



## Chronological variation of land use and land cover of coastal West Bengal

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### Abstract

The changing nature of land use and land cover is often witnessed almost all parts of the world, and it is evident that the rapid rate of population growth has a remarkable role in causing such changes. In this study, an attempt has been made to highlight the changing pattern of LULC of Nandakumar Community Development block of Purba Medinipur district, West Bengal with the help of remote sensing and geographical information system. Different satellite images of Landsat- 7 ETM+, LISS- III and Sentinel- 2 are adopted during the time of 2000, 2011 and 2022 and analysed in ArcGIS software. This study unveils that agricultural land comes down to 12.36% of the total area of Nandakumar CD block in 2022 from 2000, whereas, water body is recorded to be doubled (11.60%) followed by built-up area 2.64 km<sup>2</sup> (increased by 139.10%). In case of vegetation cover, it remains almost same. The conversion of agricultural land and barren land to water body is mainly done for the purpose of aquaculture, which is found to be more profitable source of income by the local people.

**Keywords:** Land use land cover, spatio-temporal change, satellite image, aquaculture, Purba Medinipur

### 1. Introduction

Land is a platform on earth surface which encompasses different living and non-living elements like soil, water, vegetation, micro-organisms and animals and even some invisible elements like society, culture, etc., (Mondal, 2012). In order to contain and sustain all forms of lives, land has a distinctive role to play from parturition of life to production of food, and human being belongs to the apex of the pyramid as a prime beneficiary (Lalljee & Facknath, 2008). Naturally evolved land cover has been changing from time immemorial mainly due to human interventions to meet the need of society and new land use comes to existence (Rajakumari et al., 2020). As they are complementary to each other, i.e., land use and land

cover, while understanding the chronological changes on the basis of available natural resources, how people decide to utilize the land is called as land use (Prakasam, 2010). When a tract of land is covered by land, water or vegetation etc., by nature itself is considered as land cover.

The concept of land use change has drastically been changed due to availability of instruments and tools during industrialization, for last five decades (Dutta & Guchhait, 2022). Dwellers use their tools to hunt, collect woods, timbers, food, etc., and alter barren land to agricultural land, in some places they cut vegetation cover to cultivate land. But nowadays, aquaculture is another reason behind land alteration (Mallick & Rudra, 2021). This significant change in land use pattern can alter natural setup i.e., land cover and natural ecosystem too (Mondal, 2012). Land use land cover (LULC) change can affect the events like deforestation, soil quality, soil erosion, temperature, rainfall, ground water availability, greenhouse gas emission, etc., (Dolui et al., 2014). Modification in LULC mainly occurs due to massive population pressure (Bhattacharya et al., 2021). The chronological changes in LULC are studied for several perspectives to draw inferences (Lambin et al., 2000; Dolui et al., 2014).

To detect this LULC change, Remote sensing (RS) and geographical information system (GIS) is a unique tool with global positioning system (GPS) (Dolui et al., 2014; Pandit, 2015; Mallick & Rudra, 2021). It helps to identify and understand changes over time (Rajakumari et al., 2020). In this paper, an attempt has been made to comprehend the change and its trend in LULC at Nandakumar Community Development (CD) block of Purba Medinipur district from 2000 to 2022.

### 2. Study Area

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Nandakumar CD block, bounded by Rupnarayana in north-east and river Kangsabati in south and south-west and characterized mainly by Quaternary alluvium deposits of Bengal coastal plain, comes under Tamluk sub-division of Purba Medinipur district. The CD block records an area of 165.70 km<sup>2</sup> with 262,998 populations (Census of India, 2011). The block (22°07'51.68" N to 22°15'51.46" N and 87°48'36.55" E to 87°57'45.37" E) shares its boundary with Tamluk, Mahisadal, Chandipur and Moyna CD blocks of its north, east, south and west respectively. This lower Gangetic plain area enjoys tropical climate, where temperature ranges from 25.5° C – 38.6° C throughout the year and the average rainfall of 1752.6 mm during Monsoon period. The area is dominated by deciduous vegetation and sparsely witnesses one or two tropical cyclones every year and sometimes flood too (Census of India, 2011). Large number of populations utilizes all the available resources with their full potentials, which divides the CD block into five major land use land cover (LULC) classes, e.g., vegetation, agricultural land, water body, barren land and built-up area. Around 15% growth of population from 2001 to 2011 in 101 villages of the study area is observed with population density of 1527 persons km<sup>-2</sup> (Census of India, 2011), which exerts immense pressure on natural resources and their usages. As a result, a significant change in LULC is come to see in the study of interest.

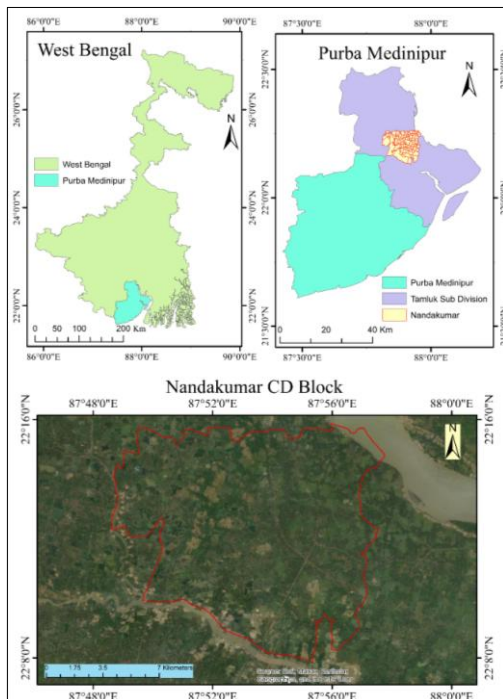


Figure 1: Location map of study area.

### 3. Materials and Methods

The present study is carried out to analyse the trend of change in LULC of Nandakumar CD block. The application of RS & GIS techniques to record the change detection of the CD block is adopted here. The satellite images of three different years from 2000 to 2022 with a temporal gap of eleven years are used. Maps of West Bengal, Purba Medinipur, Tamluk sub-division and Nandakumar CD block are collected from internet and Purba Medinipur district portal for preparation of location map. Maximum likelihood classification method is applied in ArcGIS software to classify the satellite images, and to study the spatio-temporal dynamics with the help of ground control points, minimum 50 points for each class are taken from with Google Earth Pro software. Based on classification, LULC map is categorized into five distinct groups. All the satellite images are processed and analysed in ArcGIS software. A brief detail of methodology is shown by a flow diagram (Fig. 2).

Table 1: Satellite data type, acquisition date, source and spatial resolution

Sensors	Acquisition Date	Source	Spatial Resolution
Landsat – 7 ETM+	29/03/2000	<a href="https://earthexplorer.usgs.gov/">https://earthexplorer.usgs.gov/</a>	30 m
LISS – III	25/11/2011	<a href="https://bhuvan.nrsc.gov.in/home/index.php">https://bhuvan.nrsc.gov.in/home/index.php</a>	24 m
Sentinel – 2	20/03/2022	<a href="https://earthexplorer.usgs.gov/">https://earthexplorer.usgs.gov/</a>	10 m

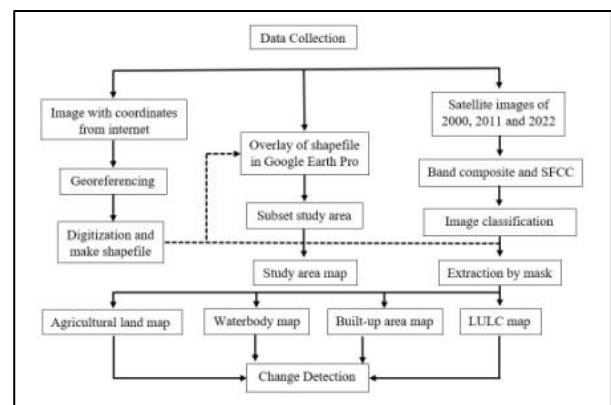


Figure 2: Flow diagram showing simplified methodology of the study.

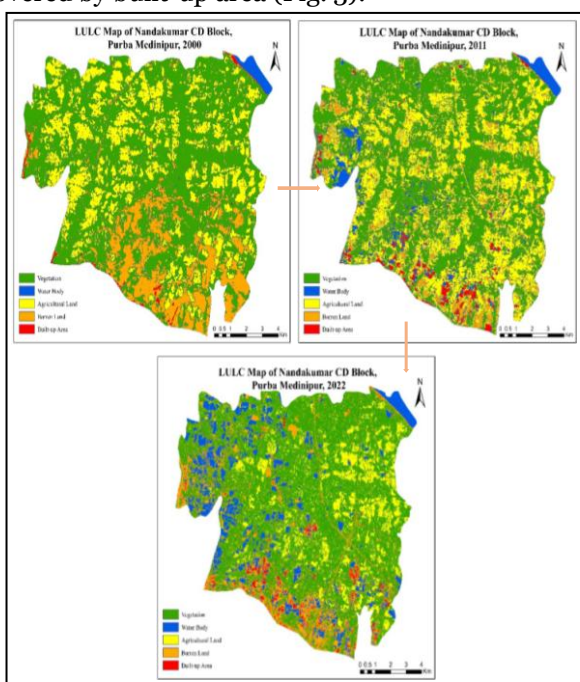
#### 4. Results and Discussion

##### LULC Change of 2000, 2011 and 2022

The CD block recorded 229,462 souls in 101 mouzas in 2001 (Census of India, 2001). It is found that most of the area of the CD block is mainly covered by vegetation and agriculture sharing 94.59 and 41.30 km<sup>2</sup> respectively in 2000. Around 15% area of the study area experiences barren land, which is mainly found in south; whereas, built-up area is found to be in smaller proportion (1.11 km<sup>2</sup>). Waterbody occupies less than 1% of area comprising local ponds, fewer numbers of depressions, rivers and river linking canals.

Scenario in 2011 is something different from 2000 on the basis of both population number and the LULC. The population number in the CD block was 262,998 in 2011 (Census of India, 2011). The LULC map of 2011 shows that vegetation cover had markedly been decreased by 16.24% and agricultural land was around 40.59% area of the CD block. Built-up area and water body cover an area of 3.94 and 6.58 km<sup>2</sup> respectively. Aquaculture is the new segment added to waterbody class and increasing the share of waterbody.

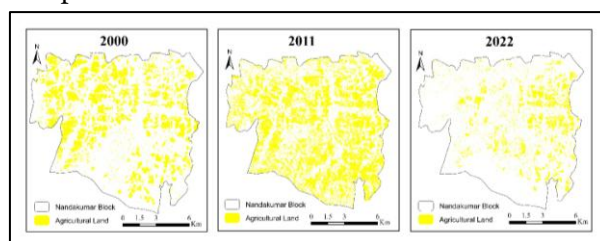
The LULC has vastly changed in 2022 compared to 2011. Agricultural land and water body share 12.36 and 11.60% area of the study area respectively, while, vegetation cover owns around 94.48 km<sup>2</sup> area. Only 1.63% area of the CD block is covered by built-up area (Fig. 3).



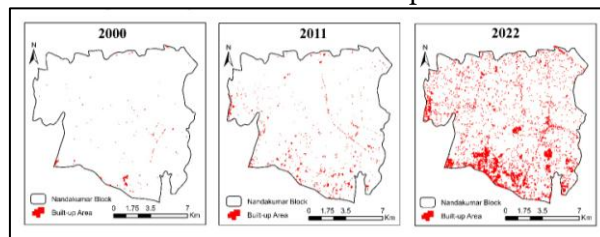
**Figure 3:** Change in LULC at Nandakumar CD block in different time periods.

##### Chronological Change in LULC

From the three LULC maps, it is found that the pattern of LULC has been changed with growing population at Nandakumar CD block. The study area was dominantly covered by vegetation cover, agricultural land and the barren land. Over the time, population number has changed, which consistently exerts pressure on food security. The situation compels to change the scenario of land use. Thus, needs of agricultural land is met up by cutting off trees and procuring barren land. Agricultural land and barren land area were 41.30 and 23.67 km<sup>2</sup> respectively in 2000, where vegetation cover was 58.32% of the total area of the CD block. Growth of built-up area was not started in large scale and recorded ~1.11 km<sup>2</sup>, which is very less in comparison to other classes. Water body was increased 0.02% in 2000 to 4.06% in 2011. LULC map of 2011 shows, agricultural land and vegetation cover were 65.84 and 79.23 km<sup>2</sup> respectively. So, agricultural land was increased by 24.54 km<sup>2</sup> and water body by 6.55 km<sup>2</sup> in respect to total area. This growth in waterbody takes place due to growth of new aquaculture for fishery activities. In 2022, picture of agricultural land is quite different. A significant proportion of agricultural land is lost and the share comes down to 12.36% (Fig. 4); whereas, the area of waterbody has almost been doubled. Now, it enjoys 11.60% area of the CD block (Fig. 6). Built-up area is observed to be 2.64 km<sup>2</sup>, which is increased by 139.10% from 2000 to 2022 (Fig. 5). Area of vegetation has been fluctuating over time from 2000 to 2011 and from 2011 to 2022; but, on a large scale, it is almost same in respect to area.

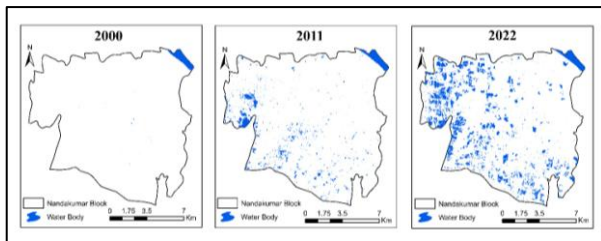


**Figure 4:** Change in agricultural land at Nandakumar CD block in different periods.



**Figure 5:** Change in built-up area at Nandakumar CD block in different periods.





**Figure 6:** Change in water body at Nandakumar CD block in different periods.

## 5. Conclusion

Nandakumar CD block does not have protected or reserve forest and no valuable mines to trigger up rapid industrialization and urbanization. People depend on agriculture as their primary source of income. During the period of 2000 to 2022, a drastic change in area of agricultural land, vegetation coverage and barren land was observed, and it is quite evident from decreasing trend of agricultural land and increasing proportion of water body. This change is occurred due to shifting of participation of population from agriculture to fishery as a source of earnings. The conversion of different LULC into aquaculture of Nandakumar CD block is highly influenced by the Moyna CD block (located at Tamluk sub-division) lying in the western part of the study of interest, as this CD block turns out to be national model of inland aquaculture after state Andhra Pradesh.

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