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"EVALUATION OF HUNSUR CITY URBAN EXPANSION USING PYTHON BASED GIS MODELING"

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Abstract:

Urban expansion in rapidly developing tier two cities poses a critical challenge to sustainable land management and ecological stability. This study evaluates the spatio temporal dynamics of urban growth and its environmental impacts in Hunsur City, Mysuru District, Karnataka, over a 30 year period from 1990 to 2020. Utilizing an integrated approach combining Remote Sensing (RS), Geographic Information System (GIS) tools and Python based computational modeling the research analyzes multi decadal changes in Land Use and Land Cover (LULC). Landsat satellite imagery (Landsat 8-9 OLI/TIRS Collection 2 Level 2) for the years 1990, 2000, 2010 and 2020 was processed using supervised classification techniques in ArcGIS to map built-up area transitions. To capture the spatial pattern and directional intensity of outward urban sprawl, a multi-ring buffer analysis was executed at 0.5 km concentric intervals extending up to 3.5 km from the city centre. Python programming libraries, including *rasterio*, *pandas* and *matplotlib* were used to quantify pixel-level urban expansion metrics map decade wise annual growth rates and generate logical raster change detection maps saved as spatial GeoTIFFs.

The findings reveal that Hunsur has experienced rapid outward spreading urbanization driven by natural population growth and intensified rural-to-urban migration. This rapid built-up expansion has caused significant environmental degradation across multiple spheres including a decline in local green cover accelerated groundwater depletion, increased surface runoff and heightened air, noise and water pollution. The concrete footprint of the city has also triggered a noticeable local Urban Heat Island (UHI) effect. By bridging remote sensing workflows with Python based spatial data modeling, this study establishes an empirical baseline of Hunsur's urban sprawl metrics. The outputs provide crucial spatial insights to assist urban planners and local municipalities in making data driven decisions, mitigating ecological vulnerability and design optimal infrastructure for a sustainable resilient urban future.

Keywords: Urban Expansion; Remote Sensing; GIS Spatial Analysis; Python GIS Modeling; Land Use Land Cover (LULC); Hunsur City; Sustainable Urban Planning.

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Introduction:

Urban expansion is the rate of expansion of an urban population and building areas. The (relative or absolute) increase in the number of people who live in Hunsur city and depends on the natural increase of the urban population and the population gained by urban areas through both net rural urban migration and the reclassification of rural settlements into taluk and villages.

Urban expansion is a critical aspect of city development especially in rapidly growing regions like Hunsur City, located in Mysuru District, Karnataka. As population increases and economic activities intensify, the demand for land, infrastructure and services also grows, leading to noticeable changes in land use patterns. Understanding and evaluating these changes is essential for sustainable urban planning and management. Geographic Information System (GIS) plays a vital role in monitoring, mapping and analyzing urban expansion over time [1, 2]. By using spatial data and satellite imagery, GIS enables accurate identification of land cover changes, growth trends and potential areas of future development. This paper focuses on evaluating the urban expansion of Hunsur City using GIS tools and techniques to provide a clear picture of how the city has grown over recent years. Through detailed spatial analysis the study aims to assess the extent, direction and impact of urban growth on natural resources and existing land use. The results can support urban planners and local authorities in making informed decisions to guide sustainable development reduce environmental degradation and improve infrastructure planning. By leveraging GIS technology this study contributes to a deeper understanding of urbanization patterns and helps in shaping a balanced urban future for Hunsur City.

IMPACTS OF URBANIZATION ON VARIOUS COMPONENTS OF ENVIRONMENT:

Urbanization in Hunsur City has led to significant changes in the natural environment, affecting various ecological components. As agricultural and forest lands are rapidly converted into residential, commercial and industrial zones the natural landscape is being replaced by built-up areas a pattern consistent with LULC transformation trends reported in other rapidly growing towns [3]. This has resulted in the loss of green cover and natural habitats causing a decline in local biodiversity. Water resources are also under stress due to increased surface runoff pollution from domestic and industrial waste and over extraction of groundwater [4, 5]. Poor waste management practices contribute to the contamination of land

and water, creating serious public health issues. Air quality has declined due to the rise in vehicular traffic, construction dust and burning of waste materials. The city's temperature is gradually increasing because of the Urban Heat Island effect where concrete and asphalt surfaces absorb and retain more heat. Noise pollution from traffic and construction adds further stress to the environment and human health. These environmental challenges not only degrade the ecosystem but also impact the quality of life for residents. Without proper planning and sustainable practices the continued growth of Hunsur may lead to irreversible environmental damage and reduced resilience to climate change and natural disasters.

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The study of urban growth and its impacts on Hunsur City is very important for both people and the environment. Over the past 40 to 50 years Hunsur has experienced rapid urbanization changing the way people live, work and interact. This growth has brought new opportunities such as improved infrastructure and lifestyle changes but it has also caused serious environmental challenges. Urbanization in Hunsur has led to pollution, water scarcity, loss of agricultural land and threats to natural ecosystems. The increase in population has put great pressure on land, water and other natural resources.

Many people have migrated from surrounding rural areas to Hunsur in search of better livelihoods. This has increased the demand for housing, food and water, often at the cost of forests and farmland being converted into urban areas. Groundwater levels in Hunsur are declining and pollution from industrial and domestic waste is a growing concern. Air pollution has also increased due to more vehicles and construction activities. These changes affect the atmosphere, biosphere, lithosphere and hydrosphere around Hunsur.

OBJECTIVES:

a) To Study the Land use and Land cover of the study area.

b) To asses the development of Hunsur city in different decades.

c) To analyse the rate of urban expansion through Python-based GIS Modeling.

METHODOLOGY:

The methodology of this study integrates remote sensing, GIS, and Python programming to assess urban expansion in Hunsur City from 1990 to 2020. The analysis involved satellite data classification, spatial modeling, and statistical evaluation to quantify and visualize the growth of built-up areas over a 30-year period.

Firstly, Landsat satellite images (Landsat 8-9 OLI/TIRS Collection 2 Level 2) for the years 1990, 2000, 2010 and 2020 were obtained from the USGS Earth Explorer. These images were classified using supervised classification techniques in ArcGIS software, following approaches similar to those used in remote sensing based urban growth monitoring [6, 7]. Each year's built-up land class was assigned a unique class code . Preprocessing steps included geometric correction, layer stacking and classification validation, followed by the generation of final LULC maps for all years.

To evaluate the spatial pattern of growth a multi-ring buffer analysis was performed by creating concentric zones (0.5 km intervals up to 3.5 km) from Hunsur city center using ArcGIS. These zones were overlaid on the LULC maps to quantify built-up areas in each ring helping assess how urbanization spread outward over time.

Urban growth quantification and modeling were done using Python. The number of built-up pixels from each classified raster was manually extracted and each pixel's area (30m x 30m = 0.09 ha) was used to calculate the total urban area for each year. A Python script using pandas,

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matplotlib and rasterio calculated decade-wise area changes, annual rates and percentage growth. These results were saved as a summary table and visualized using a line graph.

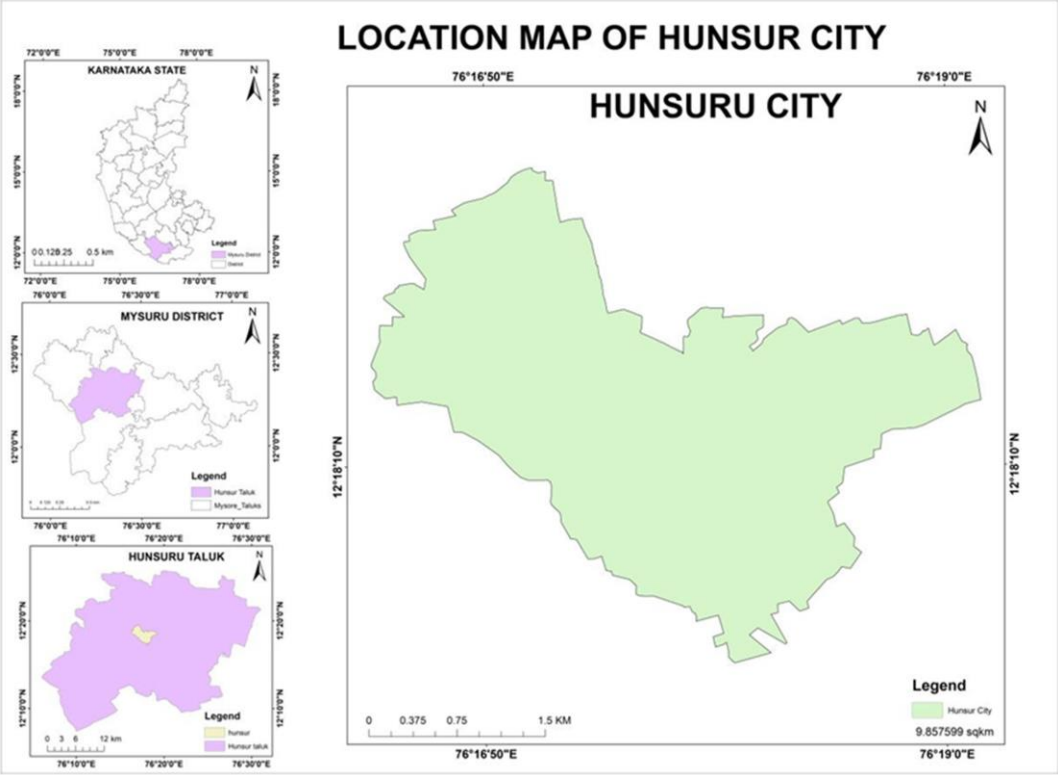
For spatial change detection, raster images from 1990 and 2020 were compared using logical operations to identify newly developed urban pixels a technique aligned with contemporary raster based change detection workflows in Earth observation research [8]. A raster map highlighting only the expansion areas was created and saved as a GeoTIFF using Python maintaining spatial metadata for further analysis.

LOCATION DETAILES OF STUDY AREA:

Hunsur is located in the Mysore district of Karnataka, India. It lies at Latitude range 12°17′15″ N to 12°19′31″ N and Longitude range 76°16′18.082″ E to 76°17′59″ E with an elevation of about 828 meters above sea level. The town is situated around 45 kilometers west of Mysuru and about 175 kilometers from Bengaluru.The town covers an area of 9.857599 square kilometers**.**

Hunsur is also located near the banks of the Lakshmana Tirtha River a tributary of the Kaveri River. This river plays an important role in the region's agriculture providing essential water for irrigation. The area surrounding Hunsur is fertile and supports the cultivation of crops

such as paddy, sugarcane, tobacco and vegetables. Because of this, the economy of Hunsur is largely based on agriculture and related activities [9].

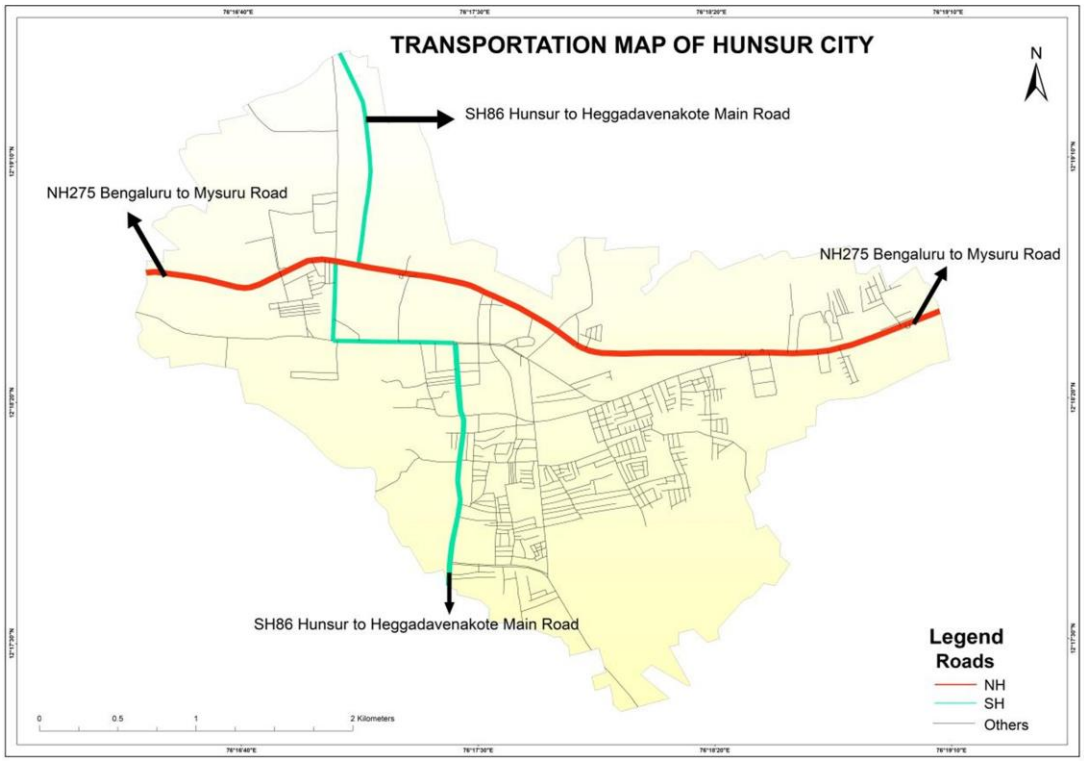


Location map of Hunsur city

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POPULATION DETAILES OF STUDY AREA:

Hunsur is a town located in the Mysore district of Karnataka, India. According to the 2011 Census the town had a population of 50,865 with an almost equal distribution between males (25,430) and females (25,435), resulting in a sex ratio of 1,000 females per 1,000 males. Children aged 0–6 years comprised 11.17% of the population numbering 5,680 individuals. The literacy rate in Hunsur stood at 81.07% surpassing the state average of 75.36% with male literacy at 85.89% and female literacy at 76.26%. The town spans an area of 11.76 square kilometers and is divided into 31 wards . Hunsur serves as the administrative center of Hunsur Taluk, which encompasses both urban and rural regions. The taluk had a total population of 282,963 as per the 2011 Census with 18% residing in urban areas and 82% in rural areas [9].



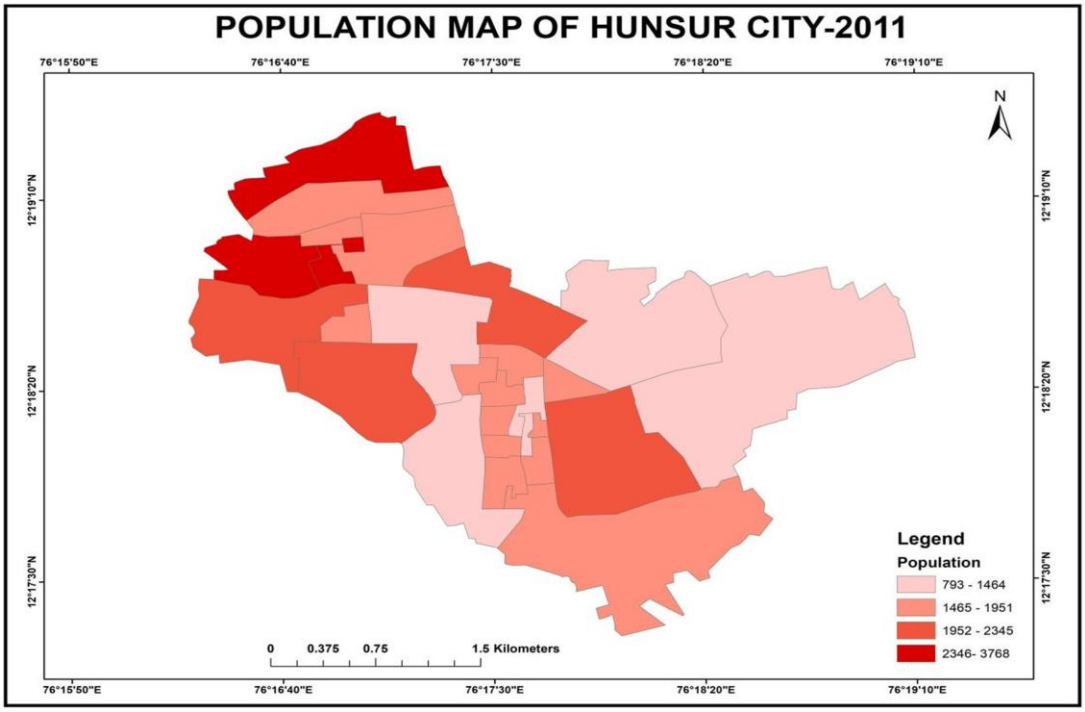
Transportation map of Hunsur City

Roads	Number Of Roads	Length in km
NH	4	5.28
SH	8	5.80
Others	312	65.05
Total	**324**	**76.15**

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Hunsur City is well connected by a network of roads, including national and state highways. The SH86 (State Highway 86) serves as the main road linking Hunsur to Heggadavenakote, facilitating regional travel. Additionally, the NH275 (National Highway 275) connects Hunsur to major cities like Bengaluru and Mysuru, ensuring seamless interstate transportation. The city's road infrastructure is categorized into NH (National Highways), SH (State Highways) and other local roads providing efficient connectivity for both commuters and freight transport.The transportation infrastructure of the study area includes a combination of national highways, state highways and other local roads, totaling 324 roads with an overall length of 76.15 kilometers. This road network plays a vital role in connecting

different parts of the region and facilitating the movement of people, goods, and services https://censusindia.gov.in/census.website/ .



Population Map Of Hunsur City

Objective 1: To Study the Land use and Land cover of the study area.

LAND USE AND LAND COVER OF HUNSUR CITY

In this study, Land Use and Land Cover (LULC) classification was performed using satellite imagery acquired from the United States Geological Survey (USGS). The data used includes Landsat Collection 2 Level-2 (C2L2) surface reflectance products from multiple Landsat missions. Specifically, Landsat 4-5 TM imagery dated 29 March 1990, Landsat 7 ETM+ imagery dated 16 May 2000, Landsat 8-9 OLI/TIRS imagery dated 24 April 2010 and Landsat 8-9 OLI/TIRS imagery dated 13 May 2020 were used for the analysis. All images correspond to Path 144 and Row 52. Landsat imagery is widely recognized for its consistent temporal availability, standardized radiometric corrections and 30 meter spatial resolution, making it well suited for long term land use and land cover studies. The years 1990, 2000, 2010 and 2020 were

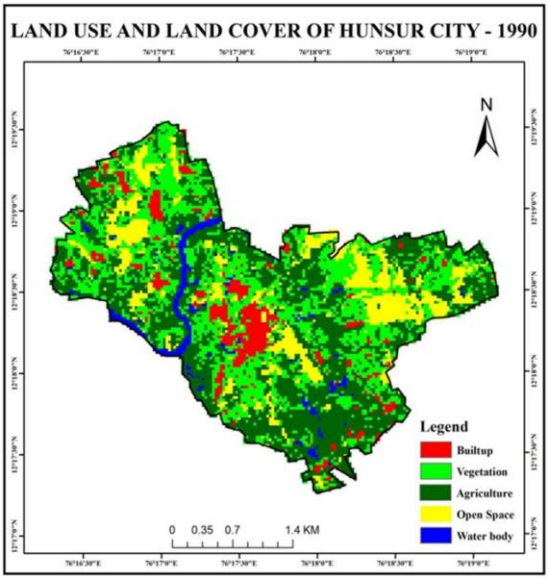
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specifically selected to capture decadal changes and assess the dynamics of land transformation over a 30 year period. This selection provides valuable insights into

patterns of urbanization, agricultural expansion, vegetation loss and other land cover modifications occurring within the study area.

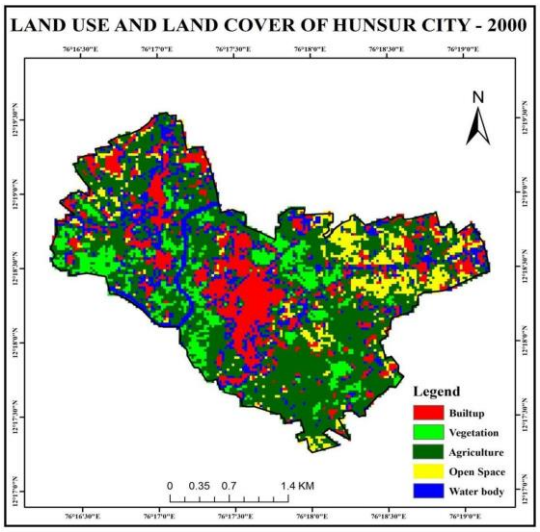
The entire process of LULC mapping was conducted using ArcGIS software a powerful tool in geospatial analysis and remote sensing. The methodology involved several important steps, beginning with image preprocessing to ensure geometric and radiometric corrections. This was followed by band composition and classification processes where different land cover types were categorized using techniques such as supervised or unsupervised classification.

Land use and Land cover in Hunsur City 1990



Class Name	Area (sq.km)	Area (%)
Agriculture	4.30	43.65
Vegetation	3.20	32.49
Open Space	1.50	15.23
Built-up	0.50	5.08
Water Body	0.35	3.55
Total	**9.85**	**100**

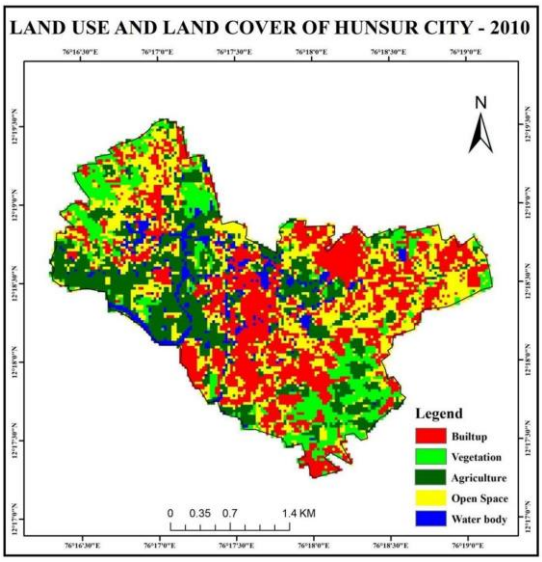
Land Use Land Cover in Hunsur city 2000



Class Name	Area (sq.km)	Area (%)
Agriculture	3.20	32.49
Vegetation	2.80	28.42
Built-up	1.60	16.24
Open Space	1.40	14.21
Water Body	0.85	8.63
Total	**9.85**	**100**

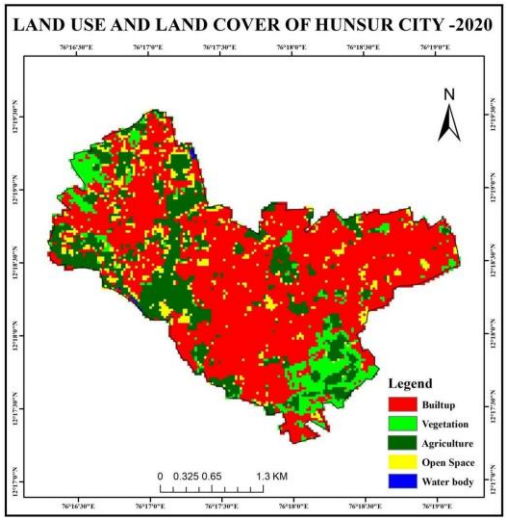
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Land Use Land Cover of Hunsur City 2010



Class Name	Area (sq.km)	Area (%)
Built-up	3.80	38.58
Agriculture	2.20	22.33
Vegetation	1.60	16.24
Water Body	1.15	11.68
Open Space	1.10	11.17
Total	**9.85**	**100**

Land Use Land Cover of Hunsur City- 2020



Class Name	Area (sq.km)	Area (%)
Built-up	6.50	65.99
Agriculture	1.30	13.20
Vegetation	0.90	9.14
Water Body	0.55	5.58
Open Space	0.60	6.09
Total	**9.85**	**100**

Objective 2: To asses the development of Hunsur city in different decades. In order to evaluate the spatial pattern and direction of urban expansion in Hunsur City a multi-ring buffer analysis was carried out using GIS techniques a method also employed to assess directional urban sprawl and expansion intensity in other regional contexts [10, 11]. This method helps in assessing how urban built-up areas expand concentrically from a central point outward over time. For this analysis, the central urban core of Hunsur was selected and marked as a point feature using ArcMap.

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LAND USE AND LAND COVER CHANGE COMPARISON 1990–2020

Class	1990 sqkm	2000 sqkm	2010 sqkm	2020 sqkm
Agriculture	4.30	3.20	2.20	1.30
Vegetation	3.20	2.80	1.60	0.90
Open Space	1.50	1.40	1.10	0.60
Built-up	0.50	1.60	3.80	6.50
Water Body	0.35	0.85	1.15	0.55
Total	**9.85**	**9.85**	**9.85**	**9.85**

Comparision Detailes in Square Kilometers

Class	1990 (%)	2000 (%)	2010 (%)	2020 (%)
Agriculture	43.65	32.49	22.33	13.20
Vegetation	32.49	28.42	16.24	9.14
Open Space	15.23	14.21	11.17	6.09
Built-up	5.08	16.24	38.58	65.99
Water Body	3.55	8.63	11.68	5.58
Total	**100**	**100**	**100**	**100**

Comparision Detailes in Percentage

The changing dynamics of land use and land cover over four decades (1990, 2000, 2010, and 2020) within a fixed study area of 9.85 sq.km. It clearly reflects the gradual yet significant transformation of land usage primarily due to rapid urbanization, socio-economic development and population growth.

Agricultural land, which accounted for 43.65% of the total area in 1990, witnessed a continuous and steep decline reaching just 13.20% in 2020. This represents a substantial loss of farmland likely caused by land conversion into urban uses and reduced dependence on traditional agriculture as urban employment opportunities expanded, a trend similarly documented in comparable LULC change studies [12].

Vegetation cover, including forests and plantations, also showed a downward trend from 32.49% in 1990 to 9.14% in 2020. This decline may be attributed to deforestation, land

degradation and the expansion of urban infrastructure. The loss of green spaces raises concerns about biodiversity, ecological balance and the reduction of ecosystem services such as carbon storage and air purification.Open space decreased from 15.23% in 1990 to 6.09% in 2020. These areas, often considered transitional or undeveloped lands were likely absorbed into built-up areas over time. Their reduction suggests that little vacant land remains for future development or ecological restoration.

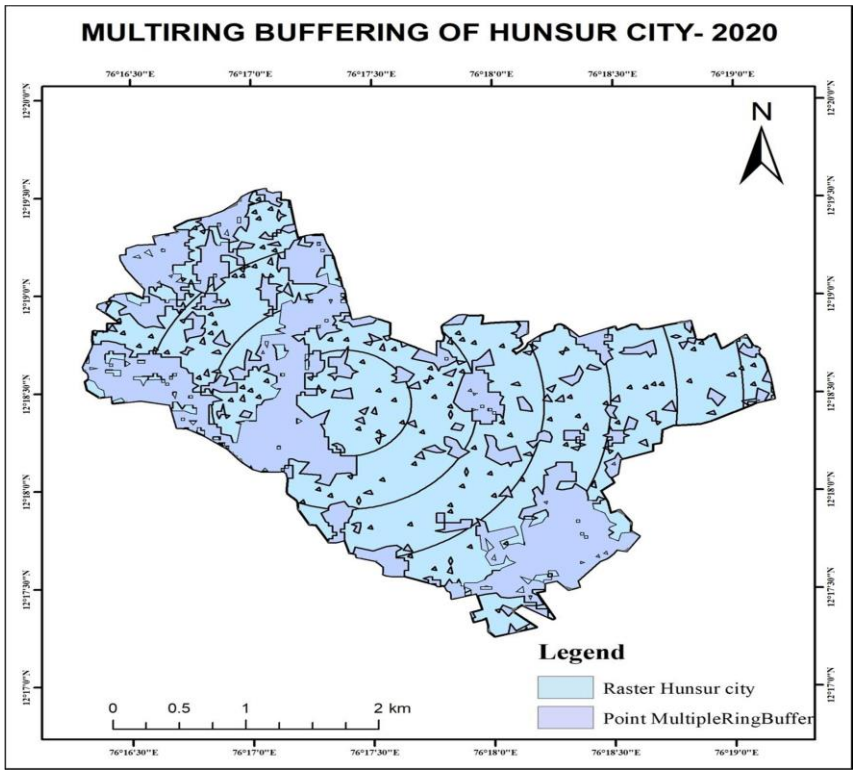
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Built-up area showed the most significant growth, increasing from a mere 5.08% in 1990 to a dominant 65.99% in 2020. This drastic increase indicates intense urban sprawl and infrastructural development, reflecting the growing demands for housing, transportation, industry and services. Such a change highlights the region's transformation from a rural or semi-rural setting into a densely urbanized landscape.Water bodies showed fluctuating trends increasing from 3.55% in 1990 to 11.68% in 2010, then decreasing to 5.58% in 2020. These changes could be the result of both natural variability (e.g., rainfall) and anthropogenic factors such as reservoir construction or encroachment.

In conclusion, this LULC comparison table offers strong evidence of the urban dominance taking shape over three decades. The data clearly reflect the loss of natural and agricultural lands, with built-up area becoming the primary land use by 2020. These findings stress the need for sustainable land use planning, ecological conservation, and resource management to mitigate the environmental impacts of rapid urban growth.

DEVELOPMENT OF HUNSUR CITY IN (2020)

A series of concentric buffer zones were then generated around this point at 0.5 km intervals, extending up to 3.5 km from the center. This was done using the Multiple Ring Buffer tool in ArcGIS, resulting in seven distance-based buffer zones (0.5 km, 1.0 km, 1.5 km, ..., 3.5 km). These buffer rings were overlaid on the classified Land Use and Land Cover (LULC) maps for various years (1990, 2000, 2010, and 2020) to quantify the spatial extent of built-up land within each zone.

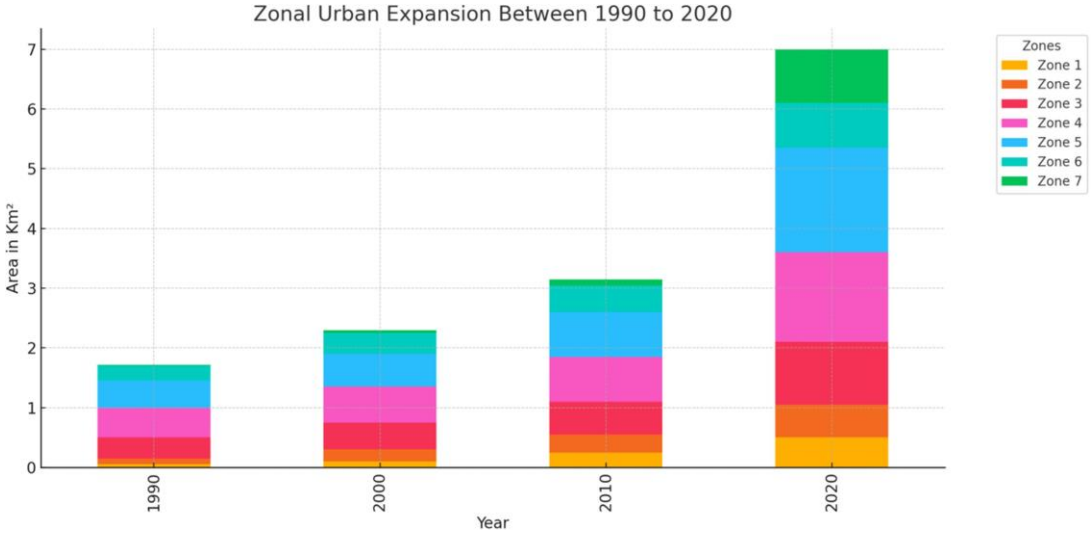


Multiring Bugger of Hunsur City 2020

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Zone(Km)	Zones	Area in sqkm
0 to 0.5	Zone 1	0.533
0.5 to 1	Zone 2	1.036
1 to 1.5	Zone 3	1.766
1.5 to 2	Zone 4	1.525
2 to 2.5	Zone 5	0.781
2.5 to 3	Zone 6	0.411
3 to 3.5	Zone 7	0.910

Multiring buffer Detailes of Hunsur City 2020



Urban Expansion by Zone Over Years

This graph shows how Hunsur City has grown outward from the center over time between 1990 and 2020. The city is divided into seven circular zone each 0.5 km wide. In 1990 and 2000, most development was close to the center (Zones 1–4), but from 2010 to 2020, the outer zones (especially Zones 3, 4, and 7) saw a big increase in urban area. Zone 3 had the highest growth and even Zone 7, which was almost empty before, grew a lot by 2020. This means the city has expanded rapidly in recent years, especially into the outer areas, showing clear urban sprawl.

Objective 3 : To analyse the rate of urban expansion through Python-based GIS Modeling.

RATE OF URBAN EXPANSION IN HUNSUR CITY (2010-2020) USING PYTHON BASED GIS MODELING

In this study effectively combines remote sensing classification with Python programming to produce a replicable urban growth modeling framework, building on earlier cellular automata and system dynamics based urban growth modeling approaches [1, 13]. The approach is low-cost, open source and highly customizable, making it suitable for use in similar studies in other towns or regions. The combination of numerical analysis, spatial change detection and graphical

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visualization provides a complete understanding of how and where urban growth is occurring. Such insights are essential for urban policy planning, land resource management, and designing sustainable development strategies for the future.

With the advancement of remote sensing and open source programming tools it has become easier to perform urban analysis over time using classified satellite imagery. In the present study, a Python based spatial analysis and modeling approach was adopted to assess the urban growth pattern of Hunsur City over a 30 year time span from 1990 to 2020. The main objective of the study was to quantify the growth of built-up areas over time determine the rate and percentage of expansion and spatially visualize where and how urban development has taken place. To achieve this, classified raster images derived from supervised classification of Landsat satellite imagery were used for the years 1990, 2000, 2010 and 2020. Each classified map contained unique class codes that represented land use categories, with specific codes assigned to the built-up or urban class for each respective year. These codes included class 6 for 1990, class 7 for 2000, class 51 for 2010 and class 69 for 2020.

URBAN EXPANTION OF HUNSUR CITY 1990-2020:

```
import rasterio
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import os
```

```
# Built-up pixel counts from classified maps
urban_pixel_data = {
    1990: {'class': 6, 'pixels': 873},
    2000: {'class': 7, 'pixels': 2031},
    2010: {'class': 51, 'pixels': 3545},
    2020: {'class': 69, 'pixels': 7088},
}
pixel_area_ha = 0.09  # each pixel = 30m x 30m
```

```
urban_areas = {}

for year, info in urban_pixel_data.items():
    ha = info['pixels'] * pixel_area_ha
    urban_areas[year] = ha
    print(f"Urban area in {year}: {ha:.2f} hectares")
```

```
Urban area in 1990: 78.57 hectares
Urban area in 2000: 182.79 hectares
Urban area in 2010: 319.05 hectares
Urban area in 2020: 637.92 hectares
```

Import Libraries, Class and Pixel Values 1990-2020

```
import rasterio
import numpy as np

# Use your actual file paths here:
path_1990 = r"D:\Project\3\EXPANSION\data_final\1990_super.img"
path_2020 = r"D:\Project\3\EXPANSION\data_final\supervised_2020_+hunsur_city.img"

# Load raster files
with rasterio.open(path_1990) as src1990:
    img1990 = src1990.read(1)

with rasterio.open(path_2020) as src2020:
    img2020 = src2020.read(1)
```

Defile Output Path and Laod Raster Filesto Array 1990-2020

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```python
# Create expansion raster (pixels that are built-up in 2020 but not in 1990)
urban1990 = img1990 == 6
urban2020 = img2020 == 69
urban_expansion = (urban2020) & (~urban1990)

# Save result
meta = src2020.meta.copy()
meta.update({"count": 1, "dtype": "uint8"})

output_path = r"C:\Users\sukru\OneDrive\Documents\OH_Project\03-Result\urban_expansion_1990_2020.tif"

with rasterio.open(output_path, "w", **meta) as dst:
    dst.write(urban_expansion.astype("uint8"), 1)

print("✅ Expansion map saved successfully.")
```

Define Built Up Pixel Value and Define Output Path 1990-2020

```python
# Path to your saved expansion raster
expansion_map_path = r"C:\Users\sukru\OneDrive\Documents\OH_Project\03-Result\urban_expansion_1990_2020.tif"

# Load the raster
with rasterio.open(expansion_map_path) as src:
    expansion = src.read(1)

# Display the map
plt.figure(figsize=(8, 6))
plt.imshow(expansion, cmap='Reds')
plt.title("Urban Expansion Map (1990 to 2020) - Hunsur City")
plt.colorbar(label="1 = New Urban Areas")
plt.axis('off')
plt.show()
```

Display Map 1990-2020

```python
import pandas as pd

# Built-up pixel data — update/add as needed
urban_pixel_data = {

    1990: 873,
    2020: 7088,

    # Add more years here if needed
}

pixel_area_ha = 0.09

def calculate_expansion(from_year, to_year):
    try:
        a1 = urban_pixel_data[from_year] * pixel_area_ha
        a2 = urban_pixel_data[to_year] * pixel_area_ha
        change = a2 - a1
        rate = change / (to_year - from_year)
        percent = (change / a1) * 100 if a1 else 0

        result = {
            "From": from_year,
            "To": to_year,
            "Start Area (ha)": round(a1, 2),
            "End Area (ha)": round(a2, 2),
            "Change (ha)": round(change, 2),
            "Rate (ha/year)": round(rate, 2),
            "Growth (%)": round(percent, 2)
        }

        df = pd.DataFrame([result])
        print(f"\n📊 Urban Expansion Summary ({from_year}–{to_year}):")
        print(df)
        return df

    except KeyError as e:
        print(f"❌ Error: Data for year {e} is missing. Please add it to urban_pixel_data.")

# ✅ Example: Just change these values for any comparison
calculate_expansion(1990, 2020)
```

Mathematical calculation using Pandas 1990-2020

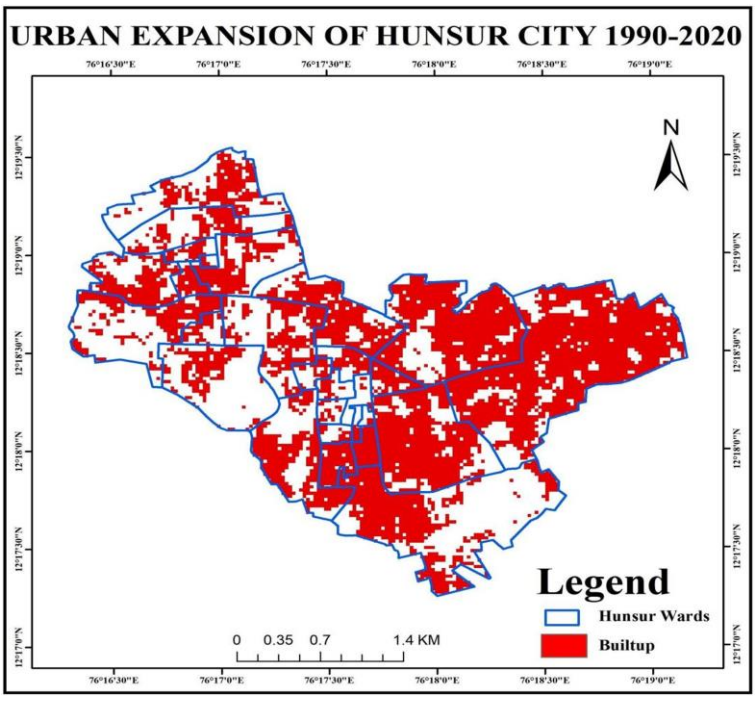
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	From	To	Start Area (ha)	End Area (ha)	Change (ha)	Rate (ha/year)	
0	1990	2020	78.57	637.92	559.35	18.64	

Result of 1990-2020

Over the span of three decades (1990–2020), Hunsur City underwent a dramatic transformation in terms of urban land expansion. In 1990, the built-up area was limited to 78.57 hectares, indicating a relatively small and compact urban footprint. By 2020, this had grown substantially to 637.92 hectares, resulting in a total increase of 559.35 hectares in built-up land. This represents a nearly 7 fold expansion in urban area highlighting the city's evolution from a modest town to a significantly developed urban center an expansion magnitude comparable to that reported for other rapidly urbanizing tier-two towns in similar geospatial studies [3]. The average annual expansion rate over this 30 year period was 18.64 hectares per year, reflecting long-term, sustained growth.This substantial change is linked to population migration from rural to urban areas, increased infrastructure development, and the conversion of agricultural and open lands into residential, commercial and industrial zones. During this period urban development spread both outwardand into peripheral areas, contributing to spatial sprawl. The expansion pattern also indicates intensified land use pressure, likely influenced by factors such as economic growth, administrative importance, road connectivity and the availability of basic urban services.

This continuous urban growth, while indicative of development, also calls attention to environmental concerns such as reduction in green spaces, pressure on water resources, and increased carbon emissions from transportation and construction. The trend from 1990 to 2020 clearly emphasizes the need for sustainable urban planning strategies to manage further growth in a balanced and ecologically responsible manner.



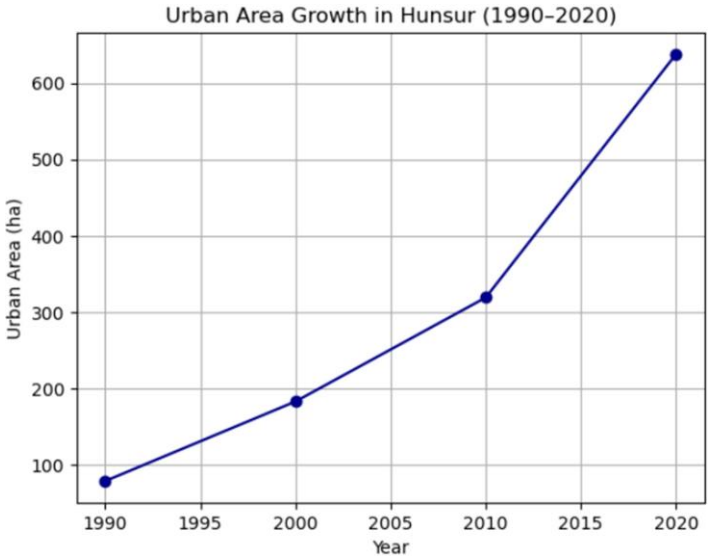
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Urban Expantion Rate of Hunsur City 1990 -2020

years	Start Area (ha)	End Area (ha)	Change (ha)	Rate (ha/year)
1990 - 2000	78.57	182.79	104.22	10.42
2000- 2010	182.79	319.05	136.26	13.63
2010-2020	319.05	637.92	318.87	31.89
1990-2020	78.87	637.92	559.35	18.64

Expansion rate detailes

```
plt.plot(list(urban_areas.keys()), list(urban_areas.values()), marker='o', color='darkblue')
plt.title("Urban Area Growth in Hunsur (1990-2020)")
plt.xlabel("Year")
plt.ylabel("Urban Area (ha)")
plt.grid(True)
plt.show()
```

Plotting Graph 1990-2020



Urban Expansion Rate in Hunsur City 1990- 2020

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RESULT AND CONCLUSION

The project titled "Evaluation of Urban Expansion of Hunsur City Using Python Based GIS Modelling" focuses on analyzing the spatial and temporal patterns of urban growth in Hunsur City over a 30 year period from 1990 to 2020. Hunsur, a growing town in Mysuru district of Karnataka, has witnessed significant urban transformation due to increasing population pressure, infrastructure development and socio-economic changes. The study aims to systematically evaluate this urban expansion using advanced geospatial techniques, with a strong emphasis on satellite data processing, spatial analysis and GIS based modeling.

The study is structured around three key objectives. The first objective was to generate land use and land cover (LULC) maps for the years 1990, 2000, 2010 and 2020. This was achieved by downloading Landsat satellite imagery and performing supervised classification using ArcGIS. Each LULC map was categorized into major classes including built-up,

agriculture, vegetation, open space and water bodies. The built-up areas were extracted using specific class values (6, 7, 51, and 69 for respective years), and their spatial extent was calculated using pixel based area computation.

The results of this study clearly highlight the pattern of urbanization growth in Hunsur City over the past 30 years. The analysis shows that urban growth has consistently increased year by year primarily driven by the rising urban population. One of the major contributing factors to this expansion is the migration of people from rural to urban areas resulting in a significant increase in population density within the city limits. The comparative land use data reveals that a large portion of land was transformed into built-up area particularly between 1990 and 2020 during which approximately 559.38 hectares of land was converted to urban use.

It was found that Hunsur's built-up area grew from 78.57 hectares in 1990 to 637.92 hectares in 2020, marking a 711.68% increase. Spatial change detection was performed by comparing classified rasters to identify newly urbanized pixels and urban expansion maps were created for each decade using Python and rasterio. These maps were then enhanced in ArcMap with north arrows, scale bars, legends and coordinate grids.

In addition to population growth, industrialization has also played a role in shaping the urban landscape. However, this has led to some environmental challenges, especially concerning water pollution. The presence of small industries, expansion of transportation infrastructure, installation of mobile network lines, water pipelines and wastewater lines along with water supply from the Lakshmana Thirtha Dam has contributed to the deterioration of water quality in Hunsur. Similarly, increased transportation and vehicle usage have resulted in higher carbon dioxide emissions thereby contributing to air pollution and a noticeable rise in local temperatures.

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CONCLUSION:

In this study, GIS techniques were effectively used to identify the spatial pattern of urban growth in Hunsur City both in the present and over past decades. The analysis provided a clear picture of how urban population expansion has led to significant land use changes. The construction of new roads, buildings, parks, playgrounds, hotels and small industries has rapidly transformed the landscape, occupying vast areas that were once open or agriculturally productive. As the population has increased, so has the demand for water and land, along with the generation of solid waste which poses serious environmental concerns for the city.

The conclusion of this project emphasizes that unchecked urbanization is leading to environmental degradation. Natural ecosystems are being destroyed and the balance of the environment is being disturbed. There is an urgent need to protect environmental features and ensure sustainable development to preserve resources for future generations. The research further suggests that detailed analysis of each developmental activity is essential to understand the broader ecological impact of urban growth. By doing so, stakeholders can make informed decisions that prioritize both development and conservation.

Ultimately, it is our collective responsibility to make this planet livable for future generations through the wise use of natural resources. Immediate action must be taken to address environmental issues caused by urban expansion and strong efforts should be made to promote sustainable urban planning that protects the Earth for the years to come.

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