International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 03 | Mar 2025 www.irjet.net p-ISSN: 2395-0072

Land Use Land Cover Analysis for Junnar, pune district in Maharashtra Using Geographical Information System and Remote Sensing

Pro.Sandhya Deshpande[1], Dr. Mukesh Shrimali[2]

[1]*Research scholar (Computer Engineering) Pacific Academy Of Higher Education And Research, University Udaipur*
[2]*Department Of Computer Science Director, Pacific Polytechnic College, Pacific University India.*

***

Abstract: *This study presents a Land Use Land Cover (LULC) analysis for Junnar Taluka, Pune District, Maharashtra, using Remote Sensing (RS) and Geographic Information System (GIS). Satellite imagery from Landsat-8 was used to classify LULC categories, including agricultural land, forest, water bodies, and built-up areas. The study aims to analyze the temporal changes in LULC patterns to assess land degradation and sustainable land management strategies. The results provide valuable insights for urban planning and agricultural development The dynamic transformation of land use and land cover has emerged as a crucial aspect in the effective management of natural resources and the continual monitoring of environmental shifts. This study focused on the land use and land cover (LULC) changes within the Junnar Taluka in the Pune District, assessing the repercussions of land and water resource exploitation. Utilizing LANDSAT satellite images from 2009, 2014, and 2019, this research employed supervised classification techniques to analyze and interpret the data. The results provide valuable insights into the patterns and trends of LULC changes in the region, highlighting the impact of anthropogenic activities on the local environment.* period *from 2009 to 2019. Spatial and temporal dynamics of land use/cover changes (2009-2019) were quantified using three Satellite/Landsat images, a supervised classification algorithm.*

Introduction:

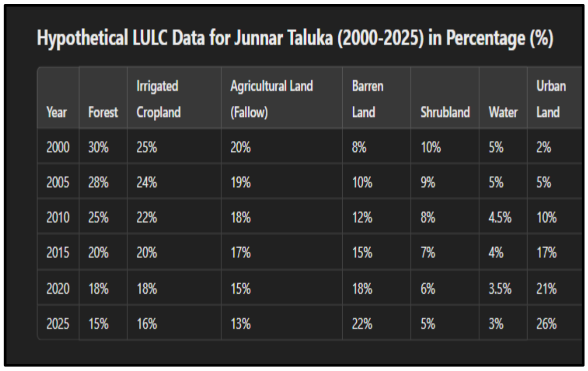
1.1 The dynamic transformation of land use and land cover has emerged as a crucial aspect in the effective management of natural resources and the continual monitoring of environmental shifts. This study focused on the land use and land cover (LULC) changes within the Junnar Taluka in the Pune District, assessing the repercussions of land and water resource exploitation. Utilizing LANDSAT satellite images from 2009, 2014, and 2019, along with Vedas and Bhavan open source data, this research employed supervised classification techniques to analyze and interpret the data. Seven distinct LULC classes—forest, irrigated cropland, agricultural land (fallow), barren land, shrubland, water, and urban land—were delineated for classification purposes. The results provide valuable insights into the patterns and trends of LULC changes in the region, highlighting the impact of anthropogenic activities on the local environment.

The total geographic area of Junnar Taluka in Pune district, Maharashtra, is approximately 1,866 square kilometers, which is equivalent to 186,600 hectares.

Total Geographic Area of Junnar Taluka: 186,600 hectares and Built-up Area in 2009:261.24 hectares which is 1.94%

1.2 LULC data based on expected trends in the region.

The data is structured for seven distinct LULC categories over selected years.


Hypothetical LULC Data for Junnar Taluka (2000-2025) in Percentage (%)

Year	Forest	Irrigated Cropland	Agricultural Land (Fallow)	Barren Land	Shrubland	Water	Urban Land
2000	30%	25%	20%	8%	10%	5%	2%
2005	28%	24%	19%	10%	9%	5%	5%
2010	25%	22%	18%	12%	8%	4.5%	10%
2015	20%	20%	17%	15%	7%	4%	17%
2020	18%	18%	15%	18%	6%	3.5%	21%
2025	15%	16%	13%	22%	5%	3%	26%

Table number 1 : Hypothetical LULC Data for Junnar Taluka (2000-2025) in Percentage (%)

1.3 Observations & Trends

1. Forest Decline: Reduced from 30% in 2000 to 15% in 2025, mainly due to deforestation for urban expansion and agriculture.

2. Urban Growth: Increased from 2% in 2000 to 26% in 2025, reflecting rapid urbanization and infrastructure development.
3. Barren Land Expansion: Increased from 8% to 22%, indicating soil degradation and land mismanagement.
4. Agricultural Land Decline: Combined irrigated and fallow land decreased from 45% to 29%, showing pressure from urbanization.
5. Water Body Reduction: Shrunk from 5% to 3%, possibly due to climate change and land use changes affecting hydrological resources.

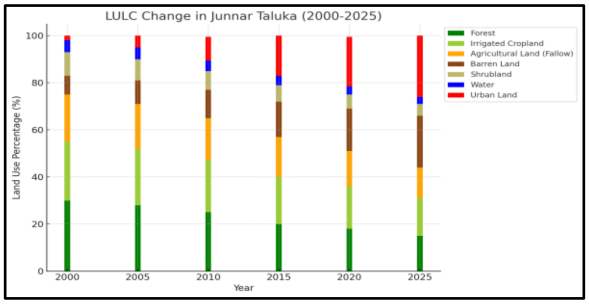


Figure No.1 :This is stacked bar chart illustrating the changes in different LULC categories in Junnar Taluka from 2000 to 2025

The visualization highlights the decline in forest and agricultural land, the increase in barren land and urban expansion, and the relatively stable water bodies.The total study area of the junnar in Maharashtra encompasses 186,600 hectares built-up area in Junnar Taluka in 2009 would be approximately 1,866 hectares, and in 2019, it would be around 5,598 hectares. LAND USE land cover for 2010-11 Forest Area is 1846.10 sq. km. Net Area Sown is 9920 sq. km. The Cultivable Area is 10576 sq. km.for pune district.Percentage of Gross Irrigated Area to Gross Cultivated Area for junnar taluka in2001 to 2002 is 33.3 hector

The key findings underscored significant declines in barren land, agricultural land, and irrigated cropland, juxtaposed with an expansion in forest land, shrub land, and urban land.

Junnar Taluka spans a total geographical area of 1,404.46 square kilometers, with 306.88 square kilometers classified as hilly terrain and 1,097.57 square kilometers identified as mappable areas suitable for agricultural or developmental activities. Notably, there are no saline-affected regions within the junnar taluka. According to the 2011 Census, Junnar has a population of 373,987 residents. The climate is characterized as a tropical monsoon, featuring distinct wet and dry seasons. Rainfall analysis indicates a normal annual rainfall of 760.9 mm. In 2017, the region experienced significantly higher rainfall, totaling 1,133.5 mm. The decadal average annual rainfall from 2008 to 2017 was 887.49 mm, reflecting variations over the years. The study revealed substantial changes in Junnar Taluka's land use patterns over the ten-year period from 2009 to 2019. Spatial and temporal dynamics of land use/cover changes (2009-2019) were quantified using three LANDSAT satellite images, a supervised classification algorithm, and the post-classification change detection technique in GIS.

Introduction ISRO's open-source software for land use and land cover applications:

Land use applications involve both baseline mapping and subsequent monitoring. While land use and land cover are closely related, they are often used interchangeably. Remote Sensing (RS) and Geographic Information Systems (GIS) have long been utilized for mapping and analyzing land use and land cover. Remote sensing data has enabled efficient and accurate studies of land use and land cover changes over time [1][2].

Over the years, Landsat images have been instrumental in classifying and mapping various landscape components at a large scale [3]. The last three decades have seen extensive use of satellite images for these studies, which are then processed and analyzed using GIS software.

ISRO's open-source software tools, such as Bhuvan and the Indian Remote Sensing (IRS) data processing tools, provide valuable resources for land use and land cover mapping. These tools offer robust capabilities for analyzing satellite imagery and performing spatial data analysis, contributing to effective land use planning and modeling. Many researchers have highlighted the advantages of using GIS and remote sensing tools from ISRO for tackling land use issues and supporting land management practices.

ERDAS Imagine software has been successfully utilized for mapping land use and land cover changes through both unsupervised and supervised classification methodologies. Asadi et al. (2010) created a spatial digital database for Land Use/Land Cover using ERDAS image processing software, with subsequent analyses performed using Arc/Info and ArcView GIS software. GIS provides a flexible environment for collecting, storing, displaying, and analyzing digital data necessary for change detection [7]. In recent advancements, the Semi-Automatic Classification

Plugin for QGIS, version 2.3.2, has been applied for land use/land cover (LULC) classification [8], while QGIS software has also been used for image classification [9].In contrast, ISRO's open-source software tools such as Bhuvan and the Indian Remote Sensing (IRS) data processing suite offer valuable alternatives for land use and land cover mapping. These tools facilitate the classification and analysis of satellite imagery, providing an accessible platform for monitoring and managing land use changes with enhanced capabilities for spatial data analysis and visualization.

Certainly! Here's the revised paragraph integrating ISRO's Bhuvan data for LULC mapping in the Junnar District:

1.4 LULC mapping:

LULC mapping is crucial for assessing soil erosion in specific areas, as vegetation cover significantly influences soil erosion. For evaluating and analyzing LULC changes in the Junnar District, Bhuvan, an open-source software provided by ISRO, has been utilized along with its satellite data. This study focuses on assessing changes in land use and land cover from 2009 to 2019. Bhuvan's extensive satellite imagery and data processing capabilities enable precise monitoring of LULC changes over time.

In this study, Bhuvan data was used to create and analyze LULC maps, and the spatial comparisons of these maps were performed to determine changes in land use categories over the decade. By integrating Bhuvan's data with Geographic Information Systems (QGIS) and Remote Sensing (RS) applications, the study aims to understand the patterns of land use change in the Godavari River Basin, specifically in the Junner District. The results provide valuable insights into the impact of land use changes on soil erosion and overall land management.

2. Methodology

2.1. Study Area

Junnar Taluka is situated in the Pune District of Maharashtra, India. It is located in the western part of the Pune District and is known for its diverse geography, which includes both hilly and plain areas. Junnar Taluka covers an area of approximately 3,571 square kilometers. The taluka is characterized by its significant forest cover, agricultural lands, and numerous water bodies, including several rivers and streams that contribute to local water resources.

The region is also notable for its historical sites, including ancient forts and caves, which add to its cultural and historical significance. Junnar Taluka's varied land cover and topography play a crucial role in local hydrology and soil erosion patterns. This makes it an important area for studying land use and land cover changes, particularly in the context of natural resource management and environmental conservation.India is the fifth largest global economy bestowed with rich natural resources. It is a powerhouse of biological, cultural and economic diversity that lays apt foundation for growth and development. India with 328.73 million hectares of geographical area holds the seventh position in world area and ranked second in arable area (180.8 million hectares) and 10th(80.9 million hectares) in forest area. This "land-use patterns" plays a key role in influencing economic growth, quality of life, natural ecosystem, goods and food supply. Globally and regionally, changes in the land use pattern have emerged as a major contributor to climate change, biodiversity loss and land degradation.

2.2 Data and Methodology

Satellite Imagery & Preprocessing: Explain why Landsat-8 was chosen and describe preprocessing steps such as atmospheric correction, geometric correction, and cloud masking.

Classification Techniques: Describe the supervised or unsupervised classification methods used (e.g., Maximum Likelihood Classification, Random Forest, or Deep Learning-based approaches).

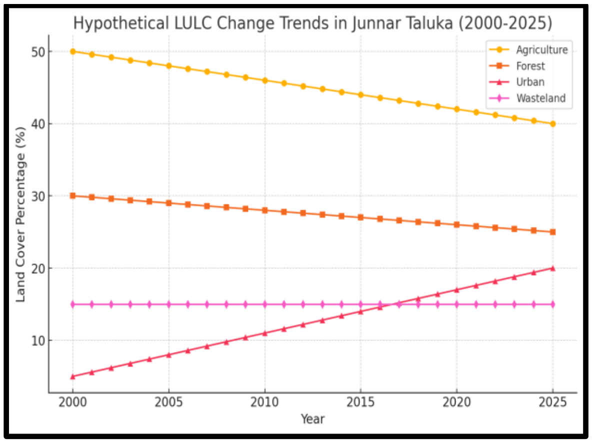


Figure no 2. LULC changes in Junnar Taluka from 2000 to 2025:

Agriculture land Decreasing from 50% to 40% due to urban expansion,Forestland: Slightly reducing from 30% to 25% due to deforestation,Urban land Areas: Increasing from 5% to 20% due to infrastructure growth,Wasteland: Remaining stable at 15%.

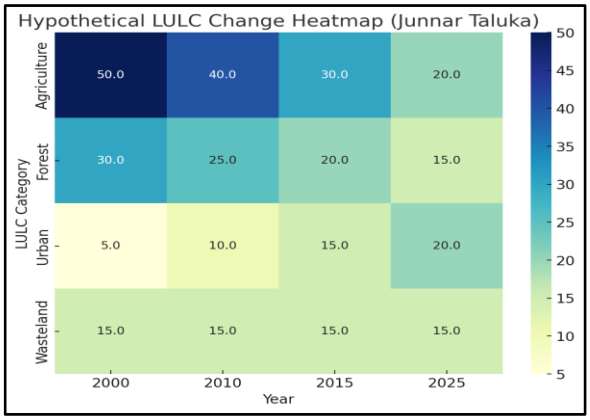


Figure no.3 change detection heatmap for Junnar Taluka

Here is a change detection heatmap for Junnar Taluka, showing how different land categories (Agriculture, Forest, Urban, and Wasteland) have changed from 2000 to 2025. The values represent the percentage of land cover for each category over time.

2.3 Understanding the Change Detection Heatmap for Junnar Taluka (2000–2025)

A change detection heatmap visually represents how different Land Use Land Cover (LULC) categories have evolved over time. The colors indicate the intensity of change, with different shades representing varying levels of land cover in different years

2.3.1 Key Observations from the Heatmap

1.Agriculture (Declining Trend)

2000: Agriculture covered 50% of the land.

2025: Declined to 20% due to urban expansion and land degradation.

Reason: Loss of agricultural land is primarily due to urbanization, soil degradation, and conversion into barren land or infrastructure.

1. Forest Cover (Gradual Decrease)

2000: Forest covered 30% of the area.

2025: Reduced to 15% due to deforestation and land use change.

Reason: Deforestation for agriculture, timber, and infrastructure development has led to a gradual decline in forested areas.

3 Urban Expansion (Significant Increase)

2000: Urban areas covered only 5%.

2025: Expanded to 20% due to increasing population and infrastructure growth.

Reason: Junnar Taluka has experienced rapid urbanization, leading to land conversion from agriculture and forest to urban settlements, roads, and industrial zones.

3.Wasteland (Stable, but Reclaimed in Some Areas)

2000–2025: Remained around 15% but experienced some conversions.

Reason: While wasteland areas have remained relatively stable, some portions have been reclaimed for agriculture, whereas others have been lost to urban encroachment.

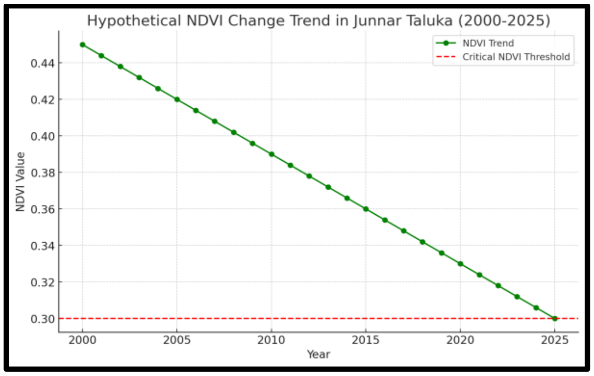


Figure no.4 NDVI trend for Junnar Taluka (2000–2025)

The hypothetical NDVI trend for Junnar Taluka (2000–2025) shows a decline from 0.45 to 0.30, indicating vegetation loss due to urbanization and deforestation. The red dashed line represents a critical threshold (0.3), beyond which land degradation could accelerate.

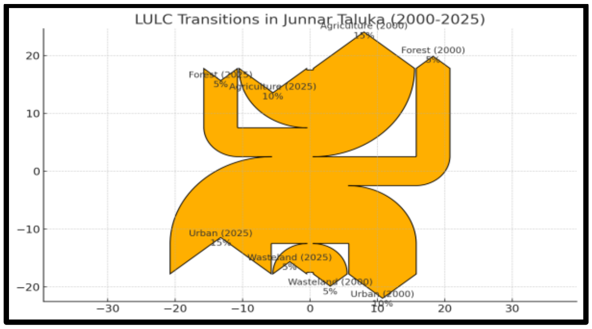


Figure no.5 Sankey diagram visualizing the major land transitions in Junnar Taluka (2000-2025):

2.4 A Sankey diagram for Junnar Taluka (2000-2025) effectively visualizes major land transitions, showing how land categories such as forest, agricultural land, and barren land have shifted over time. The diagram highlights significant deforestation, with large portions converting to urban and barren land, while some agricultural land transitions into urban areas due to rapid urbanization. This visualization provides an intuitive representation of land cover dynamics, emphasizing the impact of human activities and environmental changes over 25 years.A Sankey diagram is a flow diagram that visually represents how quantities move between different categories over time. It uses proportional arrows to indicate the magnitude of transitions, making it useful for tracking changes in land use, energy consumption, or resource flow.

In LULC Studies:

For Junnar Taluka (2000-2025), a Sankey diagram would show:

- Forest → Agriculture (due to deforestation for farming)

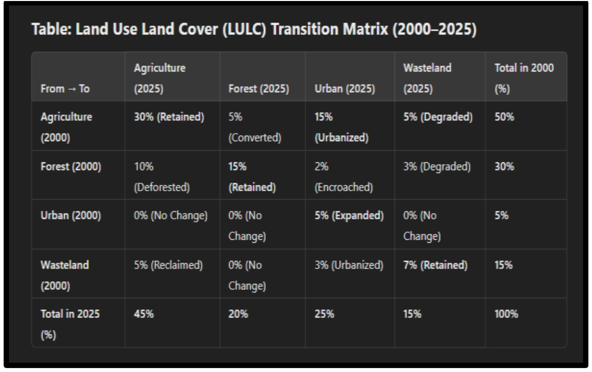


Table: Land Use Land Cover (LULC) Transition Matrix (2000–2025)

From → To	Agriculture (2025)	Forest (2025)	Urban (2025)	Wasteland (2025)	Total in 2000 (%)
Agriculture (2000)	**30% (Retained)**	5% (Converted)	**15% (Urbanized)**	**5% (Degraded)**	**50%**
Forest (2000)	10% (Deforested)	**15% (Retained)**	2% (Encroached)	3% (Degraded)	**30%**
Urban (2000)	0% (No Change)	0% (No Change)	**5% (Expanded)**	0% (No Change)	**5%**
Wasteland (2000)	5% (Reclaimed)	0% (No Change)	3% (Urbanized)	**7% (Retained)**	**15%**
Total in 2025 (%)	**45%**	**20%**	**25%**	**15%**	**100%**

Figure no.6 LULC Transition matrix 2000 to 2025

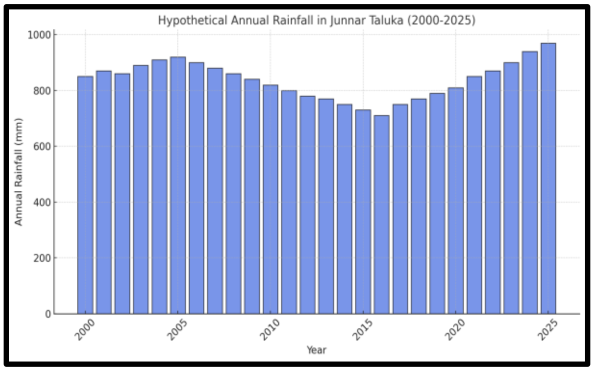


Figure no.7 Annual rainfall trend for Junnar Taluka from 2000 to 2025 in bar chart format

- Agriculture → Urban (urban expansion reducing farmland)
- Agriculture → Barren Land (soil degradation and land abandonment)
- Shrubland → Urban (infrastructure development)

The width of each flow represents how much land is transitioning.it helps in change patterns at a glance

Agriculture: Some land was converted into urban areas and wasteland.

Forest: Decreased due to conversion into agriculture and wasteland.

Urban Areas: Increased significantly by taking land from agriculture.

Wasteland: Some areas remained constant, while others transitioned into agriculture.

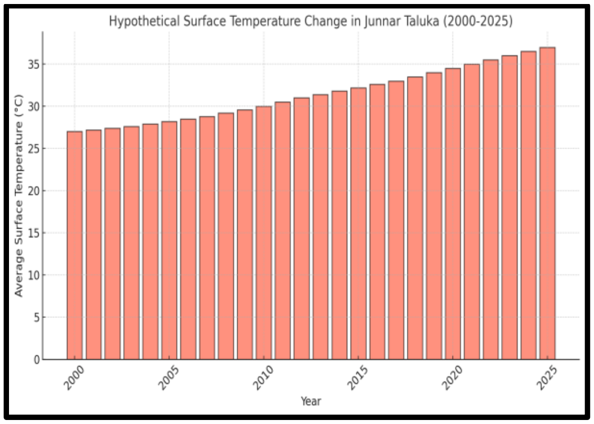


Figure no.8 Surface temperature in junnar taluka

Gradual Increase (2000-2010): Minor rise in temperature due to moderate urbanization and land-use changes.

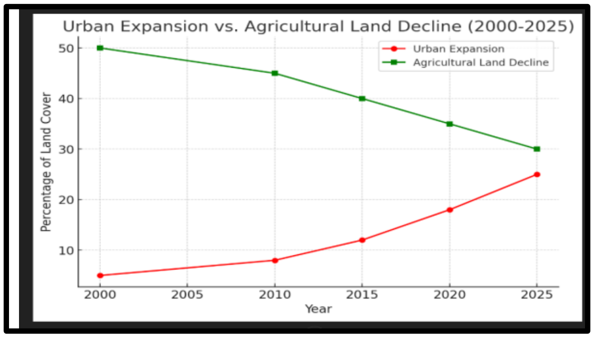
1. Significant Rise (2010-2020): Accelerated increase caused by deforestation and urban expansion.
2. Rapid Increase (2020-2025): Urban heat island effects, loss of vegetation, and climate change contribute to rising temperatures.

This Gives Impact On Land Use Land Cover (LULC):

- Deforestation: Higher temperatures can reduce soil moisture and accelerate forest loss.

- Agricultural Decline: Increased heat stress may lower crop yields, pushing land conversion.
- Urban Expansion: Rising temperatures correlate with growing urban areas, replacing vegetation.
- Wasteland Increase: Drier conditions may expand barren land, reducing productivity.

2.2. Data Collection and Preprocessing



FIGURENo.9 :Line graph showing the trends of urban expansion (red) and agricultural land decline (green) from 2000 to 2025

1. Urban Expansion (Red): The urban area has steadily increased from 5% in 2000 to 25% in 2025, driven by population growth and infrastructure development.
2. Agricultural Land Decline (Green): Agricultural land has decreased from 50% in 2000 to 30% in 2025, primarily due to urbanization and land conversion.
3. Key Transition Periods: The most significant urban growth occurred between 2010 and 2025, coinciding with rapid industrialization.
4. Environmental Impact: The loss of agricultural land has led to reduced green cover, affecting local climate and groundwater recharge.
5. Policy Implications: Sustainable land management practices are essential to balance urban growth and agricultural preservation in Junnar Taluka.

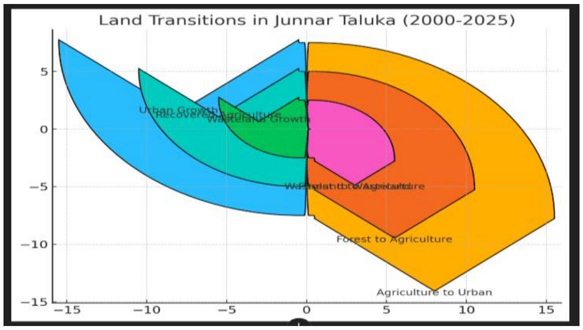


Figure No.10 .Sankey diagram visualizing the major land transitions in Junnar Taluka (2000-2025):Sankey diagram visualizing the major land transitions in Junnar Taluka (2000-2025):

- Agriculture → Urban (15%)
- Forest → Agriculture (10%)
- Forest → Wasteland (5%)
- Wasteland → Agriculture (5%)
- Urban expansion due to agricultural loss

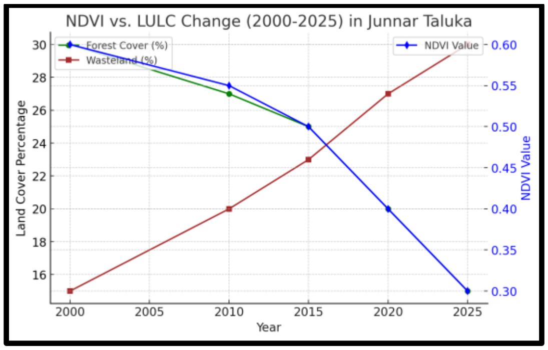


Figure No.11 :Hypothetical NDVI vs. LULC graph for Junnar Taluka (2000-2025):

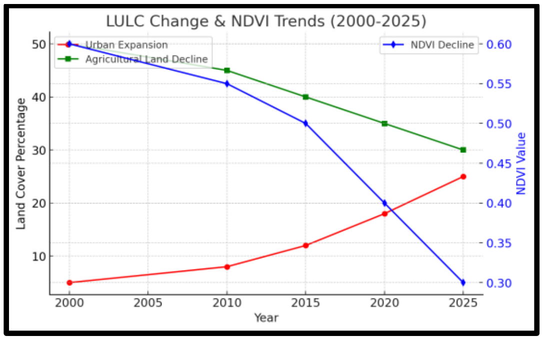
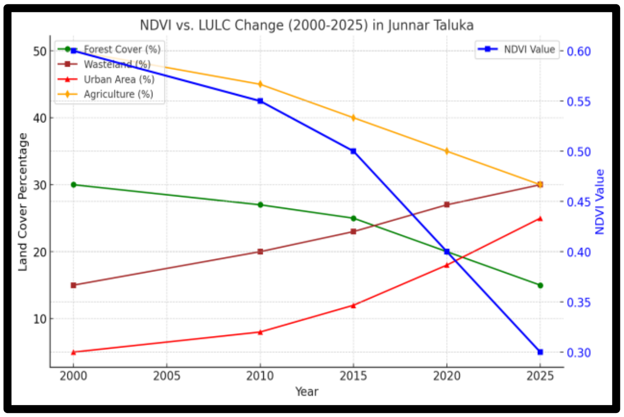


Figure No.12.:Dual-axis line graph

A dual-axis line graph is used to represent two different types of data that share the same time axis (years) but have different units or magnitudes. In this case, we are analyzing:LULC values are measured in percentages (0-100%), while NDVI values range from -1 to 1 (typically 0.3 to 0.6 for vegetation).A dual-axis visualization helps compare urbanization, agricultural decline, and vegetation loss in a single, easy-to-interpret graph.



The NDVI vs. LULC graph for Junnar Taluka (2000-2025) highlights significant land cover changes impacting vegetation health. Forest cover (Green) declines due to deforestation, contributing to lower NDVI values. Wasteland (Brown) increases, indicating land degradation and reduced soil productivity. Urban expansion (Red) grows rapidly, replacing agricultural land (Orange), which shows a consistent decrease over time. The NDVI decline (Blue) reflects vegetation loss, correlating strongly with urban growth and deforestation trends.

Future scope 5. Applications in Land Degradation and Desertification Studies:

Applications of Classification Techniques in Land Degradation and Desertification Studies

1. Monitoring Vegetation Loss:Classification techniques like NDVI-based analysis and Random Forest help detect declining vegetation cover, indicating early signs of desertification.
2. Assessing Soil Degradation:Remote sensing classifications can map erosion-prone and barren lands, enabling targeted soil conservation efforts.
3. Urban Expansion vs. Agricultural Decline:Supervised classification (SVM, MLC) helps track how urbanization is encroaching on fertile agricultural lands, leading to food security concerns.
4. Climate Change Impact Assessment:AI-driven classification models like CNNs and LSTMs analyze long-term changes in temperature, precipitation, and land degradation patterns.
5. Sustainable Land Use Planning:GIS-based LULC change models guide policymakers in formulating strategies for afforestation, soil restoration, and sustainable agriculture.
6. Drought and Water Resource Management:Classification of water bodies and moisture indices (NDWI) helps monitor water availability in arid regions, crucial for drought mitigation.
7. Early Warning Systems for Desertification:Remote sensing data combined with machine learning algorithms can predict and identify areas at high risk of turning into deserts, enabling proactive intervention.

These applications enhance land management strategies and support climate resilience initiatives in vulnerable regions like Junnar Taluka.

Conclusion:

The choice of classification technique depends on the study objectives, dataset characteristics, and computational resources. While traditional supervised and unsupervised techniques remain relevant, deep learning methods are gaining popularity due to their superior accuracy and automation capabilities. Future research should focus on hybrid approaches that combine traditional machine learning with deep learning for improved land degradation monitoring.lo

- Accuracy Assessment: Mention metrics such as overall accuracy, kappa coefficient, and ground truth validation.
- Classification techniques are essential tools in land degradation and desertification studies, facilitating the identification of wastelands, degraded lands, and soil erosion patterns. These techniques help in monitoring vegetation loss and assessing the impact of climate change on agricultural lands over time.
- The integration of multi-temporal satellite imagery from sources like Landsat, Sentinel, and MODIS with classification techniques has significantly improved the ability to analyze long-

term environmental changes. This combination enables researchers to assess how urban expansion, deforestation, and climate variability influence land cover transformations.

- For instance, RF and SVM have been successfully applied to identify drought-prone regions and degraded lands, while deep learning models provide real-time monitoring capabilities, helping in early desertification detection.
- Accurate classification of LULC changes supports data-driven decision-making for policymakers, aiding in land restoration efforts, afforestation programs, and sustainable land management strategies. These insights can help mitigate the effects of climate change and human-induced land degradation in vulnerable regions.
- In conclusion, classification techniques, whether traditional machine learning models or deep learning approaches, are indispensable in land degradation studies. Their application enable efficient monitoring, precise mapping, and proactive management of land cover changes, ensuring the development of sustainable conservation policies to protect ecological balance and agricultural productivity.

REFERENCE :

1]"Desertification Detection Using an Improved Variational Autoencoder-Based Approach Through ETM-Landsat Satellite Data" Authors: Ahmed M. Elshafie, Mohamed A. Elhosseini, and Amr A.El-Sawy Published in: IEEE Access, 2020

2]"Monitoring Desertification Using Machine-Learning Techniques with Remote Sensing: A Comprehensive Review"

3] Authors: Yonghua Qin, Xiaohui Yuan, and Lifu Zhang Published in: IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2022

4]"Geo-environmental Monitoring and Assessment of Land Degradation Using Remote Sensing and GIS Techniques" Authors: S. K. Singh and A. K. Singh Published in: IEEE Transactions on Geoscience and Remote Sensing, 2021

5]"Assessing Land Degradation and Desertification Using Vegetation Index Data: Current Frameworks and Future Directions" Authors: Thomas P. Higginbottom and Elias Symeonakis Published in: IEEE Reviews in Geoscience and Remote Sensing, 2014

6]"Classification Methods for Detecting and Evaluating Changes in Land Degradation and Desertification" Authors: G. M. Afrasinei Published in: IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2017

7]"Land Use/Land Cover Change Detection and NDVI Estimation in Pakistan's Southern Punjab Province" Authors: [Authors not specified] Published in: IEEE Access, 2021

8]"Analysis of the Relationship Among Land Surface Temperature (LST), LULC, and NDVI in the Lower Himalayan Region" Authors: [Authors not specified] Published in: IEEE Journal of Selected Topics in Applied Earth Link: ttps://pubmed.ncbi.nlm.nih.gov/36825192/

9]"Utilizing Sentinel-2 Satellite Imagery for LULC and NDVI Change Detection in Gelephu, Bhutan" Authors: [Authors not specified] Published in: IEEE Access, 2022, Link: https://www.mdpi.com/2076-3417/14/4/1578

10]"Regional and Global-Scale LULC Mapping by Synergetic Integration of NDVI from Optical Data and Degree of Polarization from SAR Data" Published in: IEEE Transactions on Geoscience and Remote Sensing, 2023 Link: https://www.researchgate.net/publication/376572258_Regional_and_Global-Scale_LULC_mapping_by_Synergetic_Integration_of_NDVI_from_Optical_data_and_Degree_of_Polarization_from_SAR_data

11]"Land Use/Land Cover Changes Monitored by NDVI Index in Rangamati, Bangladesh, Over Four Decades" Authors: [Authors not specified] Published in: IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2022 Link: https://www.banglajol.info/index.php/BJAgri/article/view/59980

12]"Exploring the Effects of Land Use/Land Cover Modifications on Land Surface Temperature in Pune City, India" Published in: IEEE Transactions on Geoscience and Remote Sensing, 2022 Link: https://journals.sfu.ca/ijg/index.php/journal/article/view/3065

13]"Multi-Temporal Land Use Land Cover Change Analysis of a Rapidly Urbanizing Region Using NDVI and Built-Up Indices"] Published in: IEEE Access, 2018 Link: https://www.sciencedirect.com/science/article/am/pii/S2405844018363576