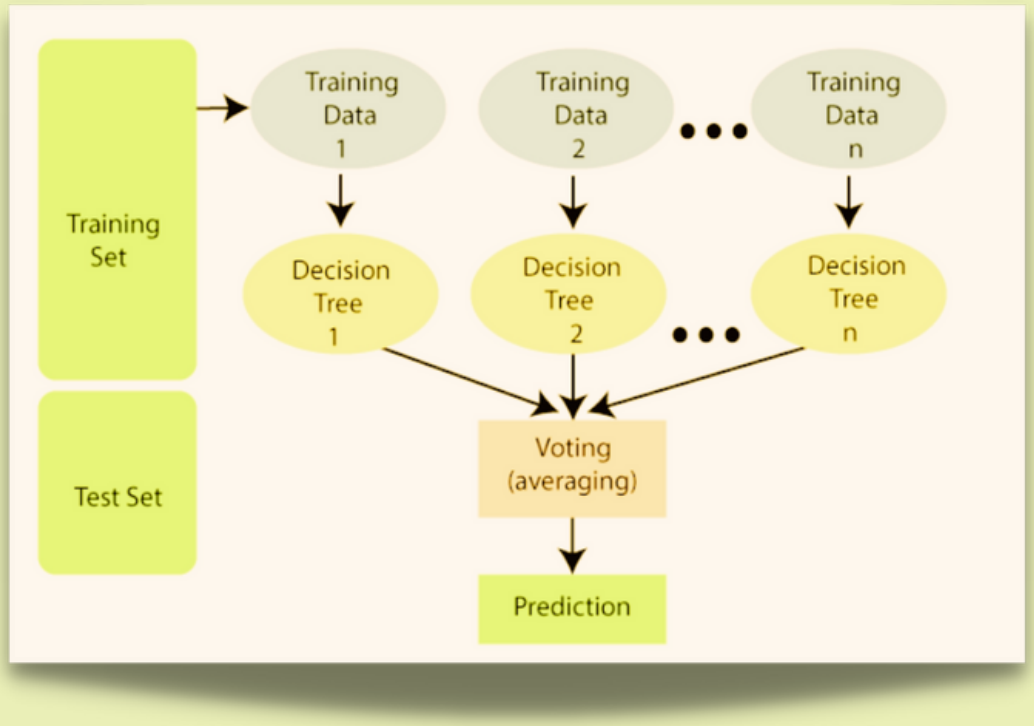
Marketing: Marketing trends can be identified using this algorithm.

Advantages of Random Forest

Random Forest is capable of performing both Classification and Regression tasks.
It is capable of handling large datasets with high dimensionality.
It enhances the accuracy of the model and prevents the overfitting issue.

Disadvantages of Random Forest

Although random forest can be used for both classification and regression tasks, it is not more suitable for Regression tasks.

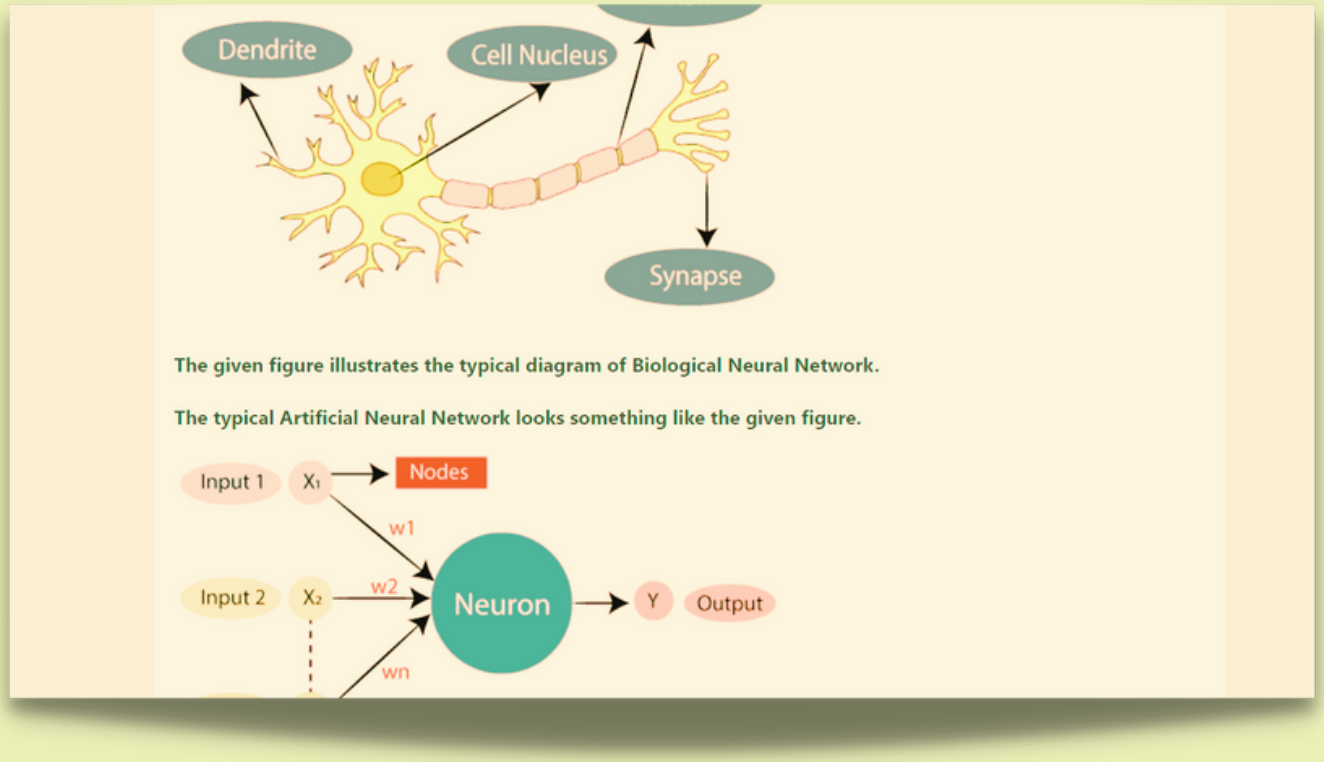


Artificial Neural Network

Artificial Neural Network Tutorial provides basic and advanced concepts of ANNs. Our Artificial Neural Network tutorial is developed for beginners as well as professions.

The term "Artificial neural network" refers to a biologically inspired sub-field of artificial intelligence modeled after the brain. An Artificial neural network is usually a computational network based on biological neural networks that construct the structure of the human brain. Similar to a human brain has neurons interconnected to each other, artificial neural networks also have neurons that are linked to each other in various layers of the networks. These neurons are known as nodes.

Artificial neural network tutorial covers all the aspects related to the artificial neural network. In this tutorial, we will discuss ANNs, Adaptive resonance theory, Kohonen self-organizing map, Building blocks, unsupervised learning, Genetic algorithm, etc.



An Artificial Neural Network in the field of Artificial intelligence where it attempts to mimic the network of neurons makes up a human brain so that computers will have an option to understand things and make decisions in a human-like manner. The artificial neural network is designed by programming computers to behave simply like interconnected brain cells.

There are around 1000 billion neurons in the human brain. Each neuron has an association point somewhere in the range of 1,000 and 100,000. In the human brain, data is stored in such a manner as to be distributed, and we can extract more than one piece of this data when necessary from our memory parallelly. We can say that the human brain is made up of incredibly amazing parallel processors.

We can understand the artificial neural network with an example, consider an example of a digital logic gate that takes an input and gives an output. "OR" gate, which takes two inputs. If one or both the inputs are "On," then we get "On" in output. If both the inputs are "Off," then we get "Off" in output. Here the output depends upon input. Our brain does not perform the same task. The outputs to inputs relationship keep changing because of the neurons in our brain, which are "learning."

Types of Artificial Neural Network:

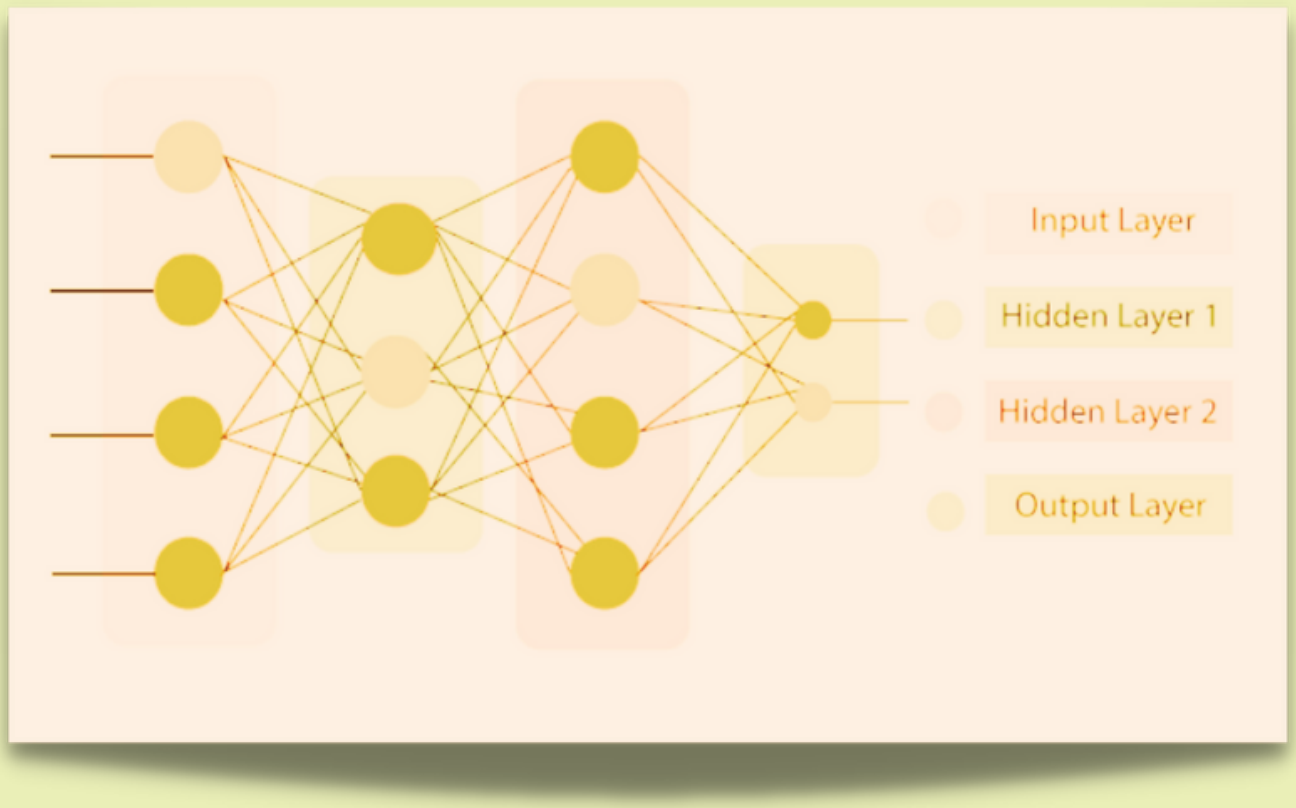
There are various types of Artificial Neural Networks (ANN) depending upon the human brain neuron and network functions, an artificial neural network similarly performs tasks. The majority of the artificial neural networks will have some similarities with a more complex biological partner and are very effective at their expected tasks. For example, segmentation or classification.

Feedback ANN:

In this type of ANN, the output returns into the network to accomplish the best-evolved results internally. As per the University of Massachusetts, Lowell Centre for Atmospheric Research. The feedback networks feed information back into itself and are well suited to solve optimization issues. The Internal system error corrections utilize feedback ANNs.

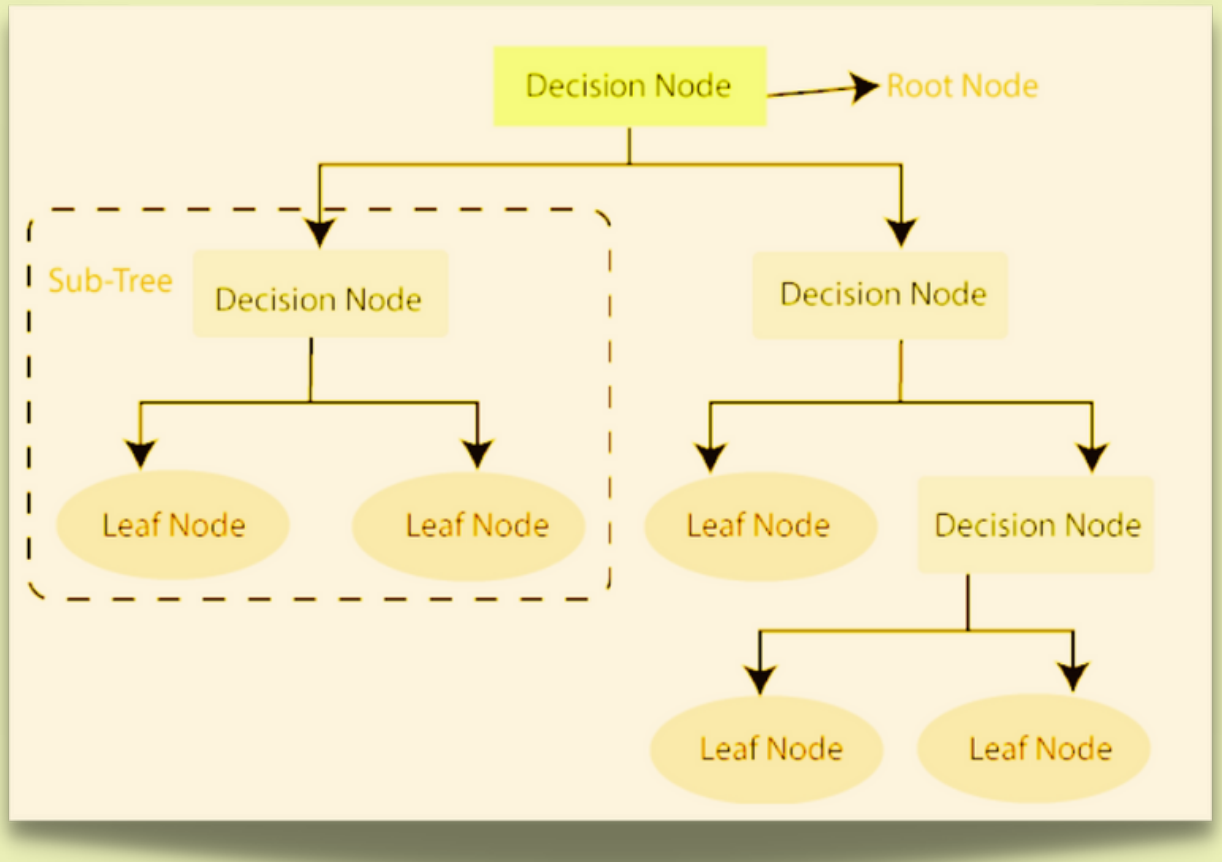
Feed-Forward ANN:

A feed-forward network is a basic neural network comprising of an input layer, an output layer, and at least one layer of a neuron. Through assessment of its output by reviewing its input, the intensity of the network can be noticed based on group behavior of the associated neurons, and the output is decided. The primary advantage of this network is that it figures out how to evaluate and recognize input patterns.



Decision Tree

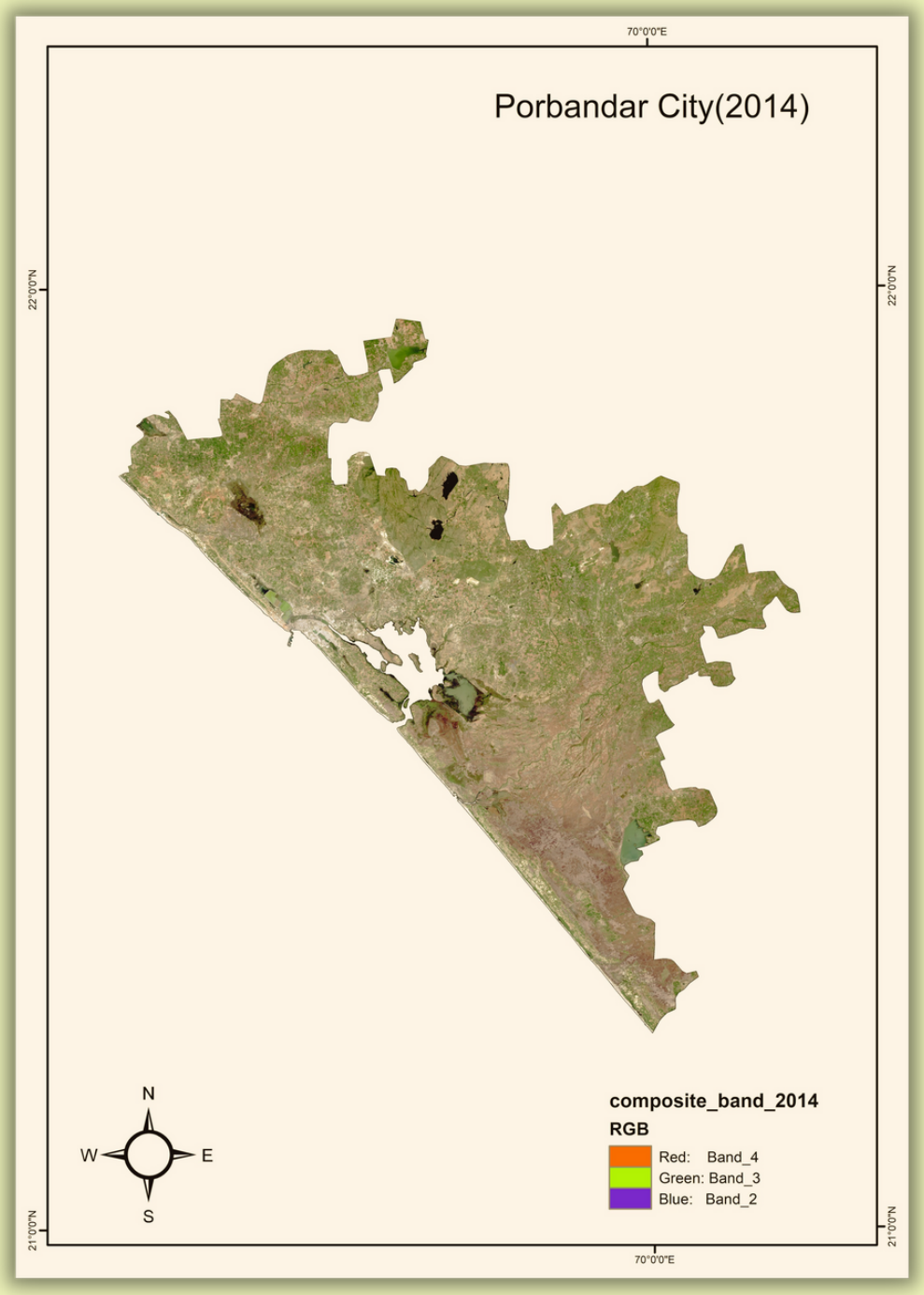
- Decision Tree is a Supervised learning technique that can be used for both classification and Regression problems, but mostly it is preferred for solving Classification problems. It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome.
- In a Decision tree, there are two nodes, which are the Decision Node and Leaf Node. Decision nodes are used to make any decision and have multiple branches, whereas Leaf nodes are the output of those decisions and do not contain any further branches.
- The decisions or the test are performed on the basis of features of the given dataset.
- It is a graphical representation for getting all the possible solutions to a problem/decision based on given conditions.
- It is called a decision tree because, similar to a tree, it starts with the root node, which expands on further branches and constructs a tree-like structure.
- In order to build a tree, we use the CART algorithm, which stands for Classification and Regression Tree algorithm.
- A decision tree simply asks a question, and based on the answer (Yes/No), it further split the tree into subtrees.
- Below diagram explains the general structure of a decision tree



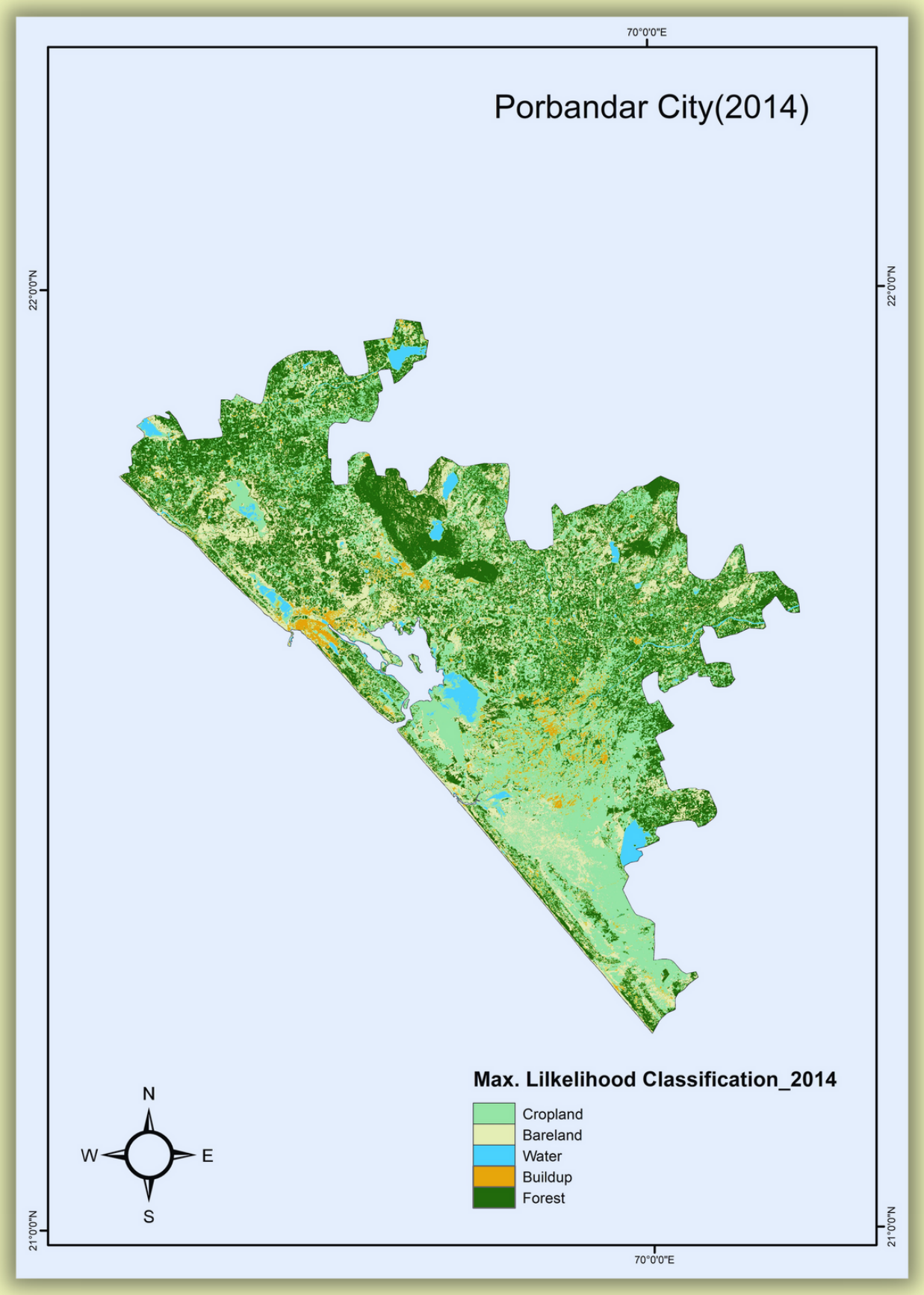
Decision Tree Terminologies

Root Node: Root node is from where the decision tree starts. It represents the entire dataset, which further gets divided into two or more homogeneous sets.
Leaf Node: Leaf nodes are the final output node, and the tree cannot be segregated further after getting a leaf node.
Splitting: Splitting is the process of dividing the decision node/root node into sub-nodes according to the given conditions.
Branch/Sub Tree: A tree formed by splitting the tree.
Pruning: Pruning is the process of removing the unwanted branches from the tree.
Parent/Child node: The root node of the tree is called the parent node, and other nodes are called the child nodes.

Land Use Land Cover Of Porbandar City(2014)



Land Use Land cover of Porbandar City in 2014 using Supervised Classification



LULC Pecentage(2014)

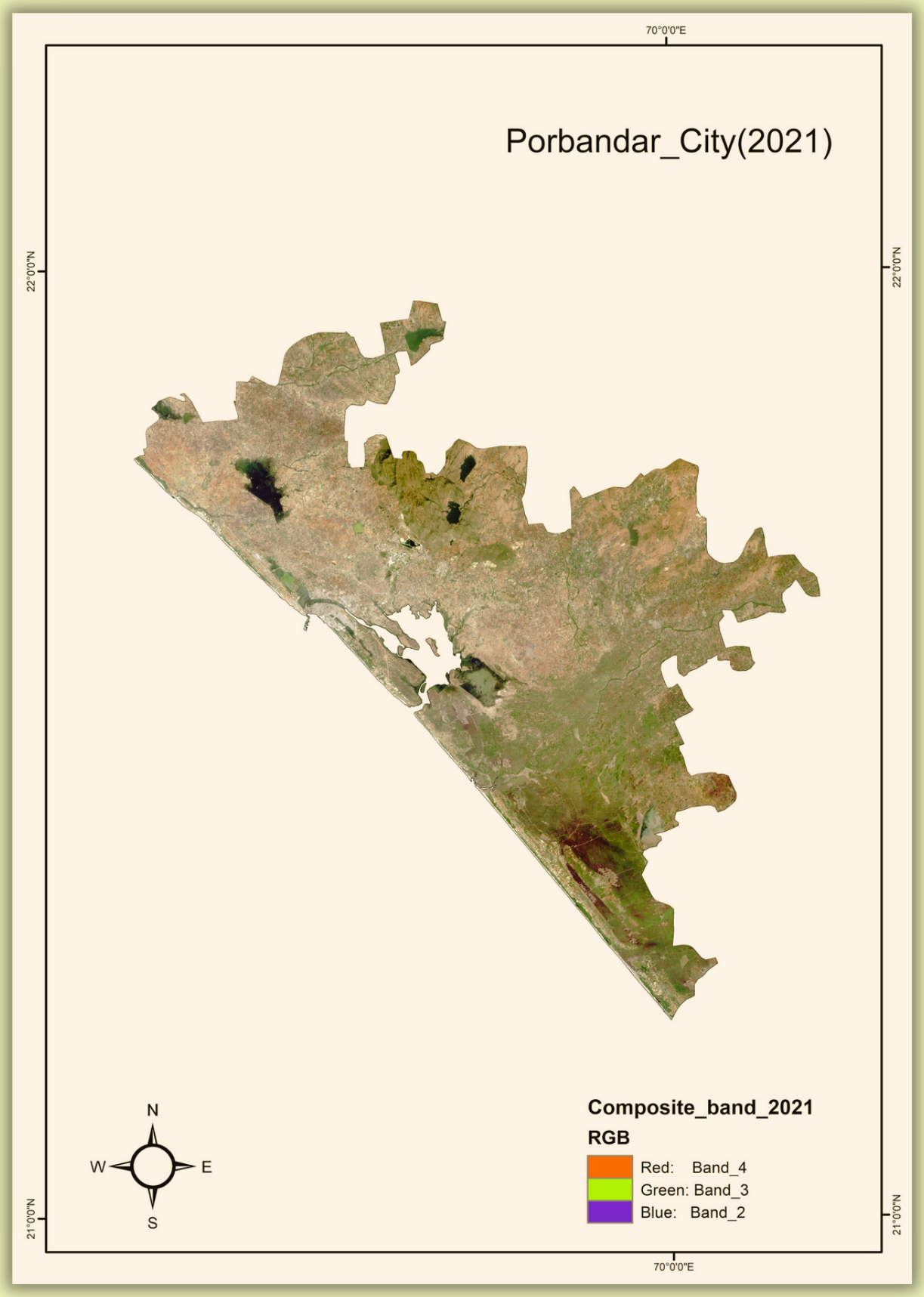
Max. Likelihood Classification_2014

Rowid	VALUE	COUNT	NAME
0	1	1001327	Cropland
1	21	515910	bareland
2	122	66755	water
3	123	68024	builtp
4	135	913569	Forest

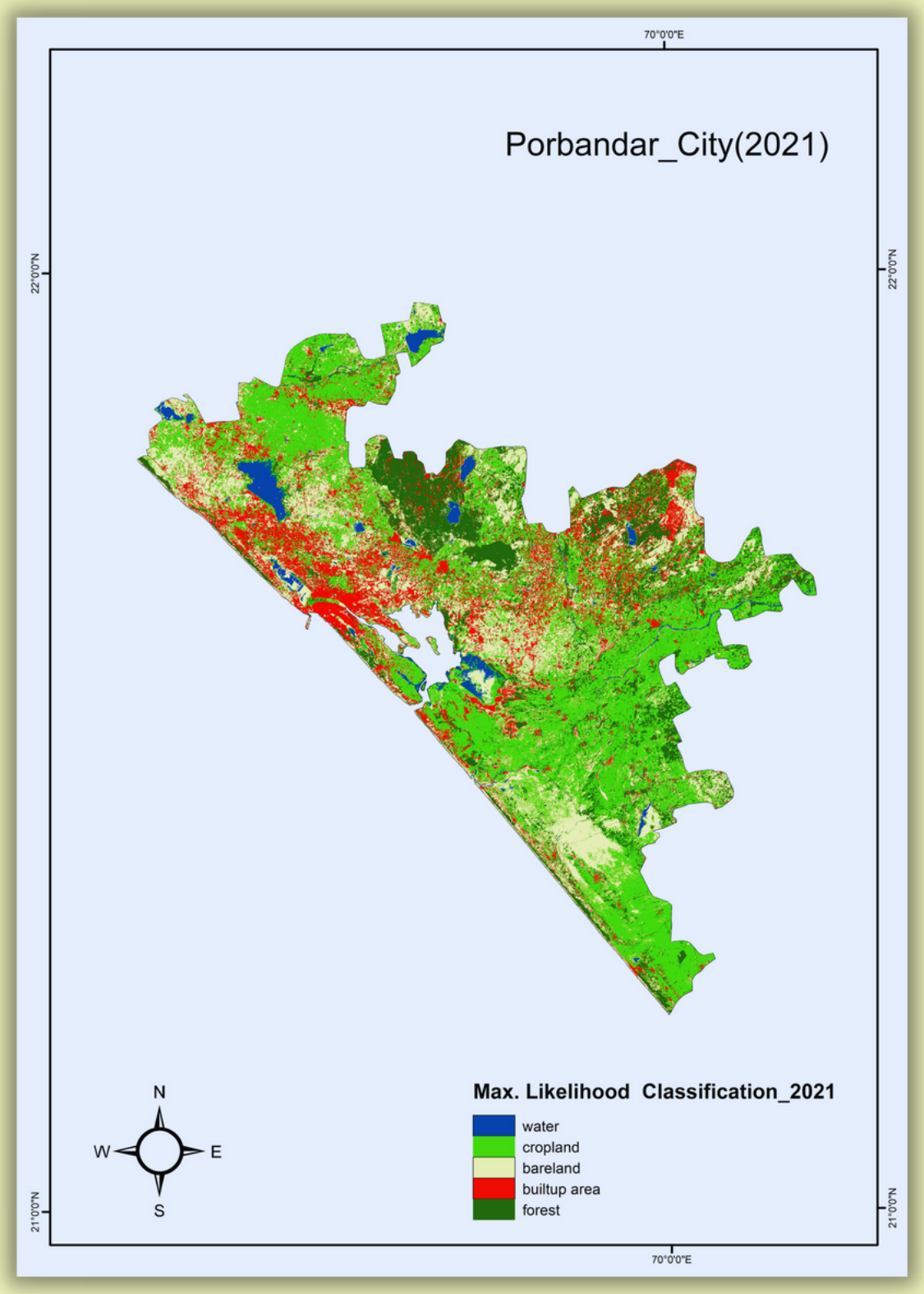
NAME	Sum of area	Percentage of land area covered
Cropland	904.0021768	39.16%
bareland	457.1700865	19.80%
builtp	57.97849202	2.51%
Forest	829.7936181	35.94%
water	59.78075937	2.59%
Grand Total	**2308.725133**	100.00%

With the help of the Supervised Classification, there is clearly showing the land use landcover in the Porbandar city 2014. With the help of raster to vector polygon conversion, the area is calculated under different land cover in the study area. The the area under cropland is 904 sq. km, the area under the bareland is 457.17 square km, the area under the built-up is 57.9 square km, the area under the water body is 59.7 square km, , and the area under Forest is 829.78 sq. km.

Land Use Land Cover Of Porbandar City(2021)



Land Use Land cover of Porbandar City in 2021 using Supervised Classification



LULC Pecentage(2021)

maxlikec2021

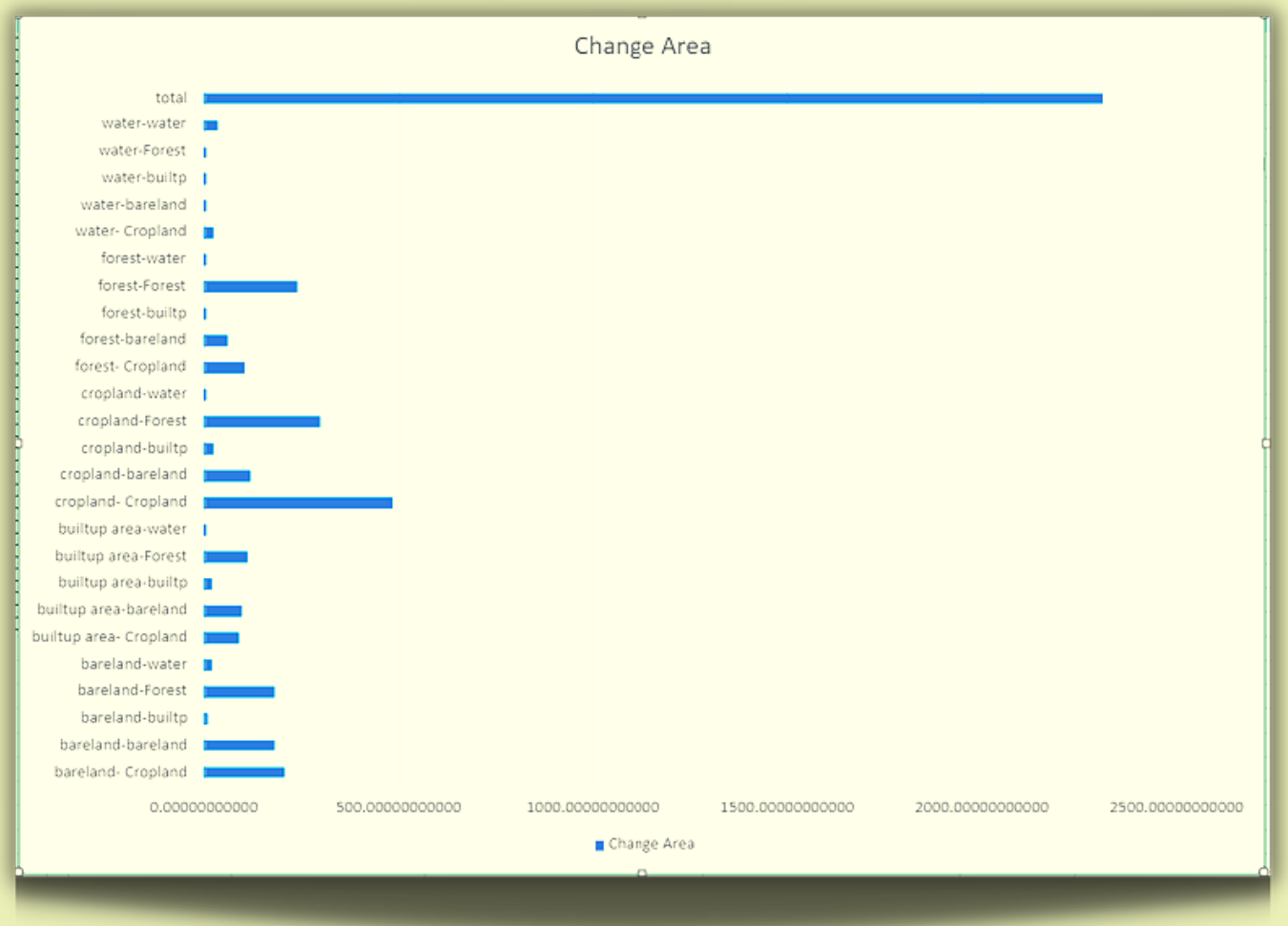
Rowid	VALUE	COUNT	NAME
0	1	72900	water
1	15	1021016	cropland
2	19	666682	bareland
3	22	354657	builtup area
4	52	450330	forest

NAME	Sum of area	Percentage of land area cover
cropland	929.9135209	40.28%
bareland	595.165402	25.78%
builtup area	314.4622044	13.62%
forest	403.5246937	17.48%
water	65.69102554	2.85%
Grand Total	2308.756847	100.00%

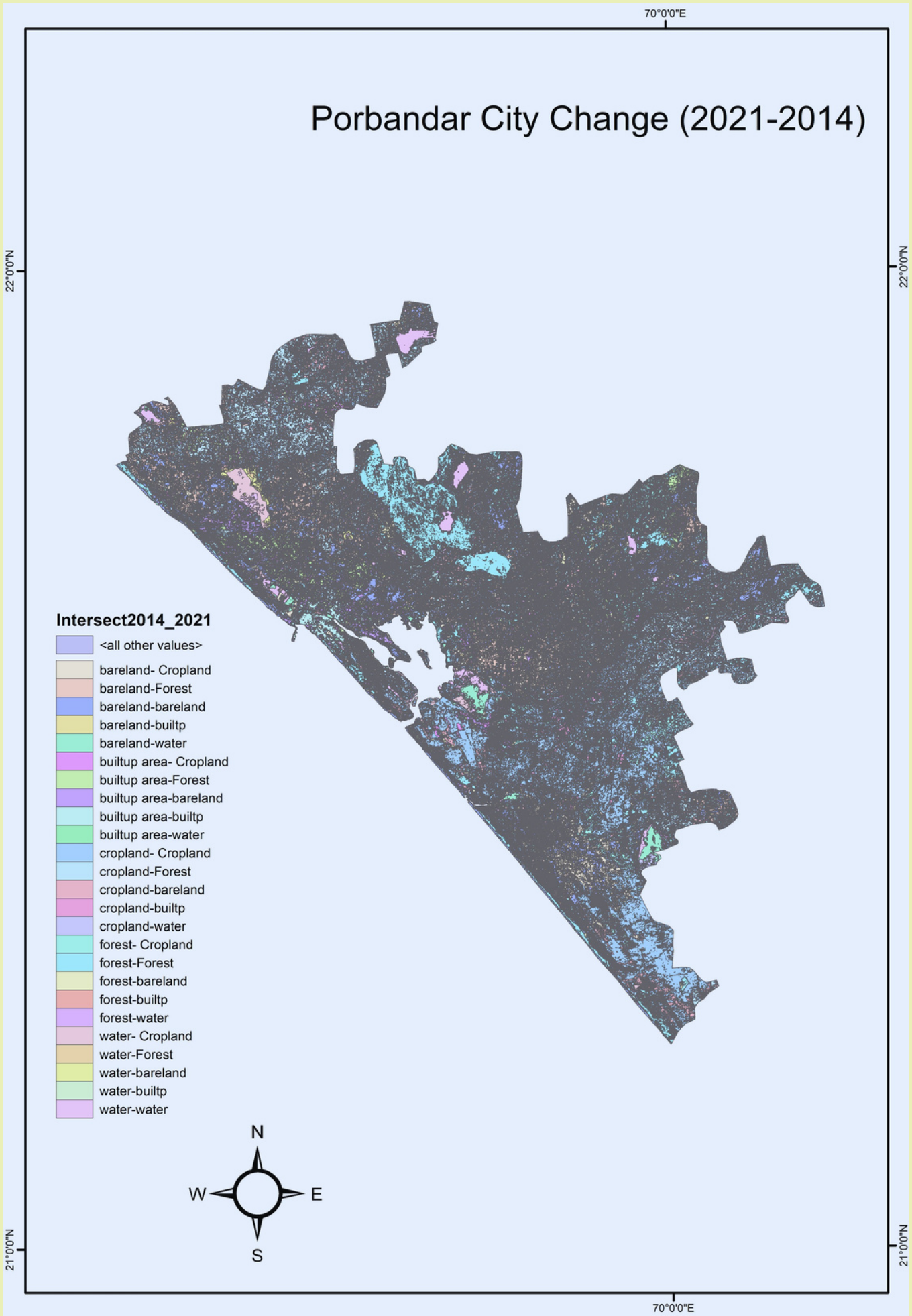
With the help of the Supervised Classification, there is clearly showing the land use landcover in the Porbandar city 2021. With the help of raster to vector polygon conversion, the area is calculated under different land cover in the study area. The the area under cropland is 929.9 sq. km, the area under the bareland is 595.16 square km, the area under the built-up is 314.46 square km, the area under Forest is 403.52 sq. km, and the area under the water body is 65.7 square km, .

Land Use Land Cover CHANGE Of Porbandar City(2014-2021)

FID	NAME_2021	area_2021	FI	NAME_2014	area_2014	Change_Name	Change_area
0	bareland	595.16500000000	0	Cropland	904.00200000000	bareland- Cropland	206.13000000000
0	bareland	595.16500000000	1	bareland	457.17000000000	bareland-bareland	178.64100000000
0	bareland	595.16500000000	2	builtp	57.97850000000	bareland-builtp	9.88863000000
0	bareland	595.16500000000	3	Forest	829.79400000000	bareland-Forest	180.60500000000
0	bareland	595.16500000000	4	water	59.78080000000	bareland-water	19.55580000000
1	builtup area	314.46200000000	0	Cropland	904.00200000000	builtup area- Cropland	87.80430000000
1	builtup area	314.46200000000	1	bareland	457.17000000000	builtup area-bareland	94.49520000000
1	builtup area	314.46200000000	2	builtp	57.97850000000	builtup area-builtp	20.41530000000
1	builtup area	314.46200000000	3	Forest	829.79400000000	builtup area-Forest	111.61500000000
1	builtup area	314.46200000000	4	water	59.78080000000	builtup area-water	0.04120700000
2	cropland	929.91400000000	0	Cropland	904.00200000000	cropland- Cropland	483.17500000000
2	cropland	929.91400000000	1	bareland	457.17000000000	cropland-bareland	120.00200000000
2	cropland	929.91400000000	2	builtp	57.97850000000	cropland-builtp	24.97520000000
2	cropland	929.91400000000	3	Forest	829.79400000000	cropland-Forest	295.78100000000
2	cropland	929.91400000000	4	water	59.78080000000	cropland-water	5.62770000000
3	forest	403.52500000000	0	Cropland	904.00200000000	forest- Cropland	102.84500000000
3	forest	403.52500000000	1	bareland	457.17000000000	forest-bareland	57.93470000000
3	forest	403.52500000000	2	builtp	57.97850000000	forest-builtp	2.46540000000
3	forest	403.52500000000	3	Forest	829.79400000000	forest-Forest	239.42600000000
3	forest	403.52500000000	4	water	59.78080000000	forest-water	0.71774700000
4	water	65.69100000000	0	Cropland	904.00200000000	water- Cropland	23.71810000000
4	water	65.69100000000	1	bareland	457.17000000000	water-bareland	5.92054000000
4	water	65.69100000000	2	builtp	57.97850000000	water-builtp	0.21670300000
4	water	65.69100000000	3	Forest	829.79400000000	water-Forest	2.04680000000
4	water	65.69100000000	4	water	59.78080000000	water-water	33.72970000000
						total	2307.77302700000



- **Bar Plot of Change analysis from 2014 -2021**


Porbandar City Change (2021-2014)
70°0'0"E
22°0'0"N
21°0'0"N
Intersect2014_2021
<all other values>
bareland- Cropland
bareland-Forest
bareland-bareland
bareland-builtp
bareland-water
builtup area- Cropland
builtup area-Forest
builtup area-bareland
builtup area-builtp
builtup area-water
cropland- Cropland
cropland-Forest
cropland-bareland
cropland-builtp
cropland-water
forest- Cropland
forest-Forest
forest-bareland
forest-builtp
forest-water
water- Cropland
water-Forest
water-bareland
water-builtp
water-water
N
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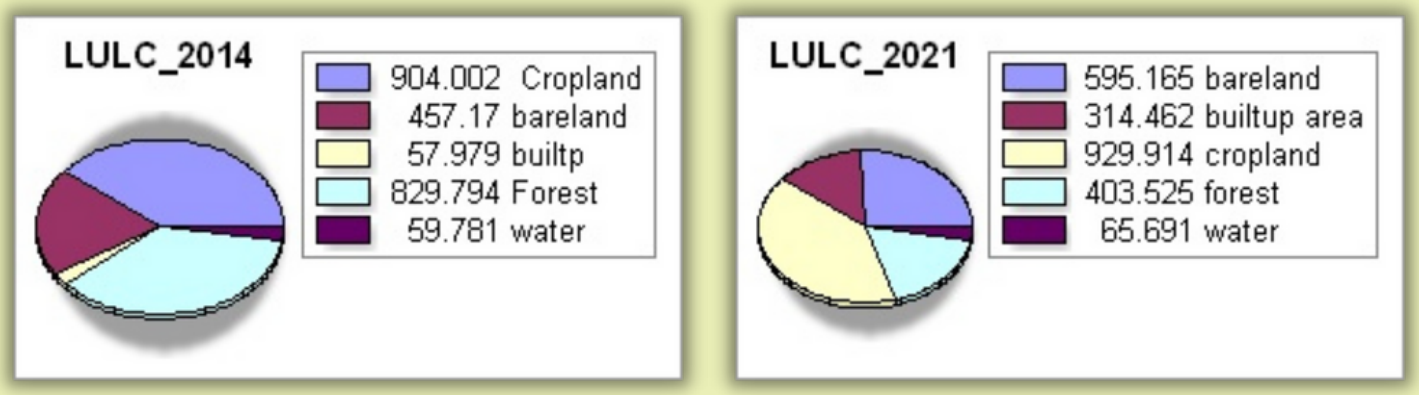
• RESULT AND DISCUSSION

With the help of machine learning, it is clear about the area of various land use cover that is related to ecosystem services. After performing the algorithm, there is some method used for valuing the above four ecosystem services. The first method is to valuing the provisioning service of Porbandar city. This includes mainly agriculture, Vegetation, etc.
The second method is to valuing the regulating services for that the city includes the water bodies and their services. The third method is valuing the cultural services for the city that include spiritual services in the city. At last, there is another supporting service in the ecosystem.



Land use map of Porbandar city from 2014 -2021

With the help of the Supervised Classification, there is clearly showing change in the land use landcover in the Porbandar city from the year 2014 to 2021. With the help of raster to vector polygon conversion, the area is calculated under different land cover in the study area. The the area change under cropland is 25.9 sq. km, the area change under the bareland is 138 square km, the area change under the built-up is 257 square km, the change of area under Forest is 426.3 sq. km, and the area change under the water body is 5.91 square km.

The land contains land ecosystems, and land use is a major activity for human survival and development. Changes in land utilization patterns will result in a land cover pattern change, which will affect the ecosystem structure, affecting the ecosystem's service functions and values (Liu, Y. et al., 2015; Liu, G. et al., 2014; Min, J., et al., 2006). Therefore, the impact and interaction of changes in land use on the value of ecosystems services are very important to understand, and research on the impact of land-use changes has been extensively carried out in recent years on regional ecosystem service

In this study, work has been done on the land-use dynamics of Porbandar city for seven years. This is done with the help of machine learning and quantum geographical information system. The main focus of the study is to analyze the land use dynamics and related ecosystem services. The area has been calculated with the help of machine learning for each class. The output of the image classification is the area under built-up has been increasing from 2014 to 2021. Some other Land use classes that help in providing ecosystem services have been decreasing by area. The above pie chart shows the area under different land cover and how it is changing. In the above diagram, the area under the built-up has been increasing since 2014. The area under the agriculture has remained constant from 2014 to 2021 almost. On the other side, water bodies and vegetation have also been decreasing during this duration. There is another important ecosystem in the city i.e. fisheries Fishing is one of the important features of the earth that support biodiversity and is a great source of ecosystem services. But if we analyze the pie diagram, the area under the waterland has been degrading since 2014 in Porbandar city. At last, the changing land use of the Porbandar city has a greater impact on the ecosystem of the area. This further affects the ecosystem services provided by the ecosystem in The Porabndar city.

- ## Major Economic Activities

1. Provisioning Services

Porbandar is an important coastal area as well as heritage tourism service provider in the region. Fishing is an important occupation in the Arabian sea. Thse service can be called ecosystem services. It is primarily an agricultural district with Groundnut and Cotton as the predominant crops. The other major crops cultivated are wheat, cumin and til etc.

2. Regulating Services

The population of Porbandar is around 133,083 and the literacy rate is quite high. The people in Porbandar are mostly engaged in agriculture, fishing, mineral industry and they speak Gujarati. A section of the population of Porbandar is artistically very sound. Their handiworks and architecture bear a mark of excellence. Some of the historical sites in Porbandar are regarded as the example of the king’s patronage of art and architecture.

3. Cultural Services

The city has a rich cultural heritage and rich history. The population of Porbandar is around 133,083 and the literacy rate is quite high. The people in Porbandar are mostly engaged in agriculture, fishing, mineral industry and they speak Gujarati. A section of the population of Porbandar is artistically very sound

- **Conclusion**

The major driver of private sector capital formation is investment credit. Immediate thrust is required to raise its share in the total agriculture credit. The document, has therefore, been prepared with emphasis on accelerating the pace of capital formation in agriculture and allied sectors. This goal can be achieved with the coordinated efforts of all the stakeholders.

Ecosystem services can bridge the gap between human and ecological processes. They are therefore closely linked to changes in land use. Modification of land-use changes the province of ESs and in turn influences human well-being significantly by direct or indirect effects on ecosystem models and processes. Thus, the interactions between multiple ESs, spatial fluctuation of ESs, and integration and optimization of ESs can contribute to enabling conditions for regional ecosystem management through an improved pool of evidence on the relationship between ecosystem processes and soil or land usage services.

The present research mainly focused on using machine learning to analyze the urban land-use changes and their impact on ecosystem services for different years in Porbandar City.
Satellite data are found to be useful in mapping and quantifying the extent of urban areas in different periods. With the help of GIS, there is a clear land cover change in the city.
As the data shows, there is a change in the area of water body, Cropland, Forest and bareland in the city . Data shows that the area under the water
decreases from 2014 to 2021. There is also a degradation of Forest land in the study area.

With the changing land cover, it will cause an impact on the ecosystem services.
ES concepts must be integrated into decision-making to improve decision-making and achieve sustainable environmental targets. It also improves the interpretation and communication of human-nature interactions. More importantly, by examining the composition, the generation procedure, the driving forces and the interactions of regional ESs, and the characteristic changes to several ESs within various scenarios, an evaluation could help us better understand the processes for generating and responding to Economic Services and fulfilling the need of the hour.

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- https://www.javatpoint.com/machine-learning-random-forest-algorithm
- https://www.javatpoint.com/machine-learning-support-vector-machine-algorithm
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