International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 04 April 2024
Page No: 988 - 993
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0138

Utilizing Aerial Photography to Trace the Development of Urbanization in the Chennai District

K. Hemalatha[1], R. Kamali[2], R. Pushpalatha[3], M. Saranya[4], P. Vijayalakshmi[5]
[1,2,3,4,5]Assistant Professor, Computer Science and Engineering, Knowledge Institute of Technology, Kakapalayam, Salem and India.
Emails: *khcse@kiot.ac.in[1], rkacse@kiot.ac.in[2], rplcse@kiot.ac.in[3], msaranya.mce@gmail.com[4], pvcse@kiot.ac.in [5]*

Abstract
Chennai, India is growing more urbanized by the day, hence studying its development is essential. We may see the world from a bird's-eye viewpoint thanks to aerial photography, a method for taking pictures of the Earth's surface from an elevated position—typically from an aircraft or drone. Scientific research, land surveying, urban planning, environmental monitoring, and mapping are just a few of the applications for these photos. Using remote sensing techniques, we are able to examine and record changes in Chennai's physical terrain over time, allowing us to trace the city's evolution through these aerial photos. ArcGIS, ERDAS, ENVI, Pix4D, Global Mapper, and QGIS were among the programs we used to process and examine the aerial photo data. Through the help of these software programs, users can extract insightful data and useful information from photos taken by satellites, drones, or airplanes. When compared to satellite images, aerial photography frequently produces imagery with a better spatial resolution, enabling more accurate and thorough study of ground-based objects. Through a comparative analysis of maps produced using aerial photography data throughout time, we have discovered that Chennai is losing open land, green spaces, and water bodies because of its growing urbanization. By closely analysing this trend and taking into account various factors, we can forecast the continued growth of Chennai.
Keywords: *Aerial photography; Chennai; Global Mapper; GIS.*

1. Introduction
Urban growth means more people living in a city or area. This usually brings more money, more things to buy, and higher prices for things, and better living conditions. It is good for a city and a country as long as we also take care of nature. If we destroy nature to make room for buildings and roads, it can cause problems like droughts and shortages of water. Preserving the urban environment is essential to mitigate disasters and maintain biodiversity across the nation by safeguarding a plants and animals in the country. Urbanization is vital to a nation's ability to advance economically. As the country's economy grows, the living conditions of individuals improve and more people move from countryside to cities. The main factors influencing this movement are the career prospects and the accessibility of high-quality healthcare and education. On the other hand, excessive urban growth frequently results in the conversion of other terrain types, such deforestation or dried-up water bodies. The ecosystem and soil fertility may suffer as a result. Chennai, population to 7 million people in 2001, is the fourth-biggest metropolitan accumulation in India. Chennai, the largest metropolis in southern India, is situated in the state of Tamil Nadu. Chennai was the principal administrative and commercial hub of the Madras Presidency during its early years, acting as its capital. The State of Tamil Nadu has selected Chennai as its capital in more recent times. The city boasts two robust industrial and tertiary sectors, contributing to its diverse economic foundation. Chennai is India's primary hub for car manufacturing and assembly, and it's becoming more and more popular as a back office and IT hub. Chennai is rapidly expanding both economically and demographically, much like other major Indian cities (see Tables 1 and 2). Between 1990–1 and 2002–2003, Chennai's GDP expanded by 13% annually on an annual compound average

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 04 April 2024
Page No: 988 - 993
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0138

basis. Chennai and other major Indian cities have seen substantial increases in population. The population of Chennai increased by 2.3% year between 1981 and 2006. Although this number is strong, it is not as high as the 2.99% growth rate for Indian cities. Indian cities had never heard of the concept of urbanization before to the late 1960s. However, Indian cities have developed significantly since then for a variety of reasons. The promise of jobs has been the main attraction for people from rural areas to move to metropolitan places. Chennai, one of the four largest cities in India, is a prime illustration of this progress, having become urbanized through the supply of the required infrastructure and amenities. Over the past thirty years, Chennai has seen substantial urban growth that has brought it closer to urban agglomeration.

2. Literature Review

Through a lens focused on Chennai, the coastal metropolis of India, the article delves into the worldwide phenomenon of urbanization and its impact on fostering sustainable urban development. It emphasizes how metropolitan areas are mapped using Earth Observation (EO) photos and how crucial this data is to the procedures involved in urban planning. The two unique land regions in Chennai that are the subject of the study have diverse land uses. It quickly locates urban areas by using fully-polarimetric L-band ALOS-2 Synthetic Aperture Radar (SAR) data. Using the same training dataset, the paragraph compares and evaluates Wishart and Support Vector Machine (SVM), two supervised classification techniques. According to the results, SVM performed better in categorizing urban and non-urban areas than the Wishart algorithm [1]. This paper examines the problem of urban sprawl in the United States, which is caused by swift population increase, and the negative consequences it has on forests, agricultural areas, and ecosystem services. The paragraph illustrates the absence of US quantification and prediction in the region using Chennai, India as a case study. The work uses Renyi's entropy to measure US and Random Forest (RF) categorization on Landsat imagery from 1991, 2003, and 2016 to close this gap. The findings indicate a notable growth in urban regions, especially at the periphery of suburban areas, with a twofold rise in the US between 1991 and 2016. Spatial measures show that agricultural and forest regions are becoming more fragmented and that existing urban areas are becoming denser. According to predicted data, there will be a significant increase in urbanization of agricultural and forest lands in the US by 2027. Urban planning authorities can lessen the social-ecological impacts of the US and maintain ecosystem services by using the useful insights and metrics provided by this study.[2] The study reveals unplanned growth by examining urban sprawl over a 20-year span in the cities of Ranchi, Jamshedpur, and Dhanbad. It analyzes urban sprawl and maps changes in land use and cover using visual interpretation of Landsat and IRS-P6 satellite imagery. Core urban areas in Dhanbad and Jamshedpur are becoming denser due to population increase and the saturation of urban regions within municipal limits. Ranchi's rapid built-up growth is accompanied by a declining population density, which points to low-density development. Poor land-use practices are highlighted by the conversion of Ranchi's agricultural land to built-up areas. Between 1986 and 2005, 103.6 km2 of land were converted into built-up areas throughout the cities. The study highlights how crucial it is for future urban development in these agglomerations to follow government city development plans.[3] The negative impacts of fast urbanization on natural systems and people are discussed in the paragraph, including the rise of Urban Heat Islands (UHI) and reduced surface permeability. It highlights how crucial thorough evaluations of surface permeability and UHI are to efficient urban development. In Tirunelveli, Tamil Nadu, India, the study shows the advantages of combining pictures from several sensors to evaluate changes in temperature, surface permeability, and land use and cover. The research attains superior classification accuracy while utilizing a Rotation Forest (RF) method to merge information from many sensors, as opposed to non-fused images. According to the data, Tirunelveli saw a rise in urban areas and a decline in vegetated areas between 2007 and 2017. There were also notable increases in surface temperature, notably in urban built-up regions, and significant decreases in surface permeability, especially in urban areas. Additionally, the study points out possible UHI hotspots in built-up areas in the southeast and cautions about the Western Riparian Zone. All things considered, our findings provide useful information for monitoring surface permeability, temperature, and urban heat island (UHI) and demonstrate the advantages of satellite image fusion for urban planning and management.[4] The paragraph discusses the detrimental effects of sprawling cities (US) caused by fast population increase on forests, fertile agricultural lands, and ecosystem services. It highlights how crucial it is to quantify the US in order to control the environment and design cities effectively. The study uses Landsat imagery from 1991, 2003, and 2016 as a case study and uses Random Forest (RF) classification to identify urban regions within a 10 km suburban buffer. Chennai, India is used as the study location. Renyi's entropy is used to quantify the size of the US and finds that, between 1991 and 2016, there was a notable increase in the number of urban areas, primarily towards the suburban outskirts of Chennai. According to the research, by 2027, more woods and agricultural lands would have been converted into urban areas, underscoring the urgent need for action to address the social-ecological effects of US and protect ecosystem services.[5] This paper explores the Urban sprawl is the global phenomenon of cities expanding due to migration and population increase; it is most noticeable in nations with high population densities, such as India. Infrastructure and natural resources are being strained by this explosive growth. In order to forecast future growth, urban planners use data, including satellite photos and geographic information systems (GIS), to analyze the pace and pattern of urban expansion. In order to identify and forecast the causes that lead to urban sprawl, this article explores metrics for measuring it and uses geographic information systems to analyze city expansion over a thirty-year period.[6] This paper covered the Chennai is expanding quickly and become more and more urbanized. Therefore, it's critical to examine its growth. These days, we can extract a wealth of important data from satellite photos using cutting-edge technologies like GIS and remote sensing. This aids in our comprehension of the city's demands and how it is growing. With these methods, we may monitor changes in Chennai's urban expansion since last thirty years, from 1989 to 2019. We use tools such as ArcGIS and ERDAS Imagine to create maps that illustrate Chennai's yearly land-use patterns derived from Landsat satellite imagery.We can observe the expansion and changes to the city by comparing these maps throughout time. According to the data, Chennai is becoming more urbanized, with less green spaces, bodies of water, and open spaces. With the use of this data, we can forecast how the city will develop going forward.[7] This paper This study looked at changes in how land was used in Tirupati, a city area, from 1976 to 2003. We used maps and satellite images to do this. In 2003, we looked at a satellite image and a map from the Survey of India. By comparing what we saw on the ground and in the pictures, we divided the area into eight different types of land. When we compared land use in 1976 to 2003, we found more buildings, forests, plantations, and other uses. However, due to the city growing quickly, we also noticed that a lot of farmland, water bodies, and dense forests disappeared during this time. There was no mining in the region in 1976, but we saw a small increase in mining areas by 2003.[8] The paper that followed discussed urban sprawl, which is the phenomenon of cities expanding globally because of an increase in population. Largely populated areas like India are particularly impacted by this. Natural resources are being rapidly depleted by the expanding cities. To ensure that everyone has access to amenities like electricity, water, and toilets, urban planners must monitor the rate of urbanization and its geographic expansion. There are insufficient basic facilities in many locations without this information. We can track the expansion of cities using data collected over time and satellite pictures. This aids in our comprehension of and ability to forecast the distribution of cities. This essay examines the way cities have expanded during the last thirty years using GIS and Remote Sensing [9]. The topic of this paper was the Using satellite imagery, this study looked at Kolkata's development between 1990 and 2015. It examined seven distinct metropolitan neighborhoods, noting a rise in urbanization and a decline in agriculture and open spaces. Due mostly to the conversion [10] of agricultural land, built-up land increased by 16.6% between 1990 and 2000 and by 24.5% between 2000 and 2015. The city grew more

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 04 April 2024
Page No: 988 - 993
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0138

quickly in some areas than others, especially those close to the river and the city center. [11] Comprehending these alterations facilitates the planning and management of future urban growth. Identifying locations that require repair was made easier with the help of GIS tools and satellite pictures.

3. Method

3.1. Aerial Photography

Utilizing aerial photography offers multifaceted benefits across various fields. In urban planning and development, it aids in assessing land use patterns, facilitating infrastructure projects. [12] It also plays a crucial role in environmental monitoring, tracking changes like deforestation and habitat loss to understand ecosystem impacts. Aerial photography is vital in disaster response, enabling damage assessment and rescue planning. Moreover, it facilitates precise surveying, essential for cartography and GIS. [13] Additionally, it supports infrastructure planning and maintenance, agricultural activities like crop monitoring, and forestry management. Aerial photography also contributes to preserving cultural heritage through archaeological research and assists in real estate assessment and infrastructure planning. Overall, it serves as a cornerstone for informed decision-making, efficient resource management, and sustainable development initiatives across diverse sectors. Experimental Input Parameters for AP shown in Table 1.

Table 1 Experimental Input Parameters for AP

Year	Parameter	Area (sq.km)	Change
1991-2021	Built-up area	102 to 295	Increased
1991-2021	Vegetation	23% to 17%	Reduced
2031	Built-up area	688	No Change
2041	Built-up area	718	No Change
2051	Built-up area	750	
2101	Built-up area	864	72% of the CMA's total land area
2051	Agricultural	346 to 289	Decreased
2051	Waterbodies	153 to 152	Drop from the present (13%) of the CMA

4. Results

4.1. Pre-Processing

Pre-processing includes reconstruction of images and rectification techniques to address geometric and radiometric data abnormalities specific to satellite platforms. Figure 1 shows Pre-Processing signal that is transmitted from the target to the sensor may also be weakened by environmental factors. [14]

4.2. Geometric Correction

Geometrical rectification is one of the preprocessing techniques used to provide a spatial coordinate system for the gathered satellite image. It is also known as georeferencing. [15]

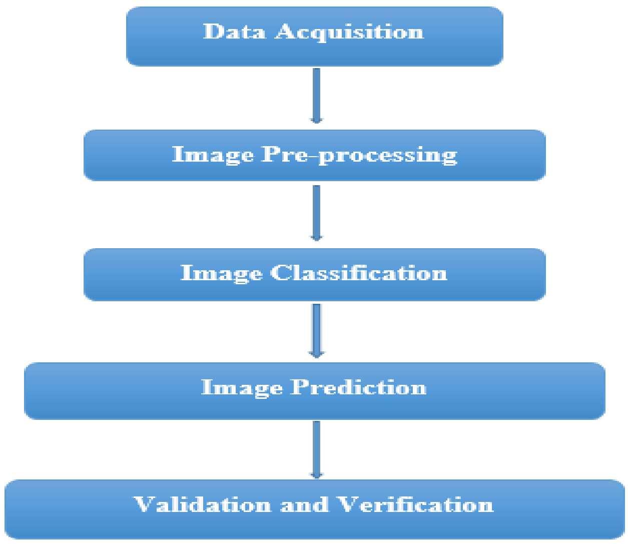

Figure 1 Pre-Processing

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 04 April 2024
Page No: 988 - 993
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0138

4.3. Land Use / Land Cover Map Analysis

Maps of land use and cover are crucial resources for determining how various geographical features are distributed within a given border. Over the past thirty years, cities' land use and vegetation areas have experienced considerable changes, and it is critical to assess how beneficial these changes have been. To comprehend the trends in growth and development throughout time, it is required to compare land use and vegetation cover (LULC) maps from different areas. [16] In the instance of the city of Chennai district, the region is demarcated using satellite imagery, and ArcGIS software is used to generate the LULC map's layout and legends. [17] For distribution, a classified map of land use covering the research years of 1989 through 2019 has been created. Classified values from the given below

- Urban
- Barren Land
- Water Bodies
- Vegetation
- Agricultural

Figure 2 & 3 shows accurate unsupervised satellite image classification is achieved by cross-referencing with Google Earth's satellite images. District-level Classified LULC maps for Chennai have been created for the years 1989–2030. [18]

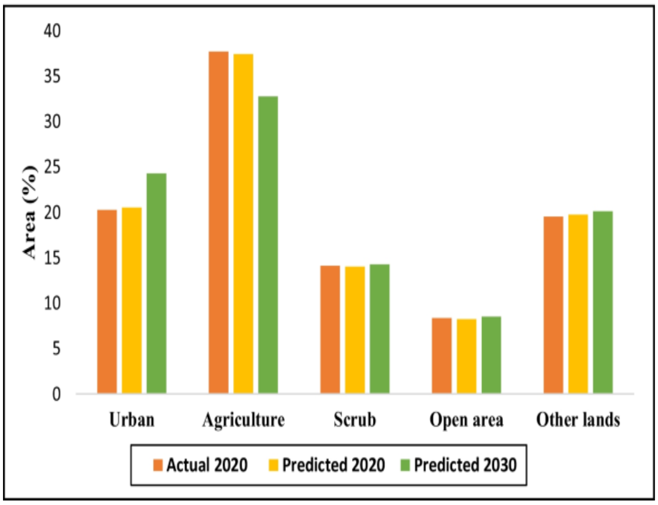

Figure 2 Unsupervised Satellite Image Classification

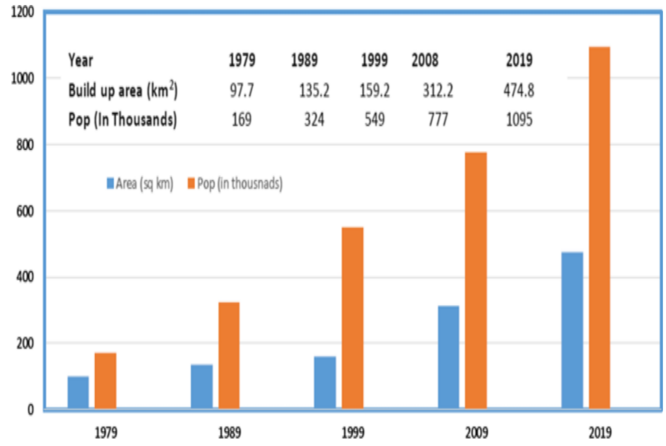

Figure 3 District-Level Classified LULC Maps

Conclusion

In conclusion, the city's existing green space per capita is 8.75 square meters per person, which is less than the 9.5 square meters per person that the World Health Organization recommends. In the years 1989 to 2030, Chennai's built-up area increased significantly from 102 square kilometers to 295 square kilometers. At the same time, the city's vegetation cover decreased from 23% to 17%, from 101.9 square kilometers to 74.35 square kilometers. Looking ahead, projections indicate further growth in the built-up area, which is expected to reach 656 sq.km in 2021, expanding to 688 sq.km by 2031, 718 sq.km by 2041, and 750 sq.km by 2051, within a total study area of 1,207 sq.km. By the end of 2101, it is forecasted that the total built-up area will escalate to 864 sq.km, constituting a significant 72% of the CMA's total area. The surge in built-up area is expected to significantly reduce agricultural lands, declining from 346 sq.km to 289 sq.km by 2051. Additionally, urban expansion and infrastructure development will contribute to the decline of waterbodies and vegetation. Waterbodies, currently covering 13% of the CMA, are projected to decrease to 152 sq.km by 2031 and further to 145 sq.km by 2051. Eventually, waterbodies are anticipated to cover only 10% of the CMA's total area by 2101.

References

[1]. Dhanashri S. Kanade, V. S. K. Vanama, Sanjay Shitole "Urban area classification with quad-pol L-band ALOS-2 SAR data: A case of Chennai city, India", 2020.

[2]. Rajchandar P.; Bhowmik A. K.; Cabral P.;

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 04 April 2024
Page No: 988 - 993
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0138

Zamyatin A.; Almegdadi O.; Wang S. Modelling Urban Sprawl Using Remotely Sensed Data: A Case Study of Chennai City, Tamilnadu. Entropy 2017, 19, 163.

[3]. Amit Kumar, Arvind Chandra pandey, "Evaluation of urban sprawl pattern in the tribal-dominated cities of Jharkhand state, India",2011

[4]. Rajchandar Padmanaban, Avit Kumar Bhowmik, Pedro Cabral" Satellite image fusion to detect changing surface permeability and emerging urban heat islands in a fast-growing city",2019

[5]. Rajchandar Padmanaban, Avit K. Bhownik, "Modelling Urban Sprawl Using Remotely Sensed Data: A Case Study of Chennai City, Tamilnadu"2017

[6]. Sudhira.H.S, T.V.Ramachandra, K.S.Jagadish, "Urban sprawl: metrics, dynamics and modelling using GIS"

[7]. Muhammed Ahsan Mahboob, Iqra Atif, Javed Iqbal, "Remote Sensing an GIS Applications for Assessment of Urban Sprawl in Karachi, Pakistan"

[8]. Praveen Kumar Mallupattu and Jayarama Reddy Sreenivasula Reddy, "Analysis of Land Use/Land Cover Changes Using Remote Sensing Data and GIS at an Urban Area, Tirupati, India".

[9]. Tamilenthi.S,J. Punithavathi,R. Baskaran, K.Chandramohan, "Dynamics Of Urban Sprawl, Changing Direction And Mapping: A Case Study Of Salem City, Tamilnadu ,India".

[10]. Mehebub Sahana, Haoyuan Hong "Analyzing urban spatial patterns and trend of urban growth using urban sprawl matrix: A study on Kolkata urban agglomeration, India".

[11]. Shalini Dhyani, Shruti Lahoti, Shubhankar Khare, Paras Pujari, Parikshit Verma, "Ecosystem based Disaster Risk Reduction approaches (EbDRR) as a prerequisite for inclusive urban transformation of Nagpur City, India"

[12]. Prakasam.C, R. Aravinth, Varindar S. Kanwar, "Land Use Land Cover Change Detection & Urban Sprawl Study: A Case Study on Shimla Tehsil, Himachal Pradesh, India".

[13]. Muchoney Dougfas M, Bary N. Haack, "Ghange Detection for Monitoring Forest Defoliation"

[14]. Muhammed Ahsan Mahboob, Iqra Atif, Javed Iqbal, "Remote Sensing an GIS Applications for Assessment of Urban Sprawl in Karachi,Pakistan"

[15]. Neelankantan, S.Mishra, M.M.Tewari, H.K.,"Characterization and microbial utilization of humic acid in Hissar soil."

[16]. Prakasam.C, R. Aravinth, Varindar S. Kanwar, "Land Use Land Cover Change Detection & Urban Sprawl Study: A Case Study on Shimla Tehsil, Himachal Pradesh, India".

[17]. Praveen Kumar Mallupattu and Jayarama Reddy Sreenivasula Reddy, "Analysis of Land Use/Land Cover Changes Using Remote Sensing Data and GIS at an Urban Area, Tirupati, India".

[18]. Pilon, P. G., Howarth, P. J., and Bullock, R. A., "An enhanced classication approach to change detection in semi-arid environments. Photogrammetric Engineering and Remote Sensing".