A

PROJECT

ON

“Tapi River Sustainability: Surat's Lifeline and Beyond”

Under SDG-14 “Life Below Water”

SUBMITTED TO

THE DEPARTMENT OF STATISTICS

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT.

IN PARTIAL FULFILMENT OF THE AWARD OF THE DEGREE OF

MASTER OF SCIENCE IN APPLIED STATISTICS

SUBMITTED BY

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Re-Accredited 'B++' 2.86 CGPA by NAAC
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Certificate

DEPARTMENT OF STATISTICS
VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT

This is to certify that the project report entitled "TAPI RIVER SUSTAINABILITY: SURAT'S LIFELINE AND BEYOND", under ***SDG Goal 14: Life below Water****, submitted to the Department of Statistics, V.N.S.G.Uni., Surat, Gujarat, India, in partial fulfilment of the degree of M. Sc. (Applied Statistics) is a record of work carried out by "DEKANI NIKUNJKUMAR KISHORBHAI (Roll No. 7), MAYAT SADIYA SAUKATALI (Roll No. 19), RAKHOLIYA DHRUVI BAVCHANDBHAI (Roll No. 30), SHUKLA ATISH LALCHANDRA (Roll No. 31), TRIVEDI NIRAV NAVNITKUMAR (Roll No. 34)" students of M. Sc. Applied Statistics (Semester-IV) for the academic year 2023-24 under my supervision and guidance.*

All sources of information/data have been duly acknowledged. No part of their analysis work has been submitted elsewhere for the award of any other degree.

Place: - Surat
Date:-

(Sahil Merai)	*(A. J. Rajyaguru)*
Supervising Teacher	*Professor and Head*
Department of Statistics,	*Department of Statistics,*
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THIS PROJECT

IS

DEDICATED TO

OUR DEPARTMENT

OUR PROFESSORS

OUR GUIDE

OUR GROUP MEMBER

AND

OUR CLASSMATES

ACKNOWLEDGEMENT

We are highly grateful to Honourable **Dr. Arti J. Rajyaguru**, the Head of the Department of Statistics, VNSGU, Surat, for her ever-helping attitude and encouraging us to achieve excel in studies.

It is very much difficult to find words to thank those, who are very much near to heart and dear ones. The most noticeable source of guidance was our advisor, He has not only made us to work but guided us to orient towards research.

We are thankful to entire teaching staff of the department and to all those people who have helped us or supported us directly or indirectly.

This acknowledgement will not be complete until we pay out gratitude to our family. Their encouragement also proved to be a handful.

DEKANI NIKUNJKUMAR K. MAYAT SADIYA S.

RAKHOLIYA DHRUVI B. SHUKLA ATISH L.

TRIVEDI NIRAV N.

DECLARATION

We, Students of M.Sc. (Applied Statistics Sem-IV) of the Department of Statistics at Veer Narmad South Gujarat University, Surat, here by declare that We have done our project work, entitled

"SDG-14 LIFE BELOW WATER" under the guidance of

Mr. Sahil Merai during academic year 2023-24. The information submitted here is true and original to the best of our knowledge.

This academic report is submitted only to the Department of Statistics, VNSGU, Surat and is used for academic purpose only.

We also declare here by that this same report will not be utilized for any other degree / diploma course and fellowship.

Date: -

Place: - Surat

DEKANI NIKUNJKUMAR K.

MAYAT SADIYA S.

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TRIVEDI NIRAV N.

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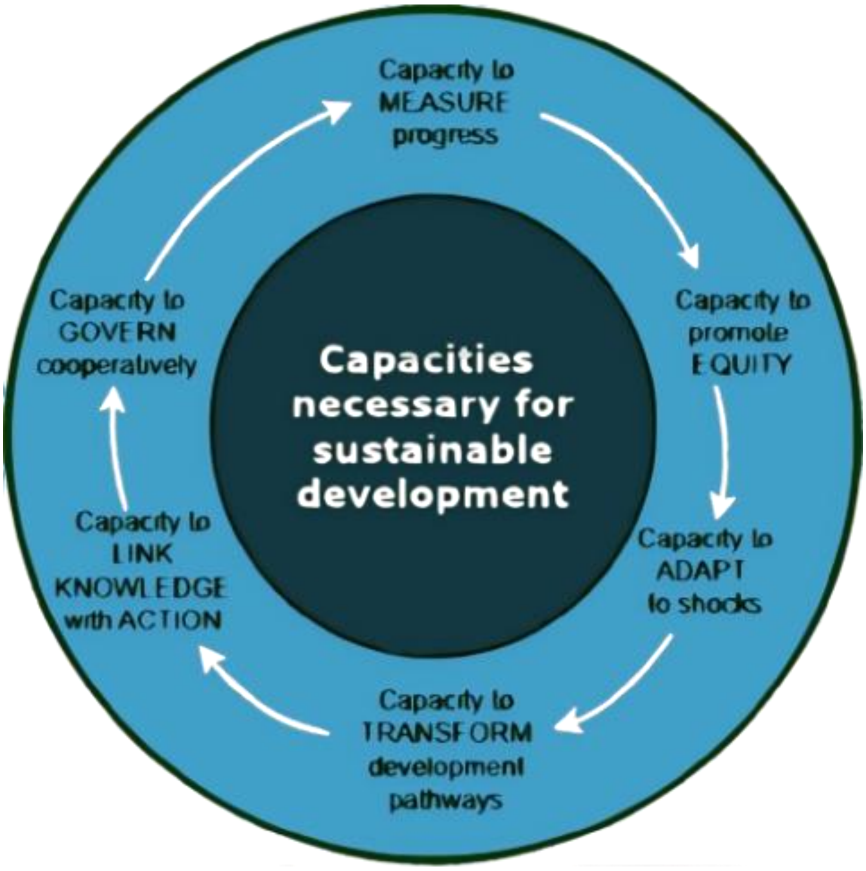
SUSTAINABLE DEVELOPMENT



"*Sustainable development* is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

For sustainable development to be achieved, it is crucial to harmonize three core elements: economic growth, social inclusion and environmental protection. These elements are interconnected and all are crucial for the well-being of individuals and societies.

1. Capacity to **MEASURE** progress
2. Capacity to measure **EQUITY**
3. Capacity to **ADAPT** to shocks
4. Capacity to **TRANSFORM** development pathways
5. Capacity to **LINK KNOWLEDGE** with **ACTION**
6. Capacity to **GOVERN** cooperatively

SUSTAINABLE DEVELOPMENT GOALS

Sustainable development was first institutionalized with the Rio Process initiated at the 1992 Earth Summit in Rio de Janeiro. The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries developed and developing in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth all while tackling climate change and working to preserve our oceans and forests.

WE CONTRIBUTE TO SUSTAINABLE DEVELOPMENT

- Clean water and sanitation.
- Affordable and clean energy.
- Industry, innovation and infrastructure.
- Sustainable cities and communities.

INTRODUCTION

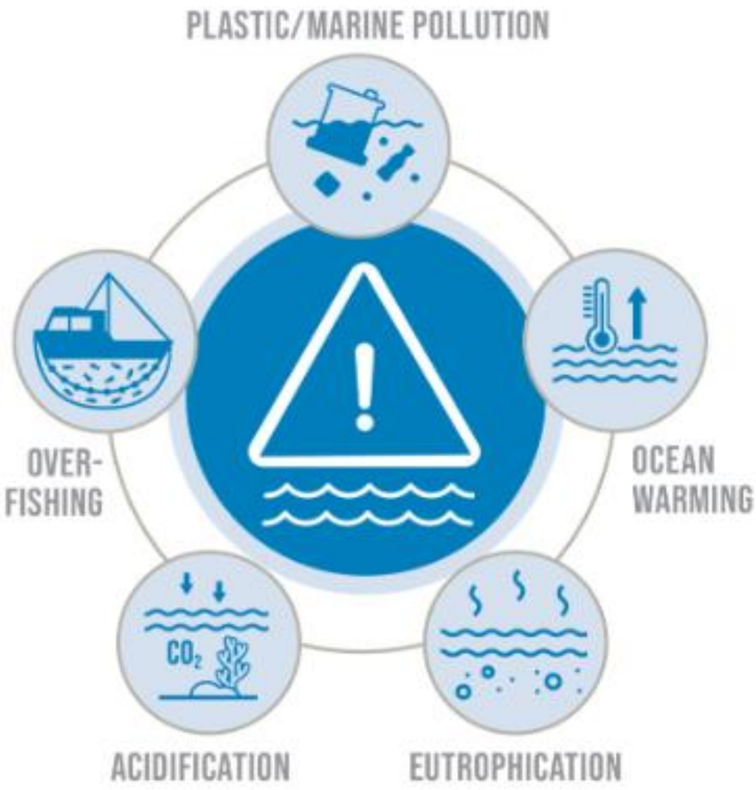
Our research endeavours to explore the intricate relationship between urban river sustainability and development, particularly focusing on the Tapi River in Surat City. While our initial impetus aligns with Sustainable Development Goal (SDG) 14, which emphasizes the conservation and sustainable use of oceans, seas, and marine resources, our approach delves deeper into the interconnectedness of various SDGs.

Our research on measuring water turbidity in the Tapi River of Surat city aligns closely with **Target 14.1 Reduce marine pollution** and **Target 14.2 protect and restore ecosystem of Sustainable Development Goal 14**, aiming to reduce marine pollution. By monitoring turbidity levels, particularly stemming from land-based activities, our research contributes to the understanding and mitigation of pollution in the river, thus directly addressing the target of preventing and significantly reducing marine pollution. Additionally, our efforts may also support **Target 14.2 by indirectly aiding in the protection and restoration of ecosystems, as high turbidity levels can adversely affect aquatic habitats and biodiversity.**

In studying the Tapi River, we employ satellite image data to assess its health and vitality over time. Through the calculation of **the Normalized Difference Turbidity Index (NDTI) and the examination of turbidity levels at 30 buffer zones along the river**, we gain insights into the river's overall condition and any potential stressors it faces. Additionally, our analysis includes monitoring changes in the river's width at 25 designated points, enabling us to understand the river's dynamics and inform recommendations for riverfront development and marine ecosystem conservation.

While our primary focus remains on **SDG 14, our research inherently intersects with several other SDGs, emphasizing the interconnected nature of sustainable development.** Specifically, our findings contribute to SDG 11 (Sustainable Cities and Communities) by informing urban planning strategies for riverfront development in Surat City. Moreover, our assessment of the Tapi River's ecological health addresses aspects of SDG 15 (Life on Land) and SDG 6 (Clean Water and Sanitation) by promoting ecosystem conservation and ensuring access to clean water resources. Furthermore, by examining the impact of river health on human well-being, our research aligns with SDG 3 (Good Health and Well-being) and SDG 13 (Climate Action), as healthy rivers play a crucial role in mitigating climate change effects and safeguarding public health.

WHY DOES MATTER?

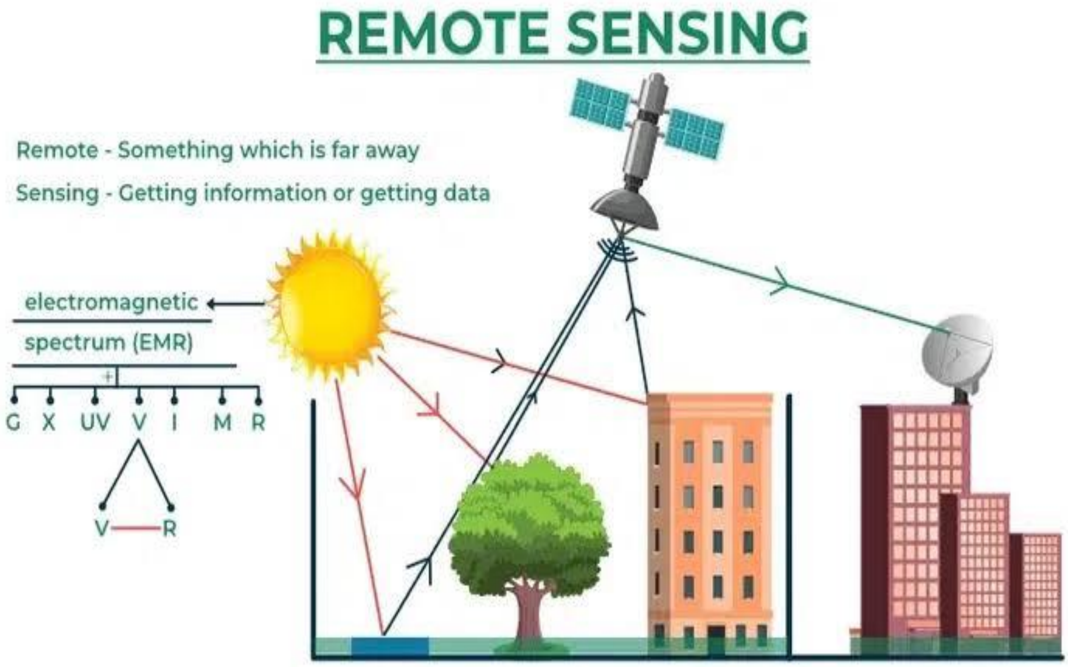


Sustainable Development Goal 14 (SDG 14), also known as "Life Below Water", aims to protect and sustainably use the oceans, seas, and marine resources for sustainable development. This goal is important because healthy oceans are essential to human life on Earth. The oceans cover more than 70% of the Earth's surface and are home to many living creatures, including seahorses, dolphins, whales, and corals. They also provide water, food, and help regulate the weather.

SDG 14 focuses on reducing pollution, promoting sustainable fishing, and reducing ocean acidification. As carbon emissions increase, the oceans absorb carbon dioxide, which increases the oceans' acidity. This acidity threatens corals, shellfish, and many plankton species, which can damage marine ecosystems and food chains. Some species may even become extinct.

WHAT IS REMOTE SENSING DATA?

Remote sensing is a technology utilized to gather information about objects, places, or phenomena without direct physical contact. Its application in detecting evidence of climate change due to human activity poses significant challenges.



According to NASA, remote sensing involves collecting data about Earth's surface, atmosphere, and other phenomena using sensors mounted on satellites, aircraft, drones, or ground-based platforms. These sensors detect electromagnetic radiation emitted or reflected by Earth, crucial for scientific research, environmental monitoring, disaster response, and more.

Satellite:

If the Moon was made of cheese, would you eat it? This is a silly question, everyone knows the Moon is not made of cheese. But what is the Moon? What is a satellite? The Moon is considered a satellite, or a small body that is kept orbiting a larger body due to the pull of gravity. Obviously, the Moon is a natural satellite, no one put it there. There are those satellites that are man-made or artificial.

A satellite is an object that moves around a larger object. Earth is a satellite because it moves around the sun. The moon is a satellite because it moves around Earth. Earth and the moon are called “natural” satellites. But usually when someone says “satellite,” they are talking about a “man-made” satellite.

According to UNOOSA (United Nations Office for Outer Space Affairs) records, there are 8,261 satellites orbiting the Earth as on January 2022. Till 2022, a total of 124 Indian satellites, including those from private operators/academic institutions, have been launched.

We are using two satellite, Sentinel-2 and Landsat 8 in our project.

1. Sentinel-2

Sentinel-2 is a constellation of Earth observation satellites developed by the European Space Agency (ESA) as part of the Copernicus program.

➢ **Features:**

- **Multispectral Imaging:** Sentinel-2 captures data in multiple spectral bands, including visible, near-infrared, and shortwave infrared, allowing for detailed analysis of Earth's surface.
- **High Resolution:** It offers high spatial resolution (10 meters, 20 meters, and 60 meters) to distinguish fine details on the ground.
- **Global Coverage:** Sentinel-2 systematically covers the Earth's land surface, providing global and frequent observations.
- **Repeat Cycle:** The satellite has a short revisit time, meaning it revisits the same area on the Earth's surface frequently.

➢ **Applications:**

- **Land monitoring:** Sentinel-2 provides high-resolution optical imagery, making it valuable for monitoring changes in land cover, land use, and urban development.
- **Agriculture:** It supports precision agriculture by monitoring crop health, vegetation indices, and crop classification.
- **Natural Disaster management:** It assists in assessing the impact of natural disasters like wildfires, floods, and earthquakes.
- **Water Quality:** The satellite's spectral bands enable the monitoring of water bodies, including assessing water quality and detecting changes in water features.

2. Landsat 8

Landsat-8 is a satellite in the Landsat program jointly managed by NASA and the US Geological Survey (USGS).

➢ **Features:**

- **Long- term Continuity:** Landsat 8 continues the legacy of the Landsat program, providing consistent and reliable Earth observation data since its launch in 2013.
- **Multispectral Imaging:** Landsat 8 captures data in multiple spectral bands, including visible, near-infrared, and shortwave infrared, allowing for detailed analysis of land cover, vegetation health, and environmental changes.
- **Moderate Spatial Resolution:** Landsat 8 offers spatial resolutions ranging from 15 to 100 meters, providing detailed imagery suitable for various applications.
- **Global Coverage**: Landsat 8 covers the entire Earth's land surface, enabling monitoring of both remote and populated areas.

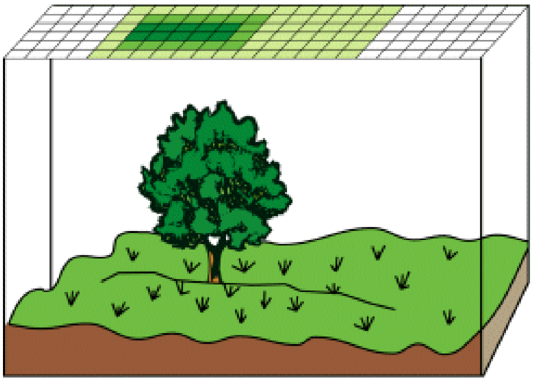
➢ **Applications:**

- **Land Cover Mapping:** Landsat 8 data is used for mapping and monitoring changes in land cover types, including forests, agriculture, urban areas, and water bodies.
- **Natural Resource Management:** Landsat 8 supports the management of natural resources such as forests, water resources, and soil, facilitating sustainable land use planning and conservation efforts.
- **Climate Studies:** Landsat 8 data contributes to climate research by providing information on land surface temperature, land cover changes, and vegetation dynamics, aiding in climate modelling and analysis.
- **Urban Planning:** Landsat 8 data is used for urban growth monitoring, land use planning, and infrastructure development, supporting sustainable urbanization and management.

- **Water Resources Management**: Landsat 8 imagery helps in monitoring water quality, assessing changes in lake and river dynamics, and studying coastal erosion, supporting effective water resources management and conservation efforts.

WHAT IS PIXEL?

The full form of the pixel is "Picture Element." It is also known as "PEL." A screen is made up of a matrix of thousands or millions of pixels. A pixel is represented by a dot or a square on a computer screen. A pixel in its basic form is a number in an array that describes the brightness and color of a point on an image when it is displayed.



A pixel is the smallest unit of a digital image or graphic that can be displayed and represented on a digital display device. Pixels are combined to form a complete image, video, text, or any visible thing on a computer display.

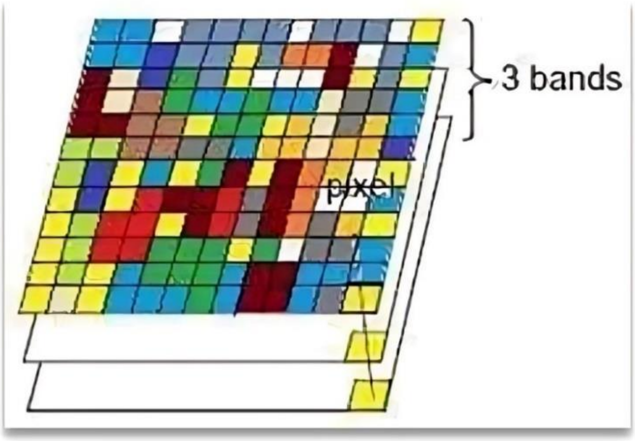
Just like the pictures on your television set, satellite imagery is made up of tiny squares, each of a different grey shade or color. These squares are called pixels and represent the relative reflected light energy recorded for that part of the image. Up to millions of pixels make up an image or video on a device's screen. Each pixel comprises a subpixel that emits a red, green, and blue (RGB) color, which displays at different intensities. Each pixel represents a specific color and brightness value, which collectively form the photograph.

The number of pixels in an image sensor determines the resolution and detail captured by the camera.

WHAT IS BANDS?

A band is represented by a single matrix of pixel values, and a raster with multiple bands contains multiple spatially coincident matrices of pixel values representing the same spatial area.

Some images have a single band, or layer which is a measure of a single characteristic, of data, while others have multiple bands. Some sensors may have only 3 or 4 bands, others may have dozens, or hundreds which are called hyperspectral sensors. Many earth-observing satellites include bands that fall within commonly used 'windows', such as “red” or “near-infrared”.



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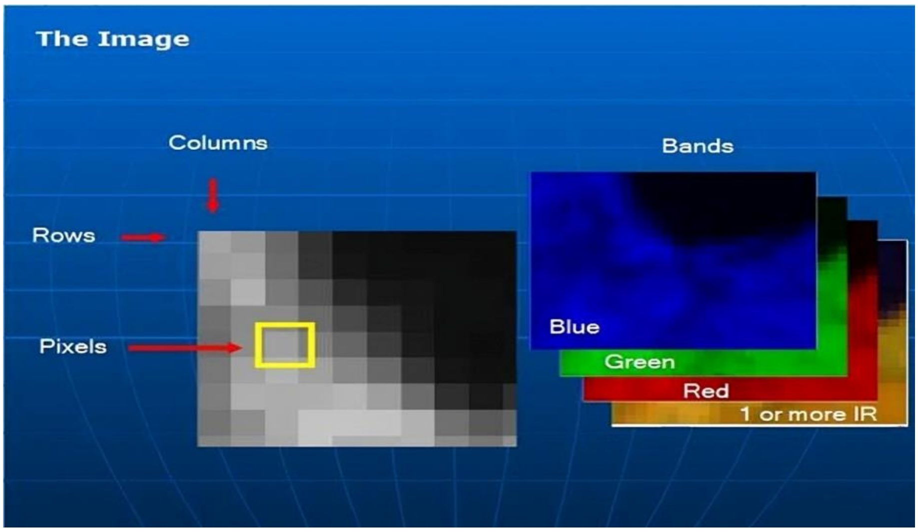


-: Bands for Sentinel 2 :-

Band 1	**(B1)**	**Coastal aerosol**
Band 2	**(B2)**	**Blue**
Band 3	**(B3)**	**Green**
Band 4	**(B4)**	**Red**
Band 5	**(B5)**	**Vegetation red edge 1**
Band 6	**(B6)**	**Vegetation red edge 2**
Band 7	**(B7)**	**Vegetation red edge 3**
Band 8	**(B8)**	**Near Infrared (NIR)**
Band 8A	**(B8A)**	**Narrow NIR**
Band 9	**(B9)**	**Water vapor**
Band 10	**(B10)**	**SWIR – Cirrus**
Band 11	**(B11)**	**SWIR 1**
Band 12	**(B12)**	**SWIR 2**

-: Bands for Landsat 8 :-

Band 1	**(B1)**	**Coastal/Aerosol (CA)**
Band 2	**(B2)**	**Blue(B)**
Band 3	**(B3)**	**Green(G)**
Band 4	**(B4)**	**Red(R)**
Band 5	**(B5)**	**Near-Infrared (NIR)**
Band 6	**(B6)**	**Shortwave Infrared 1 (SWIR-1)**
Band 7	**(B7)**	**Shortwave Infrared 2 (SWIR-2)**
Band 8	**(B8)**	**Panchromatic (PAN)**
Band 9	**(B9)**	**Cirrus (Cirrus)**
Band 10	**(B10)**	**Thermal Infrared 1 (TIRS-1)**
Band 11	**(B11)**	**Thermal Infrared 2 (TIRS-2)**

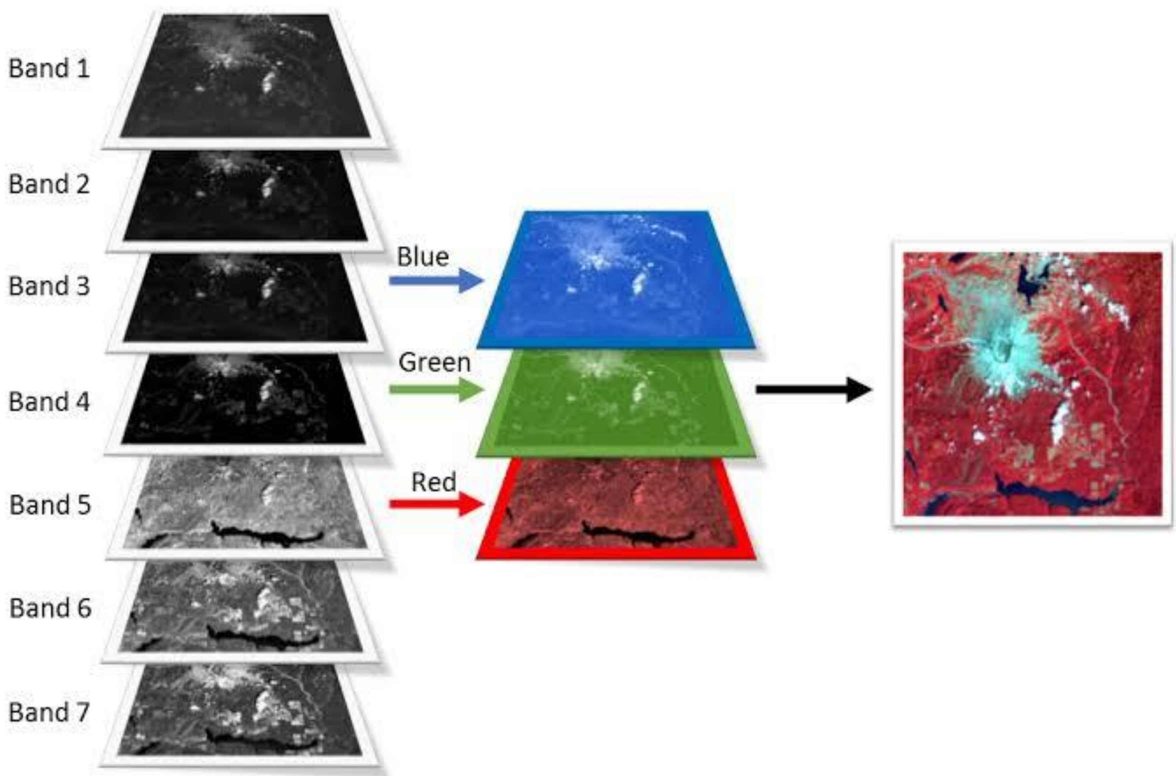
BAND COMBINATION

Bands are often combined in different ways to create images that highlight different features, such as vegetation or water. A *"band combination"* refers to the process of combining different bands or channels of image data to create a composite image.

The most common band combination is Natural Colour which is used to mimic what the human eye would see over a given region, another common combination is Colour Infrared which highlights the presence of vegetation.

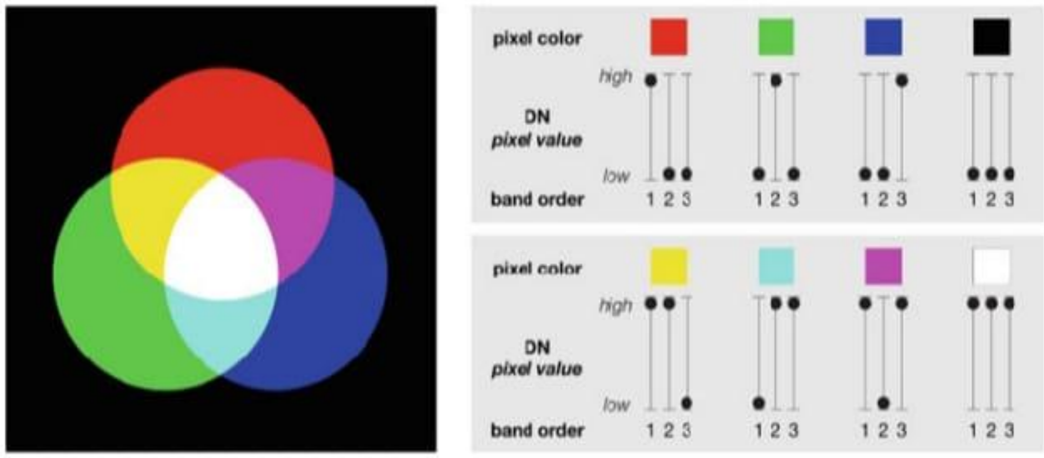
Band combinations are used to highlight the presence of certain materials and/or minimize the representation of other features. By combining bands in different ways and assigning them to different colors, we can create images that highlight specific aspects of the environment, such as vegetation health, land use, or temperature variations.

Color satellite images are composed of multiple, individual channels of data, each corresponding to a specific range of wavelengths. True color and false color composites are two different types of view that are used to gather information in Remote sensing data.



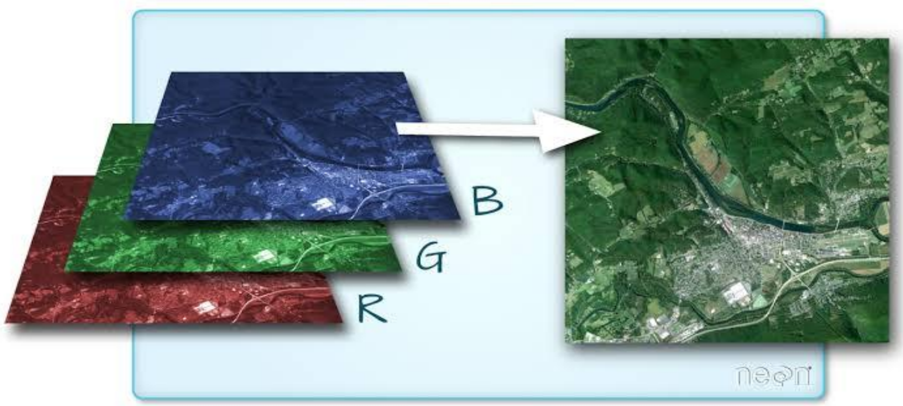
COLOR COMPOSITE

We can use color to compare these visual differences in the pixel values of each band layer all at once as an RGB composite. This method uses the three primary colors (red, green, and blue) to display each pixel's values across three bands. Many colors are formed by combining color primaries in various proportions. Same principles are applied to produce color images taken from airborne cameras or satellite sensors.



TRUE-COLOR COMPOSITE

A natural or true color composite is an image displaying a combination of visible red, green and blue bands to the corresponding red, green and blue channels on the computer. In a true color composite, the red, green, and blue channels correspond to the visible light spectrum, similar to what the human eye sees.



This type of composition shows objects on the Earth's surface in their true colors, making it easy to identify familiar features like forests, water bodies, and urban areas. This results in an image that closely resembles a natural photograph, with objects appearing in their true colors.

For example, vegetation appears green, water bodies appear blue, and urban areas appear grey or brown. The red channel is assigned to the band representing red light, the green channel to the band representing green light, and the blue channel to the band representing blue light**.**

GOOGLE EARTH ENGINE

Earth Engine is a platform for scientific analysis and visualization of geospatial datasets, for academic, non-profit, business and government users. Earth Engine hosts satellite imagery and stores it in a public data archive that includes historical earth images going back more than forty years.

Google Earth Engine is indeed recognized as one of the leading platforms for remote sensing analysis and data visualization. It provides users with a vast repository of geospatial data and powerful computing capabilities, all accessible through a user-friendly interface.

STUDY AREA

“If you want to start changes for sustainability you have to start from your city”

As the goal-14 significantly connected with local water bodies, we have done our project in justification of above sentence. Because many local water bodies, such as rivers, lakes, and estuaries, ultimately flow into the oceans and seas.

The health of local water bodies directly impacts the health of marine ecosystems. Pollution, habitat destruction, and overuse of resources in rivers, lakes, and estuaries can flow downstream and accumulate in coastal areas and the open ocean, affecting marine life and habitats. Engaging local communities in the conservation and sustainable management of water bodies is crucial, as actions taken at the city level can have significant positive effects on marine environments and the well-being of coastal communities.

The Study area has been the planning region which the city of Surat. Surat is a large city beside the Tapi River in the West Indian state of Gujarat. Surat total area is 461.6 Square kilometre. The planning area is located at 21.1702° N, 72.8311°E. The whole Surat city has been divided into 8 zones. It is one of the most dynamic cities in India, with one of the fastest growth rates due to immigration from various parts of Gujarat and other states of India. Surat has a very diverse historical background and because of its textile industries it is known "THE SILK CITY" and is also known by several other names like "THE DIAMOND CITY", "THE GREEN CITY" etc. In recent time Surat is also listed as the second cleanest city in India as of August 21st, 2020, according to the swachh survekshan.

TAPI RIVER

The Tapi is a river of central India. It is one of the major rivers of peninsular India with the length of around 724 km. It runs from east to west. Tapi River rises near Multai in the Betul district of Madhya Pradesh at an elevation of about 752 meter and flows for about 724 km before out falling into the Arabian Sea through the Gulf of Cambay. The Tapi is the second largest westward draining inter-state river basin. It covers a large area in the State of Maharashtra besides areas in the states of Madhya Pradesh and Gujarat. Traversing a length of 214 Km in Gujarat, the Tapi joins Arabian Sea in Gulf of Cambay after flowing past the Surat city. The river receives tidal influence for a length of about 20 Km upstream from mouth i.e. up to Singanapore weir.

The Tapi River Basin covers a territory of 65,145 sq km, which is almost two per cent of the entire Indian region. The catchment area of the River is situated in three different states- Madhya Pradesh- with a catchment area of 9,804 km^2, Maharashtra- with a catchment area of 51,504 sq km, and Gujarat with a Catchment area of 3,837 sq km. The Tapi River drainage basin briefly covers the districts of Burhanpur and Betul in the state of Madhya Pradesh and the district of Surat in the state of Gujarat. The Tapi River drains an area of 65145 sq km out of which 3,837 sq km lies in Gujarat.

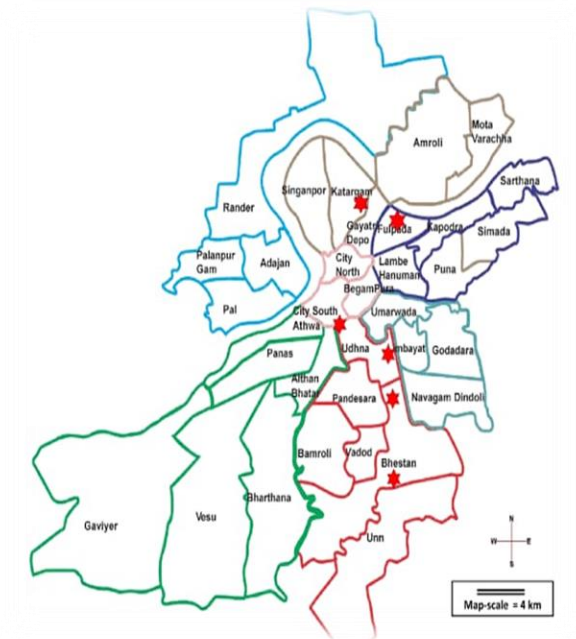
The Tapi River supports several class-I towns, many of which are well-known for their industrial activities. About 80 per cent of the domestic waste and about 70 per cent of the industrial waste are disposed into the river as wastewater. One of the primary and significant contributors to pollution loads are the largely untreated industrial effluents and urban waste. The total BOD (Biochemical oxygen demand) load is about 488 tons per day, that is, about 39 per cent and this part are highly contributed by the urban domestic wastewater and the 21 per cent contribution followed by the surrounding industries.

The total carry-over amount of the nitrogen and potassium compounds are about 10 per cent, and this problem was aggravated during the months of summer when the river flow is considerably reduced. A significant feature of the river Tapi is that the river sets apart from other Indian rivers as it drains into the Gulf of Khambhat. River Tapi has a very high-quality and richly fertile soil that is highly suitable for agricultural activities and is the most significant advantage for the farmers residing in the area.

The tribal and rural population around the Tapti River helps the people to harvest a large number of chief crops and sell it in the market to earn their livelihood. The river is also heavily used for irrigation reasons. The river also provides a means for transportation for the people living on the river banks. The Tapi River is the home to the natural habitats of several wild and exotic animals including tigers, lions, snakes, sloth, bears, and many more.

SHAPEFILE

A shapefile is a simple, nontopological format for storing the geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons (areas).



There are three components of shapefile are mandatory: 1.A main file that contains the feature geometry (. shp), 2. An index file that stores the index of the feature geometry (. shx), and 3. A dBASE table (. dbf) that stores the attribute information of features.

NDWI (NORMALISED DIFFERENCE WATER INDEX)

NDWI stands for Normalized Difference Water Index. It is a remote sensing index commonly used to identify the presence and extent of water bodies in satellite imagery. NDWI is particularly useful for distinguishing between water and non-water features in multispectral or hyperspectral imagery.

The formula for calculating NDWI is:

$$NDWI = \frac{NIR - SWIR}{NIR + SWIR}$$

Where; NIR is the Near-Infrared band.

SWIR is the Shortwave Infrared band

In this index, water bodies typically have high reflectance in the NIR range and low reflectance in the SWIR range. Consequently, healthy vegetation, which reflects strongly in the NIR but also to some extent in the SWIR, exhibits lower NDWI values compared to water.

NDWI has been employed in various applications, including monitoring changes in water bodies, assessing water availability, and mapping flood extents. It is a valuable tool for researchers, environmental scientists, and water resource managers leveraging satellite or aerial imagery for Earth observation and analysis.

NDWI values can range from -1 to 1. Higher positive values of NDWI indicate the presence of water, while lower values or negative values are associated with non-water features.Generally, water bodies NDWI value is greater than 0.5. Vegetation has much smaller values which distinguishing vegetation from water bodies easily. Build-up features having positive values lies between 0 to 0.2.

WHAT IS TURBIDITY IN WATER?

Turbidity refers to how clear a liquid is. High turbidity means that the liquid is not very clear; low turbidity means that the liquid is clearer. Turbidity is caused by solid particles being suspended in a liquid. These particles scatter light, which can give the liquid a cloudy or murky appearance. Turbidity is often used to test water quality heuristically. Greater turbidity typically implies lower quality.

WHY IS TURBIDITY IMPORTANT?

Turbidity may increase due to rain, erosion and plant and animal life in the water. However, the importance of turbidity in water treatment increases when the sand, silt, and organic matter remain in the drinking water in a community. Turbidity and water quality have a considerable impact on local communities. Other particles may exist that could contaminate water and increase turbidity along with stirring up sediments in a body of water.

WHAT PROBLEMS CAN RESULT FROM EXCESSIVE TURBIDITY?

While turbidity does not necessarily harm the population of a community, it could cause disinfection problems with the wastewater treatment methods. Suspended materials that are not adequately filtered out may become health risks to humans.

Excess turbidity can cause heavy metals to be added to the water supply. These metals may include lead, mercury, and cadmium, which are toxic to humans. Turbidity can harm aquatic life by reducing the food supply, degrading spawning beds and affecting the function of fish gills.

In our research, we utilized NDTI to measure turbidity, indicating the clarity of the water by detecting suspended solid particles, which scatter light and affect its transparency.

NDTI (NORMALIZED DIFFERENCE TURBIDITY INDEX)

NDTI, or Normalized Difference Turbidity Index, is an index commonly used in remote sensing to quantify the concentration of suspended sediments or turbidity in water bodies. It's particularly useful for monitoring water quality and sediment transport in rivers, lakes, and coastal areas.

The formula for calculating NDTI is:

$$\boldsymbol{NDTI = \frac{RED - GREEN}{RED + GREEN}}$$

The NDTI values takes range from -1 to 1.

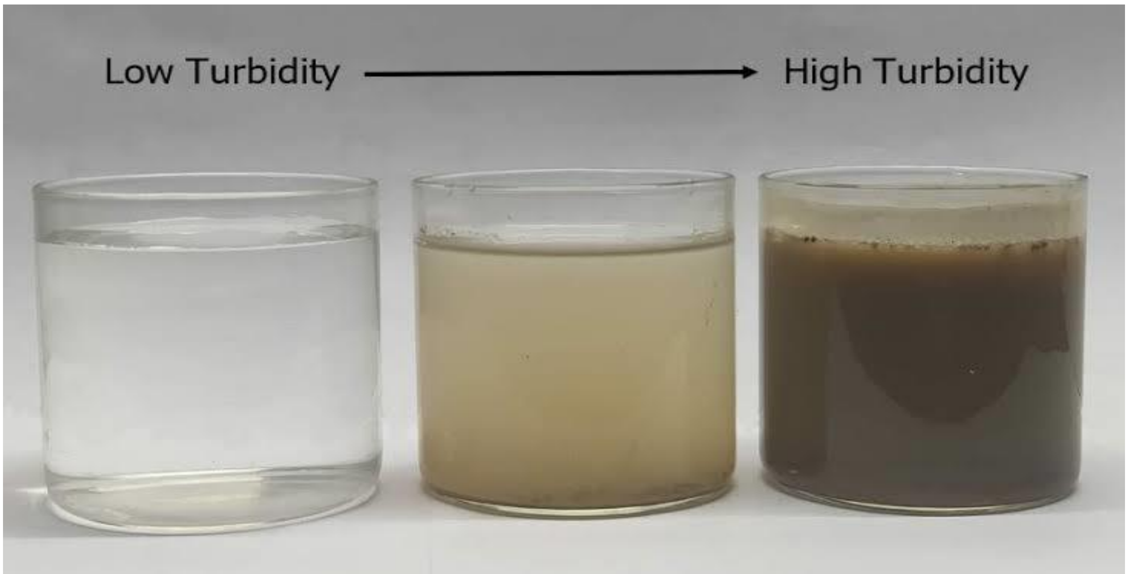
Positive values (close to 1) suggest high turbidity or high concentrations of suspended sediments. This often indicates muddy or sediment-laden water.

Negative values (close to -1) indicate low turbidity or low concentrations of suspended sediments. This may correspond to clear water or areas with low sediment load

Values around 0 or close to 0 indicate little to no difference in reflectance between the NIR and SWIR bands, which may correspond to water bodies with moderate turbidity or sediment load.

We know that NDTI takes range between -1 to +1. The Range of NDTI has been classified as follow.

- If the value of NDTI takes range between -0.15 to 0.00, it considers as low turbidity.
- If the value of NDTI takes range between 0.01 to 0.10, it considers as medium turbidity.
- If the value of NDTI takes range between 0.10 to 0.30 it considers as high turbidity.



The above image uses glasses to represent different levels of turbidity in water.

- The first glass, which is clear, represents low turbidity.
- The second glass, slightly cloudy, represents medium turbidity
- The third glass, very cloudy, represents high turbidity.

Width Of the River

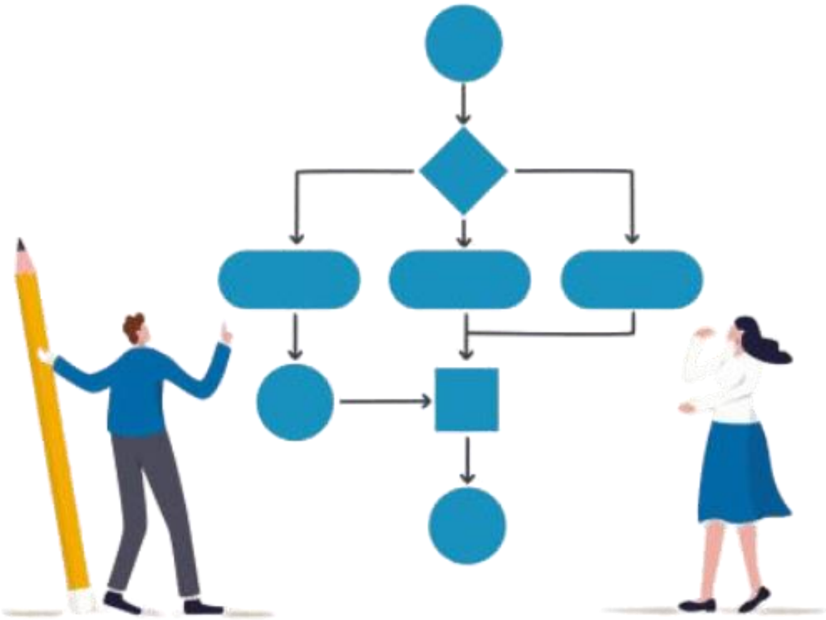
Measuring the width of the river in our research is crucial because it helps us understand how the river is changing and what impacts it might have. For example, knowing the width helps predict erosion, where the river's banks wear away, and where it's depositing sediment, which can affect the landscape and nearby buildings. This information is also important for assessing flood risk because wider rivers can carry more water, potentially causing more flooding. Additionally, understanding the width is essential for planning infrastructure development, like riverfront projects, bridges, and roads, as it determines where structures can be safely built without being damaged by the river. Furthermore, it's crucial for navigation and transportation, ensuring that boats and ships have enough space to travel safely without running aground or hitting obstacles. Finally, it's vital for designing hydraulic structures such as dams or levees, which need accurate measurements to be effective in controlling the flow of water and preventing disasters like flooding.

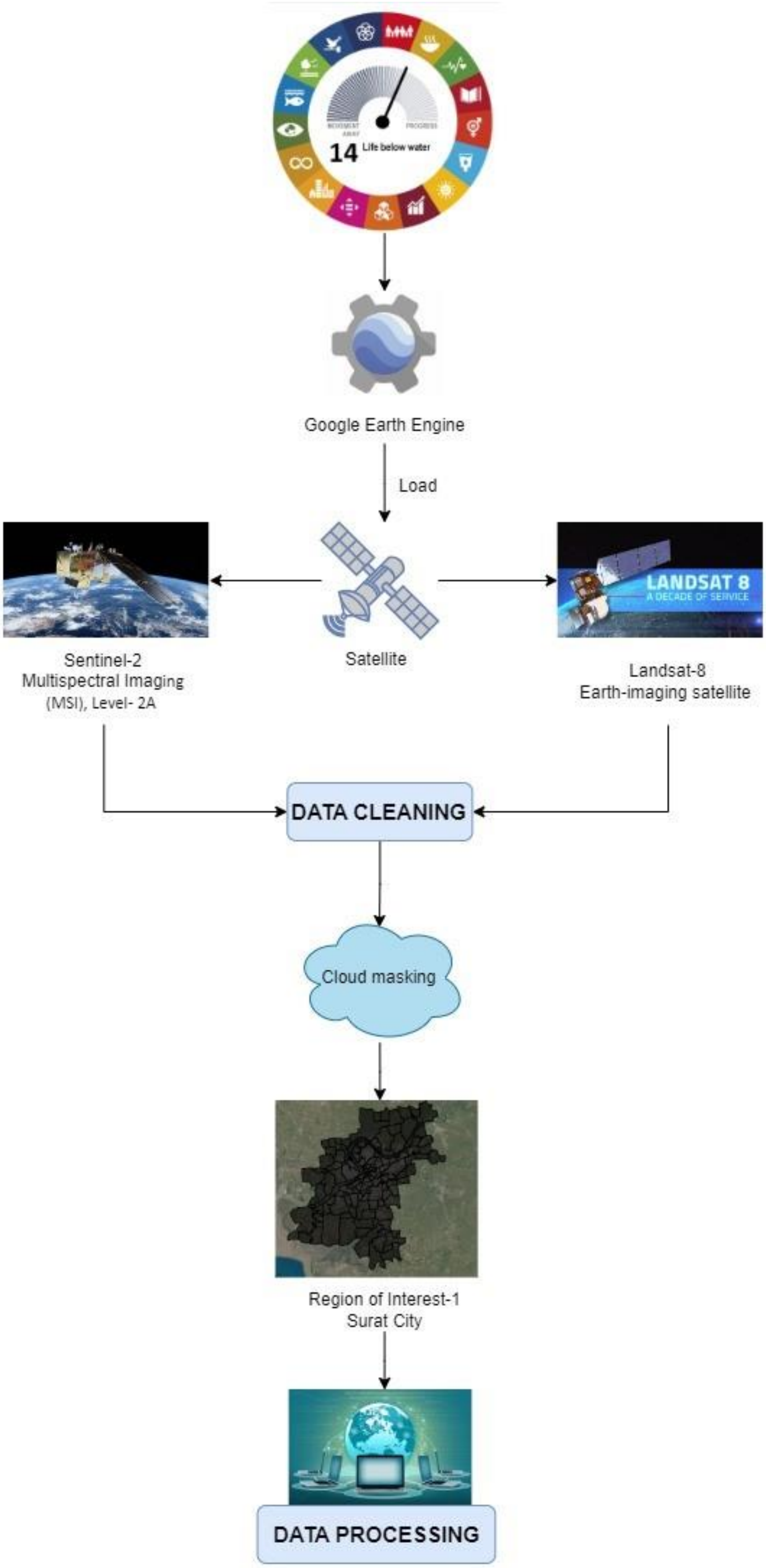
Width Of the Tapi River

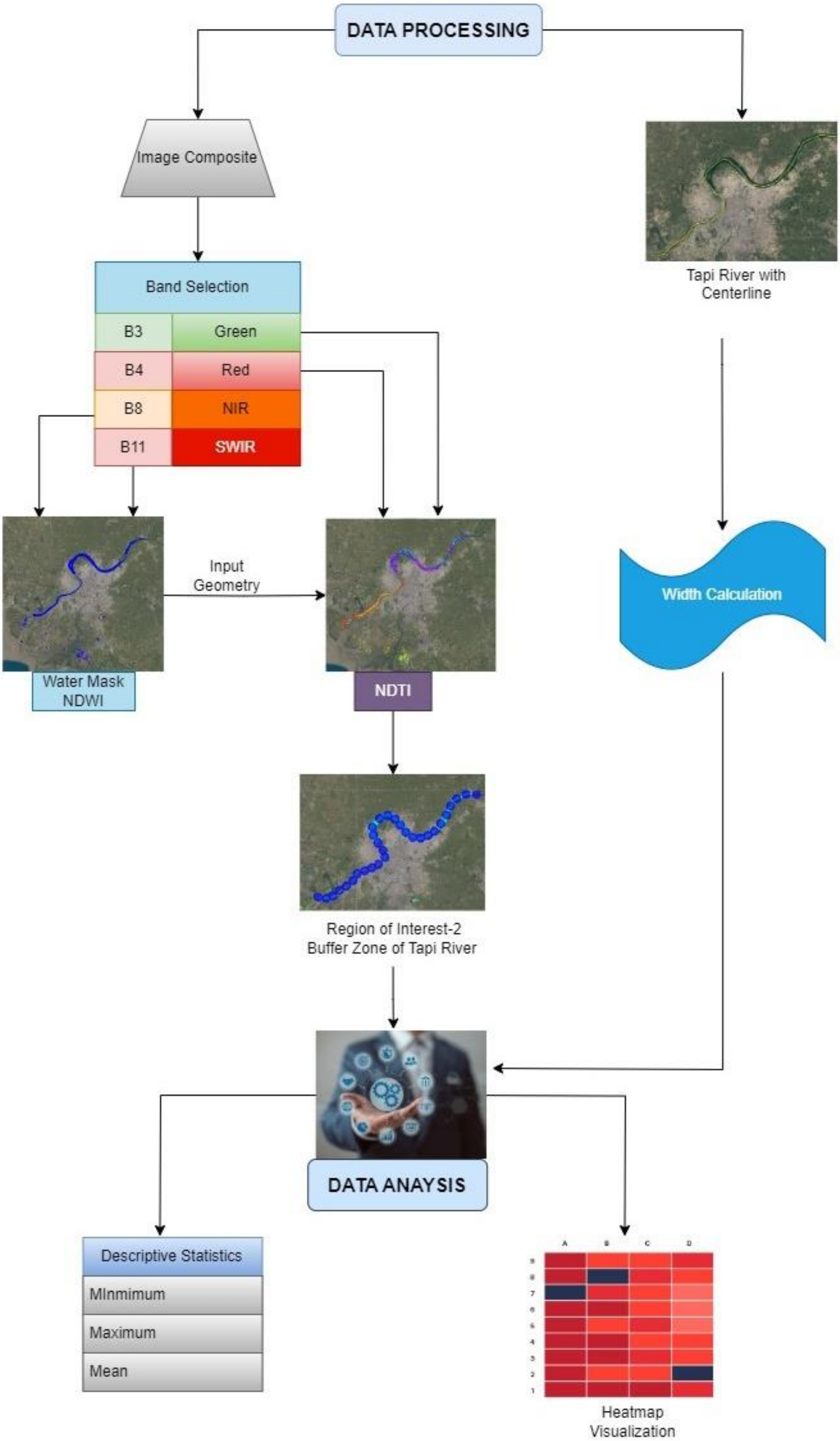
Introduction

The Tapi River, flowing through Surat, often faces severe flooding due to heavy rainfall from weather systems originating in the Bay of Bengal. These floods impact Surat and nearby areas, causing significant damage. Our study focuses on tracking changes in the width of the Tapi River from Kamrej to Dummas between 1987 to 2021. Unlike traditional methods using Geographic Information Systems (GIS), we use Google Earth Engine for our analysis. Google Earth Engine provides a user-friendly platform for processing satellite imagery, helping us understand how the width of the Tapi River has changed over time.

FLOWCHART




14 Life below water
Google Earth Engine
Load
Sentinel-2
Multispectral Imaging
(MSI), Level- 2A
Satellite
LANDSAT 8
A DECADE OF SERVICE
Landsat-8
Earth-imaging satellite
DATA CLEANING
Cloud masking
Region of Interest-1
Surat City
DATA PROCESSING


DATA PROCESSING
Image Composite
Band Selection
B3
Green
B4
Red
B8
NIR
B11
SWIR
Tapi River with Centerline
Input Geometry
Water Mask NDWI
NDTI
Width Calculation
Region of Interest-2 Buffer Zone of Tapi River
DATA ANAYSIS
Descriptive Statistics
MInmimum
Maximum
Mean
Heatmap Visualization

OBJECTIVES

1. Temporal Analysis of Water Turbidity Along the Tapi River in Surat City Using Sentinel-2 Satellite Imagery and the Normalized Difference Turbidity Index (NDTI) from 2019 to 2023.

    - Analyse seasonal variations and long-term trends in water turbidity.

    - Identify areas of high and low turbidity, and investigate potential factors contributing to changes in water quality.

2. Historical Analysis of Tapi River Width in Surat City Using Landsat 8 Satellite Imagery from 1987 to 2021:

    - Analyse trends in the width of the Tapi River to identify areas experiencing potential expansion or contraction.

    - Inform strategic planning for infrastructure development and land use allocation in the riverfront area of Surat City.

DATA COLLECTION

1] Data Collection for NDTI

Satellite Data Acquisition:

We obtained Sentinel-2 satellite imagery from the Copernicus Open Access Hub via the Google Earth Engine platform. Sentinel-2 imagery offers high spatial resolution (10 to 20 meters) multispectral data, making it suitable for monitoring environmental parameters such as water quality.

Cloud Masking and Image Compositing (median Image):

To ensure the quality of the data, we developed a custom cloud masking function. This function filters out cloud cover and atmospheric interference from the satellite imagery, allowing us to obtain clear, cloud-free images for analysis. We composited imagery (median image) for each month within the study period, from January 2019 to December 2023.

Spectral Index Calculation:

We computed spectral indices such as the Normalized Difference Water Index (NDWI) and the Normalized Difference Turbidity Index (NDTI). These indices provide quantitative measures of water quality parameters, including water turbidity and chlorophyll concentration.

Spatial Analysis with Buffer Zones:

To facilitate spatial analysis, we delineated 30 buffer zones along the Tapi River, each with a radius of 600 meters. These buffer zones cover the entire extent of the river and serve as spatial units for analysing water quality parameters.

Buffer Zone: A buffer is a zone that is drawn around any point, line, or polygon that encompasses all of the area within a specified distance of the feature.

Circular Mean NDTI Calculation:

Within each buffer zone, we calculated the mean NDTI value for each clear image date. This process provides spatially explicit insights into water turbidity levels at different locations along the river course over time.

2] Data Collection for Width of Tapi River

We have employed existing code assets to optimize data collection of width.

- The code aims to calculate river centerlines and widths using Landsat satellite imagery for a specific image ***(LC08_L1TP_022034_20130422_20170310_01_T1).***

- It utilizes functions from the 'RivWidthCloudPaper' and 'functions_Landsat' scripts.

- The script sets up a user interface (UI) for instructions, citations, and parameter adjustments.

- When the user clicks on the map, it identifies the location and generates an area of interest (AOI) around the clicked point.

- It filters Landsat imagery based on cloud cover, date range, and AOI, then sorts and aggregates image IDs.

- Width calculation is performed for each image ID, considering various filters and constraints.

- Time series data for river width is generated, displayed in a chart, and can be downloaded as a CSV file.

- Clicking on a data point in the time series chart displays the corresponding satellite image.

- The code includes instructions for adjusting parameters and citing the algorithm used.

- A GIF animation illustrating width change through time is generated and displayed. The script provides a URL for downloading the width data as a CSV file.

- By employing the provided code, we focused the analysis on the Tapi River, delineating its geometry and centreline to segment it into 25 distinct sections.

- From each centreline point, we systematically generated individual CSV files corresponding to the 25 delineated areas along the river's course.

- This approach enabled precise data collection and organization, facilitating in-depth analysis and interpretation of river width variations across different sections.

- Each CSV file encapsulates essential information, including river width measurements and associated attributes, for comprehensive spatial analysis and visualization.

STATISTICAL METHODOLOGY

Descriptive Statistics.

Descriptive statistics is a branch of statistics that deals with the collection, organization, summarization, and presentation of data. Its primary purpose is to describe and summarize the features of a dataset through numerical or graphical techniques. Descriptive statistics provide a concise summary of data that helps in understanding its basic properties and characteristics.

➢ Descriptive of NDTI

Minimum Value: Represents the lowest level of turbidity observed in the water bodies, indicating areas with relatively clear water or minimal sedimentation.

Maximum Value: Indicates the highest level of turbidity observed, highlighting areas with significant sediment loads, possibly due to runoff or industrial discharges.

Mean: Provides an average measure of turbidity across the study area, serving as a central reference point for understanding typical turbidity levels.

Variance: Quantifies the spread or dispersion of NDTI values around the mean, reflecting spatial heterogeneity in sediment concentrations.

Standard Error: Estimates the precision of the mean NDTI value, providing confidence in the representativeness of the calculated mean.

➢ Descriptive Statistics for Width

Minimum Value: Represents the smallest width observed in the river, indicating narrow sections or constriction points.

Maximum Value: Indicates the largest width observed in the river, highlighting wider sections or expanses.

Mean: Provides an average width of the river, serving as a central reference point for understanding typical river width.

Variance: Quantifies the spread or dispersion of width values around the mean, reflecting variability in river width along its course.

Standard Error: Estimates the precision of the mean river width, providing confidence in the representativeness of the calculated mean.

DATA ANALYSIS AND GRAPHICAL REPRESENTATION

Descriptive Statistics of NDTI for All Area

Area	Minimum Time Period	Minimum	Maximum Time Period	Maximum	Mean	Variance	Standard Error
Amboli	April 2023	-0.045	Oct 2022	0.213	0.0687	0.0047	0.0126
Kathor	May 2023	0.01	Oct 2022	0.115	0.0607	0.0009	0.0055
Bhadgam	May 2023	0.017	Oct 2022	0.181	0.1091	0.0014	0.0068
Abrama	April 2021	0.028	Oct 2022	0.154	0.0966	0.0009	0.0054
Valak Patiya	April 2021	0.05	Oct 2022	0.169	0.1097	0.0007	0.0049
Ring Road	April 2021	0.031	Oct 2022	0.16	0.0885	0.0009	0.0056
Savji Korat Bridge	April 2021	0.009	Oct 2022	0.118	0.0648	0.0007	0.0047
Sudama Bridge	April 2021	0.015	Oct 2022	0.133	0.0759	0.0008	0.0052
Kapodra Brige	April 2021	0.025	April 2023	0.152	0.0868	0.0009	0.0054
Utran Road	April 2021	0.017	April 2023	0.134	0.0732	0.0007	0.0047
Amroli Brige	April 2021	0.001	April 2023	0.102	0.0574	0.0006	0.0044
Chaprabhata-1	April 2021	0.062	Oct 2022	0.183	0.1195	0.0011	0.0060
Chaprabhata-2	March 2021	0.07	Oct 2022	0.187	0.1260	0.0009	0.0053
Variav Bridge	March 2021	0.067	Oct 2020	0.163	0.1154	0.0005	0.0042
Hajira Road	March 2021	0.1	Oct 2020	0.184	0.1393	0.0005	0.0040
Dabholi Village	Nov 2021	0.121	May 2023	0.226	0.1557	0.0009	0.0055
Dabholi Bridge	April 2021	0.089	May 2023	0.233	0.1373	0.0010	0.0059
Causeway	Jan-2023	-0.001	Oct 2022	0.095	0.0373	0.0006	0.0046
Chandrasekhar Azad Brige	April 2023	-0.071	Oct 2019	0.019	-0.0241	0.0009	0.0053
Nehru Bridge	April 2023	-0.07	Oct 2019	0.005	-0.0323	0.0006	0.0045
Sardar Bridge	Jan 2023	-0.056	Nov 2019	0.017	-0.0190	0.0006	0.0046
Cable Bridge	Jan 2023	-0.061	Sept 2020	0.04	-0.0151	0.0008	0.0052
Pal-Umra Bridge	Jan 2023	-0.067	Sept 2020	0.033	-0.0212	0.0007	0.0048
Rundh	Feb 2022	-0.031	Sept 2020	0.08	0.0201	0.0008	0.0050
Piplod	Jan 2023	-0.039	Oct 2022	0.068	0.0060	0.0007	0.0048
Magdalla Road-1	Jan 2023	-0.075	Sept 2020	0.05	-0.0209	0.0011	0.0059
Magdalla Road-2	Jan 2023	-0.08	Sept 2020	0.039	-0.0315	0.0009	0.0056
Dummas Road-1	Jan 2023	-0.068	Sept 2020	0.053	-0.0184	0.0010	0.0058
Dummas Road-2	Jan 2023	-0.099	Sept 2020	0.093	-0.0260	0.0021	0.0084
Dummas	April 2023	-0.063	Sept 2020	0.109	-0.0044	0.0016	0.0074

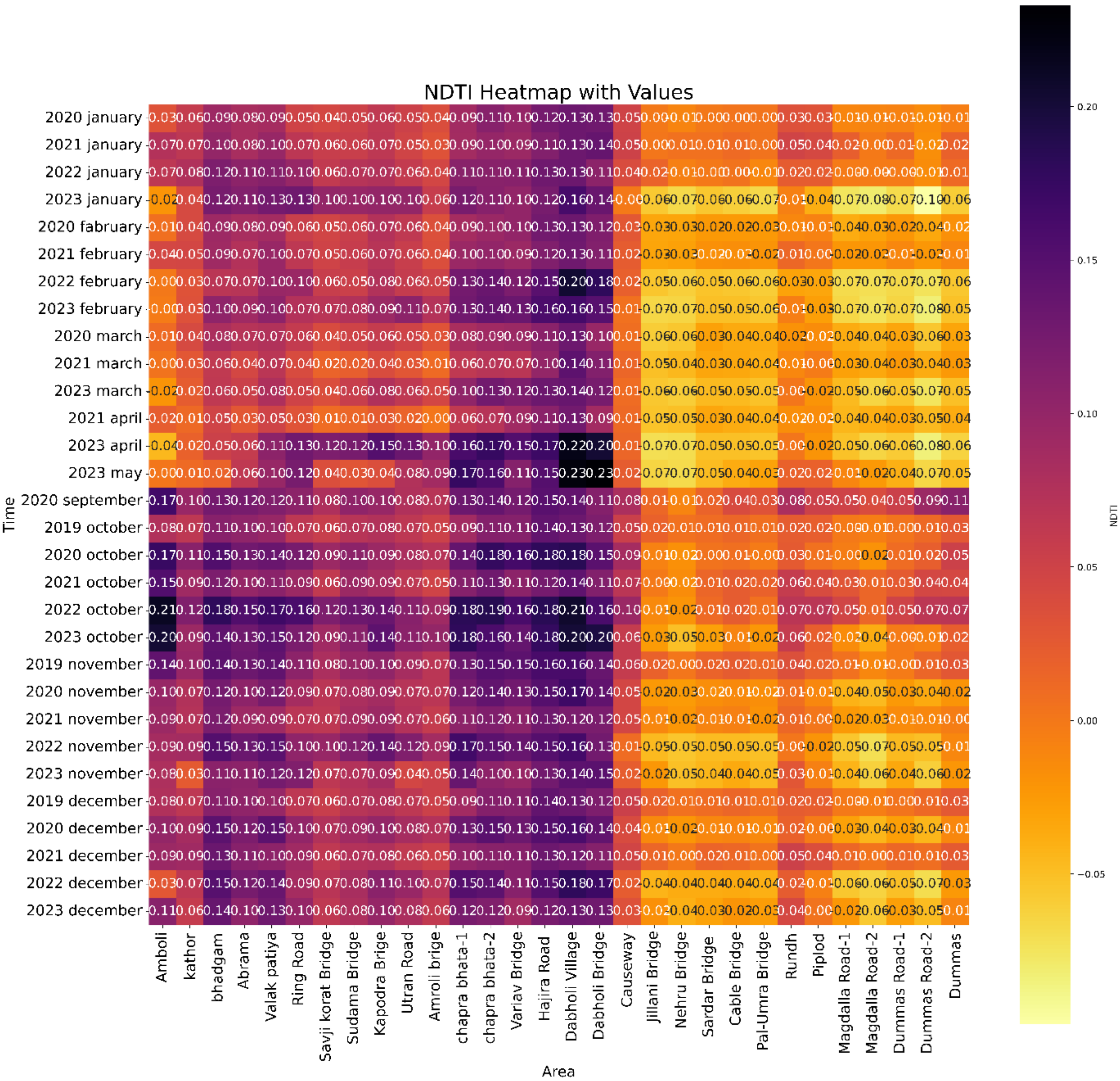
Descriptive Statistics of NDTI for Area of Before Causeway

Area	Minimum	Time Period	Maximum	Time Period	Mean	Variance	Standard Error
Amboli	-0.045	Apr 2023	0.213	Oct 2022	0.0687	0.0047	0.0126
kathor	0.01	May 2023	0.115	Oct 2022	0.0607	0.0009	0.0055
bhadgam	0.017	May 2023	0.181	Oct 2022	0.1091	0.0014	0.0068
Abrama	0.028	Apr 2021	0.154	Oct 2022	0.0966	0.0009	0.0054
Valak patiya	0.05	Apr 2021	0.169	Oct 2022	0.1097	0.0007	0.0049
Ring Road	0.031	Apr 2021	0.16	Oct 2022	0.0885	0.0009	0.0056
Savji korat Bridge	0.009	Apr 2021	0.118	Oct 2022	0.0648	0.0007	0.0047
Sudama Bridge	0.015	Apr 2021	0.133	Oct 2022	0.0759	0.0008	0.0052
Kapodra Brige	0.025	Apr 2021	0.152	Apr 2023	0.0868	0.0009	0.0054
Utran Road	0.017	Apr 2021	0.134	Apr 2023	0.0732	0.0007	0.0047
Amroli brige	0.001	Apr 2021	0.102	Apr 2023	0.0574	0.0006	0.0044
chapra bhata-1	0.062	Apr 2021	0.183	Oct 2022	0.1195	0.0011	0.0060
chapra bhata-2	0.07	Mar 2021	0.187	Oct 2022	0.1260	0.0009	0.0053
Variav Bridge	0.067	Mar 2021	0.163	Oct 2022	0.1154	0.0005	0.0042
Hajira Road	0.1	Mar 2021	0.184	Oct 2022	0.1393	0.0005	0.0040
Dabholi Village	0.121	Nov 2021	0.226	May 2023	0.1557	0.0009	0.0055
Dabholi Bridge	0.089	Apr 2021	0.233	May 2023	0.1373	0.0010	0.0059

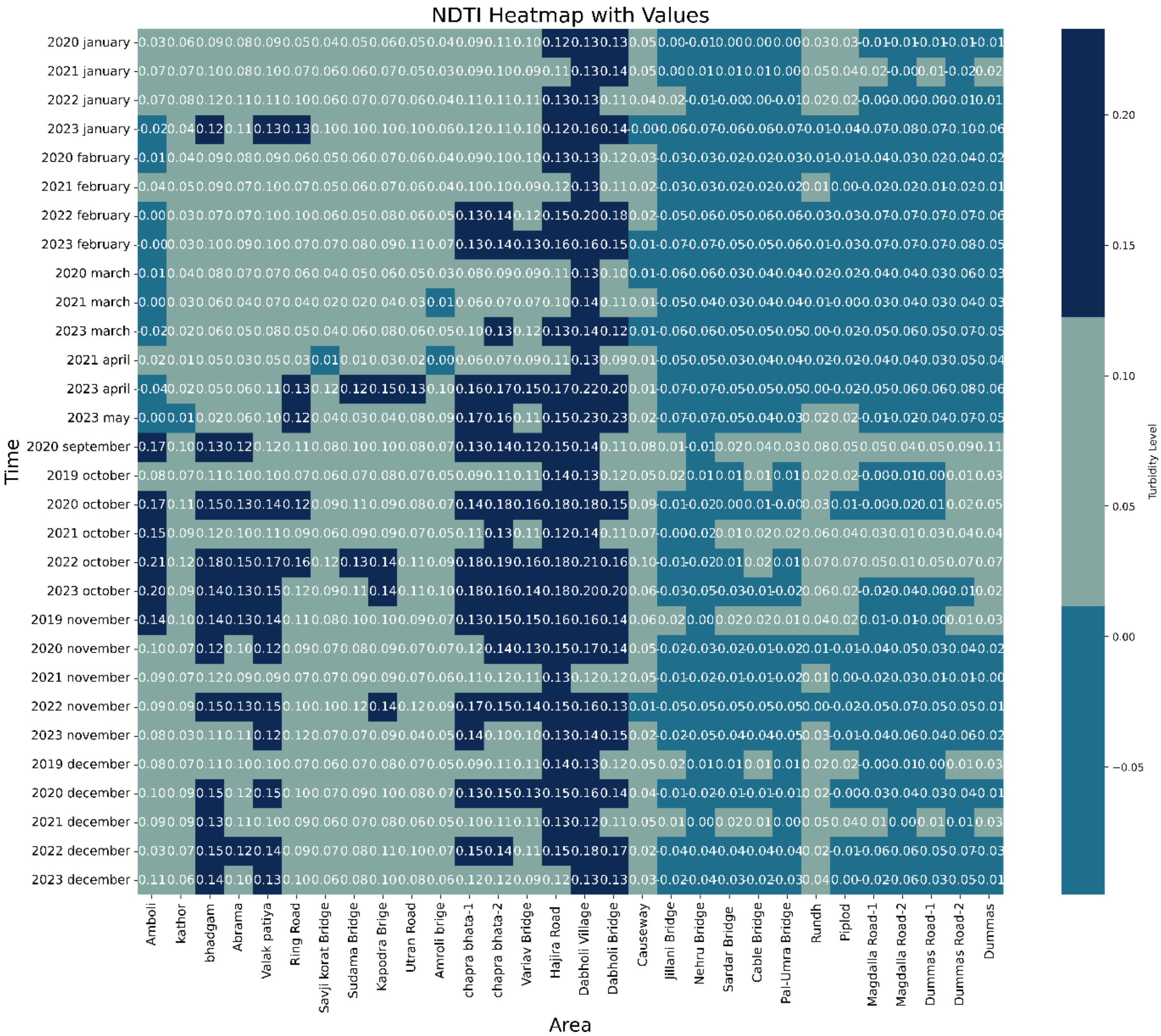
Descriptive Statistics of NDTI for Area of After Causeway

Area	Minimum	Time Period	Maximum	Time Period	Mean	Variance	Standard Error
Causeway	-0.001	Jan 2023	0.095	Oct 2022	0.0373	0.0006	0.0046
Jillani Bridge	-0.071	Apr 2023	0.019	Oct 2019	-0.0241	0.0009	0.0053
Nehru Bridge	-0.07	Apr 2023	0.005	Oct 2019	-0.0323	0.0006	0.0045
Sardar Bridge	-0.056	Jan 2023	0.017	Nov 2019	-0.0190	0.0006	0.0046
Cable Bridge	-0.061	Jan 2023	0.04	Sep 2020	-0.0151	0.0008	0.0052
Pal-Umra Bridge	-0.067	Jan 2023	0.033	Sep 2020	-0.0212	0.0007	0.0048
Rundh	-0.031	Feb 2022	0.08	Sep 2020	0.0201	0.0008	0.0050
Piplod	-0.039	Jan 2023	0.068	Oct 2022	0.0060	0.0007	0.0048
Magdalla Road-1	-0.075	Jan 2023	0.05	Sep 2020	-0.0209	0.0011	0.0059
Magdalla Road-2	-0.08	Jan 2023	0.039	Sep 2020	-0.0315	0.0009	0.0056
Dummas Road-1	-0.068	Jan 2023	0.053	Sep 2020	-0.0184	0.0010	0.0058
Dummas Road-2	-0.099	Jan 2023	0.093	Sep 2020	-0.0260	0.0021	0.0084
Dummas	-0.063	Apr 2023	0.109	Sep 2020	-0.0044	0.0016	0.0074

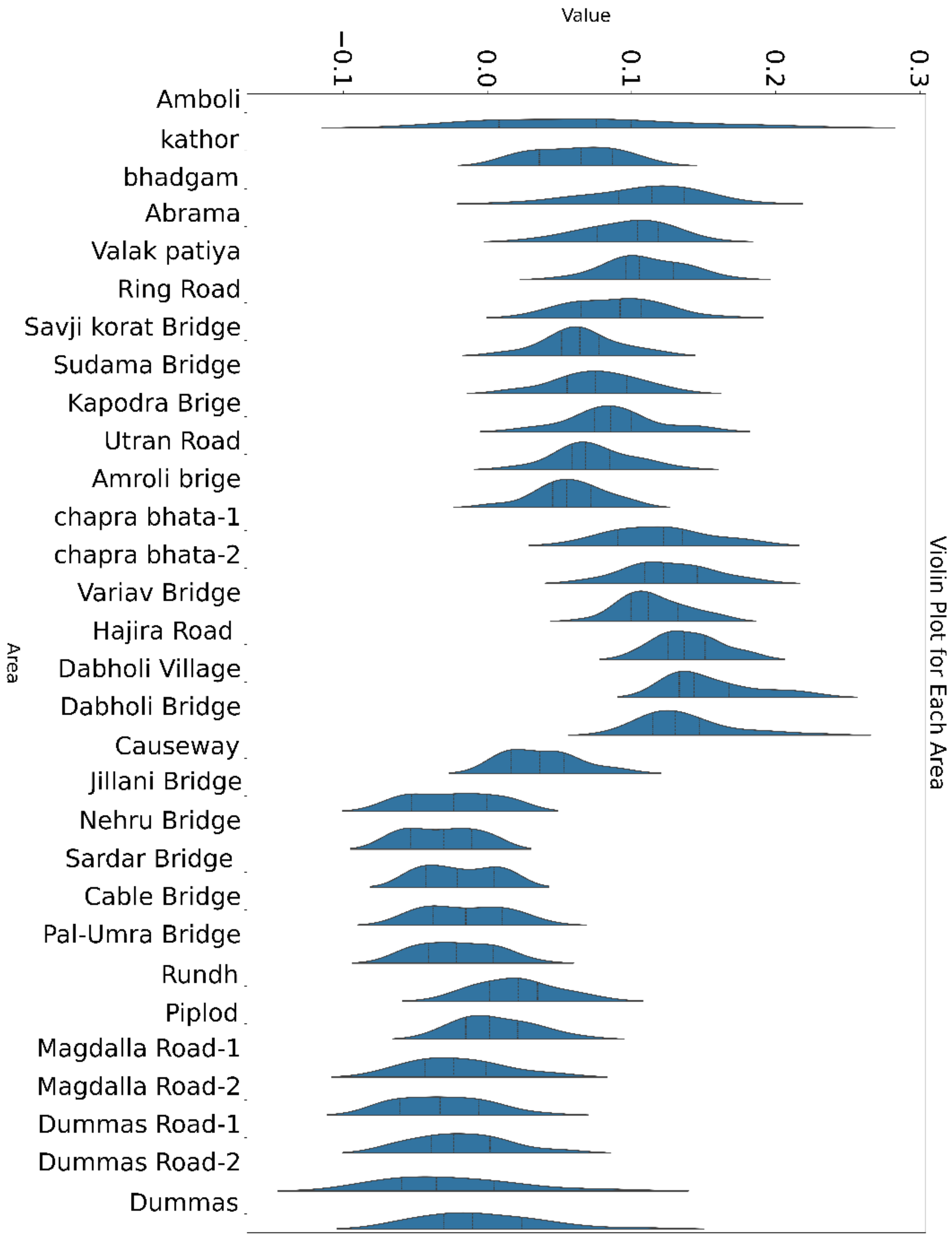
Representation of NDTI by Heatmap



Class wise Representation of NDTI by Heatmap



VIOLIN PLOT



Value
−0.1
0.0
0.1
0.2
0.3
Violin Plot for Each Area
Area
Amboli
kathor
bhadgam
Abrama
Valak patiya
Ring Road
Savji korat Bridge
Sudama Bridge
Kapodra Brige
Utran Road
Amroli brige
chapra bhata-1
chapra bhata-2
Variav Bridge
Hajira Road
Dabholi Village
Dabholi Bridge
Causeway
Jillani Bridge
Nehru Bridge
Sardar Bridge
Cable Bridge
Pal-Umra Bridge
Rundh
Piplod
Magdalla Road-1
Magdalla Road-2
Dummas Road-1
Dummas Road-2
Dummas

Interpretation

- From the Descriptive Statistics, we can interpret that in last five year Tapi River was more turbid at Dabholi bridge (Jahangirpura) in May 2023 and less turbid at Dummas Road-2 in January 2023.
- The area with low variance indicates little fluctuation of turbidity within that area over time. This localized stability suggests that the turbidity levels within each area remain relatively constant.
- While in Amboli variance is high which indicates more fluctuation in level of turbidity as compare to other area.
- The constant turbidity level within each area indicates stable environmental conditions or consistent human activities within those areas that influence turbidity.
- From the past five year's pattern we can say that there is low turbidity in most of months of winter and summer, while there is high turbidity in most of months of post-monsoon.

According to areas:

- From the heatmap we can observed that the area from Amboli to Dapholi bridge are more turbid since 2019 to till 2023 except some area which are Kathor, Savji korat bridge, Utran Road and Amroli bridge.
- The area from Chaprabhatha to Dabholi bridge are most turbid.
- While the area from causeway to Dumas are less turbid.
- Tapi river has highest turbidity at Dabholi village since last five years.
- Tapi rive has lowest turbidity at Nehru bridge since last five years.
- The area Amboli has more variation in level of turbidity.

According to Time:

- Tapi was most turbid in October 2022 and least turbid in January 2023 in last five years.
- From the last five year in every year turbidity takes peak in months of post-monsoon. i.e. October, November, December
- Whereas, in months of winter to summer turbidity goes down. i.e. March, April

- Before the causeway area, Dabholi Village had the highest water murkiness levels, indicated by the mean NDTI value.
- After the causeway area , Jillani Bridge showed the highest water murkiness levels, suggesting a shift in turbidity patterns.
- Conversely, before the causeway area , Amroli Bridge had the lowest water murkiness levels based on mean NDTI values.
- After the causeway's area , Dummas Bridge exhibited the lowest water murkiness levels.
- These changes imply possible changes in water clarity resulting from the causeway's after and before areas .

Clean Image Collection Of Surat Tapi River

Image before causeway of High Turbidity October-2022

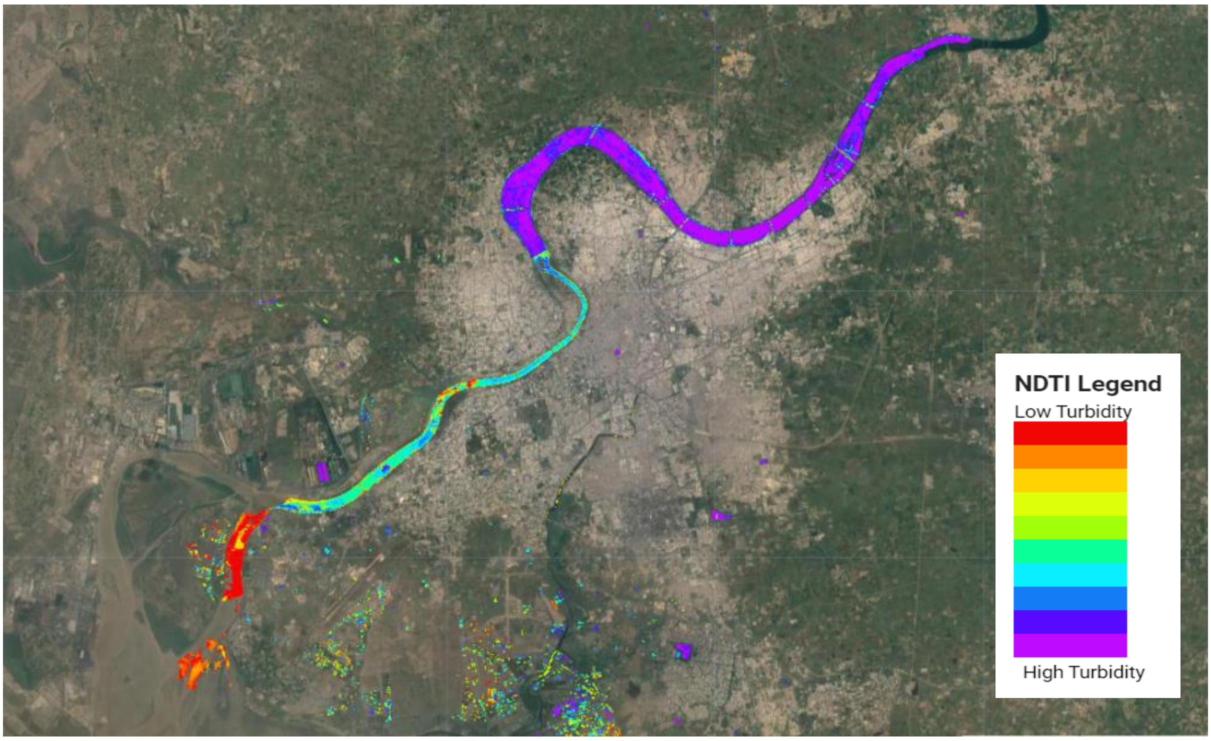


Image before causeway of low Turbidity April-2021

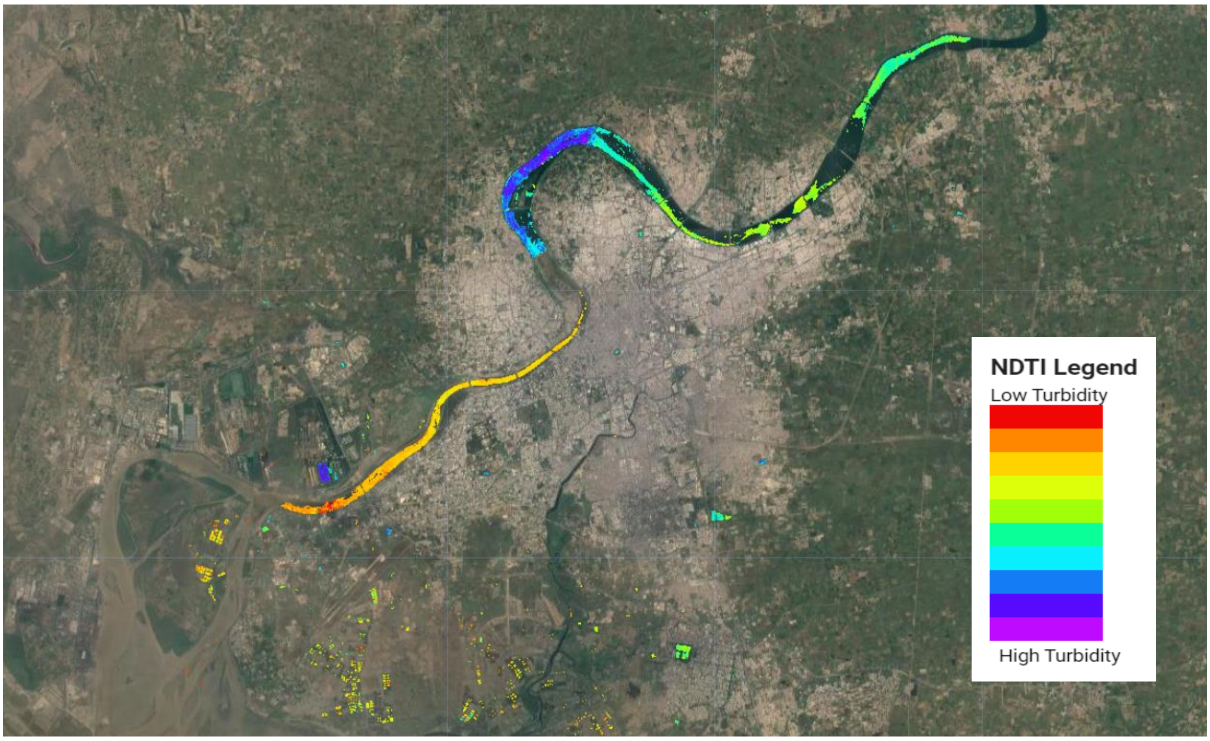


Image after causeway of High Turbidity September-2020

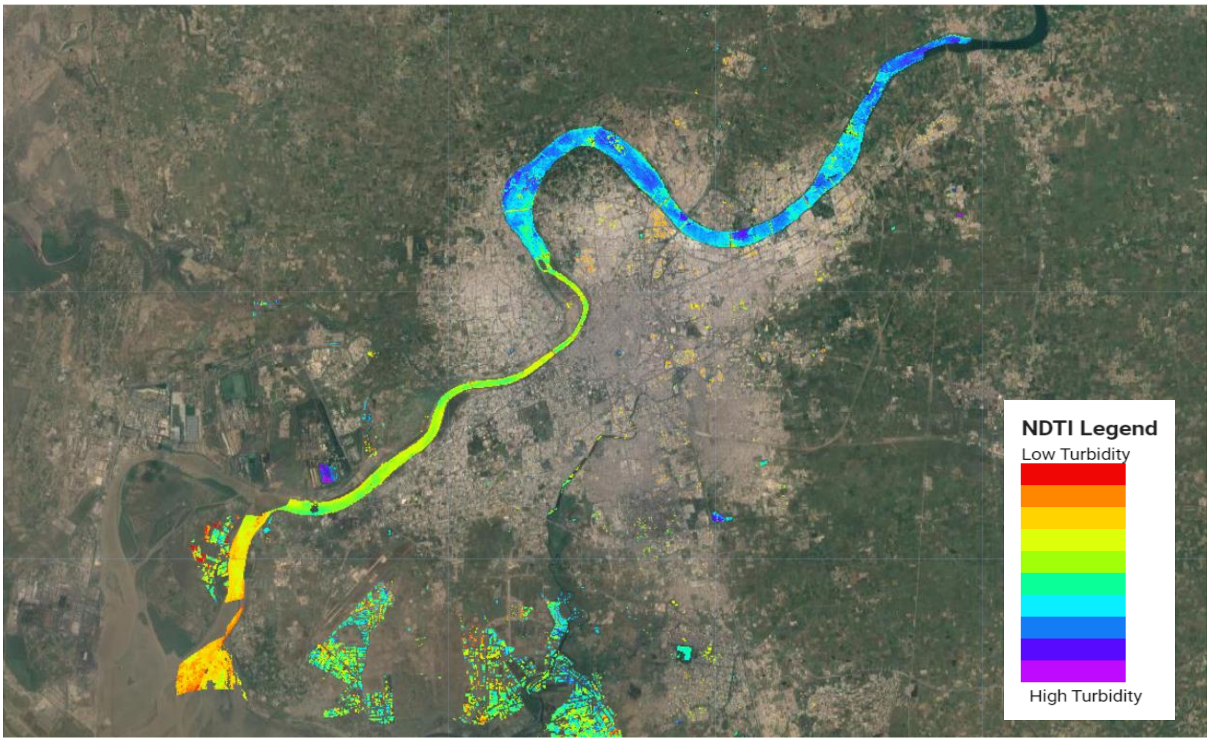
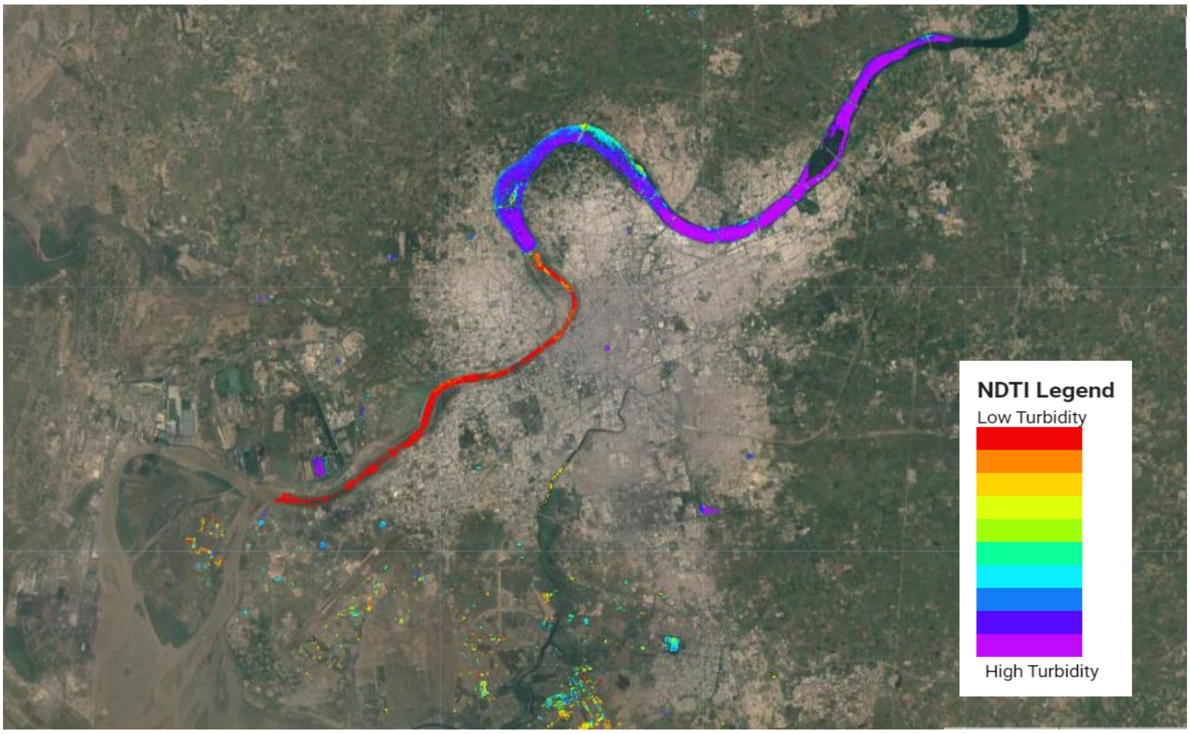
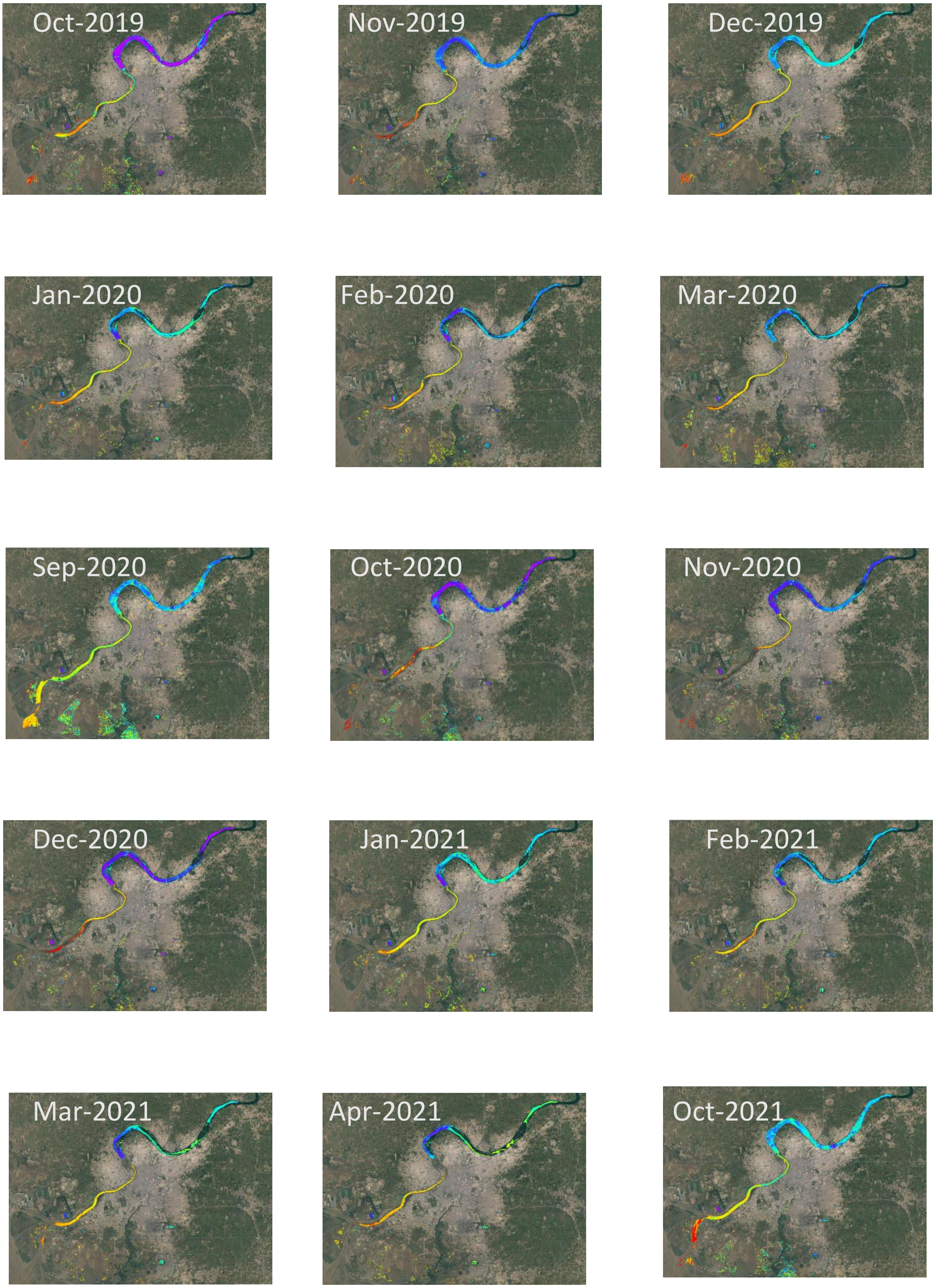
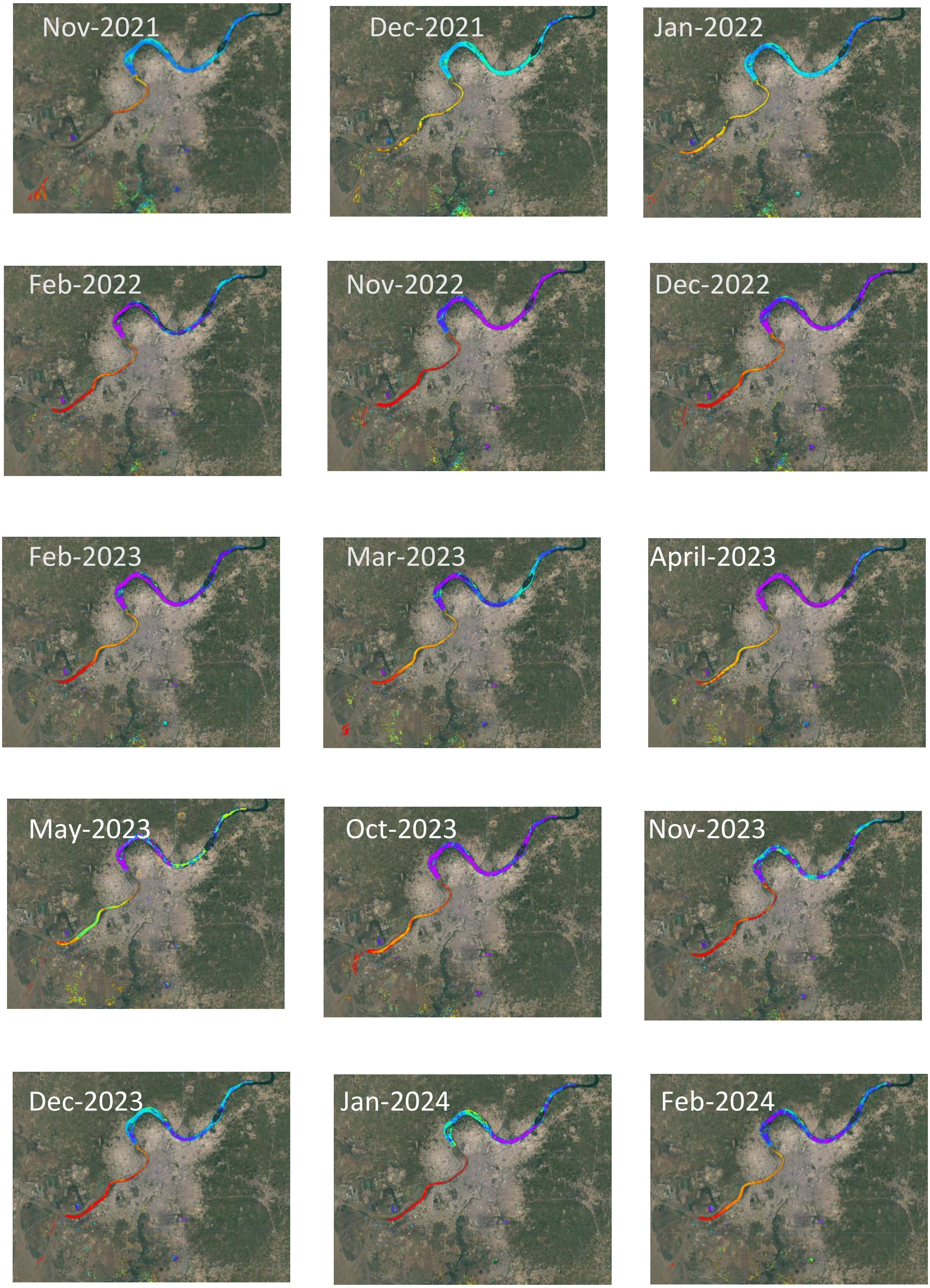


Image after causeway of Low Turbidity January-2023



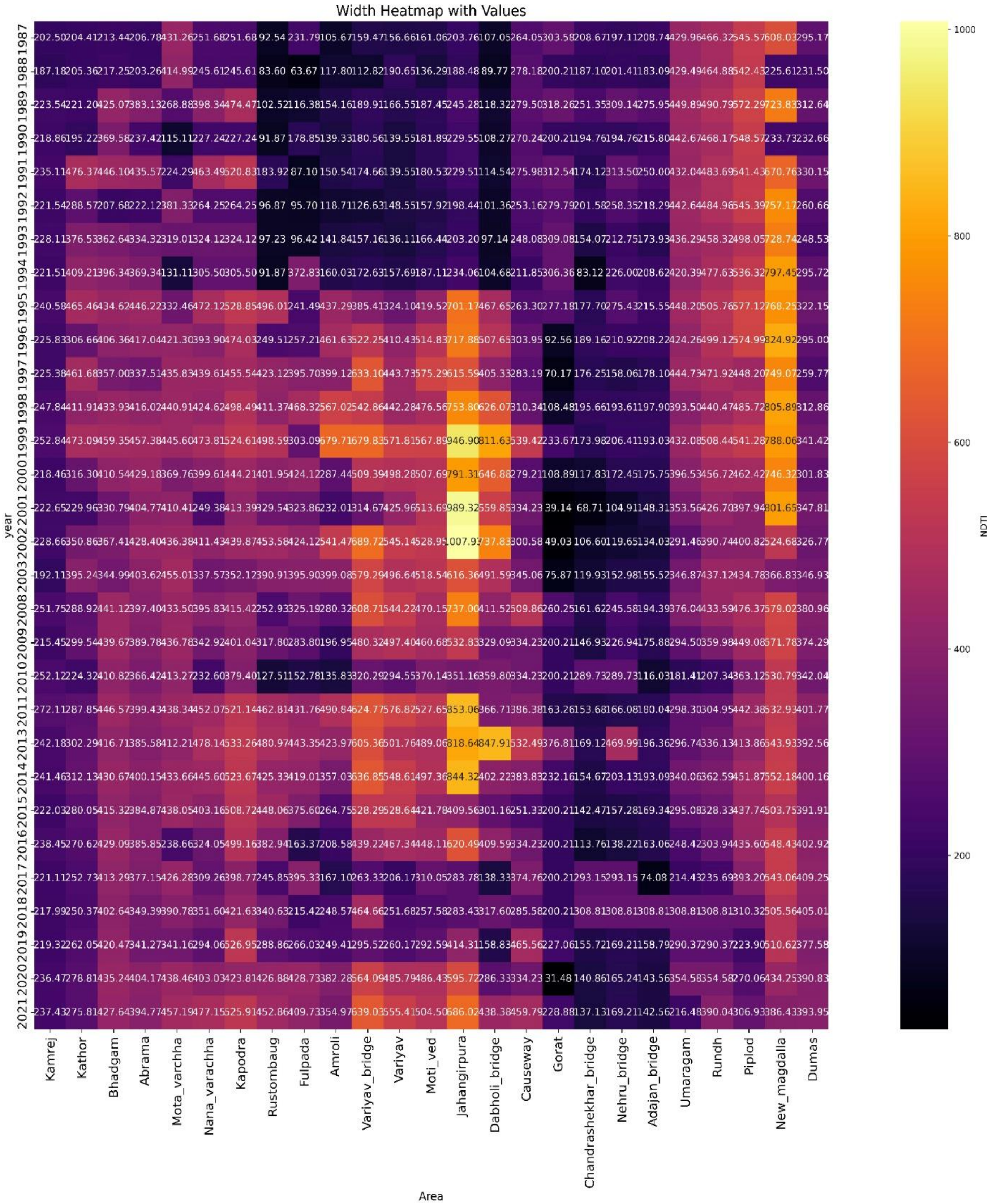

Oct-2019
Nov-2019
Dec-2019
Jan-2020
Feb-2020
Mar-2020
Sep-2020
Oct-2020
Nov-2020
Dec-2020
Jan-2021
Feb-2021
Mar-2021
Apr-2021
Oct-2021


Nov-2021
Dec-2021
Jan-2022
Feb-2022
Nov-2022
Dec-2022
Feb-2023
Mar-2023
April-2023
May-2023
Oct-2023
Nov-2023
Dec-2023
Jan-2024
Feb-2024

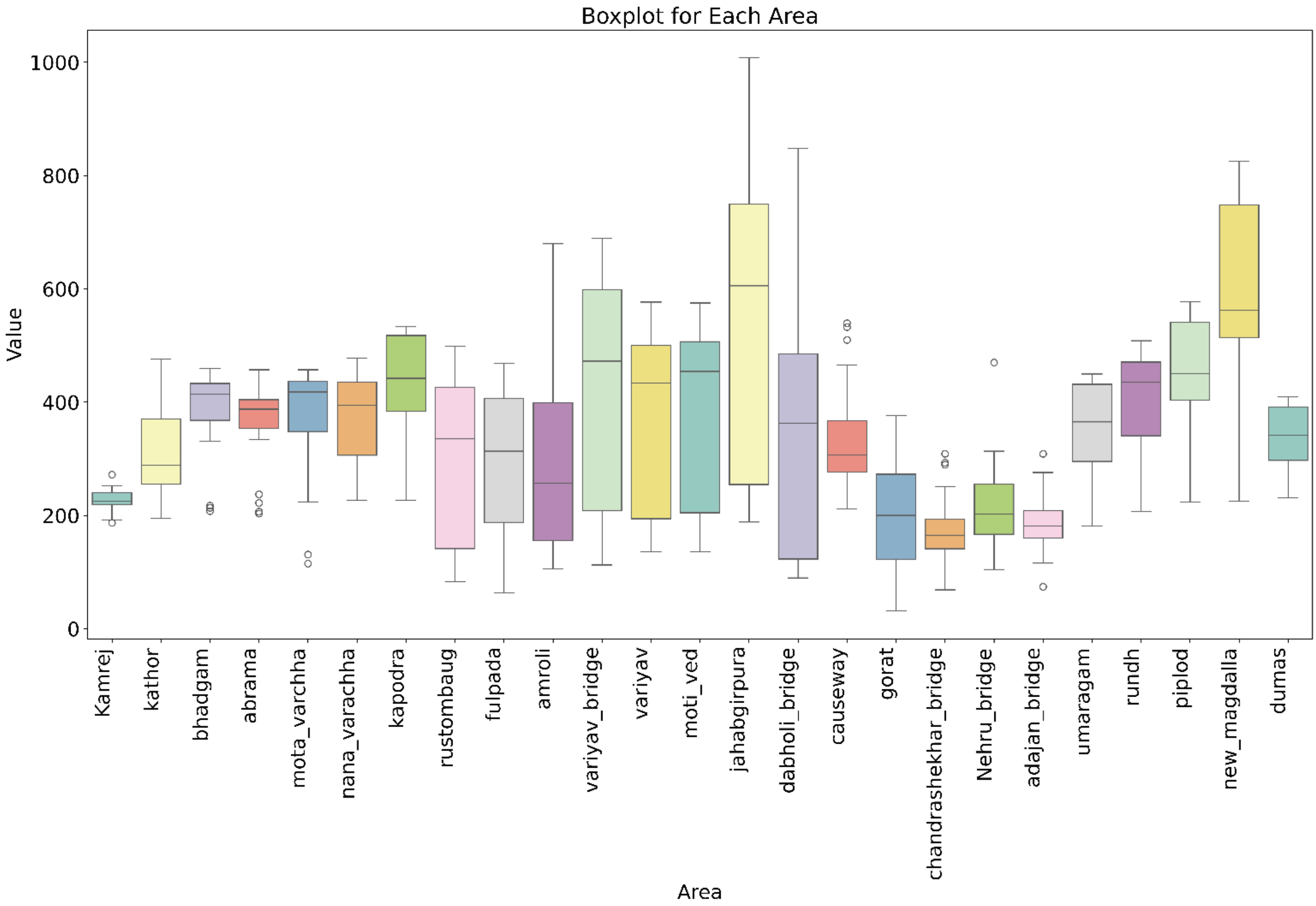
Descriptive Statistics of Width

Area	Minimum	Minimum Time Period	Maximum	Maximum Time Period	Mean	Variance	Standard Error
Kamrej	187.184	1988	272.114	2011	228.686	320.284	3.267
Kathor	195.223	1990	476.371	1991	312.451	7141.690	15.429
Bhadgam	207.680	1992	459.349	1999	390.412	4645.960	12.444
Abrama	203.265	1988	457.379	1999	370.277	4635.854	12.431
Mota varchha	115.106	1990	457.192	2021	377.732	8691.798	17.021
Nana varachha	227.238	1990	478.142	2013	366.392	6698.454	14.943
Kapodra	227.238	1990	533.258	2013	427.457	9165.190	17.479
Rustombaug	83.597	1988	498.592	1999	304.948	22135.427	27.163
Fulpada	63.666	1988	468.323	1998	292.888	16191.964	23.232
Amroli	105.673	1987	679.706	1999	295.115	23985.374	28.276
Variyav bridge	112.824	1988	689.721	2002	420.027	37975.262	35.579
Variyav	136.110	1993	576.823	2011	370.408	26730.197	29.850
Moti ved	136.286	1988	575.285	1997	383.924	22624.349	27.462
Jahangirpura	188.481	1988	1007.928	2002	543.430	73862.663	49.619
Dabholi bridge	89.767	1988	847.906	2013	362.102	50516.724	41.035
Causeway	211.847	1994	539.417	1999	334.226	7663.722	15.983
Gorat	31.484	2020	376.812	2013	200.205	8635.881	16.967
Chandrashekhar bridge	68.713	2001	308.808	2018	171.608	3252.853	10.413
Nehru bridge	104.906	2001	469.989	2013	217.001	5541.124	13.591
Adajan bridge	74.078	2017	308.808	2018	185.228	2074.573	8.316
Umaragam	181.413	2010	449.891	1989	357.659	6490.106	14.708
Rundh	207.335	2010	508.439	1999	404.936	7159.123	15.448
Piplod	223.900	2019	577.121	1995	454.258	8710.467	17.040
New magdalla	225.615	1988	824.923	1996	595.458	27464.662	30.257
Dumas	231.495	1988	409.245	2017	337.493	3085.580	10.142

Representation of WIDTH by Heatmap



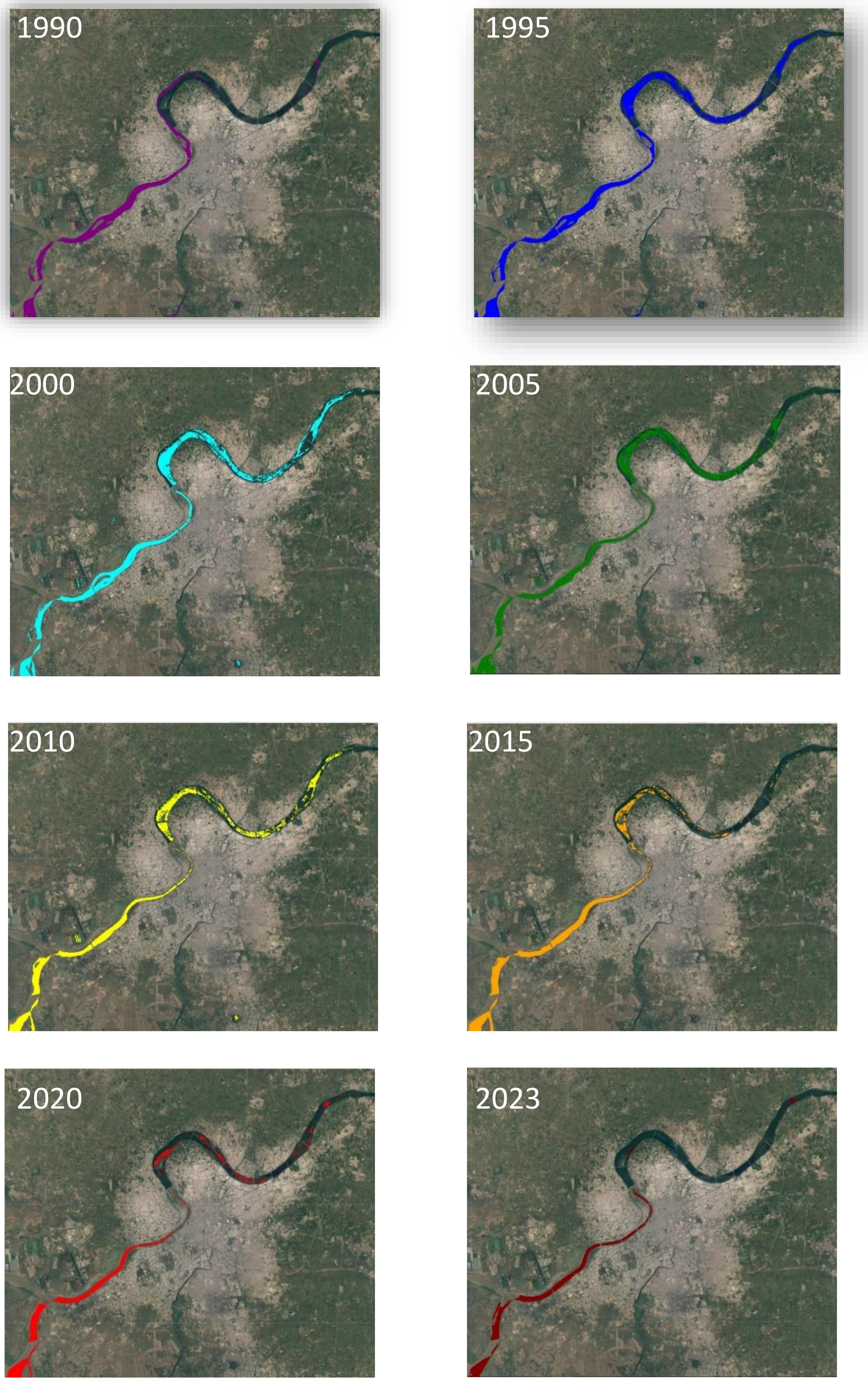
Box plot:-



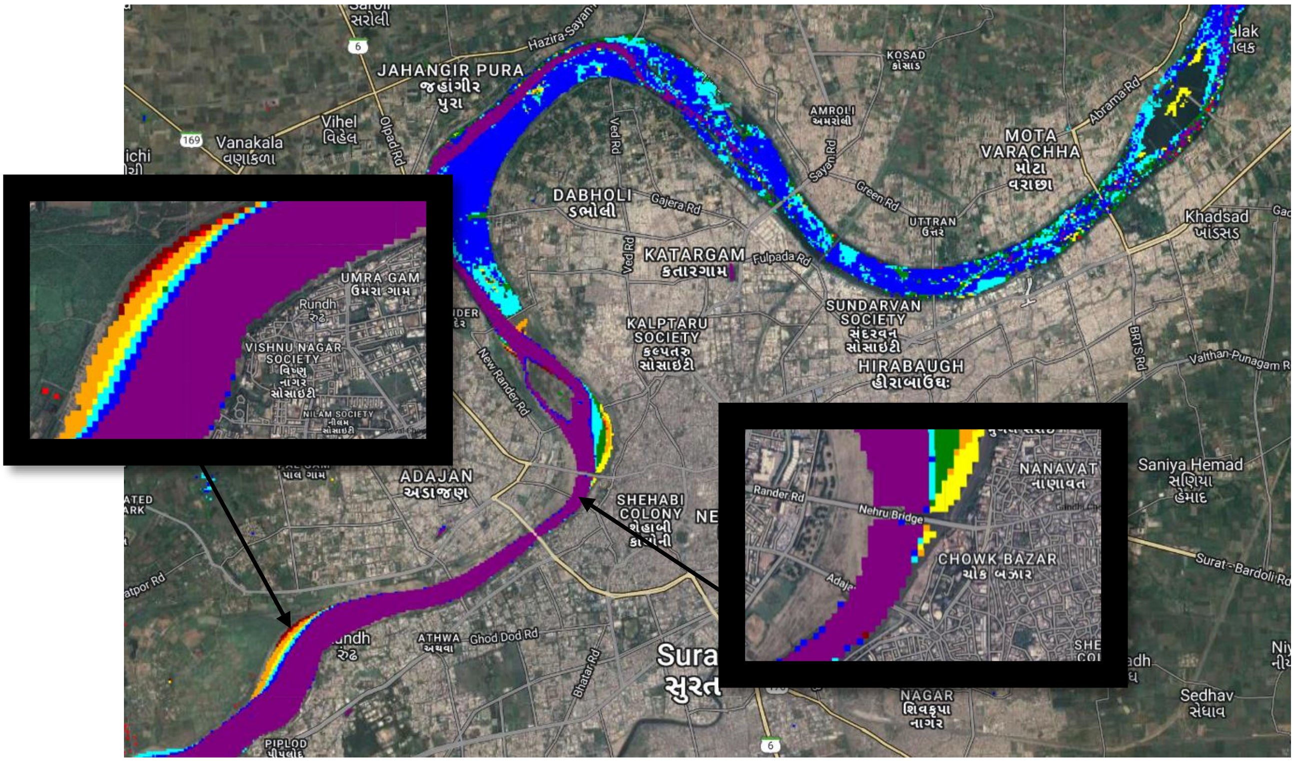
Interpretation:

- From the above heatmap we can observed that the area from Gorat to Adajan bridge, there is minor changes in width for 1987 to 2021 years.
- The area from Jahangirpura bridge is more changes to show the above width heatmap.
- While the area from Kamrej is constant in width of Tapi river for long period of time.
- While the area from Rustombaug to Adajan bridge are no changes in width of Tapi river at 1987-1994.
- From the above table, we can say that there is maximum fluctuation in width of Tapi river at Jahangirpura in the year of 2002.
- While there is minimum fluctuation in width of Tapi river at Gorat in the year of 2020.
- From the above table , we can say that there is low variance in width of Tapi river at Kamrej.

Variation in Width of Tapi from 1990-2023



"Temporal Changes in Tapi River Width: Insights from Rundh and Chowk-Bazar Since 1987"



Based on the visualization presented earlier, it is evident that the width of the Tapi River in the Rundh area has been steadily increasing since 1987. Conversely, the Tapi River in the Chowk-Bazar area has shown fluctuating but relatively constant patterns over the same period.

RESULT AND FINDINGS

Result and Findings for NDTI

Our study on water turbidity along the Tapi River revealed the following key points:

- Changes Over Time: The murkiness of the water changed over the years we studied, both before and after the Causeway area. Some areas saw big changes in water clarity, while others stayed more consistent.
- Seasonal Patterns: We noticed that the water tended to be murkier during certain times of the year, especially during the monsoon season. This showed us how weather affects water clarity.
- Different Areas, Different Murkiness: Not all parts of the river were equally murky. Some areas had clearer water than others, and this didn't change much over time.
- Steady or Changing: Some areas had pretty consistent murkiness over the years, while others changed more. This tells us that some parts of the river are more affected by changes in the environment or human activities.
- Why It Matters: Understanding how the water's murkiness changes helps us take better care of the river. By knowing when and where the water gets murkier, we can work to keep it clean and safe for everyone.

પ્રદૂષણ • 1 હજાર કરોડના પ્રોજેક્ટને સીધો પડકાર

તાપી શુદ્ધિકરણ વચ્ચે કોઝવે પાસે નદીમાં ઠલવાય છે ગટરની ગંદકી

સ્થાનિકોની વારંવાર રજૂઆત છતાં કાયમી ઉકેલ લાવવામાં પાલિકા તંત્ર સદંતર નિષ્ફળ

સિટી રિપોર્ટર | સુરત

એક તરફ પાલિકા દ્વારા એક હજાર કરોડ રૂપિયાના તોતિંગ ખર્ચથી તાપી શુદ્ધિકરણનો પ્રોજેક્ટ પૂર્ણ થવાના આરે છે. ત્યારે બીજી તરફ હજી પણ કોઝવેના ઉપરવાસમાં ગટરના ગંદુ પાણી તાપીમાં ખુલ્લેઆમ ઠલવાઈ રહ્યું છે.

કોઝવેના ઉપરવાસમાં અશ્વિનીકુમાર વોર્ડ ઓફિસ પાસે, લક્ષ્મીનારાયણ સોસાયટીની સામે શક્તિનગર વસાહત પાસે, કાપોદ્રા ભરવાડવાસ પાસે ગટરના પાણી તાપીમાં ઠલવાઈ રહ્યાં છે. છેલ્લાં એક દાયકાથી આ સ્થળેથી તાપીમાં ગટરનું પાણી સીધું ભળી રહ્યું છે. આ સ્થળેથી નજીકના અંતરે ઈન્ટેકવેલ છે. આ મુદ્દે સ્થાનિકો દ્વારા વારંવાર રજૂઆત કરવામાં આવી હોવા છતાં પાલિકા દ્વારા કોઈ નક્કર કામગીરી કરવામાં આવી નથી.

હાલમાં જ તાપીમાં ઠલવાતા ગટરના પાણી બંધ કરવા રિપેરિંગ કરાવાયું હોવાનું પાલિકાએ દાવો કર્યો હતો. પરંતુ વાસ્તવિકતાએ છે કે ગટરના પાઈપની જગ્યાએ બિલકુલ એની બાજુમાં હોલ કરીને ગટરનું પાણી ઠલવાઈ રહ્યું છે.

શક્તિનગર વસાહત પાસે ગટરનાં આઉટલેટ

કોઝવેના ઉપરવાસમાં શકિતનગર વસાહત પાસે તાપી નદીમાં સીધું ગટરનું પ્રદૂષિત પાણી ઠલવાઈ રહ્યું છે.

કાપોદ્રા ભરવાડવાસ પાસે પણ આ જ સમસ્યા

કોઝવેના ઉપરવાસમાં ત્રણ સ્થળથી ગટરના ગંદા પાણી ઠલવાઈ રહ્યાં છે. જેમાં અશ્વિની કુમાર વોર્ડ ઓફિસ પાસે, બીજું લક્ષ્મીનારાયણ સોસાયટીની સામેના સ્થળે અને ત્રીજું સ્થળ કાપોદ્રા ભરવાડવાસ પાસે પણ આ સ્થિતિ જોવા મળી રહી છે.

પાલિકા જ તાપીમાં ગંદુ પાણી ઠાલવી રહી છે

તાપીની પવિત્રતા જાળવવા તેમજ તેને વધુ પ્રદૂષિત થતી અટકાવવા એક તરફ તો મોટા મોટા કાર્યક્રમો કરાય છે. તાપી શુદ્ધિકરણ પ્રોજેક્ટ લવાયું છે પરંતુ ખુદ પાલિકા જ તાપીમાં ગટરના પાણી ઠાલવી રહી છે. » **હરિશ ગુર્જર,** સ્થાનિક

ચેમ્બર ઊંચું કરીને ગંદા પાણીની સમસ્યા ઉકેલાશે

સમાધાન આ જગ્યાએ થોડા દિવસ પૂર્વે રિપેરિંગ કરાયું હતું. મુખ્ય સમસ્યા ડ્રેનેજ લાઈન ઉભરાવાથી તેમજ ભરવાડવાસનું ગટરનું ગંદુ પાણી પણ અહીં આવી રહ્યું છે. ચેમ્બર ઊંચું કરીને ગટરનું તાપીમાં ઠલવાતું ગંદુ પાણી બંધ કરાશે. » **કમલેશ વસાવા,** કાર્યપાલક ઈજનેર વરાછા ઝોન

Overall, our findings help us understand how to manage the Tapi River better and keep it healthy for the environment and the community.

On 11th March 2024, news surfaced about sewage dumping near the Causeway, Ashwinikumar and Kapodra for Tapi river treatment. Our project revealed heightened turbidity levels from Amboli to Dabholi Bridge prior to the Causeway, Ashwinikumar and Kapodra. This underscores the urgency of addressing environmental impacts stemming from these activities, as highlighted in both the news report and our project findings.

Result and Findings for WIDTH

- Our analysis aimed to understand the historical changes in the width of the Tapi River in Surat City using Landsat 8 satellite imagery spanning from 1987 to 2021. Here's what we discovered:
- Temporal Trends: The width of the Tapi River showed significant variations over the years studied. The widest point was observed at Jahangirpura in 2002, while the narrowest point was at Gorat in 2020.
- Spatial Variability: Different areas along the Tapi River exhibited diverse patterns of width fluctuation. For instance, Kamrej showed relatively stable width, whereas Jahangirpura experienced considerable changes over time.
- Variance Analysis: The variance in width fluctuation was low at Kamrej, indicating consistent measurements over time. Conversely, Jahangirpura exhibited the highest variance, suggesting significant fluctuations in width.
- These findings provide insights into the dynamic nature of the Tapi River's width, highlighting areas of stability and variability. Understanding these historical changes is crucial for effective river management and planning sustainable development initiatives along the Tapi River in Surat City.

VISUALIZATION

For NDTI:-

For WIDTH:-

Scan the above barcode for see the effect of changes in NDTI and WIDTH on Tapi River.

LIMITATION

- Sentinel-2 takes lots of pictures, but sometimes clouds or haze get in the way, leaving gaps in the data we need to study water clarity.
- Different satellites see colors differently, so they give slightly different results when we measure water murkiness.
- Pictures may lack clarity or availability.
- Different satellites might show variations.
- Difficulty in verifying accuracy due to limited real-world data.
- Special knowledge required for understanding.
- Expertise needed for tools like Google Earth Engine.
- Addressing ocean issues involves broader considerations.

SCOPE

- Continued Monitoring for Long-Term Trends: We'll keep using satellite images to monitor how wide the Tapi River gets over time, helping us understand if there are any big patterns or changes throughout the years. This will provide valuable insights into the river's health and how it might be affected by factors like human activities or climate change.
- Expanding Water Quality Assessment: Alongside tracking the river's width, we'll continue using satellite images to assess its cleanliness. This ongoing monitoring will help us identify areas where pollution might be a problem and where conservation efforts are needed most urgently.
- Enhanced River Width Measurement: By installing sensors at 25 different locations along the river, we'll have a continuous stream of data on its width. This detailed information will enable us to pinpoint specific areas experiencing changes and assess how human interventions, such as flood gate operations, influence the river's width dynamics.
- Integrated Approach to River Management: We'll integrate our observations of water flow at flood gates with other data on river width changes. This holistic approach will inform better management strategies, helping us develop plans to maintain the river's width and overall health sustainably.

SUGGESTION

- As per our overall experience project it is suggested that We should think about using satellite data Also. It's advanced technology that can help us measure turbidity from far away. By doing this, we could spend less money on sampling and transportation while still getting good results.
- creating buffer zones around the Tapi River at equal distances using satellite imagery is a practical and advisable approach for covering the entire river and its surrounding areas for analysis, particularly when conducting remote sensing studies. This method allows for systematic coverage of the study area and ensures that data are collected from various points along the river, which can help in obtaining a more comprehensive understanding of the turbidity levels.
- Using satellite imagery to create buffer zones helps in standardizing the sampling process and ensures that no portion of the river is overlooked. Additionally, by maintaining a consistent distance of 600 meters, you can achieve uniform coverage and minimize bias in the analysis.
- According to our analysis, it is advisable to focus on developing the riverfront area between Gorat and Adajan Bridge due to its consistent width. This provides a favorable environment for the planning and construction of various amenities such as an eco-park, public recreation park, upgrading of existing gardens, and establishing an informal market.

USEFULNESS

For Riverfront Development:

- Clean Water Assurance: Ensures safe and clean water for riverfront activities.
- Infrastructure Planning: Guides development to prevent flooding and erosion risks.

For Educational Purposes:

- Hands-on Learning: Offers real-world experience in environmental monitoring.
- Awareness Building: Educates about the importance of river ecosystem preservation.

For Development Purposes:

- Informed Planning: Provides data for strategic development decisions.
- Infrastructure Guidance: Helps plan infrastructure to minimize environmental impact.

For Sustainable Development:

- Ecosystem Preservation: Protects River ecosystems for long-term sustainability.
- Community Engagement: Involves locals in caring for their natural resources.

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We are highlighting , Whatever reference we have preferred, the technique of measuring water quality of tapi river by making buffer zone is tackle by us only which is innovative,

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