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Chronicles of Peri-Urban Expansion in Small Rural Towns: a Comprehensive Study of Makhado Biaba's Built-Up Areas from 1995 to 2022

Ngudo Winny Nthangeni, Trynos Gumbo, Emmaculate Ingwani, Nils Ekelund

(Winny Ngudo-Nthangeni, PhD Candidate Department of Urban and Regional Planning, Faculty of Engineering and the Built Environment, University of Johannesburg, nthangeni19@gmail.com)
(Trynos Gumbo, Professor; Department of Urban and Regional Planning, Faculty of Engineering and the Built Environment, University of Johannesburg, tgumbo@uj.ac.za)
(Emmaculate Ingwani, Senior Lecturer; Department of Urban and Regional Planning, Faculty of Environmental Sciences, University of Venda, emaculate.ingwani@univen.ac.za)
(Nils Ekelund, Professor; Department of Natural Sciences, Mathematics, Society, Faculty of Faculty of Education and Society, Malmö University, nils.ekelund@mau.se)

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1 ABSTRACT

Over the past few decades, the phenomenon of peri-urban expansion has emerged in South Africa as a significant and complex challenge, particularly for small towns across rural municipalities. Traditionally characterized by their rural economies and close-knit communities, these towns now find themselves at the crossroads of urbanization, grappling with the complex implications of expanding urban influence. This paper investigates the dynamic changes in the Makhado Biaba town's spatial landscape post-apartheid era, spanning from 1995 to 2022. The work adopted a mixed methods research approach, which employs both quantitative and qualitative research approaches. Google Earth Engine (GEE) was used for supervised classification to evaluate the Support Vector Machine (SVM) algorithms, using Landsat-8 images. Questionnaires were administered to collect qualitative and quantitative data and key informative interviews were conducted to gather qualitative data. Statistical Package for Social Sciences (SPSS) was used to analyse quantitative statistical data and thematic analysis was employed for qualitative data analysis. Findings reveal that the land cover of the build-up area increased from 1443.0 HA in 1995 to 1936.0 HA in 2011 and further increased to 2279.0 HA in 2022. This significant increase highlights the visible increase of built-up areas, attributed to the rapid growth in population, which drives the escalating demand for land to accommodate housing and infrastructure needs. Leading to the encroachment of urban settlements into neighbouring rural areas, causing the convergence of urban and rural settlements. Due to the communal tenure system, it is frequently difficult for the municipality to facilitate the demarcation of sites and commercial development on tribal land. Limited authority over such areas, makes it difficult for rural municipalities to control growth and align development with the goals of the municipal bylaws. Ultimately, the study recommends sustainable urban development strategies in mitigating adverse effects on the environment and community well-being. Thus, there is a need to reconcile conflicting By-laws to create a cohesive land management framework that accommodates both traditional practices and modern spatial planning and land use management by-laws. There is also a need to formulate peri-urban expansion strategies tailored to rural contexts by considering local needs, minimizing environmental impact, and actively involving the community in the planning process.

Keywords: sustainable development, land use, peri-urban, accuracy assessments, small rural towns

2 INTRODUCTION

The phenomenon of peri-urban expansion is a globally recognized trend that is significantly reshaping the landscapes of small rural towns. The small rural Makhado Biaba Town, situated in the heart of Limpopo, stands as a poignant example of this transformative process. Over the past few decades, the town has experienced a surge in spatial development, blurring the lines between rural and urban spaces. The expansion of infrastructure and changing land use patterns have all contributed to the gradual spatial evolution of Makhado Biaba Town into a dynamic peri-urban entity. Understanding the nuances of peri-urban expansion is imperative not only for Makhado Biaba but also for countless similar towns grappling with similar transitions worldwide (Jain, Sikder and Korzhenevych, 2023).

The term peri-urban is complex and has been defined differently by different scholars. It has been described as a location, process, or concept. Peri-urban is the zone between rural and urban activities as a concept; as a process, it is the gradual transformation of rural areas as they acquire more urban characteristics; and as a

location, it is the region between rural and urban zones (Mortoja and Yigitcanlar, 2021; Douglas, 2006). Peri urban often refer to a compound of rural and urban features in transition which are characterized by unregulated land uses and multiple land administration structures (Hungwe, 2014; Ingwani, 2021) without a fixed definition. Additional to the conventional rural and urban spaces, the peri-urban areas may be conceptualized as a "third space" (Ingwani & Gumbo, 2016). Currently, the peri-urban expansion of Makhado Biaba Town seems to be inevitable. This expansion not only reshaped the town's physical footprint but also redefined its socio-economic dynamics, engendering new patterns of land use and community life. Furthermore, peri-urban expansion is likely to continue for as long as the agricultural land is available in the vicinity. In many small rural towns of South Africa, agricultural activities are slowly diminishing because of the insurgence of a cash economy and off-farm income streams. According to Ingwani (2019), similar situations were observed in Domboshava and Masvingo in Zimbabwe, where peri-urban livelihoods are changing because of the outward spatial expansion of the peri-urban zone. As the peri-urban zones extend into the hinterland, the existing peri-urban area is pushed out further and replaced by a new frontier usually characterized by inhabited land (Hoggart, 2016). Thus, through such expansion, rural areas assume the character of cities. Small rural towns of South Africa are service centers located in the rural areas on the bottom rung of the ladder that classifies and defines cities. They are surrounded by villages dominated by agricultural production (Temudo, Cabral and Talhinhas, 2020) Currently, a significant number of South Africa's population live in small rural towns which experience a considerable inflow of migrants.

The study of peri-urban expansion in Makhado Biaba Town is situated within a broader scholarly discourse on urbanisation, regional development, and sustainable planning. While urbanization has traditionally been associated with large metropolitan areas, the increasing prevalence of peri-urban growth in small towns presents unique challenges and opportunities (Salvia, Halbac-Cotoara-Zamfir, Cividino, Salvati, and Quaranta, 2020). By delving into the specifics of Makhado Biaba's experience, this study contributes to a more nuanced understanding of urban dynamics at the rural-urban interface and also seeks to bridge the gap between academic inquiry and practical policymaking. By offering insights gleaned from empirical analysis and spatial analysis, it aims to inform decision-makers, planners, and stakeholders involved in shaping the future trajectory of Makhado Biaba Town. In doing so, it aspires to foster sustainable development practices that reconcile the imperatives of growth with the preservation of Makhado Biaba's Town cultural and environmental heritage.

3 CONCEPTUAL SYNOPSIS

The Theory of Change (ToC) provides a framework for understanding how interventions or actions lead to desired outcomes (Yang, van Timmeren and Tillie ,2023). In the context of peri-urban expansion in small rural towns like Makhado Biaba, the ToC can help elucidate the interconnected factors driving this phenomenon and its potential impacts. One key aspect of the ToC is recognising the drivers of change, which in this case include demographic shifts, spatial dynamics, and infrastructure development (Waisbord ,2020). Consequently, as rural areas experience population growth and economic transformation, there is increased pressure on land and resources, leading to the expansion of peri-urban areas. Additionally, investments in infrastructure, such as roads and utilities, may facilitate this expansion by improving accessibility to previously remote areas, thereby attracting both residents and businesses.

Furthermore, the theory of change highlights the pathways through which interventions or policies can influence outcomes (Taplin, Clark, Collins and Colby,2013). Interventions aimed at land use planning, governance structures, and economic development can play a crucial role like implementing zoning regulations and land use planning strategies to help manage the spatial growth of peri-urban areas, balancing the need for urban development with the preservation of agricultural land and natural resources. Similarly, promoting inclusive governance structures that involve both traditional leadership and local municipalities can enhance coordination and decision-making processes, ensuring that peri-urban expansion is guided by sustainable development principles and addresses the needs of all stakeholders. Peri-urban areas are transitional areas experiencing rapid transformations as a result of demands from development and urban growth. ToC provides an organized way to think about how deliberate activities and planned interventions can result in improvements in these areas (Meyer, Louder, and Nicolas, 2022). Planners can use it to map the progression of events and effects, guiding decision-making toward sustainable and balanced development.

4 METHODOLOGY

This study adopted the case study research design where Makhado Biaba town in South Africa was studied. The work applied a mixed method research approach and also utilized high-resolution satellite sensors like Landsat 5 TM and Landsat 8 OLI to detect changes in Land Use Land Cover (LULC) (Jamal & Ahmad, 2020; Jamali, 2019). Non-Parametric Machine Learning classifier like Support Vector provided accurate LULC classification results. Images were uploaded through GEE coding each year, with atmospheric correction and ready for classification using Support Vector Machine (SVM) algorithms (Foody & Mathur, 2004). Ground-based fieldwork was conducted, with 100 sample sizes per class for bare soil and built-up areas. Systematic random sampling was applied for each class, with 70% training samples and 30% validation testing. Ground truth data collection for land use and land cover (LULC) change in Makhado Biaba town involved systematic random sampling, stratified sampling, field surveys and thorough validation procedures. The collected information was cross-checked and verified through multiple visits and comparisons with existing data sources to ensure the reliability and representativeness of the final sample. Questionnaires survey and key informative interviews was applied as primary data collection methods, and SPSS and thematic analysis were employed for data analysis respectively (Alshenqeeti, 2014). This work also conducted interviews and questionnaires. Key informant interviews were conducted with key informant personnel from Makhado Local Municipality and the Traditional leaders. Questionnaires were distributed to people who reside in Makhado Biaba and five surrounding villages. Interviews with the municipal officials were unstructured and the interviews were conducted physically, and the questioners conducted with residents were structured. Random sampling was used to select households that were targeted for participating in the survey. SPSS and thematic analysis were also employed for data analysis respectively.

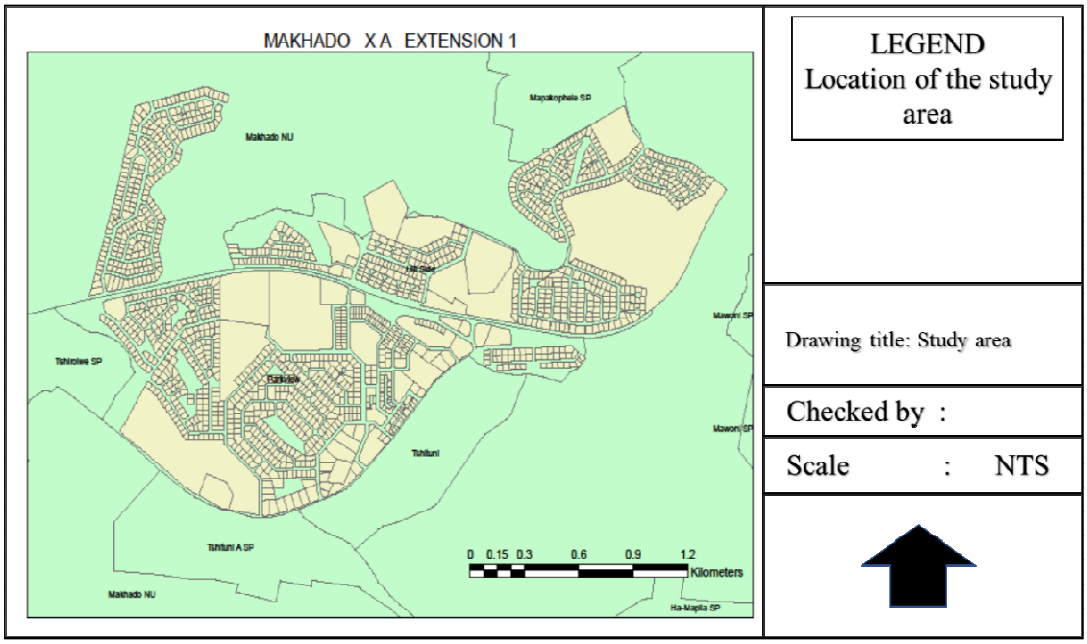

Figure 1: Location of the study area (Makhado Biaba town and surrounding villages). Source: Modified by authors, 2023

5 STUDY AREA

Makhado Biaba used to be one of the four districts in the former Republic of Venda, along with Vuwani, Mutale and Thohoyandou (Makhado Municipality IDP, 2018/19). The majority of the surrounding Villages in Makhado Biaba town survive primarily on subsistence farming and livestock keeping, with vegetables being sold when deemed necessary and appropriate in town. Makhado Biaba Town consist of nine villages, and five villages were selected purposively and conveniently to participate in the research (Makhado IDP, 2018/19). Land administration, of the peri-urban villages of Makhado Biaba town are administered by local traditional leadership, chiefs, and village headman's. They act as the central institute in land governance, specifically for allocating land tenure rights in terms of a Permission to Occupy (PTO) on behalf of governmental bodies like the state and local municipalities (Ingwani, 2021). Makhado Biaba is generally rocky and can be described as a mountainous area in local terms. Like many former R293 towns, Makhado Biaba town was established in terms of the Proclamation 45 of 1990. The Proclamation R293 is still in use

with the Town Planning Scheme. This implies that R293 still exists in Makhado Biaba town as it has not been repealed, and the town is also within the Scheme and Ordinance areas. Demarcation of sites is no longer applicable in Makhado Biaba town. Sites are being subdivided in terms of section 92 of the Town Planning and Township's Ordinance, 15 of 1986, Makhado Municipality Spatial Planning, Land Development and Land Use Management By-Law of 2016 and Makhado Land Use Management Scheme of 2009. However, in the surrounding villages (peri-urban) demarcation of sites exists through chiefs.

Figure 1 shows Makhado Biaba town and the surrounding villages, which falls under the Makhado local municipality which is Category B.

6 FINDINGS

This section presents the findings and discussion of the study analyzing Landsat 5 TM and Landsat 8 OLI data, revealing quantification and prognosis results for the SVM classifier, providing a comprehensive understanding of LULC detection in Makhado Biaba Town over 27 years.

6.1 Land Cover/Land Use Classification

The study used Landsat's TCC to digitize training sites, generate imagery from Google Earth Engine, and classify images using the South African classification system. SVM was used for the classification. Using Landsat images, Google Earth Engine, and remote sensing technology allows to access and analyze a large amount of spatial information over a long period of time, providing a comprehensive view of the changes in Makhado Biaba town. Landscape Metrix analysis, including confusion matrix and support vector machine algorithm, allows for the accurate classification and quantification of land cover and land use changes over time. Overall accuracy, producers and user's accuracy, as well as kappa statistics, provide a quantitative measure of the accuracy of our analysis. Additionally, patch density, greatest patch area, mean patch area, number of patches, and landscape proportion provide important metrics for understanding the spatial patterns and distribution of land cover changes in Makhado Biaba town. Ultimately, these methods and tools are essential for accurately mapping and assessing the spatial changes in the town from the post-apartheid era (1995) to the present day (2022). In order to map spatial changes in Makhado Biaba town post-apartheid era from 1995 to 2022, it is necessary to use Landsat images, Google Earth Engine, and remote sensing technology to access historical and current satellite data. Landscape Metrix analysis, confusion matrix, and support vector machine algorithm are important tools for processing and analyzing the satellite imagery to accurately identify and classify changes in land cover over time. Metrics such as overall accuracy, producers and users accuracy, as well as Kappa statistics, are essential for evaluating the accuracy of the land cover classification. Patch density, greatest patch area, mean patch area, number of patches, and landscape proportion are used to quantify the spatial patterns and fragmentation of land cover changes. Additionally, it is important to assess the size and distribution of different land cover types in order to understand the overall landscape changes in Makhado Biaba town over the specified time period. Therefore, the integration of these tools and techniques is crucial for effectively mapping and monitoring the spatial changes in the town over the post-apartheid era.

6.2 Results For Quantifying Land Use Land Cover Change Using Landscape Metrics/Accuracy Assessments

This research focuses on monitoring and detecting changes in land use using landscape metrics, including compositional and configurational metrics. The study uses Patch Density (PD), greatest patch area (GPA), mean patch area (MPA), and number of patches (NP) types of landscape metrics. The "number of patches" (NUMP) is expected to increase with nucleated urban development, but decreases significantly when urban patches combine into a single homogenous patch. Total Edge (TE) determines the overall perimeter of all urban patches, while the "mean patch edge" (MPE) refers to the typical amount of edge found in each patch. Later, landscape metrics for each map from 2008 to 2022 were calculated using the Landscape Metrics Plugin on QGIS, a product of the FRAGSTATS software. These metrics were chosen to calculate six main characteristics of land use land cover areas: absolute size, relative size, and complexity. The absolute size of urban features was calculated using QGIS software. LULC maps created through satellite data interpretation were applied to landscape analysis tools to evaluate the structural characteristics of various cover types. Each LULC class was considered, and every metric was computed and analyzed for every value.

6.2.1 Landscape Matrix Analysis/ Accuracy Assessments

Table 1 gives results using the patch matrix model in Landscape matrix analysis which helps understand land use systems and changes by interpreting quantitative landscape indicators. It quantifies metrics such as fragmentation, connectivity, and heterogeneity, providing insights into ecological integrity. In Makhado Biaba town within Makhado Local Municipality, it identifies areas needing interventions and explores social and economic implications of land use change, such as impacts on livelihoods and urban-rural dynamics.

Landscape Matrix SVM Classification_1995						
Class	Patch Density	Greatest Patch area	Mean Patch area	Number of Patches	Landscape proportions (%)	Land cover (HA)
Baresoil	$6.063432835820896\times10^{-3}$	1620.0	109.42307692307	26	66%	2845.0
build-up	$1.1194029850746268\times10^{-2}$	950.0	30.0625	48	34%	1443.0
TOTAL					100%	
Landscape Matrix SVM Classification_2011						
Class	Patch Density	Greatest Patch area	Mean Patch area	Number of Patches	Landscape proportions (%)	Land cover (HA)
Baresoil	$1.3489437515907355\times10^{-}2$	643.0	37.603773584905	53	24%	1993.0
build-up	$1.5525579027742428\times10^{-2}$	1013.0	31.737704918032	61	23%	1936.0
TOTAL					47%	
Landscape Matrix SVM Classification_2022						
Class	Patch Density	Greatest Patch area	Mean Patch area	Number of Patches	Landscape Proportions (%)	Land cover (HA)
Build-up	$1.0944260626113514\times10^{-2}$	1501.0	53.0	43	27%	2279.0
Baresoil	$3.0287604988546706\times10^{-2}$	745.0	13.865546218487	119	20%	1650.0
TOTAL					47%	

Table 1: Landscape Matrix Analysis for SVM Classifier (1995, 2011 and 2022). Source: Author, 2023

The study examines landscape structures using metrics such as Patch Density (PD), greatest patch area (GPA), mean patch area (MPA), number of patches (NP), landscape proportions (LP), and landcover area to study changes in LULC classes. The support vector classifier was used to calculate GPA values for buildup and baresoil. The results show landscape metrics play a crucial role in understanding landscape changes and their effects. In the year 1995, baresoil had the largest GPA at 1620, comprising 66% of the LP then the build-up with a GPD of 950 comprising 34% of the LP. In 2011, a shift occurred with build-up's GPA becoming the largest at 1013, occupying 23% of the LP, while the baresoil had a decrease in the GPA at 643, comprising 24% of the LP. By 2022, Build-up reclaimed the position with a considerable increase in the Greatest Patch area, reaching 1501 and constituting 27% of the LP. Population growth, economic activities, infrastructure development, and cultural influence, indeed indicate dynamic trends in the dominance and consolidation of Makhado Biaba town. while the baresoil had a GPA of 745.0, comprising 20% of LP.

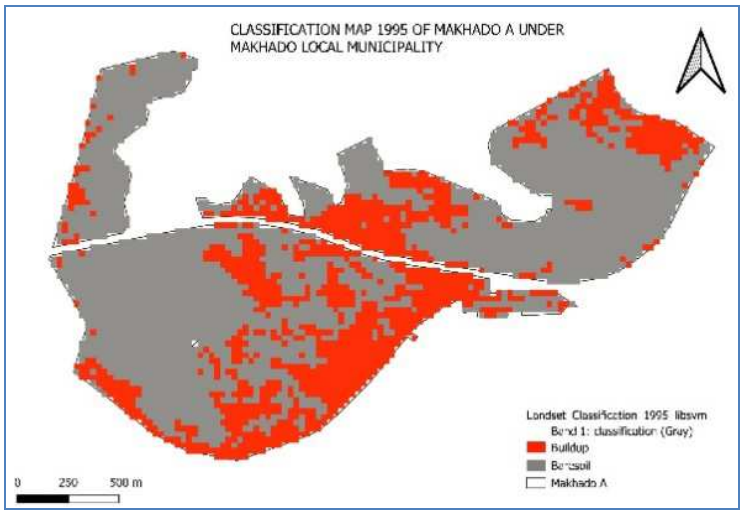

Figure 2: SVM classification results for 1995 in Makhado Biaba town. Source: Authors, 2023

6.3 Results and data interpretation of LULC classification and accuracies

The land use Land cover maps for the year 1995 (figure 1), the year 2011 (figure 2) and the year 2022 (figure 3), are based on supervised classification and visual interpretation, showing changes in Makhado Biaba town

over the years. Overall classification accuracy and landscape matrix, as well as the area of each land use and land cover, users' accuracy, and Producers accuracy.

6.3.1 Results for SVM in 1995, 2011 and 2022

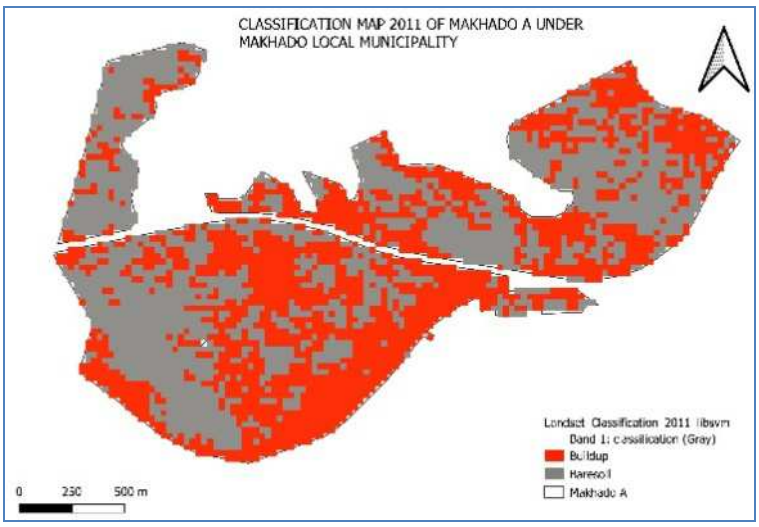

Figure 3: SVM classification results for 2011 in Makhado Biaba town. Source: Authors, 2023

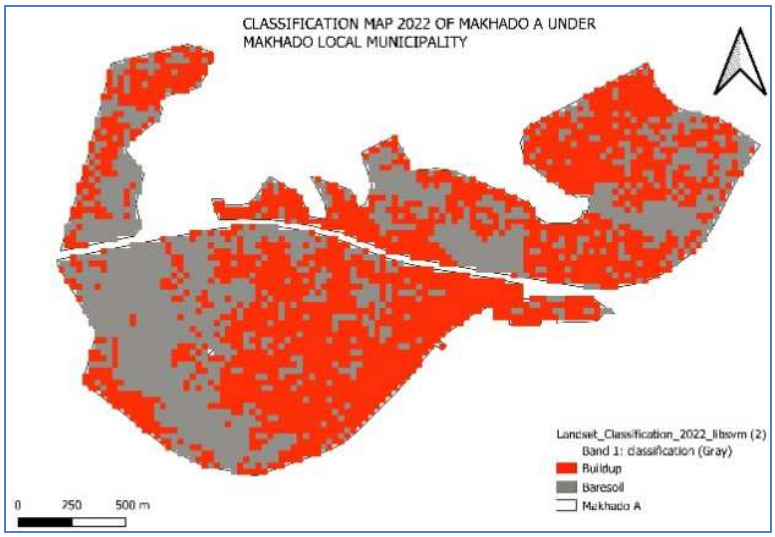

Figure 4: SVM classification results for 2022 in Makhado Biaba town. Source: Authors, 2023

The results from figure 1, figure 2 and figure 3 shows that there's a consistent decline in baresoil land cover from 2845 hectares in 1995 to 1650 hectares in 2022. The area decreased steadily, indicating potential factors of urbanization expansion. Build-up land cover shows an increase from 1443. Hectares in 1995 to 1936 hectares in 2011, followed by a slight further increase by 2279 hectares in 2022. This suggests urban development or infrastructure development and human settlement expansion over the years in the Makhado Biaba town. Leading to the reduction of baresoil areas, contributing to the conversion of natural land to build-up areas.

6.3.2 Accuracy assessment results for SVM (1995, 2011 and 2022)

Table 2 shows the validation test for land use and land cover (LULC) classification, the Support Vector Machine (SVM) algorithm for three different years: 1995, 2011, and 2022. The accuracy assessment for the training data in 1995 reveals a total accuracy of 82%, indicating a relatively high level of model performance, meaning the classifier has produced more true ground data and the maps are reliable.

6.4 Tests of association between socioeconomic statuses

The findings provided in Table 3, 4, 5, and 6 provide significant insights into the dynamics of peri-urban expansion in the small rural town of Biaba of Makhado local municipality. Firstly, the results highlight the

multifaceted drivers influencing settlement patterns, such as proximity to work, amenities, and family ties, as well as the availability of land and affordability. This indicates a complex interplay of socio-economic factors shaping individuals' decisions regarding where to settle. Secondly, the mode of land acquisition, predominantly through PTO (Permission to Occupy), highlights the informal nature of land tenure systems in these areas, suggesting a need for formalization and regulation to address issues of land ownership and rights. Thirdly, the demographic profile of residents, with a substantial portion being older adults and pensioners, suggests a potential trend of rural-to-urban migration among younger generations, which could impact the socio-economic landscape and service demands in these towns. Finally, the correlation between livelihood activities and educational qualifications highlights the importance of education in accessing employment opportunities, indicating potential areas for intervention to promote economic development and social mobility within these peri-urban communities.

Accuracy Assessment For SVM Classification Landsat (1995) for Training data 70%

		Reference Data			
		Baresoil	Build-up	Total	User' Accuracy
Classified Data	Baresoil	38	243	281	0,14
	Build-up	147	44	191	0,23
	Total	185	287	472	Kappa Index
	Producer's Accuracy	0,21	0,15	0,36	0,68
					Overall Accuracy 0,82

Accuracy Assessment For SVM Classification Landsat (2011) for Test data 70%

		Reference Data			
		Baresoil	Build-up	Total	User' Accuracy
Classified Data	Baresoil	27	154	181	0,15
	Build-up	226	34	260	0,13
	Total	253	188	441	Kappa Index
	Producer's Accuracy	0,11	0,18	0,287570431	0,69
					Overall Accuracy 0,80

Accuracy Assessment For SVM Classification Landsat (2022) for Test data 70%

		Reference Data			
		Build-up	Baresoil	Total	User' Accuracy
Classified Data	Build-up	69	0	69	1,00
	Baresoil	0	31	31	1,00
	Total	69	31	100	Kappa Index
	Producer's Accuracy	1,00	1,00	2	0,73
					Overall Accuracy 0,83

Table 2: Accuracy assessments, Confusion Matrix for the training samples results of SVM classification training data 70% (1995, 2011 and 2022). Source: Author, 2023

Place of residence * Pull factor for settling in the area									
			Pull factor for settling in the area						Total
			To be next to work	To be close to facilities	To be next to relatives	Bigger plots of land	Because it is cheaper to live in the area	Looking for land to reside in	
Place of residence	Makhado Biaba	Count	11	9	0	0	0	10	30
		% of total	6.1%	5.0%	0.0%	0.0%	0.0%	5.6%	16.7%
	Tshirolwe (ntha)	Count	2	3	12	6	5	2	30
		% of total	1.1%	1.7%	6.7%	3.3%	2.8%	1.1%	16.7%
	Tshituni (ntha)	Count	9	3	7	5	3	3	30
		% of total	5.0%	1.7%	3.9%	2.8%	1.7%	1.7%	16.7%
	Tshituni (fhasi)	Count	3	2	12	8	3	2	30
		% of total	1.7%	1.1%	6.7%	4.4%	1.7%	1.1%	16.7%
	Maphakhopele	Count	1	1	16	8	1	3	30
		% of total	0.6%	0.6%	8.9%	4.4%	0.6%	1.7%	16.7%
	Tshirolwe SP (Fhasi)	Count	4	1	13	3	1	8	30
		% of total	2.2%	0.6%	7.2%	1.7%	0.6%	4.4%	16.7%
Total		Count	30	19	60	30	13	28	180
		% of total	16.7%	10.6%	33.3%	16.7%	7.2%	15.6%	100%

Table 3: Place of residence, and pull factor for settling in the area. Source: Authors, 2023

Table 3 results indicate that out of the largest share equal to 33% (n = 60) of total participants who indicated the need to be next to relatives as a pull factor for settling in the area, the largest sub-share accounting for about 9% (n = 16) of total participants resided in Maphakhopele, followed by 7% (n = 13) who resided in Tshirolwe SP (Fhasi) and equal shares of about 7% (n = 12) who resided in Tshituni (fhasi) and Tshirolwe (ntha). From the second largest 17% (n = 30) who indicated the need to be next to work as the pull factor, the top two largest sub-proportions equal to 6% (n = 11) and 5% (n = 9) of total participants resided in Makhado Biaba and Tshituni (ntha), respectively. Furthermore, from the equivalent 17% (n = 30) of participants who indicated bigger plots of land as the key pull factor, approximately 4% (n = 8) resided in Tshituni (fhasi) and also 4% (n = 8) resided in Maphakhopele.

Place of residence * Process of acquiring land							
			Process of acquiring land				Total
			Inherited	PTO	Squatting	Deed of grant	
Place of residence	Makhado Biaba	Count	5	0	0	25	30
		% of total	2.8%	0.0%	0.0%	13.9%	16.7%
	Tshirolwe (ntha)	Count	6	24	0	0	30
		% of total	3.3%	13.3%	0.0%	0.0%	16.7%
	Tshituni (ntha)	Count	3	25	1	1	30
		% of total	1.7%	13.9%	0.6%	0.6%	16.7%
	Tshituni (fhasi)	Count	0	30	0	0	30
		% of total	0.0%	16.7%	0.0%	0.0%	16.7%
	Maphakhopele	Count	4	26	0	0	30
		% of total	2.2%	14.4%	0.0%	0.0%	16.7%
	Tshirolwe SP (Fhasi)	Count	4	26	0	0	30
		% of total	2.2%	14.4%	0.0%	0.0%	16.7%
Total		Count	22	131	1	26	180
		% of total	12.2%	72.8%	0.6%	14.4%	100.0%

Table 4: Place of residence and process of acquiring land. Source: Authors, 2023

Table 4 results reveal that out of the largest share equal to 73% (n = 131) of total participants who acquired land through PTO, the largest sub-share equal accounting for approximately 17% (n = 30) resided in Tshituni (fhasi), followed by equivalent shares of about 14% (n = 26) who resided in Tshirolwe SP (Fhasi) and Maphakhopele. From 14% (n = 26) of participants reported that they acquired land through the deed of grant, almost all of them resided in Makhado Biaba.

Main livelihood activity * Age group								
			Age group					Total
			18 - 25 years	26 - 30 years	31 - 35 years	36 - 40 years	> = 41 years	
Main livelihood activity	Employed	Count	1	3	8	17	15	44
		% of total	0.6%	1.7%	4.4%	9.4%	8.3%	24.4%
	Unemployed	Count	3	7	7	11	17	45
		% of total	1.7%	3.9%	3.9%	6.1%	9.4%	25.0%
	Self-employed	Count	1	1	9	7	9	27
		% of total	0.6%	0.6%	5.0%	3.9%	5.0%	15.0%
	Farmer	Count	0	0	2	0	2	4
		% of total	0.0%	0.0%	1.1%	0.0%	1.1%	2.2%
	Pensioner or grant	Count	1	1	3	7	48	60
		% of total	0.6%	0.6%	1.7%	3.9%	26.7%	33.3%
Total		Count	6	12	29	42	91	180
		% of Total	3.3%	6.7%	16.1%	23.3%	50.6%	100%

Table 5: Main livelihood activity and age group. Source: Authors, 2023

Table 5 results reveal that out of the largest share equal to 51% (n = 60) of total participants who were aged 41 years and above, the largest sub-share of about 27% (n = 48) were pensioners or obtaining a grant while 9% (n = 17) were unemployed and 8% (n = 15) were employed. The second largest share accounting for 23% of total participants was aged 36-40 years, out of which the largest sub-share equal to 9% (n = 17) were employed and 6% (n = 11) were unemployed. Out of the 16% (n = 29) aged 31-35 years, 5% (n = 9) were self-employed and 4% (n = 8) were employed.

Table 6 results show that from the largest share equal to 23% (n = 41) of total participants who had matric, the largest sub-share of about 11% (n = 19) were unemployed, and 5% (n = 9) were employed. From the second largest 22% (n = 39) who had a diploma, about 9% (n = 16) were employed, while equal shares of 6% (n = 10) were unemployed and self-employed. The third largest share of participants which accounted for about 16% (n = 29) of total respondents had no schooling, and out of these 16%, the largest sub-share equal to 14% were pensioners. From the 16% (n = 28) of those had a degree qualification, about 9% (n = 16) of them were employed.

Main livelihood activity * Highest educational qualification									
			Highest educational qualification						Total
			Degree	Diploma	Matric	Secondary level	Primary level	No schooling	
Main livelihood activity	Employed	Count	16	16	9	3	0	0	44
		% of total	8.9%	8.9%	5.0%	1.7%	0.0%	0.0%	24.4%
	Unemployed	Count	3	10	19	10	2	1	45
		% of total	1.7%	5.6%	10.6%	5.6%	1.1%	0.6%	25.0%
	Self-employed	Count	3	10	7	4	1	2	27
		% of total	1.7%	5.6%	3.9%	2.2%	0.6%	1.1%	15.0%
	Farmer	Count	2	2	0	0	0	0	4
		% of total	1.1%	1.1%	0.0%	0.0%	0.0%	0.0%	2.2%
	Pensioner or grant	Count	4	1	6	9	14	26	60
		% of total	2.2%	0.6%	3.3%	5.0%	7.8%	14.4%	33.3%
Total		Count	28	39	41	26	17	29	180
		% of total	15.6%	21.7%	22.8%	14.4%	9.4%	16.1%	100%

Table 6: Main livelihood activity and highest educational qualification. Source: Authors, 2023

6.5 Peri-urban dynamics challenges

To promote urban growth for future habitation, it is important to understand the process of land use change in the urban centre and along the rural-urban boundary. Land use and land cover are influenced by a variety of environmental, socioeconomic, political, and historical factors. In addition, these variables interact dynamically, resulting in a variety of landscape change sequences and trajectories depending on the particular situation they occur in. The participants were asked questions. The data was structured to demonstrate common viewpoints while also demonstrating the actual phrases used by the participants. The data collected from the participants was also confirmed by the literature review.

6.5.1 Land Governance in Makhado Local Municipality

What is often forgotten in the assessment of local government is that, before 1994, there were significant parts of the country where no local authorities existed. One of those areas is the rural areas of South Africa, where traditional leaders continue to be the face of local government. This is something which traditional leaders have been for many centuries. Traditional leaders serve as cultural custodians and cater to the needs of the communities they serve (Tshishonga and Sithole, 2022). Town planning officials in Makhado local municipality indicated that traditional leaders are expected to collaborate with municipalities to bring about development in the villages. However, due to the communal tenure system, it is frequently difficult for the municipality to facilitate development on tribal land. Since the municipality has limited authority over such areas, traditional leaders can allocate land that is unfit for human habitation. This makes it difficult for the municipality to control growth and align development with the goals of the municipality. The proposed intervention impacts the conflict to bring about the desired outcome. Theory of change states, that by engaging in the activities, one is hoping to achieve the goals, which will have a particular impact on the conflict and result in the desired change. Town planning officials continued to say that if the municipality had full control over tribal land, it might be in a better position to limit unstainable spatial development in the areas. There is also a division in decision-making between traditional leaders and municipal authorities. This has resulted in contradictory stand allocation whereby the traditional authority has placed some households in areas deemed unsuitable for development by the municipality. As a result, traditional authorities and municipal authorities must collaborate and have a good working relationship that is transparent and mutual.

6.5.2 Urban regulation and land use management.

Out of the sample of 5 traditional leaders who were interviewed about whether they were satisfied with the practice of land management in the study area, 3 (60%) of them were not satisfied with the land management practices in the area. These 3 traditional leaders gave various reasons as to why they were not satisfied as indicated in table 7.

Dissatisfaction with land management in the study area by Traditional Leaders
(1) The planning department uses a top-down approach
(2) Issues of land ownership between chiefs and local municipality
(3) Municipality wanting to take the roles and responsibilities of traditional leaders

Table 7: Traditional Leaders Views on Land Management. Source: Field Survey, 2022

The conflict between traditional leaders and local government structures continues to be a major issue in South African local governance. It is worth noting that more than 60% of the total sample of traditional leaders had reasons not to be satisfied with land management in their areas. All the reasons for their dissatisfaction pointed at the local government as the cause. As indicated in Table 7 traditional leaders argued that the local municipality uses a top-down approach which is the issue of inappropriate communication channels being used by the local municipality. One of the traditional leaders indicated that the reason why most traditional leaders show weak involvement in matters of land management with the local municipalities is not because of lack of willingness but rather a lack of understanding by local municipalities on the role and responsibilities of traditional leaders. This lack of appropriate communication affects poor working relations between local municipalities and traditional leaders. Although traditional leadership is often intended to address cultural and social issues, its importance in land use planning and management should be recognized. This argument stems from the fact that traditional leaders have accused local municipalities of manipulating them when they require community assistance, and they are rarely consulted.

Municipalities have been involved in numerous land disputes with traditional leaders, an indication that governance and administration are tipping. As indicated in table 7 the issue of land ownership between chiefs and the local municipality was brought up by one of the traditional leaders who provided an incident that happened between the Netshituni traditional leadership and the Makhado local municipality. In this incident, a dispute erupted over a plot of land measuring approximately 100 hectares in the area. The Netshituni traditional leadership contended that because the land belonged to them, the municipality had no legal right to auction it. The municipality, on the other hand, had already begun the auction process, and some people had already paid deposits for the auctioned land. However, the issue has been handed over to court and is being dealt with by the law.

6.5.3 Challenges of the land use scheme in terms of Spatial Planning and Land Use Management Act 16 of 2013 (SPLUMA)

Makhado town planning officials argued that the reality is that in rural areas there still exists a land use and land allocation system which is administered by traditional leaders in terms of customary law and this has been the case for many centuries. This has led to the emergence of two systems of land use management existing parallel to each other. The existence of the two systems in the same area potentially serves as a recipe for conflicts and contestations. Another serious issue which is proving to be challenging for Makhado local municipality is finalising their land use scheme. The town planning manager indicated that as the municipality is busy preparing the land use scheme, past legislations such as Proclamation 45 and R188 have not yet been repealed which will make it difficult for the municipality to effectively implement the wall-to-wall land scheme. The delay can also be attributed in part to the tensions between traditional leaders and the municipality. The town planners continued to indicate that municipal officials are often not allowed to assess and survey those areas where traditional leaders govern to include them in the municipality's land use scheme. Consequently, a significant amount of time and effort is lost trying to secure the buy-in and cooperation of traditional leaders to implement SPLUMA. The town planning manager indicated that Makhado Local Municipality is currently still in the process of finalizing their land use scheme which is in line with SPLUMA requirements.

7 SUMMARY AND CONCLUSION

The study provides a comprehensive understanding of the evolving landscape in Makhado Biaba town. Through the application of support vector machine (SVM) classification, the study tracks changes in land cover over three distinct time periods thus 1995, 2011, and 2022. Results highlight significant shifts in land cover composition, with notable implications for urban development, population growth, and socio-economic dynamics. Moreover, the research delves into the socio-economic factors influencing settlement patterns and land tenure systems. Traditional leaders play a pivotal role in land governance, complicating municipal efforts to manage and regulate land use effectively. Challenges such as conflicting roles between traditional leaders and local government structures, coupled with issues of land ownership and tenure, underscore the complexities inherent in peri-urban dynamics. These challenges are exacerbated by the coexistence of traditional land allocation systems alongside modern legal frameworks, leading to conflicts

and contestations over land use management. Furthermore, the study sheds light on the regulatory hurdles faced by the Makhado Local Municipality in implementing effective land use schemes, particularly in reconciling traditional and modern systems of land governance. Delays in finalizing land use schemes, tensions between municipal officials and traditional leaders, and legislative complexities hinder the municipality's ability to effectively manage land use in line with contemporary standards. Overall, the research underscores the need for collaborative approaches between traditional leaders, local government authorities, and relevant stakeholders to navigate the complexities of peri-urban dynamics and achieve sustainable land use management in evolving landscapes.

In conclusion, Monitoring and understanding the dynamics of LULC and peri urban expansion is essential for effective urban planning, environmental conservation, socio-economic development, and governance factors shaping land use and land cover change in peri-urban areas. By employing advanced classification techniques, landscape metrics analysis, and socio-economic assessments, the research contributes to a deeper understanding of the challenges and opportunities associated with urban expansion and peri-urban development.

8 RECOMMENDATIONS

The paper come up recommendations for sustainable urban development strategies in mitigating adverse effects on the environment and community well-being as listed and discussed below:

- Harmonize Legislation: Reconcile conflicting policies and By-laws to create a cohesive land management framework that accommodates both traditional practices and modern ordinances that is a comprehensive and integrated approach to land management by addressing conflicts between different legal frameworks.
- Facilitate multidisciplinary research to restructure the inherited spatial development pattern: This can be achieved by fostering partnerships between academic institutions, research organizations, government agencies, and non-profit organizations. Collaborative research projects can generate valuable insights into local dynamics, drivers of peri-urban expansion, and innovative approaches to sustainable land use and development.
- Compact Urban Design: Compact development encourages higher building densities, mixed land use, and efficient use of infrastructure, reducing the need for sprawling development and preserving green spaces.
- Capacity Building and Awareness: Implement programs to enhance the capacity of traditional leaders, municipal officials, and community members in understanding contemporary land governance frameworks, including land use planning, zoning regulations, and land tenure systems. Promote awareness campaigns to educate stakeholders about the importance of sustainable land use management and the benefits of adhering to legal and regulatory frameworks.
- Develop peri-urban expansion strategies: Strategies tailored to rural contexts, considering local needs, environmental impact, and community involvement.

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