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Land Use and Cover Change as well as Its Impact on Agriculture: A Study on Onda C.D. Block of Bankura District, West Bengal

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Abstract: Land Use Land Cover (LULC) change has emerged as a critical issue influencing agricultural sustainability, particularly in semi-arid regions like Onda Community Development Block of Bankura District, West Bengal. This study examines the spatiotemporal dynamics of LULC change and its consequent impact on agricultural practices and productivity in the region. Utilizing satellite imagery, the research identifies significant transformations in land use patterns over the past two decades. Agricultural land has gradually declined due to increasing settlement expansion, infrastructural development, and conversion to fallow or degraded land. Simultaneously, there has been a noticeable shift in cropping patterns, irrigation dependency, and seasonal land utilization. The findings reveal that these changes have adversely affected agricultural output, soil fertility, and water availability. Fragmentation of farmland and erratic rainfall patterns have further intensified the vulnerability of farmers. Moreover, the encroachment of non-agricultural activities has disrupted traditional agrarian systems and livelihoods. The study highlights the role of both anthropogenic and environmental factors, including Population pressure, policy gaps, and climate variability, in driving LULC change. The research underscores the urgent need for sustainable land management strategies, integrated planning, and policy interventions to mitigate adverse impacts. Promoting agroforestry, efficient irrigation practices, and land restoration initiatives can help enhance agricultural resilience in the study area. This study contributes to a better understanding of the complex relationship between land use dynamics and agricultural sustainability in rural West Bengal.

Keywords: Land Use Land Cover (LULC) Change, Agricultural Productivity, Remote Sensing and GIS, Land Degradation, Cropping Pattern, Environmental Impact

1. INTRODUCTION

Land Use and Land Cover (LULC) change has emerged as a significant area of research in understanding the dynamics of environmental transformation and its implications for agriculture. Rapid population growth, increasing demand for food, urban expansion, and infrastructural development have accelerated changes in land use patterns across developing regions. In India, particularly in West Bengal, these transformations are highly pronounced due to intensive agricultural practices and growing socio-economic pressures. The Onda C.D. Block of Bankura District represents a typical rural landscape where agriculture serves as the primary livelihood. However, over recent decades, this region has experienced noticeable shifts in land use and land cover, including conversion of agricultural land into settlements, fallow lands, and degraded surfaces. Such changes have directly and indirectly affected agricultural productivity, cropping patterns, soil fertility, and water availability. Understanding the patterns and drivers of LULC change in this region is crucial for sustainable agricultural planning and resource management. This study aims to examine the extent of LULC changes in Onda C.D. Block and analyze their impact on agricultural practices, thereby contributing to the development of informed land management strategies.

2. STUDY AREA

According to [1] emphasized that LULC is primarily driven by anthropogenic activities, including deforestation, industrialization, and infrastructure development. Increasing demand for food and bioenergy has intensified land transformation processes, resulting in environmental degradation, biodiversity loss, and climate change impacts. These transformations directly affect soil fertility, water availability, and agricultural sustainability. Development have accelerated the transformation of natural landscapes into built-up and agricultural areas, significantly influencing agricultural productivity and land sustainability. In [2] geospatial techniques enable accurate detection of spatial and temporal

land use changes, facilitating better planning and management of agricultural land. Their study revealed that urban expansion and economic growth are major drivers of agricultural land conversion, leading to reduced arable land and altered cropping patterns. In [3] LULC research highlight the integration of big data, machine learning, and real-time monitoring systems for improved land management. Noted that modern geospatial technologies have revolutionized land monitoring by enabling near real-time analysis and multi-scale assessment, which is crucial for sustainable agricultural planning and policy making.

In [4] at the global level, land use change has been closely linked with ecosystem services and food security. Studies indicate that conversion of agricultural land into non-agricultural uses adversely affects provisioning services such as crop production, thereby threatening food security. Furthermore, changes in land cover significantly influence regulating services like climate regulation, water cycles, and soil conservation, which are essential for agricultural sustainability. In [5] Himalayas, rapid urbanization and population pressure have led to significant changes in land cover, negatively affecting ecosystem services and agricultural productivity. Similarly, global assessments reveal that land degradation and unsustainable land use practices are major threats to agricultural systems, contributing to declining soil quality and reduced crop yields as [6]. Moreover, recent systematic reviews highlight that LULC research has expanded significantly over the past three decades, focusing on understanding drivers, patterns, and impacts across different spatial scales. A bibliometric analysis by identified that most studies emphasize urbanization, climate change, and agricultural expansion as key factors influencing land use dynamics, while also pointing out gaps in socio-economic and policy-oriented research.

2.1. Research Gaps

Existing studies, including [1], inadequately address region-specific and micro-level variations in LULC impacts on agriculture. There is limited integration of socio-economic drivers with biophysical changes, and insufficient longitudinal analysis. Moreover, gaps remain in assessing adaptive strategies, policy effectiveness, and the role of advanced geospatial technologies in sustainable land management. The study lacks micro-level analysis of socio-economic impacts on farmers and does not integrate ground-based validation with geospatial data. It overlooks policy effectiveness, climate variability, and long-term sustainability aspects. Additionally, limited focus is given to farmers adaptation strategies and region-specific variations in land use change dynamics. Despite advancements, significant gaps remain in integrating big data and machine learning with ground-based validation for accurate LULC analysis. Limited accessibility to high-quality real-time data, especially in developing regions, restricts application. Moreover, challenges persist in scaling models across diverse agroecological conditions and linking technological outputs with practical policy implementation.

While highlighting global linkages between land use change, ecosystem services, and food security, the study lacks localized, micro-level analysis of impacts on smallholder farming systems. It also underexplores socio-economic drivers, adaptation strategies, and the role of emerging geospatial technologies in monitoring and mitigating land use change effects on agriculture. Limited attention has been given to micro-level, region-specific analyses linking land cover change with agricultural productivity in the Himalayas. There is also a gap in integrating socio-economic drivers with biophysical factors. Furthermore, long-term empirical studies and the application of advanced geospatial and modelling techniques remain insufficiently explored. Despite extensive focus on drivers and patterns of LULC change, limited attention has been given to socio-economic inequalities, local governance, and policy effectiveness. There is also a lack of micro-level, region-specific studies and integration of socio-economic data with geospatial analysis to better understand impacts on agricultural sustainability and rural livelihoods.

2.2 Research Questions

- What are the major patterns and trends of LULC change in the study area over time?
- What are the primary drivers (e.g., urbanization, population growth, policy changes) influencing LULC change?
- How has LULC change affected agricultural land availability and cropping patterns?
- What is the impact of LULC change on agricultural productivity and soil quality?
- How do changes in land cover influence water resources and irrigation practices in agriculture?
- What are the socio-economic consequences of LULC change for farmers and rural livelihoods?

2.3. Objectives

To analyze the spatiotemporal patterns of LULC change over a specific period using geospatial techniques such as remote sensing and GIS. To identify the major drivers of LULC change, including urbanization, population growth, and economic activities, and assess their influence on agricultural land. To examine the impact of LULC change on agricultural productivity, including changes in cropping pattern, yield, and

land availability, to evaluate the effects of LULC change on soil quality and water resources, and their implications for sustainable agriculture.

3. DATABASE AND METHODOLOGY

Database: The present study is based on Secondary data sources to analyze Land Use Land Cover (LULC) change and its impact on agriculture. Satellite Data: Satellite imagery is used for LULC analysis. United States Geological Survey Landsat series 8-9 OLI/TIRS C2 L2 (2014), Landsat series 8-9 OLI/TIRS C2 L2 (2026). LANDSAT Collection 2 level- 2 Data. Spatial resolution: 10m – 30m. Use Base Maps or Location Map: Collection for base map District Census [7-9]. Agricultural Data: Gross Crops Area and Irrigated Area in Bankura District Under Principal Crops (2006-2011). Land Use Land Cover Change in water body, Vegetation, Agricultural Land, Fallow Land, built up area during the period (2014-2026) Change Detection Analysis (Water body, Vegetation, Agricultural Land, Fallow Land, Built up area) during the period (2014-2026) NDVI and NDWI analysis in specific period (2014 and 2026).

3.1 Study Area

Geographically Bankura district is situated between 22°38"N and 23°38" North latitudes and between 86°36"E and 87°46" East longitudes. It is bounded by Purba Medinipur and Hugli district to the East, Puruliya to the West, District Barddhaman to the North and Paschim Medinipur to the South. Bankura is almost triangular in shape with a total area of 6,882 sq. kms. Its north to south extension is of 112 km. and that of east to west is of 120 km [10-12].

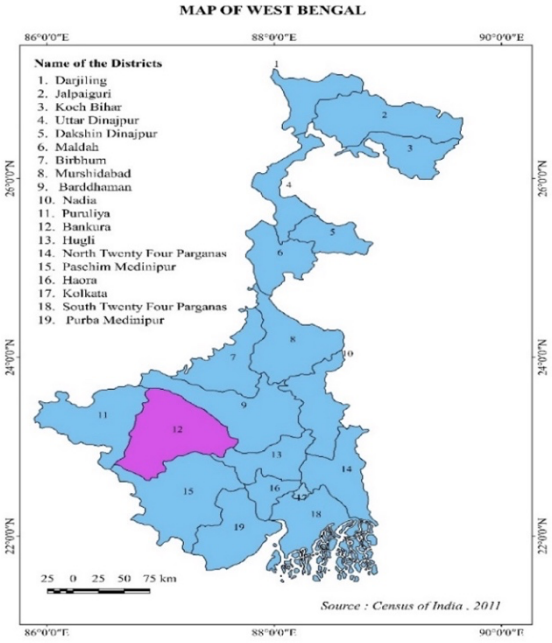


Figure 1. Location Map of Study Area [7]

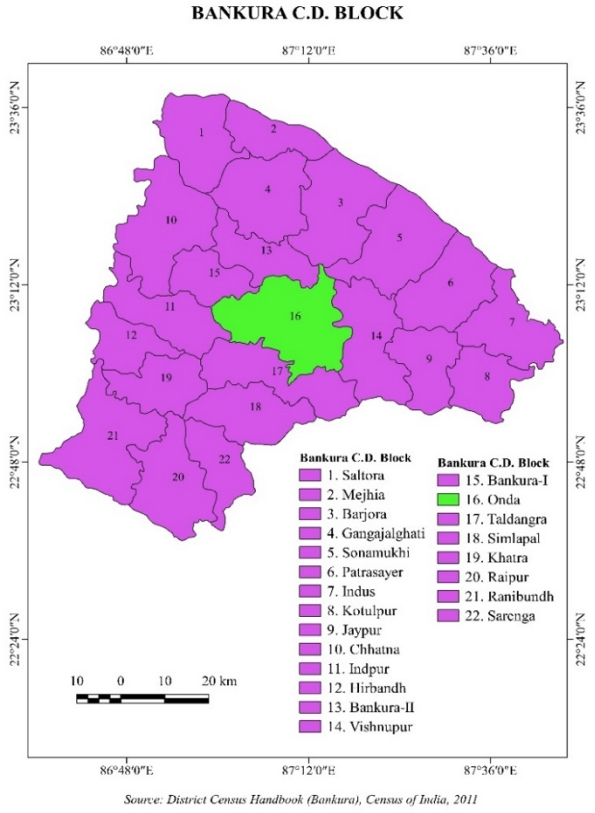


Figure 2. Map No: 1.1 [7].

3.2 Test Area

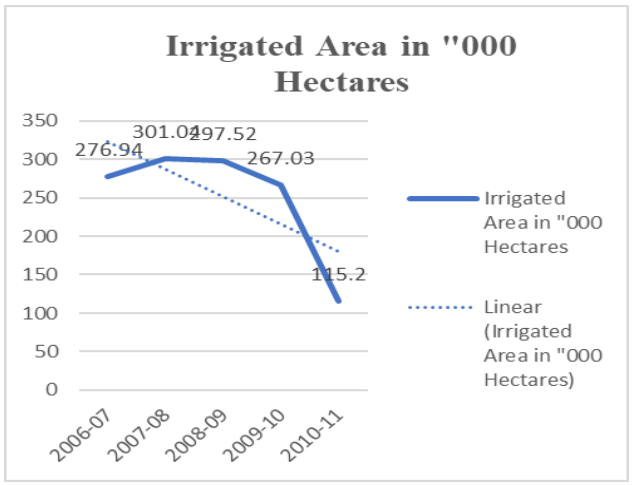
The test area involves in many sides that possible to get environments data as shows in many area.

Figure 2 shows the Bankura C.D Block resource and in the Table 1. shows gross crops of area and irrigated the gross crops per year for every year start from 2006 to 2010.

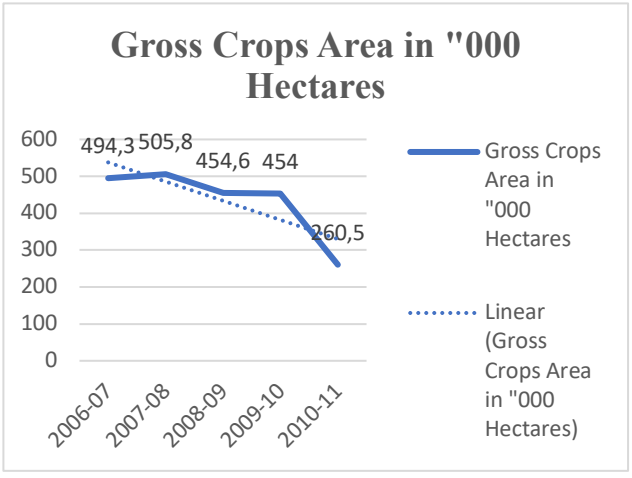
Table 1 Areas Under Principal Crops

Year	Gross Crops Area in "000 Hectares	Irrigated Area in "000 Hectares
2006-07	494.3	276.94
2007-08	505.8	301.04
2008-09	454.6	297.52
2009-10	454	267.03
2010-11	260.5	115.20

Figure 3. Shows how the comparison between irrigated versus gross crops.



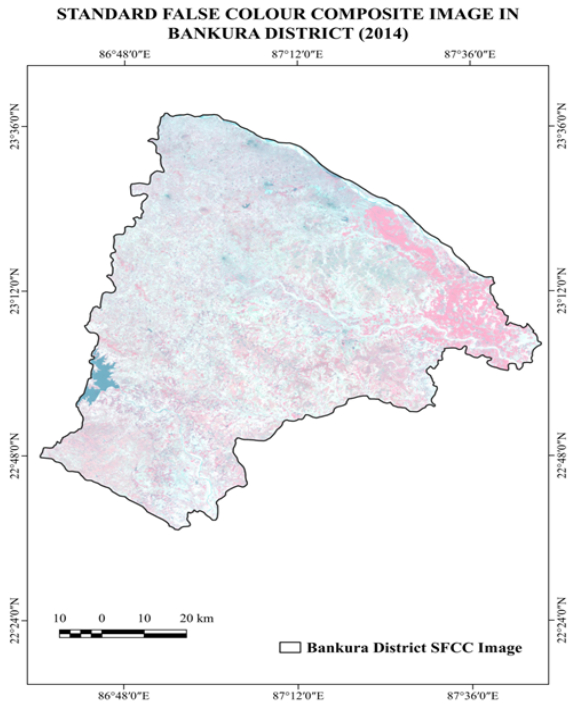
(a)



(b)

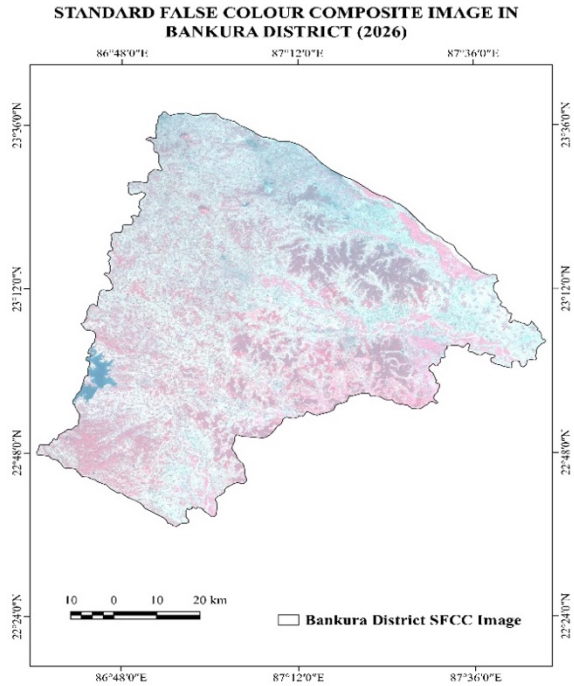
Figure 3. Elaborated the irrigated of area in 000 hectare (a) irrigated (b) gross crops.

Standard false color composite image in Bankura District for period (2014-2026) as shows in figure 4, while 4(a) 2014 and 4(b) 2026.



Source: Prepared based on LANDSAT-8 Satellite Image Data (Path-139 and Row-044), Date of Pass- 28th March, 2014

(a)



Source: Prepared based on LANDSAT-8 Satellite Image Data (Path-139 and Row-044), Date of Pass- 8th January, 2026

(b)

Figure 4. Standard false color composite image in Bankura District (a) 2014 and (2026) [23].

While standard false color composite image in onda C.D. Block Time Period (2014-2026) as show in figure 5.

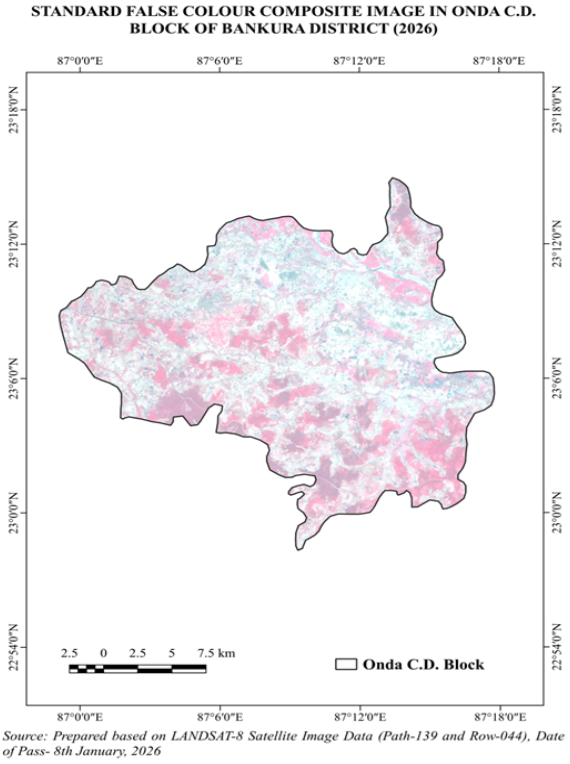
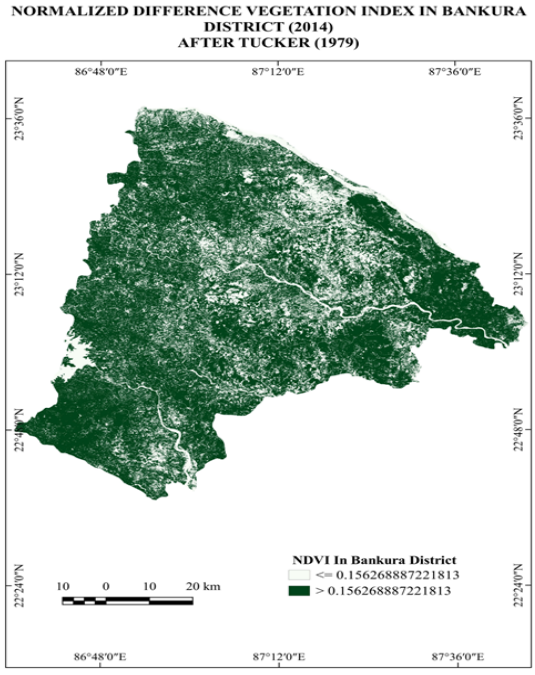


Figure 5. Standard false color composite image [23].

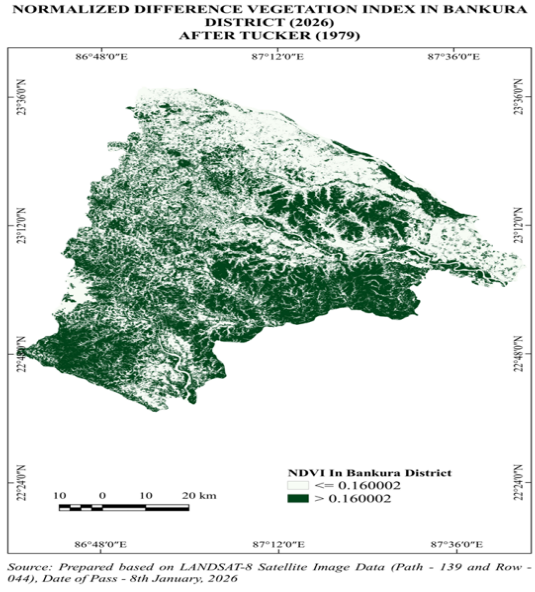
Table 2. Result of NDVI and NDWI in Bankura District (2014-2026)

Year	District	NDVI	NDWI	High Zone	Low Zone
2014	Bankura	NDVI	NDWI	>0.1562 NDVI >0.42483 NDWI	<0.1562 NDVI <0.16665 NDWI
2026	Bankura	NDVI	NDWI	>0.160002 NDVI >0.156569 NDWI	<0.160002 NDVI <-0.156569 NDWI

The NDVI and NDWI analysis for Bankura district shows a slight improvement in vegetation condition between 2014 and 2026, as indicated by the marginal increase in NDVI threshold from 0.1562 to 0.160002. This suggests better vegetation health or coverage [13-15]. However, NDWI thresholds indicate variability in surface moisture, with 2026 reflecting a broader fluctuation, including negative values. Overall, the results imply moderate vegetation growth alongside inconsistent water availability across high and low zones. Figure 6 shows the normalized reference of vegetation index, 6(a) 2014 and 6(b) 2026.



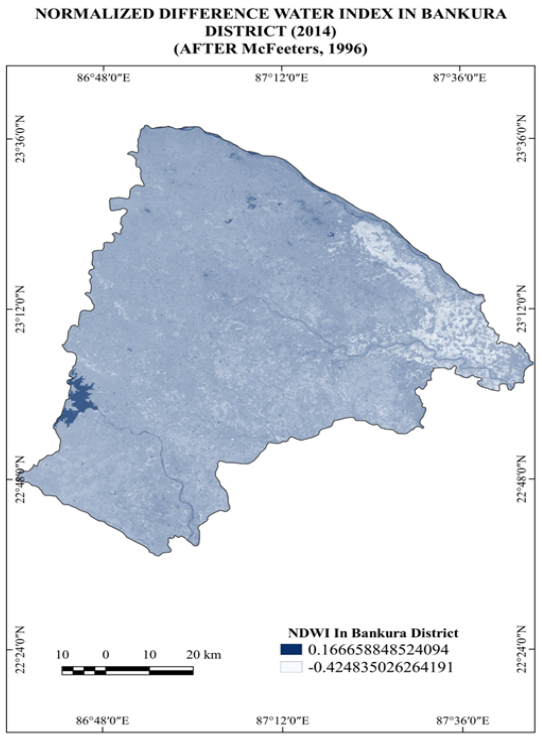
(a)



(b)

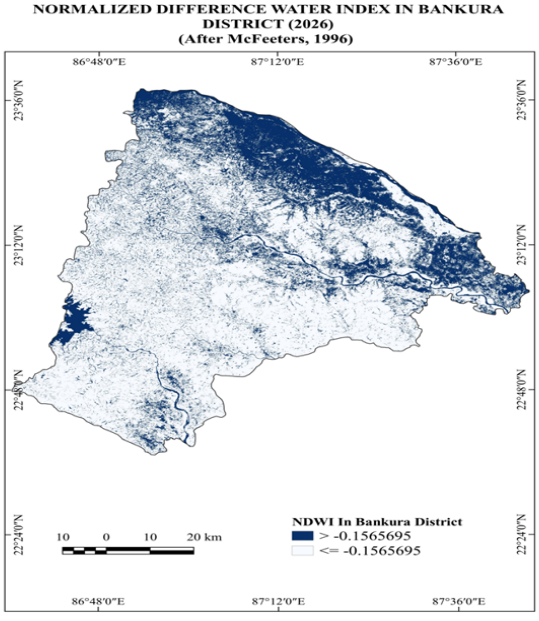
Figure 6 shows the normalized reference of vegetation index, (a) 2014 and (b) 2026.

Figure 7 shows the normalized references of the index in Bankura, while 7(a)year 2014 and 7(b)year 2026.



Source: Prepared based on LANDSAT-8 Satellite Image Data (Path - 139 and Row - 044), Date of Pass - 28th March, 2014

(a)

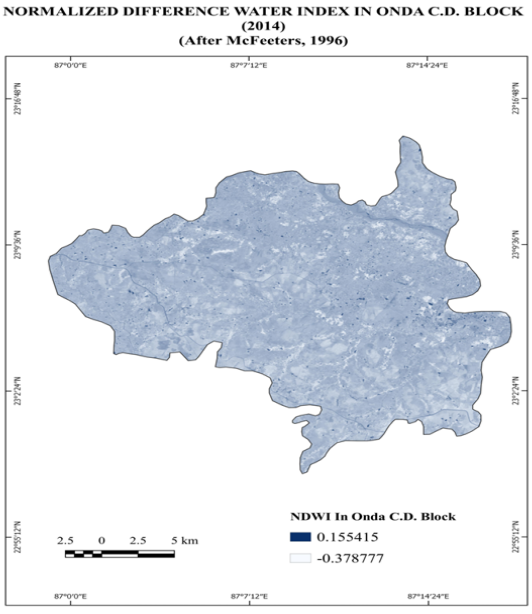


Source: Prepared based on LANDSAT-8 Satellite Image Data (Path - 139 and Row - 044), Date of Pass - 8th January, 2026

(b)

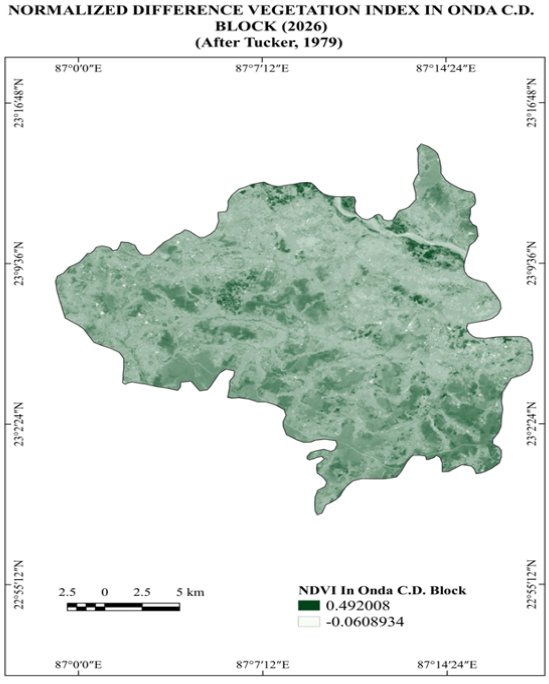
Figure 7 shows the normalized references of the index in Bankura, while (a) 2014 and (b) 2026.

Figure 8 shows the normalized references of the index in Onda C.D, while 8(a)year 2014 and 8(b)year 2026



Source: Prepared based on LANDSAT-8 Satellite Image Data (Path - 139 and Row - 044), Date of Pass - 28th March, 2014

(a)



Source: Prepared based on LANDSAT-8 Satellite Image Data (Path - 139 and Row - 044), Date of Pass - 8th January, 2026

(b)

Figure 8 shows the normalized references of the index in Onda C.D, while (a) 2014 and (b) 2026.

The comparison between 2014 and 2026 in Onda C.D. Block reveals a noticeable improvement in vegetation health, as indicated by the rise in NDVI high-zone values from >0.4127 to >0.4920. This suggests increased biomass or agricultural intensity [16-18]. However, NDWI high-zone values declined from >0.1554 to >0.0799, indicating reduced surface moisture availability. The shrinking negative NDVI range also reflects vegetation recovery, while more negative NDWI values imply increasing water stress or drying conditions over time while in figure 9 shows it.

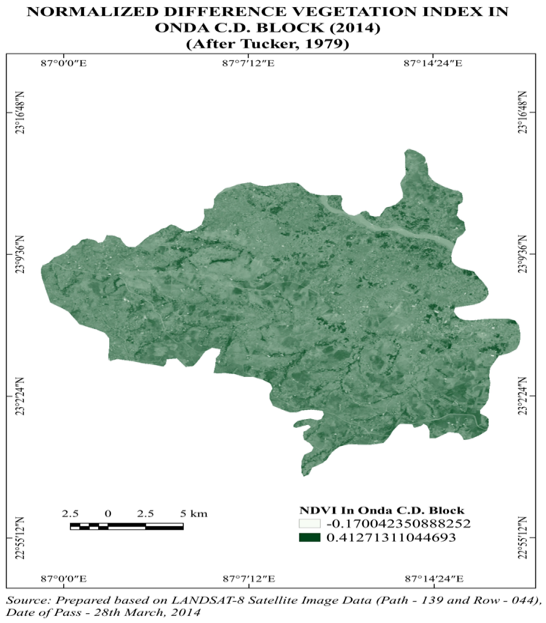


Figure 9 shows the normalized difference vegetation.

Table 3 shows the LULC for Onda C.D. block.

Table 3. LULC in Onda C.D. Block of Bankura District (2014)

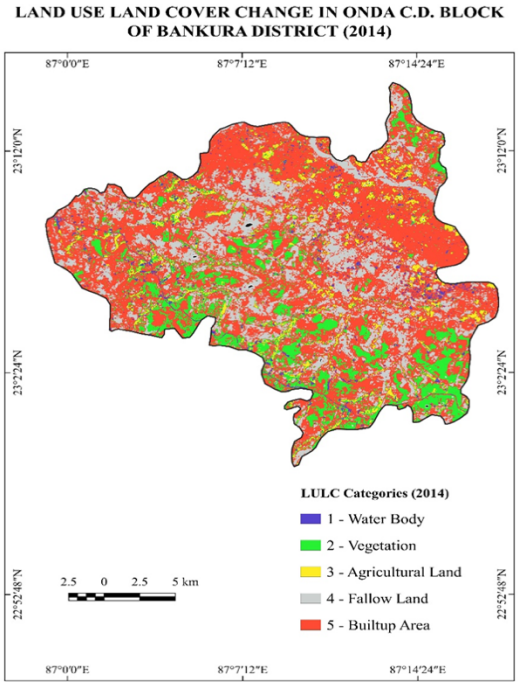
Class	Pixel Sum	Percentage (%)	Area [metr^2]	Area (Sq.km)
Water Body	13433	15.22	12089700	12.0897
Vegetation	77376	20.22	69638400	69.6384
Agricultural Land	24032	40.33	21628800	21.6288
Fallow Land	121665	15.22	109498500	109.4985
Built-up Area	31661 8	9.01	284956200	212.8554
Total		100	497811600	425.7108

The land use land cover analysis reveals a diversified landscape with clear dominance of agricultural and fallow land. Agricultural Land (40.33%) indicates the primary economic base of the region, reflecting intensive farming practices. However, a significant share of fallow land (15.22%) suggests seasonal inactivity or declining soil productivity. Vegetation cover (20.22%) Highlights moderate ecological stability, while water bodies (15.22%) indicate adequate surface water availability. The built-up area (9.01%) remains relatively low, implying limited urban expansion. Overall, the region shows a rural-agricultural character with scope for improving land utilization efficiency and sustainable resource management [19-20] as shows in table 4.

Table 4. LULC in Onda C.D. Block of Bankura District (2026)

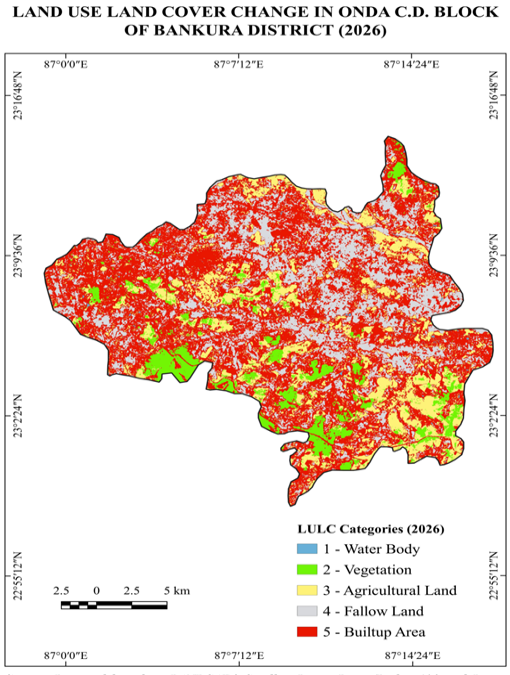
Class	Pixelsum	Percentage (%)	Area [metre^2]	Area (Sq.km)
Waterbody	2500	18.2	2250000	2.25
Vegetation	40785	22.2	36706500	36.7065
Agricultural Land	96443	42.1	86798700	86.7987
Fallow Land	131336	11.1	118202400	118.2024
Builtup Area	282060	6.4	253854000	253.854
Total		100	497811600	497.8116

The land use land cover pattern is dominated by Built-up Area (253.85 sq.km; 6.4%) and Agricultural Land (86.80 sq. km; 42.1%), indicating a landscape under strong human influence with intensive agricultural practices. Vegetation covers 36.71 sq.km (22.2%), reflecting moderate ecological presence, while Fallow Land (118.20 sq. km; 11.1%) suggests seasonal or unused agricultural fields. Water bodies occupy only 2.25 sq. km (18.2%), indicating limited surface water availability [21-22]. Overall, the area exhibits a mixed land use structure where agriculture and urban expansion are ecological drivers, potentially impact natural resources and sustainability if not managed properly. Figure 10 shows the LULC change in Onda C.D versus in Bankura, while 10(a) in 2014 and 10(b) in 2026.



Source: Prepared based on LANDSAT-8 Satellite Image Data (Path - 139 and Row - 044), Date of Pass - 28th March, 2014

(a)



Source: Prepared based on LANDSAT-8 Satellite Image Data (Path - 139 and Row - 044), Date of Pass - 8th January, 2026

(b)

Figure 10. shows the LULC change in Onda C.D versus in Bankura, (a) 2014 and (b) 2026.

Table 5 shows the LULC of the Onda C.D versus Bankura.

Table 5. LULC in Onda C.D. Block of Bankura District 2014-26

Cross Class Code	New Class	Reference Class	Pixel Sum	Area [metre^2]	Area (Sq.km)
12	Waterbody	Waterbody	1928	1735200	1.7352
13	Waterbody	Vegetation	48	43200	0.0432
15	Waterbody	Agricultural Land	20	18000	0.018
18	Waterbody	Builtup Area	133	119700	0.1197
22	Waterbody	Builtup Area	371	333900	0.3339
14	Vegetation	Waterbody	12	10800	0.0108
16	Vegetation	Vegetation	21221	19098900	19.0989
19	Vegetation	Agricultural Land	179	161100	0.1611
23	Fallow Land	Vegetation	2032	1828800	1.8288
27	Builtup Area	Vegetation	17341	15606900	15.6069
17	Agricultural Land	Waterbody	671	603900	0.6039
20	Agricultural Land	Vegetation	21597	19437300	19.4373
24	Agricultural Land	Agricultural Land	2383	2144700	2.1447
28	Agricultural Land	Fallow Land	22367	20130300	20.1303
31	Agricultural Land	Builtup Area	49425	44482500	44.4825
21	Waterbody	Fallow Land	1563	1406700	1.4067
25	Fallow Land	Vegetation	5279	4751100	4.7511
29	Fallow Land	Agricultural Land	8085	7276500	7.2765
32	Fallow Land	Fallow Land	51325	46192500	46.1925
34	Builtup Area	Fallow Land	65084	58575600	58.5756

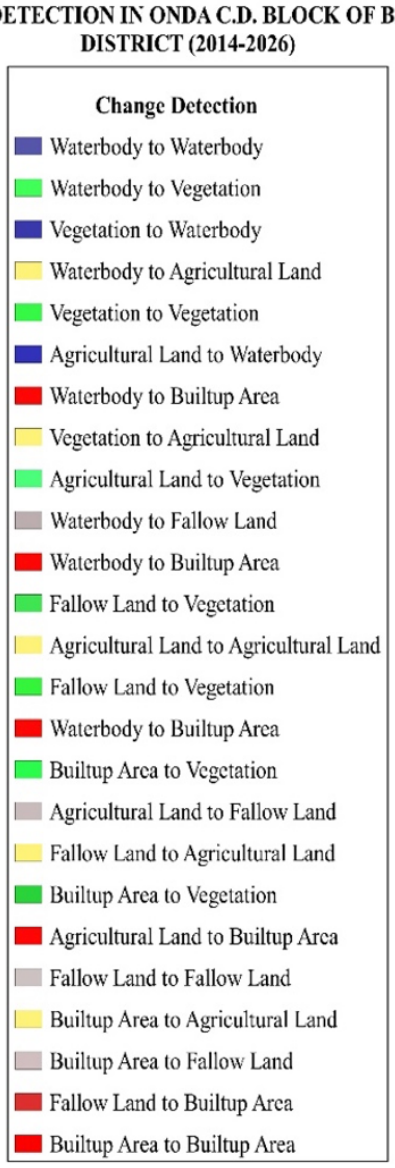
26	Waterbody	Builtup Area	9259	8333100	8.3331
30	Builtup Area	Vegetation	29231	26307900	26.3079
33	Builtup Area	Agricultural Land	13365	12028500	12.0285
35	Fallow Land	Builtup Area	45808	41227200	41.2272
36	Builtup Area	Builtup Area	184397	165957300	165.9573

The cross-classification matrix reveals significant LULC transformations within the study area. A substantial portion of land has remained stable, particularly in the Built-up Area (165.96 sq. km) and Fallow Land (46.19 sq. km) categories, indicating persistence of urban expansion and unused agricultural land. Similarly, Vegetation (19.10 sq. km) and Agricultural Land (2.14 sq. km) also show limited stability, suggesting dynamic transitions in these classes. A notable trend is the large-scale conversion of Agricultural Land to Builtup Area (44.48 sq. km), reflecting rapid urbanization and infrastructural development. Additionally, significant transformation from Fallow Land to Builtup Area (41.23 sq. km) and Builtup Area to Fallow Land (58.58 sq. km) indicates fluctuating land utilization, possibly due to seasonal or economic factors. The transition from Agricultural Land to Fallow Land (20.13 sq. km) suggests declining agricultural activity or land degradation. Vegetation dynamics are also evident, with conversions such as Builtup Area to Vegetation (26.31 sq. km) and Agricultural Land to Vegetation (19.44 sq. km), Which may indicate afforestation or natural regeneration. Waterbody changes are relatively minor, though some encroachment into built-up and fallow land is observed. Overall, the matrix highlights intense anthropogenic pressure, urban sprawl, and shifting agricultural practices, emphasizing the need for sustainable land management strategies.

4. RESULTS AND DISCUSSION

The comparative analysis of NDVI and NDWI values for Bankura district between 2014-2026 reveals noticeable changes in vegetation health and surface water conditions. In 2014, the high NDVI zone (>0.1562). indicated moderate vegetation cover, while the high NDWI threshold (>0.42483) suggested the presence of relatively stable water bodies and moisture-rich areas. Conversely, low NDVI (<0.1562) and NDWI (<0.16665) zones reflected sparse vegetation and limited water availability, possibly due to seasonal dryness or land degradation. By 2026, a slight increase in the NDVI high zone threshold (>0.160002) indicates marginal improvement in vegetation density, which may be attributed to afforestation initiatives, improved agricultural practices, or favorable climatic conditions. However, the significant decline in the NDWI high zone threshold (>0.156569) suggests a reduction in surface water availability and moisture content. The expansion of low NDWI zones (<- 0.156569) further highlights increasing water stress, potentially caused by irregular rainfall, groundwater depletion, or rising anthropogenic pressure. Table 6 mention the change detection in Onda C.D block versus Bankura.

Table 6. Change Detection analysis in Onda C.D. Block of Bankura District (2014-2026)



Overall, the results indicate a mixed environmental trend in Bankura district – While vegetation shows slight improvement, water resources appear to be under stress. This imbalance may be implications for agricultural sustainability, necessitating integrated water resource management and climate-resilient land use planning. The comparative analysis of NDVI and NDWI values for Onda C.D. Block between 2014 and 2026 reveals notable changes in vegetation health

and surface moisture conditions. The NDVI high-value threshold increased from > 0.4127 in 2014 to > 0.4920 in 2026, indicating an improvement in dense vegetation cover and overall plant vigor. This may be attributed to better agricultural practices, increased irrigation facilities, or afforestation initiatives in the region. Simultaneously, the low NDVI threshold improved from < -0.1700 to < -0.0608, suggesting a reduction in severely degraded or barren land areas.

In contrast, NDWI values show a mixed trend. The high-value threshold declined from > 0.1554 in 2014 to > 0.0799 in 2026, indicating a reduction in surface water availability or moisture content. This could be linked to declining water bodies, erratic rainfall, or increased water extraction for agricultural purposes. Furthermore, the low NDWI values became more negative (from < -0.3787 to < -0.4384), reflecting intensifying dryness in certain areas. In overall, while vegetation condition appears to have improved, the decline in moisture availability highlights emerging water stress. This imbalance suggests the need for sustainable water resource management to support long-term agricultural productivity and ecological stability in the Onda C.D. Block.

The LULC analysis reveals a diverse spatial distribution of different classes within the study area. Agricultural land emerges as the dominant Category, accounting for 40.33% of the total area (21.63 sq. km), indicating the agrarian nature of the region and the dependence of the local economy on farming activities. Vegetation covers 20.22% (69.64 sq. km), suggesting a moderate presence of natural or semi-natural green cover, which plays a crucial role in maintaining ecological balance. Fallow land constitutes 15.22% (109.50 sq. km), reflecting a significant portion of land remaining unused or temporarily out of cultivation. This may be attributed to seasonal variability, soil degradation, or lack of irrigation facilities. Water bodies occupy 15.22% (12.09 sq. km), indicating the availability of surface water resources, which are essential for irrigation and domestic use. Built-up area, comprising 9.01% (212.86 sq. km), highlights the extent of urbanization and infrastructural development. Although relatively lower in percentage, the large spatial extent suggests concentrated settlement growth. Overall, the LULC pattern indicates a rural-dominated landscape with emerging urban expansion and notable scope for improving land utilization.

The LULC analysis reveal a diverse spatial distribution of surface features within the study area, with significant implications for agricultural dynamics and regional planning. Agricultural land constitutes the largest proportion, covering 42.1% (86.79 sq. km), indicating the dominance of farming activities and highlighting the agrarian nature of the region. This suggests favorable agri-environmental conditions and a strong dependence on agriculture for livelihood. Vegetation cover for 22.2% (36.71 sq. km), reflecting moderate forest or green cover, which plays a crucial role in maintaining ecological balance, soil conservation, and micro-climatic regulation. Water bodies occupy 18.2% (2.25 sq. km), which despite a relatively smaller spatial extent, are vital for irrigation and sustaining agricultural productivity.

Fallow land represents 11.1% (118.20 sq. km), indicating a considerable portion of land left uncultivated, possibly due to soil degradation, lack of irrigation, or socio-economic constraints. This highlights potential areas for agricultural expansion or land reclamation. Built-up area comprises only 6.4% (253.85 sq. km), suggesting limited urbanization and relatively low infrastructural development. Overall, the LULC pattern reflects a predominantly rural landscape with opportunities for enhancing agricultural efficiency and sustainable land management practices. The cross-classification matrix reveals significant dynamics in LULC transitions within the study area. A notable degree of persistence is observed in categories such as Built-up Area (165.96 sq. km), Fallow Land (46.19 sq. km), and Vegetation (19.10 sq. km), indicating stability in urban cores, uncultivated lands, and vegetation cover. However, major transformations are equally evident. The most striking change is the large-scale conversion of Agricultural Land to Built-up Area (44.48 sq. km), reflecting rapid urban expansion and increasing anthropogenic pressure on cultivable land. Similarly, substantial transitions from Fallow Land to Built-up Area (41.23 sq. km) and Vegetation to Built-up Area (15.61 sq. km) further emphasize ongoing urbanization and land development processes.

Agricultural Land also shows dynamic interchange with Fallow Land (20.13 sq. km), suggesting shifting cultivation patterns, possibly due to seasonal fallowing or declining agricultural productivity. Additionally, Vegetation gains from Agricultural Land (19.44 sq. km) indicate localized regeneration or plantation activities. Waterbody transformations, such as conversion to Built-up Area (8.33 sq. km) and Fallow Land (1.41 sq. km), raise concerns regarding environmental degradation and loss of aquatic ecosystems. Overall, the analysis highlights a strong trend of urban expansion at the expense of agricultural and natural landscapes, underscoring the need for sustainable land management and planning strategies.

5. CONCLUSION

The analysis of LULC change in Onda C.D. Block of Bankura district clearly reveals a dynamic transformation of the landscape, driven primarily by population pressure, agricultural intensification, and expanding built-up areas. Over the study period, significant conversion among agricultural land, fallow land, vegetation, built-up surfaces have been observed, indicating a shift in land utilization patterns. Such transformations reflect both developmental processes and environmental stress within the region. One of the most notable findings is the gradual reduction or fragmentation of agricultural land in certain pockets due to its conversion into settlements and other non-agricultural uses. This trend is critical because loss of cultivable land directly threatens agricultural productivity and food security. Globally,

similar patterns have shown that conversion of farmland to urban uses reduces production potential and increases vulnerability to food insecurity in Onda, this is further compounded by the increase in fallow land, suggesting declining soil fertility, inadequate irrigation, or socio-economic constraints faced by farmers.

Simultaneously, changes in vegetation cover and water bodies also influence agricultural sustainability. Reduction in vegetation can lead to soil erosion and degradation, ultimately lowering crop yield and affecting farmers livelihoods. On the other hand, minor increases in water bodies or improved irrigation potential can positively support agricultural activities, though such benefits remain spatially uneven. The study also highlights the role of LULC change in modifying local environmental conditions such as temperature, moisture availability, and micro-climate, which indirectly affect crop productivity. Increasing built-up areas and decreasing natural cover may contribute to local climatic variations and reduced ecological resilience. LULC changes in Onda C.D. Block have a mixed impact on agriculture while some changes reflect development and land-use efficiency, others indicate degradation and declining agricultural sustainability. Therefore, there is an urgent need for proper land-use planning, sustainable agricultural practices, and conservation measures to balance development with ecological stability and ensure long-term agricultural productivity.

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