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STUDY ON URBAN SPRAWL AND ITS IMPACT ON LANDUSE/LANDCOVER OF SILCHAR CITY

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Abstract : Unplanned urban expansion has changed the land use and cover (LULC), especially in emerging cities and towns. Due to minimal or inadequate planning efforts and rapid urban population increase, many Indian cities are experiencing issues with unexpected LULC transformation. The Silchar Municipal Corporation is among one of those urban agglomeration which faces such issues. The current study evaluates the LULC's trajectory using Landsat imageries acquired in 2014 and 2023. The spatial depiction of four classes of built-up, waterbody, barren agricultural land and dense vegetation shows a significant amount of change for the year 2014 to 2023. Therefore, the study's spatial data are intended to aid in understanding the dynamics of urban expansion and the pattern of changing land cover. The outcome can help decision-makers, stakeholders, and other government agencies to make the best decisions possible with relation to scarce land-based resources to secure an economically successful and environmentally sustainable future. Additionally, to comprehend the urban space and its planning as a result of urban densification and city development, a general evaluation questionnaire survey was conducted in Silchar. It describes the problems and challenges faced by urban space as densification processes evolve. To emphasize the urgent problems that needed to be resolved, additionally AHP (analytic hierarchy process) survey was conducted with local architects, structural engineers, government employees and professors on the concerns and challenges that had been found.

IndexTerms **- GIS, Urban planning, Urban expansion, Landuse/Landcover change, AHP, Public survey, Silchar municipal corporation.**

1.INTRODUCTION

"Cities are here to stay, and the future of humanity is undoubtedly urban". Due to their higher standard of life and stable economic viabilities, urban areas have seen a rapid increase in human population around the world. Over the next three decades, the global urbanization rate will increase, rising from 56% in 2021 to 68% in 2050 -." – world city report UN.

Cities in the developing world have seen fast urban growth as a result of the development(Singh Bijender, 2014). Additionally, whether intentional or not, urban development in most metropolitan regions puts a huge strain on peri-urban ecosystems(Colantoni et al., 2016). One of the main causes of urban sprawl is unprecedented population expansion brought on by migration(Siegel, n.d.). Urban sprawl is the phrase used to describe the phenomena of growing urban areas occupying a larger percentage of the available land area(Oueslati et al., 2015).
In contrast to the four megacities that make up the majority of the country's population—Delhi, Mumbai, Kolkata, and Bangalore—one-quarter of the 100 million additional urban people predicted in India by 2030 would dwell in smaller or secondary cities like Agartala, Imphal, Tiruppur, and Tirupati(Bloomberg, 2016). Large metropolitan areas have historically been the centre of urban policy studies, with minor cities often receiving less attention(Andreasen et al., 2017). Despite mounting evidence that mid-sized cities are crucial for the growth of national economies and secondary cities are anticipated to have a stronger impact on the future economic growth of countries and bigger geographic areas.

Currently, our nation is dealing with a significant urban expansion challenge. Although urbanization has been a tool for social, political, and economic advancement, it has also resulted in significant socioeconomic issues.
The primary contributors to this state of affairs are the sheer size of the metropolitan population, the haphazard and uncontrolled expansion of urban areas, and a critical shortage of infrastructure. Public services including housing, sanitation, transportation, water, energy, health, and education are under a lot of strain due to the fast increase of the metropolitan population, both naturally and via migration.
The rural immigrant population is plagued by poverty, unemployment, underemployment, beggarly, thievery, dacoities, burglaries, and other social ills. Precious agricultural land is being quickly encroached upon by urban expansion.

The Cachar district's administrative centre is located at Silchar, Assam, close to the Bangladesh's border on the banks of the Barak River. Approximately 343 kilometres separate the city from the state's capital, Guwahati, and it is linked to these locations via roads, railroads, and air routes. Geographically, it is 35 meters above mean sea level between 24° 22′ N latitude to 93°24′ E longitude. With a total population of 3,26,907(Census of India, 2011), it has an area of 125.80 square kilometre and 42 wards.
The Silchar Municipality Corporation oversees city administration. The city's climate is classified as humid subtropical, with average annual temperatures ranging from 29 °C in the summer to 19 °C in the winter, and average annual rainfall of 2134.5 mm. As one of the most significant administrative and economic centres of Assam, Silchar City is currently renowned as a trading and processing hub for tea, rice, and other agricultural goods.

There is a void in the urban literature of Silchar due to the dearth of comprehensive research on urban expansion and its dynamics. Therefore, the current work uses remote sensing and geographic information system approaches to examine changes in land use and land cover (LULC) as well as to determine the kind of urban expansion in the city.
The study's objectives are to create a map of Silchar's land use and land cover using pictures from the Landsat series taken between 2014 and 2023, as well as to analyze and evaluate the kind and extent of land use and land cover change.

Again, through an analysis of user happiness using random public survey, this research also assesses the adequacy of urban planning. Additionally, the goal of this study was to serve as an indicator of urban planning performance based on aspects like transportation, urban sprawl, waste management, environmental context, quality of life, and crime-monitoring for the city's location and to provide recommendations for the Silchar Municipality Corporation's future work in managing urban planning.

Additionally, the Analytical Hierarchy Process (AHP) model has been used to prioritize the concerns related to various facets of urban planning that were identified during the Silchar random public survey. Software called Expert Choice is used to apply the AHP and may provide results that can be seen visually.

2.RESEARCH FRAMEWORK

2.1 DATA

Due to recent delineation of city boundary of Silchar in the year 2022, the study area has now been identified and a time frame of 2014 to 2023, over a period of 8 years was established to study the change in LULC. For the study LANDSAT 8 OLI-TIRS for the year 2014 and LANDSAT 9 OLI-TIRS for the year 2023 satellite imagery was used. Given that there was less than 8% cloud cover, the images were taken in the months of March 2023 and April 2014.
Topographical maps for the study were collected from Silchar Municipality Board and Google Earth Images.

In this research, we also examine the urban quality of life for the Silchar city's development. As a beginning point, a survey with a random sample of participants was conducted.
The survey resulted in a public prioritization of urban issues generated into the current urban realm. A sample size of 321 numbers participated in the survey.

Finally in addition, an analytical hierarchy procedure was employed to rank the concerns identified by the performed random public survey. One of the approaches for multi-attribute decision making that is most often employed is the analytical hierarchy process (AHP). Thomas Saaty created the AHP in 1977 with the intention of assisting decision-makers in incorporating both qualitative and quantitative elements of a complicated issue with many subjective criteria(Lee & Park, 2020).
A total of 24 samples were taken to conduct the AHP survey of which 4 numbers of architect, 12 numbers of civil engineer, 12 numbers of government employee and 5 numbers of university professor were selected.

2.2 DATA PRE-PROCESSING

The research area boundary map was scanned and turned into a digital raster picture using ArcGIS 9.3 software (www.esri.com). It was georeferenced to WGS 84 datum and geometrically corrected using the closest neighbor resampling approach.
In order to subset the Landsat imageries relevant to the research region, the Silchar Municipal Corporation (yet to be announced) boundary vector layer was produced using on-screen digitization. The 60*60 m Landsat data was resampled to 30*30 m pixels in order to match all the datasets to the same pixel size, and the snap raster function was used to fix the pixel mismatch issue(Dhanaraj & Angadi, 2022) (Fig.1).

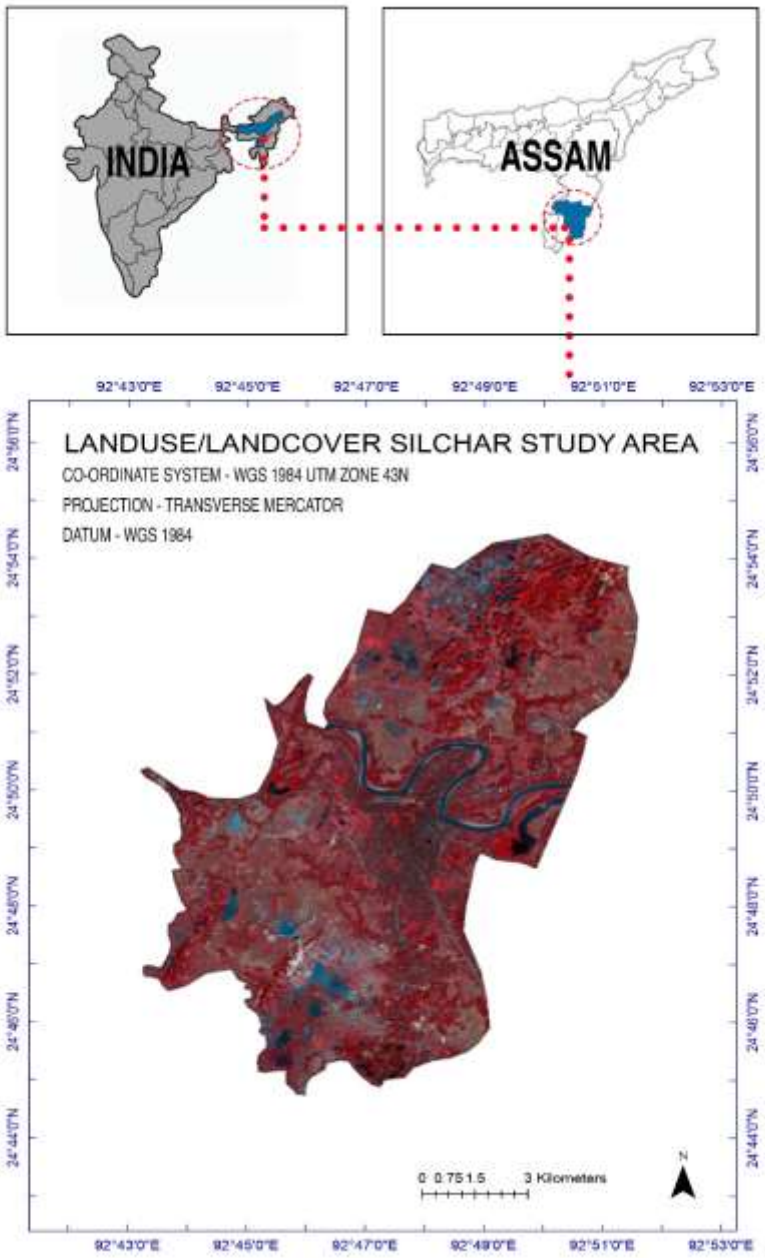

Fig.1 Location of study area.

For the public evaluation of the city, the questionnaire focuses on "urban issues," thus it's important to assess its "questionnaire suitability" to the current index of urban problems in order to gauge how well-accepted and understandable these indices are by city's regular residents (Fig.2).

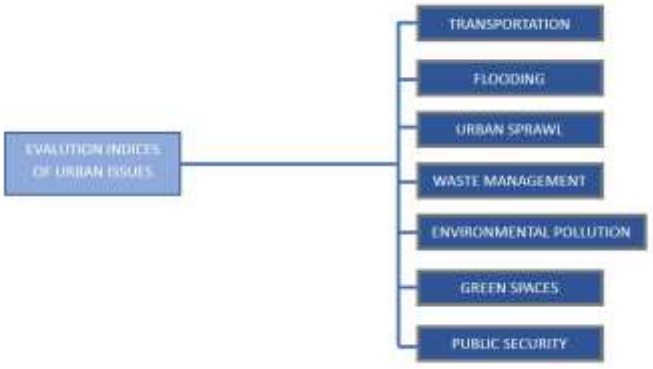

Fig.2 Framework for questionnaire on urban issues.

Based on the literature research and expert interviews, an AHP model was created (Fig.3). Additionally, a pairwise comparison format was used in the creation of an AHP questionnaire to indicate the relative relevance of the various criteria and aspects. The

significance ratings were based on a scale of 1 to 9, with 1 representing equal relevance and 9 being the overwhelming importance of one item over another(Lee & Park, 2020) (Table 1).

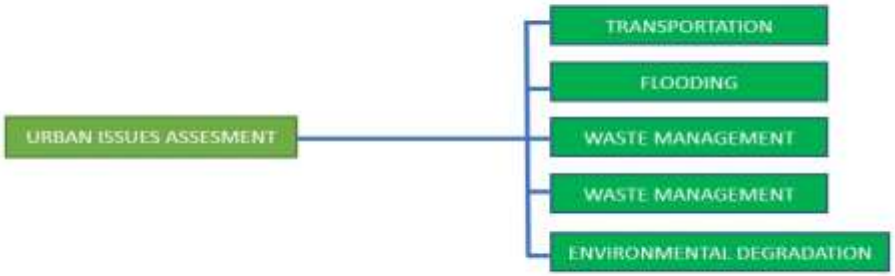

Fig.3 Model for Analytical Hierarchy Process.

INTENSITY OF RELATIVE IMPORTANCE	DEFINITION
1	Equal importance
3	Weak importance
5	Essential or strong importance
7	Demonstrated importance
9	Absolute importance
2,4,6, and 8	Intermediate values between two adjacent judgments

Table 1. Analytical Hierarchy Process pairwise comparison scale.

2.2 DATA POST-PROCESSING

For mapping all the land use/cover classes, the most popular image classification approach, maximum likelihood classification, was utilized once the classification scheme had been created. Google Earth photos and empirical study of satellite imagery were thoroughly examined before the selection of training samples (Table 2)(Bhat et al., 2017).

LULC CATEGORY	CLASS INCLUDED GENERAL DESCRIPTION
BARREN/AGRICULTURAL LAND	Irrigated agricultural area and agricultural fallow land
BUILT-UP	Settlements and roads
DENSE VAGETATION	Land with tree canopy density more than 40%
WATERBODY	Areas covered by perennial river and other watershed

Table 2. Description of different LULC categories.

For each LULC class and each year taken into consideration (2014 and 2023), an accuracy evaluation was done using 40 random ground locations. For the photos from 2014 and 2023, respectively, overall accuracy of 87.72% (= 0.83) and 89.83% (= 0.86) was attained. It is typically regarded as sufficient for a remotely sensed data collection to have an overall accuracy of 85%(Pawe & Saikia, 2018).

According to standard procedure in the network for public opinion surveys, survey accuracy (maximum permissible sample error) is associated to survey respondent variance, assumed confidence coefficient, and sampling technique in addition to sampling size(Fan, 2015). Since there are now roughly 1,79,000 people living in urban areas in Silchar City, a sample of 321 people was chosen for the survey, which has a guaranteed 95% confidence level and a 5% margin of error.

The rankings were created using Expert Choice, decision-making software created to execute the AHP(Lee & Park, 2020). For the purpose of ranking the assessment items, all comparisons were combined. Based on the overall relevance cited by the participants, the AHP's result was a prioritised ranking of the assessment elements.

2.2 METHODOLOGY FLOWCHART

The study's methodology flowchart is organized according to the sequence in which it was carried out. The first step in the research is to discover the LULC pattern (Fig. 4), which helps to pinpoint the problem area. The second step is to identify the problems by a random public poll (Fig. 5) and the third step is to execute an analytical hierarch process to rank the problems that were found (Fig. 6).

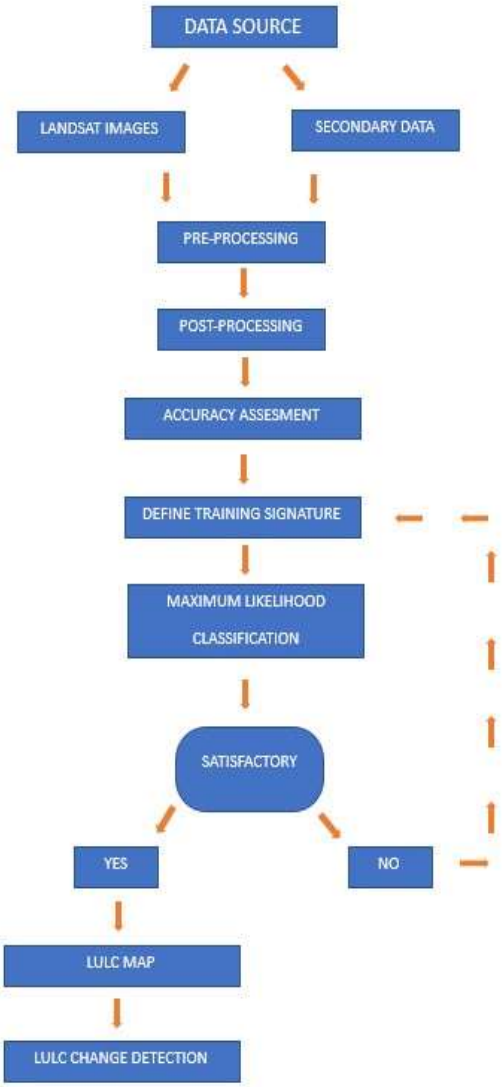

Fig.4 Flowchart of the methodology used in the LULC study.

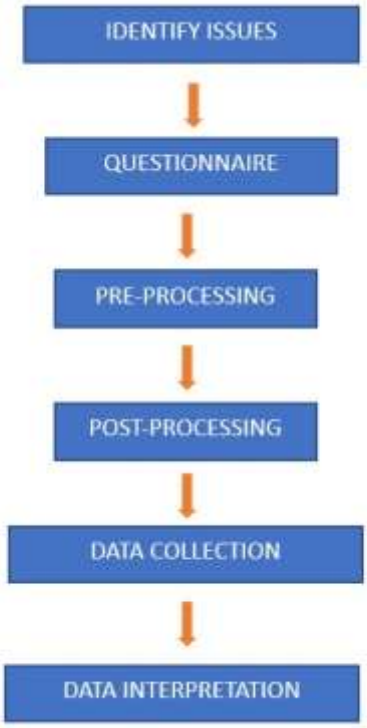

Fig.5 Flowchart of the methodology used in the random public survey study.

Fig.6 Flowchart of the methodology used in the analytical hierarchy process study.

3.RESULT

3.1 LANDUSE/LANDCOVER CHANGE

Although just 31.30 percent of the population of India lives in urban agglomerations or towns, it is one of the least urbanized nations in the world and is now experiencing a severe urban growth dilemma.

Given their vulnerability as one of the planet's most delicate ecosystems, the Himalayan Mountains are also undergoing an urban revolution. Urban expansion is quickly encroaching on the valuable land, which is affecting the area's land use and land cover.

The surrounding ecosystems, land resources, the shape and layout of the urban region, and ultimately quality of life are all directly impacted by the present trend of urban expansion(Bhat et al., 2017). Silchar City is the research location, where over the last several years, the neighborhood has seen significant changes in urban land use. The city's pattern of land use and land cover has undergone substantial geographical and chronological changes (Fig. 7).

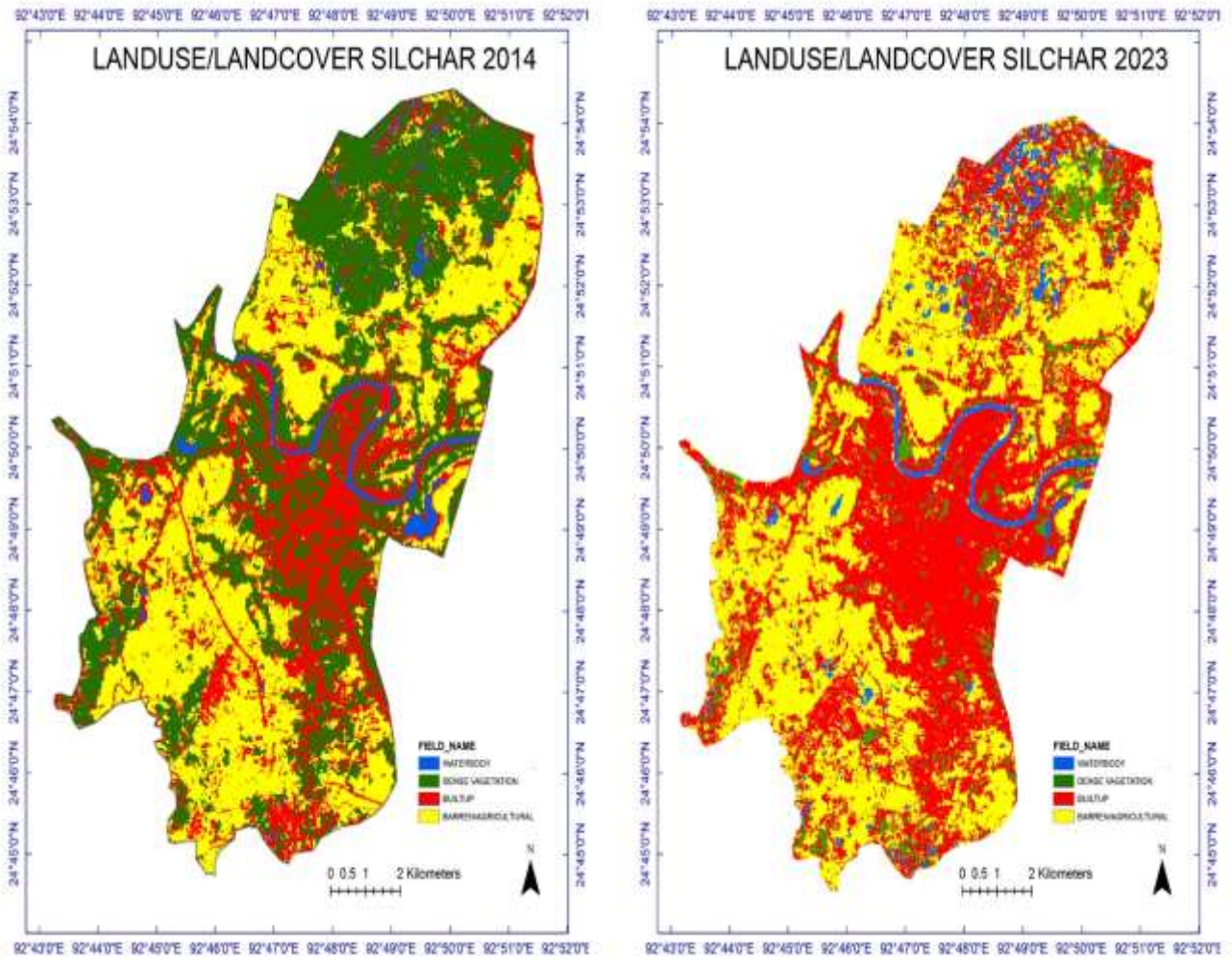

Fig.7 LULC change map for the year 2014 and 2023.

Waterbodies and built-up areas showed favorable changes, whereas barren, agricultural areas, and areas covered in thick vegetation showed negative changes.

According to the study, the size of urban built-up areas increased by 26%, from 31.45 square kilometers to 55.68 square kilometers. Due to the loss of 23.13 sq.km of agricultural land, fallow land, and unoccupied land to development between 2014 and 2023, the research demonstrates the astonishing urban expansion in and around the city (Fig. 8). These results indicate that the layout and organization of urban characteristics in the studied region have experienced significant changes. The urban sprawl measurement has also aided the landscape study. The findings of the sprawl measurement show that between 2014 and 2023, there was a significant rate of sprawl and scattered urban growth (Fig. 9).

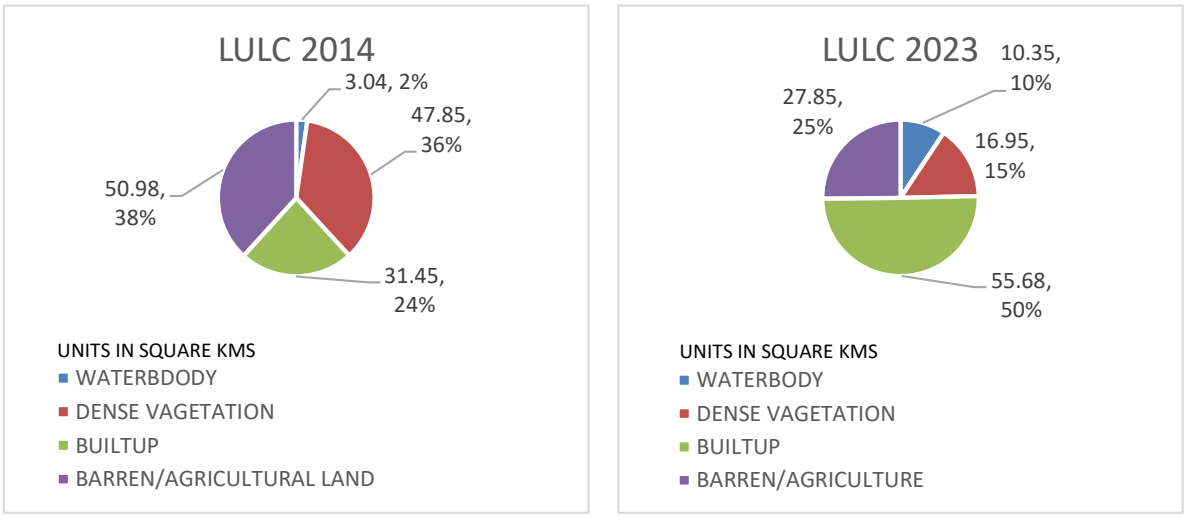

Fig.8 Percentage and area change of LULC in 2014 and 2023

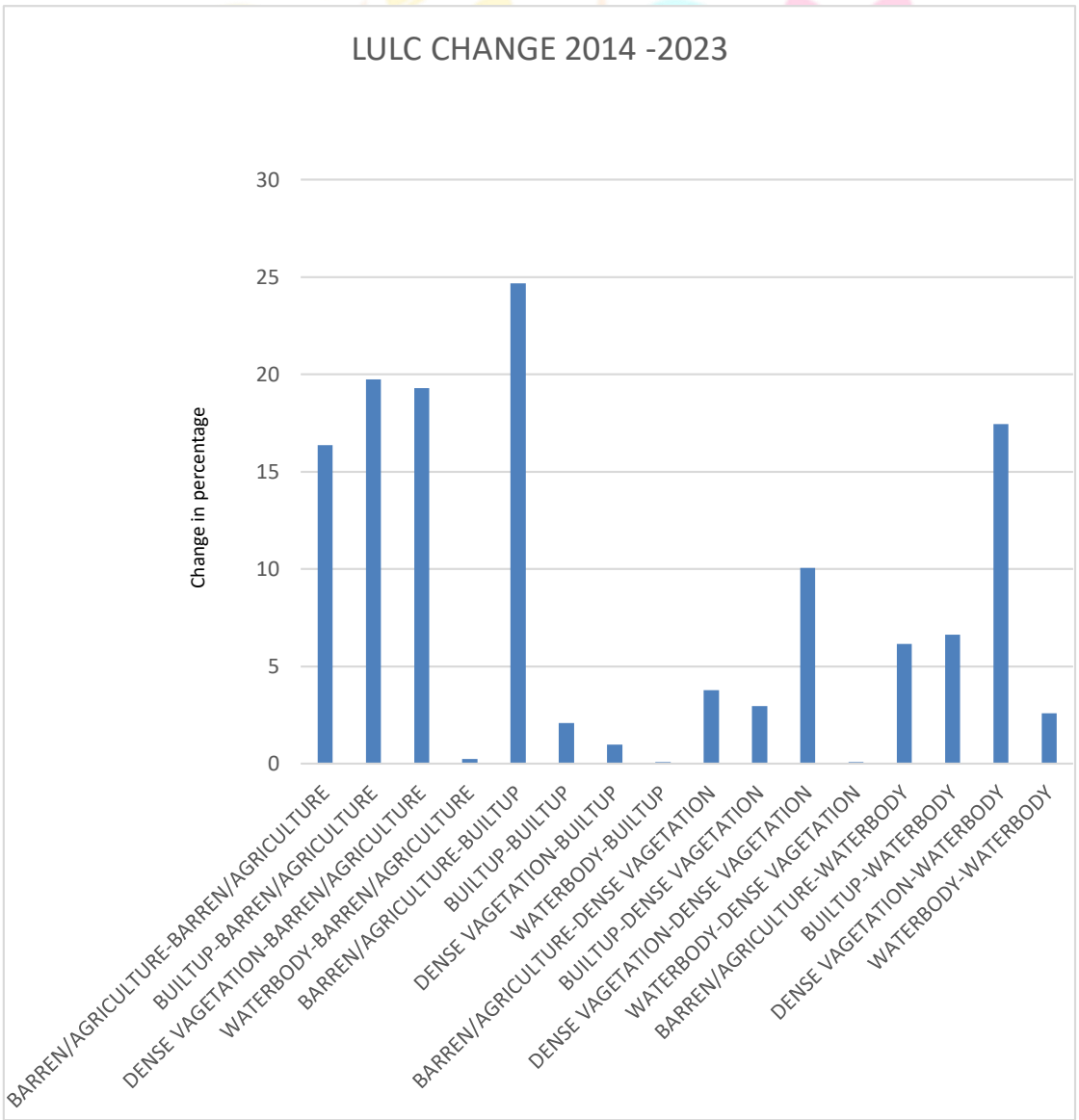

Fig.9 LULC change matrix of 2014 and 2023

The thick vegetation has undergone a striking alteration, growing negatively by 21%. Between 2014 and 2023, it shrank by around 47.85 square kilometers to 16.95 square kilometers. The majority of it has been covered by urban, built-up, and mixed vegetation (Fig. 8). A bleak image is painted by the research area's extensive vegetation and forest conditions.

Due to unequal expansion in urban built-up regions, new catchment areas have arisen despite the river bed and limited area essentially remaining intact. A 7.31 square kilometer shift is seen as a result of expanding water-clogged catchment areas (Fig. 8).

According to the contemporary world, improvements in the built-up and urban areas are desirable, while declines in the other vegetation classes—forest, agricultural, and mixed—are bad from a socioeconomic standpoint.

3.2 RANDOM PUBLIC SURVEY

A questionnaire survey with a sample size of 321 numbers was conducted to identify the problems related to urban expansion. Transportation, urban flooding, urban sprawl, waste management, environmental degradation, safety and crime monitoring, child safety, universal design, city accessibility, and public sanitation are the emergent issues of the problem areas, as shown by the result (Fig. 10).

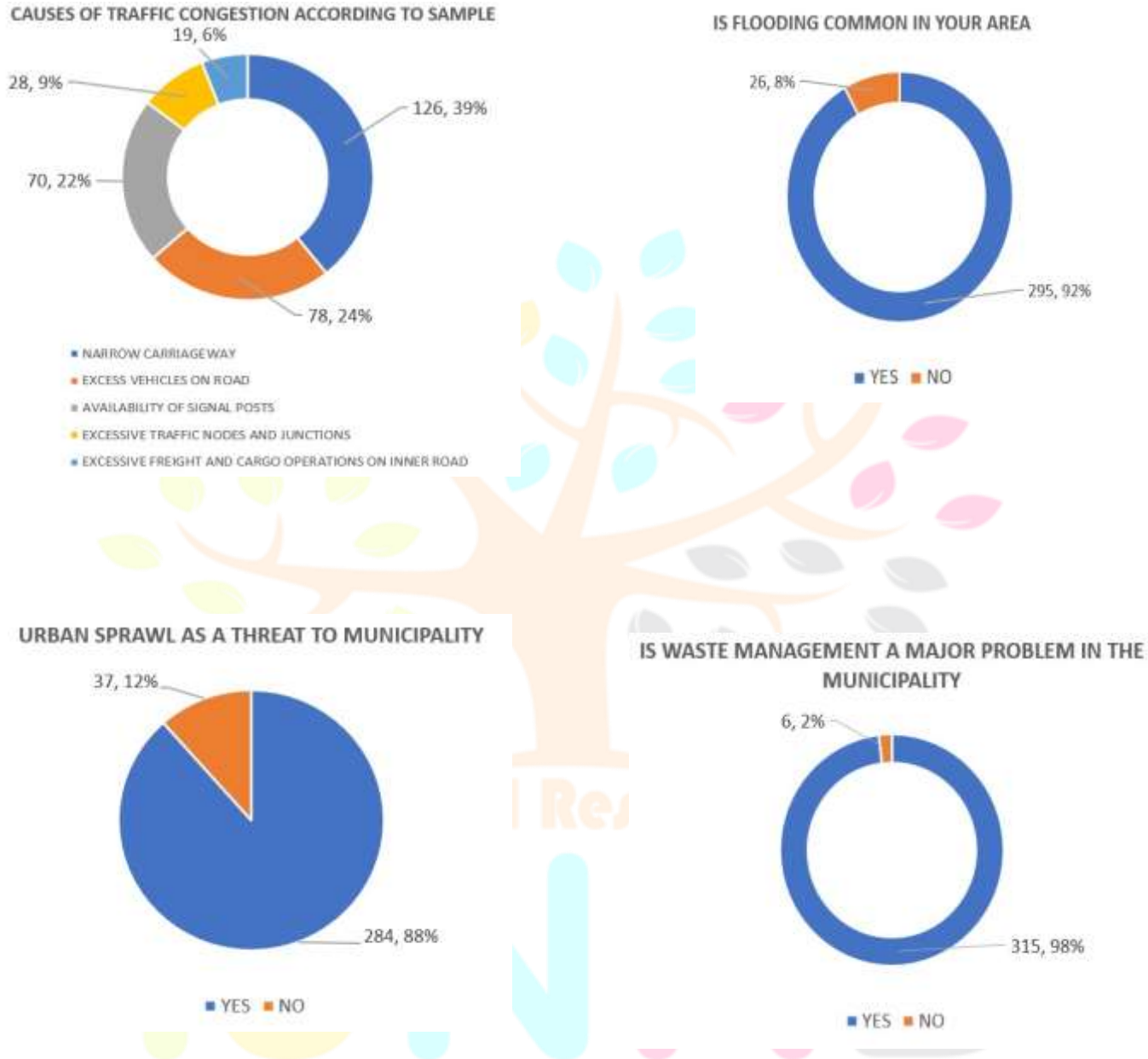

Fig.10 Analysis of the random public survey.

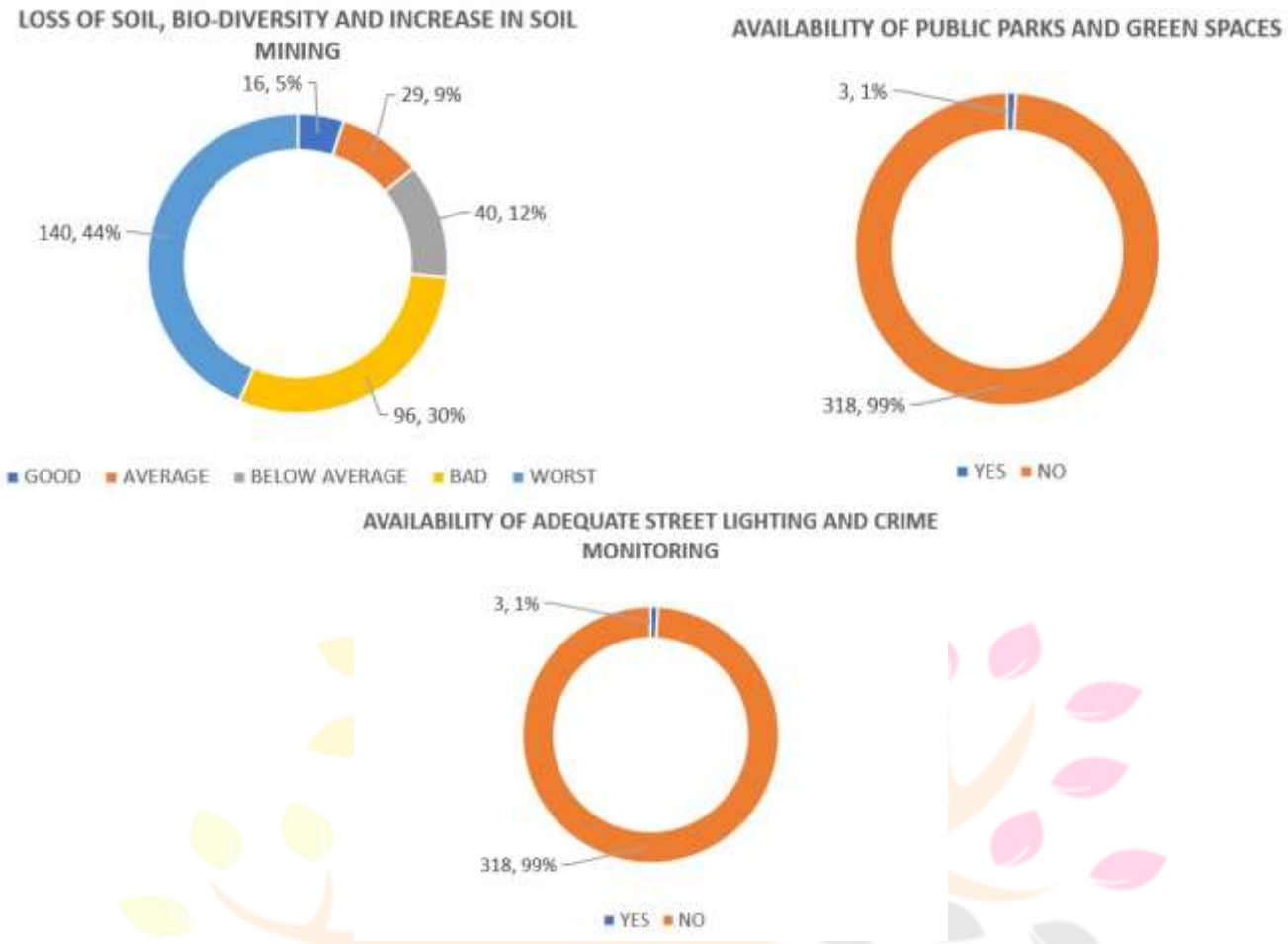

Fig.10 Analysis of the random public survey.

3.3 ANALYTICAL HIERARCHY PROCESS SURVEY

A questionnaire survey has been conducted taking sample size of 24 numbers to perform AHP prioritization.
The sample size breakdown is as follows –
Architects - 4, Civil engineers – 12, Government employed engineers – 5, University Professors – 3

According to the results of the weightings of the five criteria, urban floods come in second with a weighting of approximately 19.8%, and transportation is regarded as the major component of urban challenges, accounting for about 51.1% of the overall certification. Waste management, urban sprawl, and environmental deterioration each received weightings of 16%, 6.8%, and 6.3%, respectively (Fig. 11).

According to the sample data gathered, the transit problem constituted more than 50% of the weightage and is the most significant component for urban challenges.

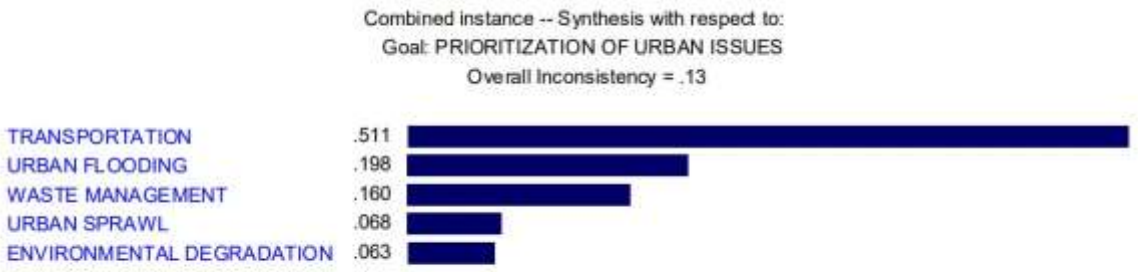

Fig.11 Analysis of the analytical hierarchy process survey.

4.CONCLUSION AND DISCUSSION

The surrounding ecosystems, land resources, the form and layout of the urban region, and ultimately quality of life are all significantly impacted by the present trend of urban expansion. The study region, which is a part of Silchar City, has seen significant

changes in urban land use during the last several years. Given these underlying facts, the main goals of this research were to identify and assess the trend of urban land use changes in the study region and create a change detection map.

Rapid growth in both urban and built-up areas caused significant changes in both land use and land cover, as seen by a substantial decline in both thick vegetation and agricultural land. Additionally, uneven growth has caused catchment areas and waterbodies to grow in the studied regions while not keeping up with the drainage of extra rainwater. Due to an overly dense population, these negative factors have significantly reduced the city's ability to handle the problems posed by contemporary growth and expansion, necessitating the development of planning rules to ensure a sustainable environment. In order to reduce the negative consequences of urbanization and improve the sustainability of a key urban center in Silchar city, sensible urban planning policies must be implemented.

Whether the goal is administrative or significant participation, creating a personalized public opinion survey system seems to be required for the people's engagement in questionnaire surveys.
The survey had highlighted traffic, flood, urban sprawl, waste management, and environmental deterioration as the main urban problems. The survey's findings revealed significant urban problems in Silchar that had existed for some time and had a negative impact on the city's planning and operation.

Finally, the value of this work is in the development of evaluation criteria that are appropriate for urban concerns, weighting calculations, trend analysis based on application scenarios, and demonstrating the prospect of building a logical prioritized assessment system.
To develop independent assessment factors to objectively assess urban issues, this study derived items—including traffic, flood, urban sprawl, waste management, and environmental deterioration. The AHP result showed a significant weightage to transportation planning.

In essence, the findings of this study indicate that more emphasis should be placed on sustainable transportation planning and policies to better manage future urbanization in the region.

5.ACKNOWLEDGEMENT

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