International Journal of Multidisciplinary Research and Development
www.allsubjectjournal.com
Online ISSN: 2349-4182, Print ISSN: 2349-5979
Received: 30-04-2022, Accepted: 16-05-2022, Published: 31-05-2022
Volume 9, Issue 5, 2022, Page No. 151-154

Spatio-temporal dynamics of urban-rural settlements: A case study of Alwar District, Rajasthan

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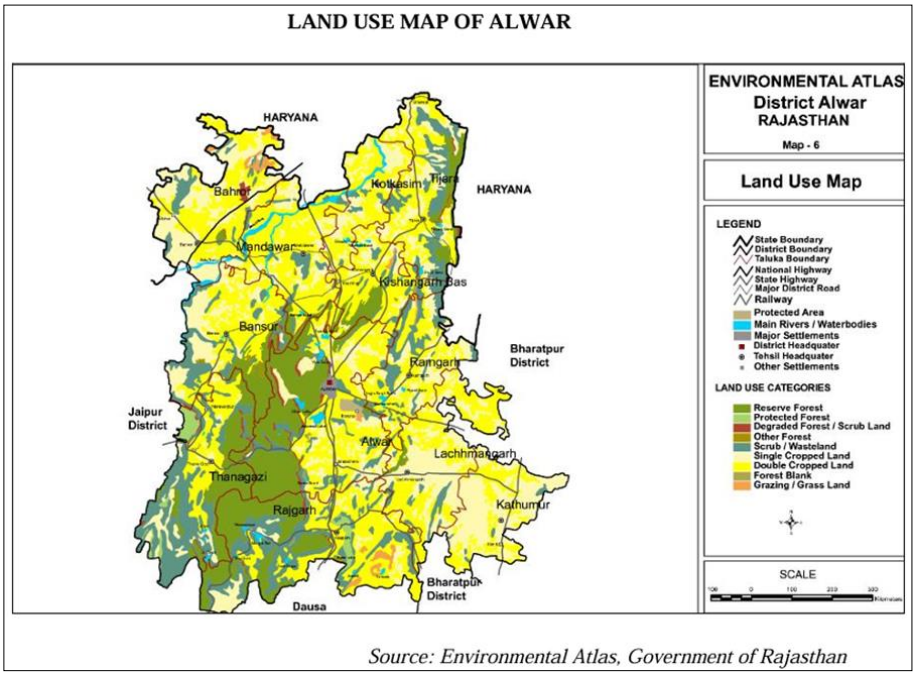
Abstract
Alwar District, situated in the northern region of India, presents a fascinating landscape marked by rapid urbanization juxtaposed with traditional rural settlements. Through the utilization of Bhuvan Thematic service data of Land Use Land Cover (LULC) this study aims to comprehensively analyse the evolution of settlements within the district over time. By harnessing the capabilities of Bhuvan LISS3 satellite imagery, the research delineates the spatial extent and distribution of urban and rural settlements with high precision. Through spectral analysis and image classification algorithms, the study discerns land cover changes, identifying urban expansion and rural expansion in Alwar District in 10 years. Furthermore, temporal analysis of multi-temporal satellite images allows for the identification of trends and patterns in settlement dynamics, shedding light on the drivers and consequences of urban-rural transitions. The research also integrates socio-economic data, demographic information, and environmental variables to contextualize the findings within broader development paradigms. By examining the impact of settlement dynamics on livelihoods, infrastructure, and environmental sustainability, the study offers insights into the socio-economic implications of urbanization in Alwar District. Other than settlement data this research also focus on agriculture dynamics of Alwar District.Ultimately, this research contributes to a deeper understanding of the complex interplay between urban and rural dynamics in Alwar District, facilitating informed decision-making for sustainable development and equitable growth in the region.

Keywords: LULC, settlement, sustainability, urbanization

Introduction
Economic development and population growth have initiated swift transformations in the Earth's land cover throughout the past two centuries, and all indications suggest that the rate of these alterations will intensify in the coming years. These rapid changes overlay long-term dynamics linked with climate variability (Roy, n.d.). Although population growth is widely acknowledged as a significant factor contributing to changes in land cover, the impact of unplanned human settlements is often overlooked and not sufficiently recognized (Muriuki *et al*., 2011) [6]. Integrating geographic information systems (GIS) and remote sensing techniques with landscape ecological methodologies is used to analyses concentrate on significant forces operating on the Earth's surface, including the intersection of agricultural and urban areas, agriculture and forestry, and other relevant subjects concerning environmental policy and management (Nagendra *et al*., 2004) [7]. Urban spatial expansion has surged in recent decades, with urban population growth rates outpacing overall population growth in many cities. This trend is attributed to urban areas serving as hubs of economic activity and transportation (Horo & Punia, 2019) [3]. Over the past five decades, urban areas have undergone rapid spatial expansion, with urban population growth rates surpassing overall population growth in most countries. This phenomenon can be attributed to urban areas serving as the focal points for economic activity and transportation networks (Masek *et al*., 2000) [5]. India ranks as the world's second most populous country, with a population exceeding 1.21 billion people, accounting for 17.5% of the global population (*Home | Government of India*, n.d.). Undergoing rapid urbanization, India is experiencing significant alterations in its land cover and land use (Punia & Singh, 2012) [8]. Alwar has been identified as a key regional priority town in the National Capital Region Plan-2021 by the Government of India, with plans for it to become a significant focal point for the region (Dhingra *et al*., 2017) [1]. As the district headquarters, Alwar is the largest town in the Rajasthan sub-region, covering an area of 8,380km^2, constituting 24.5% of the total National Capital Region and 2.5% of the state of Rajasthan (Kannan, n.d.).

Study Area
Alwar district, located in the northeastern part of the state of Rajasthan, India. Alwar serves as a significant gateway to Rajasthan from the northern region of India and is situated between 27º03' and 28º14'North Latitude and 76º7' and 77º13' East Longitudes. Alwar district is characterized by diverse landscapes, including plains, hills, and forests, contributing to its rich ecological and cultural heritage. It shares borders with Bharatpur district (Rajasthan) to the north and northeast, Mahendragarh district (Haryana) to the northwest, Jaipur district (Rajasthan) to the southwest, and Dausa and Jaipur districts (Rajasthan) to the south The district comprises 12 tehsils and 14 panchayat samities, namely Behror, Mandawar, Kotkasim, Tijara, Bansur, Kishangarh Bas, Alwar,

Ramgarh, Thanagazi, Laxmangarh, Rajgarh, and Kathumar, each with its unique socio-economic and environmental characteristics This study aims to investigate the spatio-temporal dynamics of urban-rural settlements within Alwar district, focusing on factors such as population growth, land use changes, infrastructure development, and socio-economic transformations over time. The research will utilize geographic information systems (GIS), remote sensing techniques, and socio-economic surveys to analyse and interpret the spatial and temporal patterns of settlement dynamics.

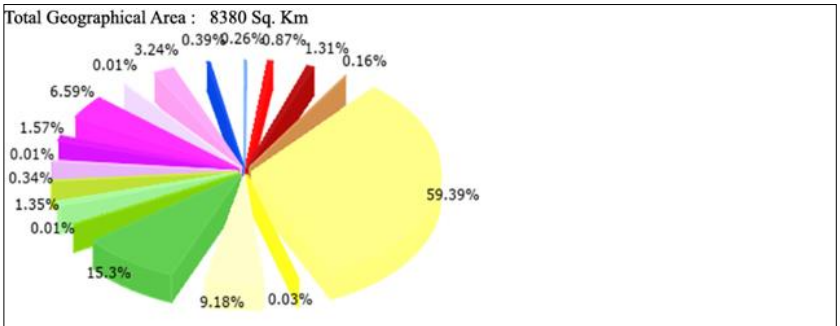


Source: Environmental Atlas, Government of Rajasthan

Fig 1

Methodology

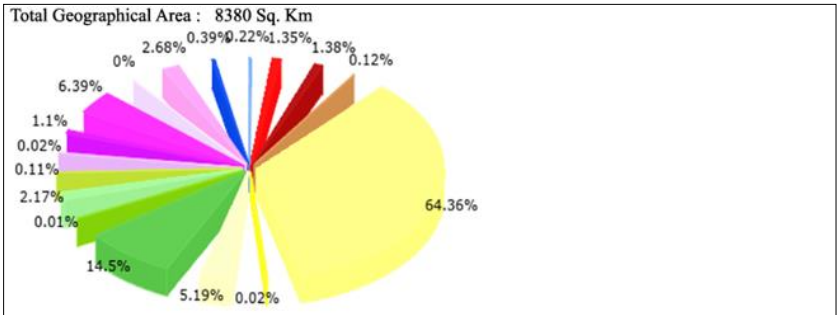
To investigate the spatial disparities in urban-rural settlements within Alwar District, Rajasthan, multi-temporal satellite imagery from Resourcesat-1 and Resourcesat-2 LISS III covering the years 2005-06, 2011-12, and 2015-16 has been employed, utilizing Bhuvan and Google Earth Engine platforms. Additionally, Survey of India toposheets at a scale of 1:50,000 have been referenced. Land Use and Land Cover (LULC) data sourced from Bhuvan has been utilized and interpreted specifically for settlement analysis.



LULC Class	Area (Sq.Km)	LULC Class	Area (Sq.Km)
Builtup,Urban	72.72	Builtup,Rural	109.63
Builtup,Mining	13.74	Agriculture,Crop land	4977
Agriculture,Plantation	2.48	Agriculture,Fallow	769.05
Forest,Deciduous	1282.55	Forest,Forest Plantation	0.43
Forest,Scrub Forest	112.89	Grass/Grazing	28.5
Barren/unculturable/ Wastelands, Salt Affected land	1.15	Barren/unculturable/ Wastelands, Gullied/Ravinous Land	131.18
Barren/unculturable/ Wastelands, Scrub land	551.95	Barren/unculturable/ Wastelands, Sandy area	0.43
Barren/unculturable/ Wastelands, Barren rocky	271.85	Wetlands/Water Bodies, River/Stream/canals	32.63
Wetlands/Water Bodies, Reservoir/Lakes/Ponds	21.82		
Total			8380.00

Source: Bhuvan, ISRO

Fig 2: LULC Information (2005-06) for Alwar



LULC Class	Area (Sq.Km)	LULC Class	Area (Sq.Km)
Builtup,Urban	112.94	Builtup,Rural	115.37
Builtup,Mining	10.29	Agriculture,Crop land	5393.01
Agriculture,Plantation	1.66	Agriculture,Fallow	434.61
Forest,Deciduous	1215.15	Forest,Forest Plantation	0.43
Forest,Scrub Forest	181.93	Grass/Grazing	9.04
Barren/unculturable/ Wastelands, Salt Affected land	2.08	Barren/unculturable/ Wastelands, Gullied/Ravinous Land	92.3
Barren/unculturable/ Wastelands, Scrub land	535.16	Barren/unculturable/ Wastelands, Sandy area	0.05
Barren/unculturable/ Wastelands, Barren rocky	224.91	Wetlands/Water Bodies, River/Stream/canals	32.44
Wetlands/Water Bodies, Reservoir/Lakes/Ponds	18.61		

Source: Bhuvan, ISRO

Fig 2: LULC Information (2015-16) for Alwar

Table 1: Land use land cover classification of rural and urban settlement

S.No.	Classes (km^2)	2005-06 (km^2)	2015-16 (km^2)
1.	Urban Settlement	72.72	112.94
2.	Rural Settlement	109.63	115.37
Total		182.35	228.31

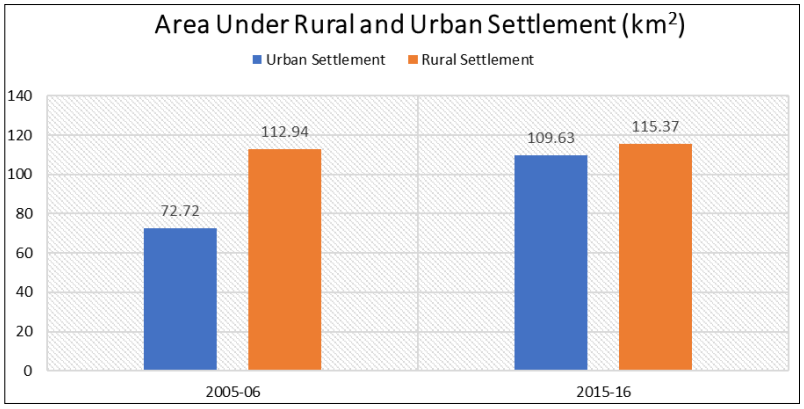


Fig 1

Result

The geographic research on the spatio-temporal dynamics of urban-rural settlements in Alwar District, Rajasthan, utilizing secondary land use land cover data from LISS3 satellite imagery, reveals notable changes in settlement patterns over the study period. Analysis of the data indicates the following spatio-temporal dynamics:

Urban Settlements

- In 2005-06, the urban settlement area in Alwar District was measured at 72.72 km^2.
- In 2015-16, the urban settlement area had expanded significantly to 112.94 km^2, indicating a substantial increase over the decade.

Rural Settlements

- In 2005-06, the rural settlement area in Alwar District covered approximately 109.63 km^2.
- By 2015-16, the rural settlement area experienced a slight increase, reaching 115.37 km^2.

These findings suggest a notable expansion of urban settlements in Alwar District over the study period, accompanied by a modest increase in rural settlement areas.

Conclusion

The research underscores the dynamic nature of settlement patterns in Alwar District, Rajasthan, and the implications for land use planning and development. The significant expansion of urban settlements highlights the growing urbanization trend in the region, likely driven by factors such as population growth, economic development, and infrastructure expansion. The observed increase in urban settlement areas underscores the need for sustainable urban planning strategies to manage land use change, address infrastructure demands, and mitigate environmental impacts. Such strategies may include promoting compact development, improving transportation networks, and enhancing green spaces to ensure liveability and environmental quality in urban areas. Meanwhile, the slight increase in rural settlement areas indicates ongoing changes in rural land use patterns, possibly influenced by factors such as agricultural expansion, rural development initiatives, and demographic shifts. Understanding these dynamics is crucial for informing policies and interventions aimed at promoting balanced regional development, preserving rural livelihoods, and safeguarding natural resources. Overall, the spatio-temporal analysis of urban-rural settlements in Alwar District provides valuable insights into the evolving landscape of human habitation and land use in the region. Continued monitoring and analysis of settlement dynamics are essential for informed decision-making and sustainable development planning in Alwar District and similar contexts.

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