

# Mapping the wetlands of Thane creek and surrounding area using Remotely sensed Sentinel-2b data, Mumbai, Maharashtra, India

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**Abstract:** Mumbai is surrounded by many wetlands, including mudflats, mangroves, salt pans, creeks, freshwater lakes, and estuaries. Because the city is so developed, the greatest threat to the wetland ecology is population growth and urbanisation. Thane Creek is more important than the others in those wetlands because it borders the most valuable mangroves and mudflats. Thane Creek (also Thana Creek) is an inlet in the Arabian Sea shoreline that connects Mumbai (Bombay) to the Konkan region of India. Sentinel 2b data was used to map the distribution of wetland habitats in the study area. This study identified four separate units: creek, mangrove, mudflats and urban from a supervised classification using Sentinel 2b data. The classification is based on the defined spectral signatures for the supervised representative samples required for each land cover class.

Thane is the most significant creek in the Mumbai region. 55.5 km<sup>2</sup> area was classified as the creek, around 30 % of the total study area. Similarly, 43.5 km<sup>2</sup> area was classified as the mangroves, which is around 23 %. When classifying mudflats, they covered 51 km<sup>2</sup> area, around 27 % of the total study area. Urban growth is rapid in this part. As a result, 37.73 km<sup>2</sup> area was classified as a metropolitan area.

Mudflats in the study area are in massively unsafe conditions because of urbanisation. This study confirmed that the Mangrove area is more stable because of strict orders of the High Court compared to the past, though they are under threat by urbanisation.

**Keywords:** Sentinel 2b, Wetlands, Remote sensing, GIS, Thane Creek

## 1. INTRODUCTION:

Wetlands are regions of land covered by water either temporarily or permanently, depending on the season (Mitsch *et al.*, 2010). Creeks, estuaries, saltmarshes, riverbanks, seashores, backwaters, and coral reefs are examples of natural wetlands. Wetlands include artificial lakes, abandoned quarries, salt pans, reservoirs, and dams. Wetlands are the most important but least understood ecosystems on the planet. These wetlands are a valuable natural resource for groundwater recharge, flood management, and water quality improvement (Rundquist, Narumalani and Narayanan, 2001). Wetlands are also vital to the ecology and the plant and animal species that inhabit them (Li *et al.*, 2015).

Thane Creek (also Thana Creek) is an inlet in the Arabian Sea shoreline that connects Mumbai (Bombay) to the Konkan region of India. It is situated between Mumbra and Retibunder, as well as the Mankhurd-Vashi Bridge. The brook is divided into two halves. The first leg is between Ghodbunder and Thane (Thana), where the Ulhas River runs from Mumbai Island's north to the Arabian Sea in the west. The second stretch of the waterway is located at Trombay / Uran, just before the Gharapuri islands, between Thane and the Arabian Sea. The rise in pollution levels in Thane Creek and its adjacent coastal waterways and the increase in population and industrialisation in and around Mumbai necessitates regular monitoring for effective management of the local environment and waste disposal systems. Wetland loss has been extensive in countries all over the world (Mitsch, 1993). As the worth of wetlands to civilisation has become acknowledged, it is now necessary to maintain these valuable resources (Ozesmi and Bauer, 2002).

Remote sensing technology has shown to be a success in monitoring wetlands, and it has a wide range of applications dating back to 1983 (Butera). Many Indian researchers demonstrated this in different locations of the country, including Mumbai (Prasad *et al.*, 2002; Samant, 2002; Selvam, 2003; Ramasubramanian *et al.*, 2006; Garg, 2015). Initially, colour infrared aerial photography was utilised, and more recently, multispectral visible, infrared, and microwave digital imaging was obtained from airborne or satellite-borne sensors (Butera, 1983; Rundquist, Narumalani and Narayanan, 2001). However, several researchers discovered technical difficulties when mapping complicated coastal wetlands using satellite sensors with a limited spatial resolution (Ramsey and Laine, 1997; Civco *et al.*, 2006).

Remote sensing research is more advanced than in the past due to technological improvement. As a result, many satellite sensors with the higher spatial and spectral resolution are already in service. One of them is Sentinel. Sentinel-2 provides satellite images with spatial resolutions ranging from 10 to 60 metres (Drusch *et al.*, 2012). Sentinel 2 has been utilised successfully by several researchers for wetland mapping and classification (Kaplan and Avdan, 2017, 2018; Wachid *et al.*, 2017). Thus, Sentinel 2b data was used to map the distribution of wetland habitats in the study area.

### **Study area:**

The study area's northern boundary is the Thane Kalwa rail bridge (latitude 19°11'30"). In the current study, Thane Creek's southern limit extends to Trombay, roughly 7 km south of the Bombay Vashi rail bridge (latitude 19°02'). The southern boundary was thus established north of the dredging channel. The creek is tide-dominated and is fringed with mangrove mudflats along both banks. The map of the creek depicts in Figure 1.

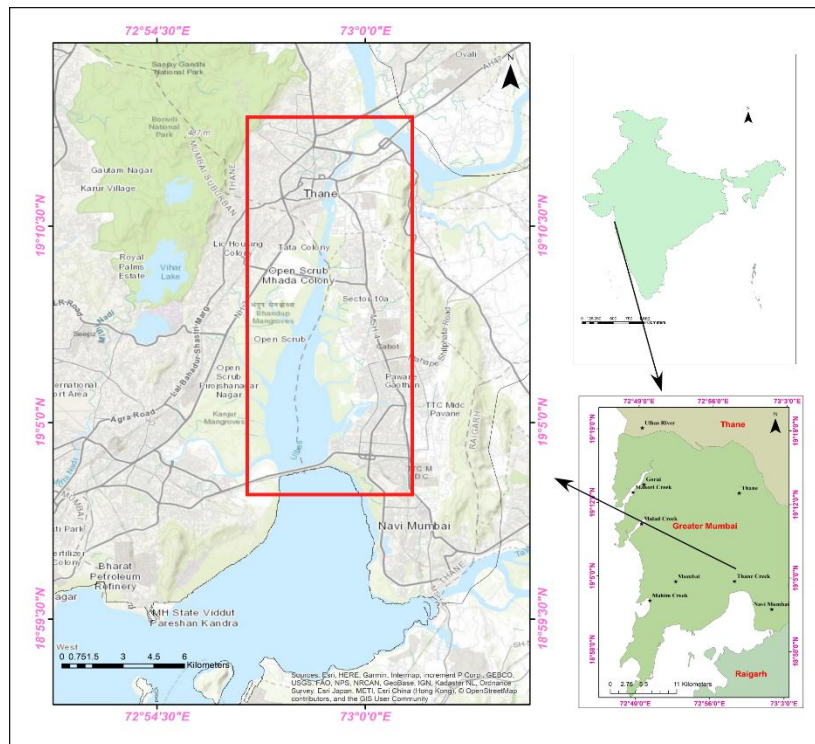


Figure 1 Location map of the study area

## 2. MATERIALS AND METHODS

Sentinel 2b data from the 28th of May, 2019 were used in this investigation. Sentinel-2b is a satellite that is part of the Sentinel-2 programme. The European Space Agency (ESA) launched the Sentinel 2b satellite (Sentinel-2b) on March 7, 2017, to enhance forest monitoring, land cover changes, detection, and natural disaster management. Sentinel-2b has 13 bands of spectral resolution, a spatial resolution of 10m in four visible bands, a spatial resolution of 20m in six red edge and shortwave infrared bands, and a spatial resolution of 60m in three atmospheric correction bands.. The Copernicus Open Access Hub (<https://scihub.copernicus.eu>) provided the satellite image for free.

The downloaded data was analysed using the European Space Agency's SNAP (Sentinel Application Platform) toolbox, an open-source and adaptable scientific toolkit. To obtain a layer stack of the spectral bands, the data were re-sampled. Following the layer stack, the Thane wetland of the Thane creek using supervised classification.

**Supervised classification:** Many approaches to supervised classification are available, however the Maximum Likelihood Classifier (MLC) (Settle and Briggs, 1987) was used in this work. The categorization is based on the spectral signatures that have been defined for the supervised representative samples that are necessary for each land cover class. The stream, mangrove, mudflats, and urban units were classified as distinct units in this study.

## 3. RESULTS AND DISCUSSION:

Four classes were classified in the supervised classification method for the entire study area with the help of spectral signatures. They are creek, mangrove, mudflats and urban.

Table 1 Supervised Classification results of the study area

OBJECTID	Pixel_Count	Class Name	Percentage	Area in Km2
1	140870	Creek	29.66	55.5
2	109917	Mangrove	23.14	43.5
3	128878	Mudflat	27.13	51
4	95220	Urban	20.07	37.73

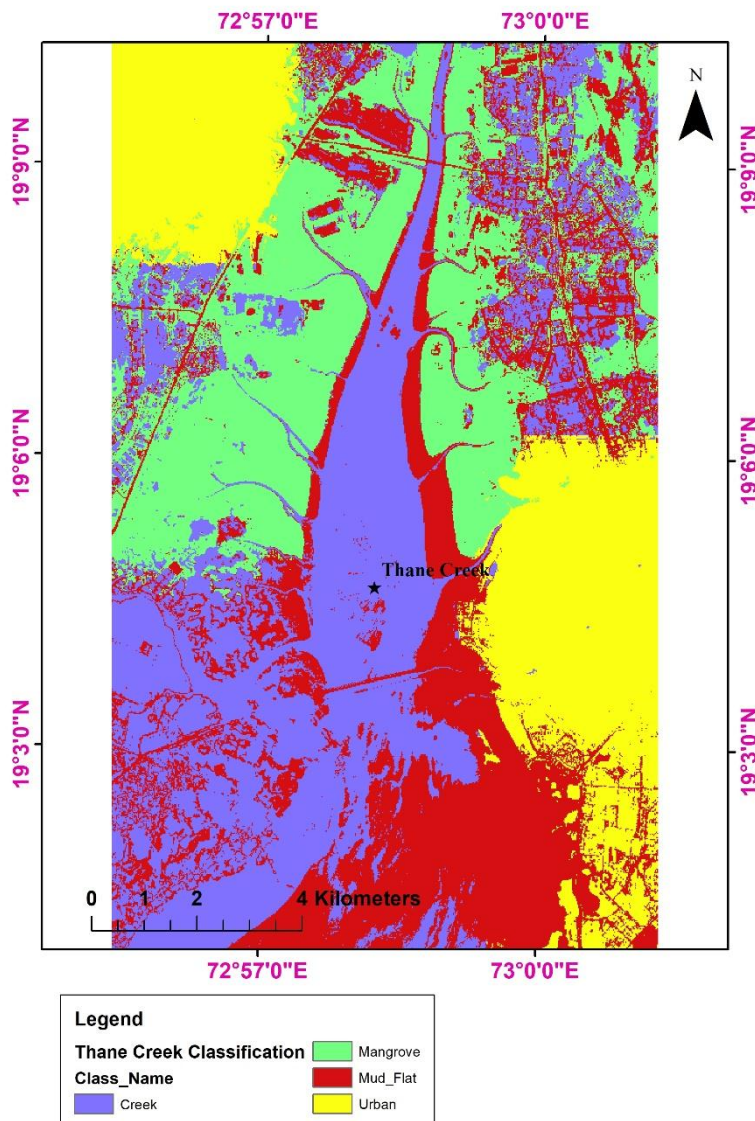


Figure 2 Supervised classification map of the study area

#### 4.1 Creek:

A creek is a tiny stream that flows into a river. Thane is the most significant creek in the Mumbai region. 55.5 km<sup>2</sup> area was classified as the creek, around 30 % of the total study area. Totally 140870 pixels were fallen as the creek in the study

area. The creek is sensitive to anthropogenic activity since it is used as a dumping place for domestic and industrial garbage (Quadros *et al.*, 2001).

#### **4.2 Mangroves:**

Mangroves are trees and shrubs that grow in the coastal intertidal zone. A dense tangle of support roots distinguishes many mangrove forests, giving the trees the impression of standing on stilts over the sea. Because of this tangle of roots, the trees can endure the daily rise and fall of tides, which means that the majority of mangroves are swamped at least twice a day. By slowing the movement of tidal waters, the roots force sediments to settle out of the water and build up on the muddy bottom. Mangrove trees aid in the stabilisation of the shoreline and the reduction of erosion caused by storm surges, currents, waves, and tides.

After the Mumbai High Court ruled in 2005 that mangroves should be classified as forests, a concerted campaign to safeguard them. As a result, they are better protected than in the past while being threatened by urbanisation. These Mangroves are primarily found in and around the creek.

Totally 43.5 km<sup>2</sup> area was classified as the mangroves, around 23 % of the total study area. Totally 109917 pixels were fallen as the mangroves in the study area.

#### **4.3 Mudflats:**

Mudflats, also known as tidal flats, are coastal wetlands formed by intertidal sands deposited by tides or rivers. According to a 2019 global analysis, tidal flat habitats are as common as mangroves, encompassing at least 127,921 km<sup>2</sup> of the Earth's surface (Murray *et al.*, 2019). These mudflats have widened enough in Thane Creek to be classified using remote sensing data. As a result, Thane Creek was classified independently using supervised classification.

Totally 51 km<sup>2</sup> area was classified as the mudflat, around 27 % of the total study area. Totally 128878 pixels were fallen as the mudflats in the study area.

#### **4.4 Urban:**

A built-up area, often known as an urban area, is a human settlement with a high population density and built-environment infrastructure. Urban areas are established as a result of urbanisation and are categorised as cities, towns, conurbations, or suburbs according to urban morphology. Wetlands provide a purpose by promoting biodiversity and offering natural and enjoyable recreation areas for city dwellers. Wetlands are also being destroyed as cities expand.

Totally 37.73 km<sup>2</sup> area was classified as an urban area, around 20 % of the total study area. Totally 95220 pixels were fallen as the urban in the study area.

#### **4.5 Validating the supervised classification**

With the increasing complexity of digital classification, there is a greater requirement to evaluate the credibility of the results (Congalton, 1991). The error matrix technique was used to validate the remote sensing categorization and verify the trustworthiness of the results. Error matrix (confusion matrix) - compares ground truth data to categorization findings. Total of 80 points were assigned to the accuracy assessment based on field knowledge.

Table 2 Accuracy assessment

Class name	Truth1 Creek	Truth2 Mangroves	Truth3 Mudflats	Truth4 Urban	Row
<b>Creek</b>	<b>18</b>	0	1	1	20
<b>Mangroves</b>	1	<b>19</b>	2	2	24
<b>Mudflats</b>	1	1	<b>17</b>	<b>0</b>	<b>19</b>
<b>Urban</b>	0	0	0	<b>17</b>	17
<b>Column Total</b>	20	20	20	20	80

#### 4.5.1 Producers Accuracy

Producers Accuracy quantifies omission error and reflects the likelihood of a reference pixel being correctly identified (Congalton, 1991). The producer's accuracy is identified using the following formula for each class.

$$\text{Truth} / \text{Column Total}$$

Producers' accuracy

Mangroves =  $19/20$  which is 0.95

Creek =  $18/20$  which is 0.9

Urban =  $17/20$  which is 0.85

Mud flat =  $17/20$  which is 0.85

#### 4.5.2 Users Accuracy

Users Accuracy indicates the chance that a pixel identified on the image represents that category on the ground (Story and Congalton, 1986). The user's accuracy is calculated using the following formula for each class

$$\text{Truth/row total}$$

Users' Accuracy

Mangroves =  $19/24$  which is 0.79

Creek =  $18/20$  which is 0.9

Urban =  $17/17$  which is 1

Mud flat =  $17/19$  which is 0.894

#### 4.5.3 Overall Accuracy

The overall accuracy is calculated using the following formula

$$\text{Sum of the total Truth/row total}$$

The sum of the total truth is  $71/80$ . Hence the overall accuracy of the supervised classification result of the study area is found as **0.8875**.

#### 4. CONCLUSION:

With an overall accuracy of 0.8875, the study proved that the sentinel data could map wetlands. This study confirmed that the Mangrove area is more stable because of strict orders of the High Court compared to the past, though they are under threat by urbanisation.

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