JURNAL GEOGRAFI
Geografi dan Pengajarannya
ISSN : 1412 - 6982
e-ISSN : 2443-3977
Volume 22, Number 1, June 2024
https://journal.unesa.ac.id/index.php/jg
DOI : https://doi.org/10.26740/jggp.v22n1.p1-18

SPATIAL ANALYSIS OF LAND CARRYING CAPACITY AND RESIDENTIAL GROWTH IN SIRIMAU DISTRICT, MALUKU PROVINCE, INDONESIA

Mohammad Amin Lasaiba[*1]
[1]Geography Education Study Program, FKIP, Pattimura University, Ambon

ARTICLE INFO

Article history:
Received 14 January 2024
Revised 27 May 2024
Accepted 30 May 2024

***Keywords*:**
Spatial Analysis, Land Carrying Capacity, Residential Growth

ABSTRACT

Population growth and urbanization pose challenges in maintaining sufficient land-carrying capacity. This research analyzes land carrying capacity and urban development in Sirimau District, Ambon City. Direct observation and document collection are used to collect data. A quantitative descriptive approach and spatial analysis with overlays of relevant parameters are used in data analysis. The results show that the most significant growth occurs in Batu Merah Village. Land carrying capacity calculations reveal an average decrease in residential land carrying capacity. In 2022, Ahusen Village, Rijali Village, and Galala Village recorded a decline in land-carrying capacity below 1, indicating that these areas can no longer accommodate the remaining population, which suggests that population pressure and unchecked urban growth negatively impact land-carrying capacity. Sustainable management measures, such as prudent urban spatial planning, protection of green areas, and appropriate infrastructure development, must be implemented.

A. INTRODUCTION

Over the past two centuries, the growth of the human population and urbanization have been the primary catalysts for changes in global environments dominated by humans (Lambin & Meyfroidt, 2011; Liao et al., 2022; Roy, 2023). Expanding industry and urban infrastructure has adversely impacted ecology and the environment (Muhammad et al., 2020; Tan et al., 2022), creating significant obstacles to sustainable development in many regions worldwide (Zhang & Chen, 2021). More than half of the planet's land has been altered in some manner (Dinerstein et al., 2019), and nearly one-third of the Earth's surface has been significantly altered by various developments and land uses. These changes include urban expansion, agricultural conversion, deforestation, and infrastructure projects, all of which profoundly impact natural landscapes, ecosystems, and biodiversity. This extensive alteration underscores the need for sustainable land management practices to mitigate further environmental degradation. (Turner et al., 2007; Caballero et al., 2022; Liao et al., 202).

[*]Correspondence address: lasaiba.dr@gmail.com

Recent studies reveal that about 60% of global development from 1982 to 2016 is directly associated with human activity and population growth (Song et al., 2018). The swift population increase drives the demand for residential housing, commercial spaces, and public infrastructure (Hopkins et al., 2023). Consequently, human settlements continually expand into available areas (Liu et al., 2023). This expansion occurs in urban, rural, and peri-urban areas (Lasaiba, 2023a). New settlements are often developed on previously agricultural, forested, or undeveloped (Kusumadiya et al ., 2023). This transformation alters natural areas into residential zones with various buildings, roads, and other infrastructure.

Unplanned and widespread residential development in urban areas has reduced natural spaces and the exploitation of resources, potentially compromising the land's carrying capacity (Takyi et al., 2023). This development has resulted in the shrinking of agricultural land and the loss of natural habitats, which has decreased food availability and biodiversity and altered the water cycle, potentially triggering sustainable environmental degradation (Zhao et al., 2021). Whether directly or indirectly, unsustainable land use can damage the ecosystem's ability to provide natural resources and essential environmental components that support human life and other living organisms, known as ecological carrying capacity (Mahfudin & Kurniawati, 2023). Additionally, ecosystems that have experienced degradation may still need to regain their original support capacity even after decades of restoration efforts (Veldkamp et al., 2020).

Non-integrated residential development leads to a range of social and economic challenges. The uneven expansion of settlements has given rise to significant social and economic disparities, with pronounced differences in quality of life and access to public facilities between urban and rural areas (Bikis, 2023). Urban areas often benefit from better infrastructure, healthcare, and educational services, while rural regions lag, exacerbating inequality. Furthermore, the rapid growth of residential areas places additional pressure on existing infrastructure, such as roads, public transportation, and utilities, which may need to be equipped to handle the increased demand (Lasaiba, 2023b).

In this context, considering the land's carrying capacity is crucial for sustainable residential development. Land carrying capacity refers to the ability of the land to meet human needs while maintaining its essential ecological functions, such as water absorption, food production, and biodiversity conservation (van der Meer et al., 2023). Incorporating an understanding of land-carrying

capacity into settlement development planning is vital for achieving sustainable development (Ambugadu & Hosni, 2022).

Sustainable protection and management efforts are necessary to maintain the land's carrying capacity. These efforts include carefully selecting settlement locations to avoid ecologically sensitive areas, effective land use practices that optimize space without causing degradation, and the protection of critical lands vital for ecological and agricultural functions. Responsible water management is also essential to ensure that the water needs of both human populations and ecosystems are met without causing depletion or contamination (Sorker et al., 2023). Achieving sustainable residential development requires an integrated and comprehensive approach. This approach should involve various stakeholders, including government agencies, civil society organizations, the private sector, and international organizations. Collaboration among these parties is essential to develop and implement policies and practices that support sustainable land use and protect ecological functions (Sarjanti *et al*., 2023).

Focusing on and prioritizing the carrying capacity of land in residential development brings various benefits (Ayu et al., 2023). First, efficient land use and optimization can minimize the conversion of important agricultural and forest land, which supports sustainable food production, reduces dependence on food imports, and maintains biodiversity. Second, by considering the land's carrying capacity, we can reduce negative impacts on the water cycle and the risk of flooding.

Sirimau Subdistrict in Ambon City faces significant challenges related to land-carrying capacity and rapid settlement growth. This area is dominated by hilly terrain, making it highly susceptible to flood and landslide disasters. The varied topography with many hilly areas increases the risk of natural disasters, especially during the rainy season (Septian et al., 2020). Furthermore, intensive land conversion in the protected forest area of Gunung Nona in this subdistrict, caused by high population density and the need for new land for settlements, further adds pressure on the available land and threatens environmental sustainability. Green spaces and conservation areas are increasingly diminishing due to land conversion for new settlement development, significantly reducing the region's ability to absorb rainwater and maintain local ecosystem balance (Prihandono, 2020). High population density also increases pressure on the available land, worsening environmental quality and threatening the long-term sustainability of the area (Sutikno et al., 2023). The lack of public awareness about

the importance of land conservation and the minimal coordination in spatial planning in the Sirimau Subdistrict also exacerbates this situation, as development often needs to consider environmental aspects and disaster risks. Thus, settlement development in the Sirimau Subdistrict can be carried out sustainably, reducing the risk of natural disasters and improving the quality of life for residents. An integrated approach involving various stakeholders in planning and implementing development is crucial to balancing settlement needs and environmental conservation.

Implementing policies that promote effective spatial organization and responsible land use will help ensure that development in residential areas is sustainable and in line with the available land capacity. In this way, we can ensure that the region's growth provides short-term benefits and positively contributes to long-term environmental quality and community well-being, which involves the development of densely populated urban areas while ensuring stringent protection of agricultural land and vital ecosystems. To achieve this, close collaboration between government, society, the private sector, and international institutions is integral in formulating holistic policies and ensuring their effective implementation (Aswad & Kesaulya, 2023). Thus, joint efforts to manage and plan land use will significantly contribute to environmental sustainability and responsible residential development.

Ambon City, the capital of Maluku Province, Indonesia, has experienced rapid residential growth in recent years, driven by significant population growth, ongoing urbanization, and the ever-increasing need for urban infrastructure. The impact of this development is an increase in the number of settlements and development in the area, which can directly impact the carrying capacity of existing land. Land carrying capacity is essential because it reflects the ability of an area to accommodate population and urban activities sustainably. In the context of the Sirimau District, this intensive growth can result in an increased burden on available land. Therefore, a good understanding of the carrying capacity of Ambon City land and appropriate efforts in managing residential development is fundamental to maintaining the balance between residential needs and available land capacity.

B. METHOD

The data collection stage is one of the critical aspects in carrying out research or studies, and in this context, the methods used are observation and documentation. Observation plays a vital role in understanding phenomena or events that are directly observed, especially in the case of residential development in Sirimau District, Ambon City. This

process involves field visits to settlement locations, following changes over time, and recording data related to settlement area, population density, and settlement expansion patterns. In addition, the documentation approach is also an integral part of data collection by utilizing secondary information such as government reports, population data, geospatial data, and other sources of information relevant to settlement development and land capacity in Sirimau District, Ambon City. This secondary data contributes to completing and supporting a more comprehensive analysis of settlement changes and aspects of land-carrying capacity.

After the data was successfully collected, the next step in this research involved using quantitative descriptive analysis methods. This method aims to provide an in-depth explanation and description of the data using descriptive statistical tools. In the context of the analysis of settlement development and land carrying capacity in Sirimau District, Ambon City, In the context of analysis of settlement development and land carrying capacity in Sirimau District, Ambon City, a quantitative descriptive analysis approach was carried out to explain the calculation results. For example, the results of these calculations can include data such as residential area, population density, and residential expansion patterns from 2012 to 2022. Dengan menggunakan metode analisis deskriptif kuantitatif dalam menjelaskan seperti rata-rata, median, modus, dan deviasi standar, sehingga memungkinkan kita untuk memperoleh pemahaman yang lebih mendalam tentang tren pembangunan perumahan dan kapasitas lahan di wilayah tersebut..

In analyzing the development of settlements in the Sirimau District of Ambon City, the approach used is interpreting time series satellite images. This approach involves using a series of satellite images taken at two different times, namely in 2012 and 2022, to monitor changes and developments in the settlements within the area during that period. By utilizing this satellite image data, we can identify growth patterns, changes in land use, and the impact of urban development on the Sirimau District in a more detailed and comprehensive manner. Satellite image interpretation is a process that requires the identification, classification, and mapping of settlement features from the image to understand the changes that occurred in a specific period. In this context, Landsat satellite imagery is a data source for interpreting satellite imagery. Landsat satellite imagery is a source of remote sensing data that is very commonly used in mapping and land analysis, which provides an accurate picture of settlement development and land changes in Sirimau

District, Ambon City, during a specified period.

In analyzing the distribution of settlements in the Sirimau District of Ambon City, a neighboring analysis method is employed by calculating the distance between each settlement point and its nearest neighbors. The goal is to identify and understand the patterns and characteristics of the settlement distribution. The ArcGIS application for this analysis utilizes the Average Nearest Neighbor (ANN) tool available within the software. We can perform more in-depth statistical analysis using the ANN tool to assess whether the settlement distribution pattern is random, concentrated, or evenly dispersed in the Sirimau District area. This analysis will provide deeper insights into the area's structure and distribution of settlements. The Average Nearest Neighbor (ANN) tool is a spatial analysis tool that is useful for calculating and describing spatial distribution patterns from point data, which will provide deeper insight into the distribution and structure of settlements in the Sirimau District, Ambon City.

Calculating the land carrying capacity value refers to the method that Muta'ali (2012:51) proposed, which explains a series of steps used in estimating and evaluating land carrying capacity. This method guides calculating the extent to which land can accommodate and support various types of land use, as well as assisting in understanding the potential and limitations of land in the context of urban development or sustainable land use as follows:

$$DDPM = \frac{LPM/JP}{\infty} \quad \text{..... (1)}$$

Information:

DDPm = Settlement Carrying Capacity
JP = Total population
∞ = Coefficient of area needed for space/capita (m^2 /capita)

This research uses coefficients based on the Indonesian National Standard (SNI) 03-1733-2004 with a benchmark area of 26 m² to calculate the land area considered suitable for settlement, expressed in the variable LPm (land area ideal for settlement) in square meters. However, it is essential to remember that according to the Minister of State for Public Housing Regulation No.11/PERMEN/M/2008, land area requirements for settlements can vary based on the area concerned. In the context of this research, the researcher has chosen to adopt certain limitations based on calculations on SNI 03-1733-2004. However, it needs to be acknowledged that in practice, factors such as geographical location and local government regulations can also influence the land area requirements for adequate settlements. as follows:

LPm = LW – (LKL + LKRB) ……. (2)

Information:

LW	=	Total Area
LKL	=	The area of the Protected Area
LKRB	=	Area of Disaster Prone Areas

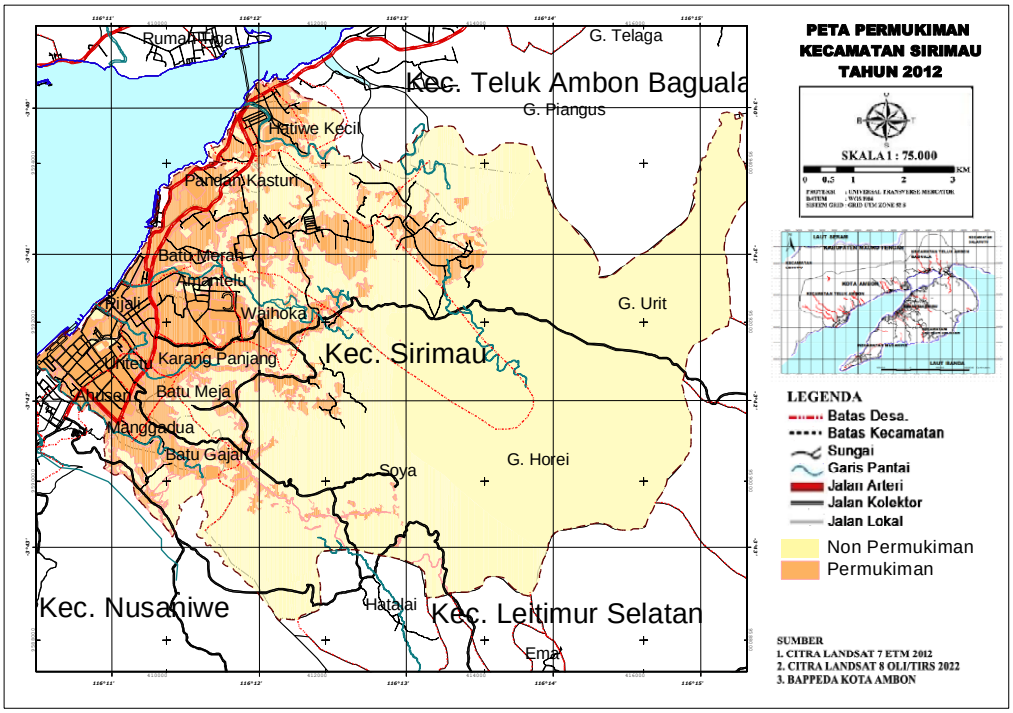
Using the classification that has, this research can provide precious information regarding the carrying capacity conditions of settlements in the research area. The results of the DDPm (Settlement Carrying Capacity Index) calculation, which indicates the level of land availability for settlement, can provide an in-depth understanding of the extent to which the area can accommodate residents to settle. If DDPm > 1, this indicates that the carrying capacity of settlements in the area is still high, and the area can accommodate the population more optimally. On the other hand, if DDPm = 1, there is an ideal balance between the number of residents living and the available area. However, if DDPm < 1, the settlement's carrying capacity is low, and the area can no longer adequately accommodate the population. This information has significant value in development planning and settlement management. It is an essential decision-making tool regarding regional development and population density adjustments, which can contribute to sustainable development and improve the quality of life in the research area.

C. RESULT AND DISCUSSION

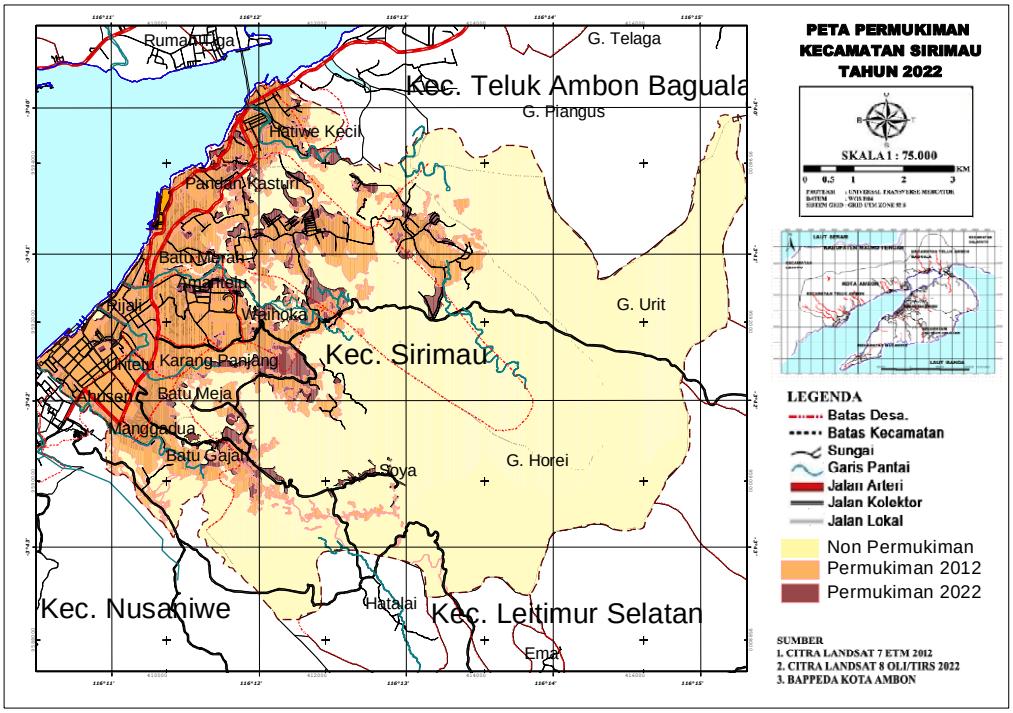
C.1. RESULT

a. Image Analysis and Classification Accuracy Assessment

Sirimau District, located in the center of Ambon City, Indonesia, plays a vital role in this region. With a strategic geographical position, Sirimau District is between 30 and 40 South Latitude (LS) and 1280 and 1290 East Longitude (BT). Ambon City is the capital of Maluku Province and is a vital economic, political, and social center in Maluku. Sirimau District consists of fourteen different sub-districts or villages, each with unique characteristics and developments that have impacted the spatial layout and structure of diverse settlements in this region. Along with significant population growth, Sirimau District has experienced a rapid increase in residential development. This development includes residential construction, public facilities, and other supporting infrastructure. Figure 1 depicts the changes and development of settlements in Sirimau District over time, reflecting population growth and the needs of local communities. These changes characterize Sirimau District as a dynamic and continuously developing region, which demands careful and sustainable urban planning to maintain quality of life and ensure efficient and sustainable land use.



(a)



(a)

Figure 1. Sirimau District Settlements in 2012 (a) and 2022 (b)

b. Settlement Development

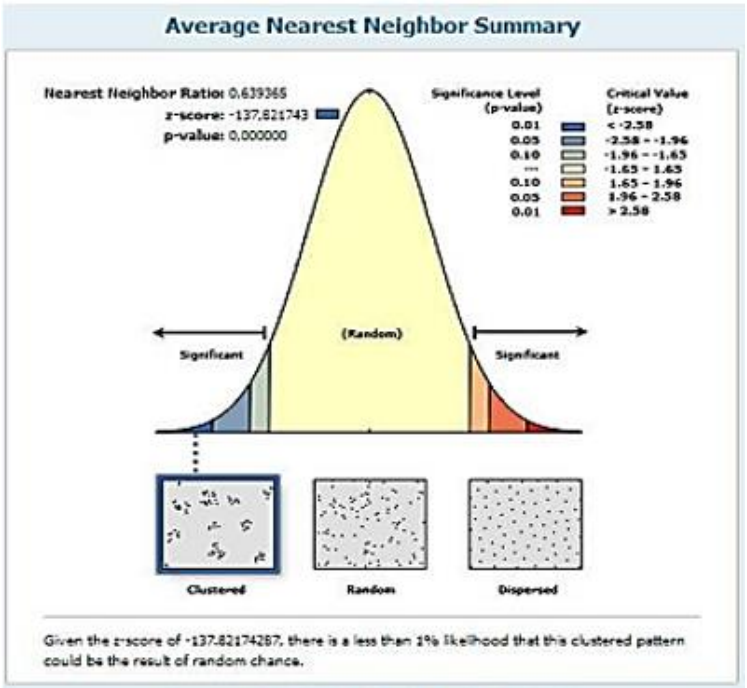
Research shows that most of Sirimau District and Ambon City sub-districts have experienced significant residential area development. However, those five sub-districts are exceptions to this trend: Honipopu, Ahusen, Uritetu, Rijali, and Pandan Kasturi. These five sub-districts have reached a high population density and development level, making it difficult to build new houses in the area. This condition indicates the need for careful monitoring and management to avoid overloading existing land and infrastructureOne of the exciting villages to take note of is Batu Merah Village. Despite having a high population density, there are ongoing activities for the construction of new houses in the area, there is new house construction activity in the area, indicating that Batu Merah Village can still accommodate the construction of new homes, possibly by optimizing existing land use. In this context, wise planning and spatial planning, as well as the implementation of sustainable policies, maybe the key to maintaining a balance between residential development and land capacity in these sub-districts and ensuring that this growth can occur sustainably and adequately for the local population.

Furthermore, the research results also revealed that the highest percentage of development occurred in Batu Merah Village—this percentage was calculated by comparing the residential development and sub-district areas. Previously, Soya Village also experienced significant regional development, but the percentage was smaller because it had a larger area. On the other hand, the Waihoka and Batu Meja subdistricts have smaller areas. However, their level of development is almost the same as that of the Soya subdistrict, which is over 10 hectares, which gives Tegalrejo Village a higher percentage of development. Thus, this research provides a very varied picture of the development of residential areas in Sirimau District, with some sub-districts facing problems with population density and development. In contrast, others can still build new houses. In addition, there are sub-districts with the highest level of development, indicating different dynamics in the spatial layout of settlements in the area, which is very important to pay attention to in planning sustainable urban development and management.

c. Settlement Distribution Pattern

Based on the results of nearest neighbor analysis calculations in Figure 2, a ratio of 0.639 is obtained. With this ratio showing its nature, the distribution pattern of settlements in Sirimau District is included in the "clustered" category, meaning that settlements tend to be in separate groups. Mean shape, the settlement pattern in Sirimau District tends to be elongated or "l when viewed in

terms of shapewear." This elongated shape occurs because the population chooses residences close to primary road access. As a result, these settlements were formed sequentially along the main routes or accesses in the Sirimau District area. This combination of "clustered" and "linear" patterns reflects the dynamics of complex urban spatial planning and shows how residents choose the location of their settlements in areas with reasonable accessibility.



Average Nearest Neighbor Summary

Observed Mean Distance:	12,0587 Meters
Expected Mean Distance:	18,8605 Meters
Nearest Neighbor Ratio:	0,639365
z-score:	-137,821743
p-value:	0,000000

Dataset Information

Input Feature Class:	sebaran
Distance Method:	EUCLIDEAN
Study Area:	56781100,000000
Selection Set:	True

Figure 2. Nearest Neighbor Analysis

d. Land Carrying Capacity for Settlement Development

Based on the data in Table 1, in 2012, three subdistricts in Sirimau District had a settlement carrying capacity value of less than 1: Ahusen Subdistrict, Rijali Subdistrict, and Galala which indicates that these areas can no longer accommodate residents to establish new settlements. These three sub-districts have very high levels of population density.

They are in the city center, so they have reached the limit of their capacity to accommodate further residential development. In sustainable urban development, it is necessary to carry out careful monitoring and management to overcome the challenges of high population density in these areas, including optimizing existing land use and wise spatial planning.

In 2022, the number of areas with a carrying capacity value of less than one will increase with the inclusion of Ahusen and Uritetu sub-districts. This sub-district has the highest percentage of residential area growth because its location is very strategic in the city center and has easy access. However, the calculation shows that the average carrying capacity value has decreased. A significant decrease in the carrying capacity value occurred in Soya Village, with a value of 70,008, due to the large area of protected areas, so the area for residential development is more limited compared to other sub-districts. Small changes in residential areas and population size can significantly impact carrying capacity values, emphasizing the importance of wise and sustainable spatial planning in rapid urban growth.

Table 1. Development of Residential Areas on Changes in Carrying Capacity

Subdistrict/Village	An area	Area of Residential Area (Ha)		Change	Total population		Land Carrying Capacity (DDPm)	
		2012	2022		2012	2022	2012	2022
Honipopu	38,046	37,035	37,612	0.577	6,509	5,034	1,119	0.208
Ahusen	22,893	21,774	21,855	0.081	2,987	3,471	0.969	0.833
Uritetu	33,394	32,059	33,294	1,235	5,175	4,884	1,052	0.695
Rijali	22,781	19,138	20,097	0.959	5,071	6,716	0.016	0.414
Karang Panjang	46,624	31,025	38,865	7,849	6,018	6,515	7,747	7,156
Amantelu	83,834	66,016	74,312	8,296	5,335	6,991	15,714	11,992
Pandan Kasturi	83,951	57,351	61,643	4,292	4,867	6,628	4,921	3,614
Galala	12,563	12,563	12,576	0.013	1,335	1,450	0.422	0.388
Hatiwe Kecil	158,249	74.16	87,691	13,531	6,411	10,953	24,684	14,448
Batu Gajah	64,130	22,632	29,473	6,841	6,061	6,304	10,581	6,804
Batu Merah	1018.271	241,694	327,049	85,355	36,608	64,795	27,270	15,407
Soya	1945.221	164,317	178,739	14,422	7,241	9,231	89,248	70,008
Batu Meja	73,520	31,652	46,408	14,756	8,235	8,750	8,928	8,402
Waihoka	42,152	21,613	26,692	5,079	4,134	4,704	10,196	8,961

Source: Research calculation results

The development of residential areas also plays a vital role in influencing the carrying capacity value of land. Housing construction by developers in Sirimau District has reduced available vacant land, which results in land that meets the requirements for residential development becoming increasingly limited. Apart from that, these new housing developments also attract buyers and have the potential to

increase the number of residents in the area. This increase in population can then cause the carrying capacity of the land to decrease.

Thus, changes in population and the development of residential areas are important factors that impact the carrying capacity value of land in Sirimau District. A decrease in population can increase the carrying capacity value, while an increase in population due to housing development can cause a reduction in the carrying capacity value. Therefore, it is essential to pay attention to the balance between population growth and the development of residential areas to maintain the sustainability and continuity of the residential environment in Sirimau District. Wise planning efforts and sustainable residential development management will be to overcome this challenge.

C.2. DISCUSSION

The centrifugal spatial development in Sirimau District can be categorized into three main types: linear, leapfrog, and concentric spatial development. However, it should be noted that linear spatial development occurs in a limited number of areas in the Sirimau District. Certain areas, such as Karang Panjang, Batu Merah, and Waihoka, experience linear spatial development characterized by growth along major roads and transportation routes, leading to elongated urban forms and concentrated infrastructure development along these corridors. This phenomenon is constrained because most areas along the roads in Sirimau District have already been developed with buildings from various sectors, including education, offices, industry, trade, and services. Urban land development is often limited by the availability of land already used for multiple infrastructure purposes (Mardiansjah & Rahayu, 2019). Therefore, linear spatial development occurs in a limited manner in these areas, indicating different development patterns in the Sirimau District. Land limitations for horizontal expansion compel urban development to adopt alternative spatial models like vertical and leapfrog development. (Rupini et al., 2017).

The second type of spatial development is leapfrog development; however, it should be noted that it also occurs in limited numbers, primarily in Soya Village. This leapfrog development can be considered offensive to agricultural land, as residential development takes over previously existing agricultural land. Leapfrog development often leads to land use conflicts, especially when agricultural land has to be converted into residential areas (Rahmawati & Arif, 2023). Meanwhile, the third type of spatial development is concentric development, which is the most dominant in the Sirimau District, especially in neighborhoods such as Honipopu, Ahusen, Uritetu, Rijali, and Pandan Kasturi. Almost every

neighborhood experiences concentric development, indicating increased activity and development around the neighborhood centers, gradually spreading to surrounding areas. Concentric development in urban areas typically indicates economic and social consolidation around key activity centers (Muta'ali & Nugroho, 2019). Furthermore, most of the concentric development occurs in coastal areas, suggesting the potential for urban growth and development focused on the coastal regions of Sirimau District.

This research reveals that many residential areas in Sirimau District have been built without adhering to the applicable Regional Spatial Planning. This phenomenon can be attributed to the need for more adequate knowledge and understanding of Regional Spatial Planning among developers and landowners. Although most developers in Sirimau District have constructed their housing per Regional Spatial Planning provisions, a small portion still needs to comply with these regulations. This finding aligns with Yunus's statement that spatial and regional planning concepts often remain good on paper but must be better implemented in the field. The main obstacle in implementing Regional Spatial Planning is the need for more understanding and awareness among developers about the importance of these regulations (Yunus, 2005). Despite good spatial and regional planning concepts, they often only serve as guidelines in planning studios and need more meaning when applied in the field. The main factor influencing this is the lack of sufficient knowledge and understanding regarding Regional Spatial Planning ((Setyoko, 2022). Therefore, efforts to enhance learning and awareness of the importance of Regional Spatial Planning in developing residential areas in the Sirimau District are highly relevant and urgent.

The "clustered" and linear settlement patterns in Sirimau District reflect residents' preferences for living locations close to road accessibility. This accessibility factor includes good transportation access, ease of access to public facilities, and accessibility that supports economic and social activities in the vicinity. Residents tend to choose locations that allow them to easily access transportation facilities, workplaces, schools, and public amenities such as markets and shopping centers. Transportation accessibility plays a crucial role in determining settlement patterns because it affects the comfort and efficiency of daily mobility (Adisasmita, 2011). These distribution patterns reflect the importance of high-quality transportation infrastructure and efficient access systems in shaping urban spatial planning that aligns with residents' preferences and needs. The quality of infrastructure and accessibility are major factors driving people to settle in an area,

as they are directly related to their quality of life (Mungkasa, 2020).

Several areas in Sirimau District have already reached their carrying capacity for residential development. In contrast, other regions have experienced a decline in carrying capacity due to limited land available for development. Based on research findings, several factors significantly influence the changes in land-carrying capacity in Sirimau District. One of the main factors is the change in population numbers. For instance, in Honipopu and Uritetu, a decrease in population has led to an increase in carrying capacity, even though there has yet to be any expansion of residential areas. A population reduction can reduce pressure on the land, increasing its carrying capacity (Aswad & Kesaulya, 2023). it is indicated that a smaller population can reduce pressure on the land's carrying capacity. Changes in land use policies and spatial planning can also play a role in influencing land carrying capacity. Appropriate land use policies are crucial for balancing development and environmental sustainability (Setyoko, 2022). Therefore, these policies need to be considered in managing sustainable residential development.

D. CONCLUSION

The research results show residential growth in almost every sub-district in Sirimau District, Ambon City, except for Honipopu, Ahusen, Uritetu, Rijali, and Pandan Kasturi sub-districts. Batu Merah Village is the sub-district with the highest residential development, while the most significant percentage of growth occurred in the Sirimau district. However, calculating land's carrying capacity shows an average decrease in residential land's carrying capacity. There are Ahusen Subdistrict, Rijali Subdistrict, and Galala, which experienced a decline in land carrying capacity below a value of 1, indicating that the area can no longer maintain its population to settle, which means a negative impact of residential growth on the carrying capacity of land in the Sirimau District. Population pressure and uncontrolled settlement growth can result in limited land suitable for settlement. Therefore, it is necessary to make wise management efforts in urban spatial planning, protecting green land, and developing appropriate infrastructure to maintain sustainability and balance between residential growth and land-carrying capacity.

BIBLIOGRAPHY

Adisasmita, S. A. (2011). *Transportasi dan pengembangan wilayah*. Graha Ilmu. https://books.google.co.id/books?id=jahqygAACAAJ

Ambugadu, A. M., & Hosni, N. B. (2022). Modeling Informal Settlements Expansion for Sustainable Urban Development: A Scientometric Revie. *Journal of Archaeology of Egypt/Egyptology*, *19*(1), 1567. https://archives.palarch.nl/index.php

/jae/article/view/10939

Aswad, W. S. J., & Kesaulya, H. M. (2023). Analisis Kapasitas Daya Dukung dan Daya Tampung Lingkungan Hidup Kawasan Perkotaan Demak dengan Pendekatan Supply dan Demand. *INNOVATIVE: Journal Of Social Science Research*, *3*(2), 7772–7789. https://doi.org/https://doi.org/10.31004/innovative.v3i2.1265

Ayu, C., Wahoni, N., Nurminda, E., Mandalika, D., & Kunci, K. (2023). Analisis Daya Dukung Lahan Pertanian Di Desa Penyangga Kawasan Ekonomi Khusus Mandalika - Kabupaten Lombok Tengah. *JSEH (Jurnal Sosial Ekonomi Dan Humaniora)*, *9*(1), 99–106. https://doi.org/https://doi.org/10.29303/jseh.v9i1.314

Bikis, A. (2023). Quantifying and analyzing the impact assessment on land use change of urban growth using a timeline. *Environmental Science and Pollution Research*, *30*(22), 62762–62781. https://doi.org/10.1007/s11356-023-26443-1

Caballero, C. B., Ruhoff, A., & Biggs, T. (2022). Land use and land cover changes and their impacts on surface-atmosphere interactions in Brazil: A systematic review. *Science of The Total Environment*, *808*, 152134. https://doi.org/https://doi.org/10.1016/j.scitotenv.2021.152134

Dinerstein, E., Vynne, C., Sala, E., Joshi, A. R., Fernando, S., Lovejoy, T. E., Mayorga, J., Olson, D., Asner, G. P., Baillie, J. E. M., Burgess, N. D., Burkart, K., Noss, R. F., Zhang, Y. P., Baccini, A., Birch, T., Hahn, N., Joppa, L. N., & Wikramanayake, E. (2019). A Global Deal For Nature: Guiding principles, milestones, and targets. *Science Advances*, *5*(4), eaaw2869. https://doi.org/10.1126/sciadv.aaw2869

Hopkins, E., Potoglou, D., Orford, S., & Cipcigan, L. (2023). Can the equitable rollout of electric vehicle charging infrastructure be achieved? *Renewable and Sustainable Energy Reviews*, p. *182*, 113398. https://doi.org/https://doi.org/10.1016/j.rser.2023.113398

Ilmiah, M. (2023). Analisis daya dukung fungsi lindung untuk kelesterian lingkungandi subdas logawa kabupaten banyumas. *Geomedia*, *21*(1), 43–48. https://doi.org/10.21831/gm.v21i1.43822 Abstract

Kusumadiya, P., Rusdiana, O., & Mulatsih, S. (2023). Analisis Daya Dukung untuk Mendukung Swasembada Pangan di Provinsi Kalimantan Utara. *Journal of Environmental Engineering and Waste Management*, *8*(1), 79–90. https://doi.org/http://dx.doi.org/10.33021/jenv.v8i1.4109

Lambin, E. F., & Meyfroidt, P. (2011). Global land use change, economic globalization, and the looming land scarcity. *Proceedings of the National Academy of Sciences*, *108*(9), 3465–3472.

https://doi.org/10.1073/pnas.1100480108

Lasaiba, M. A. (2023a). Evaluation Of Settlement Land Suitability Based On Remote Sensing And Geographical Information Systems In The City Of Ambon. *SPATIAL: Wahana Komunikasi Dan Informasi Geografi*, *23*(1), 70–84. https://journal.unj.ac.id/unj/index.php/spatial/article/view/33157

Lasaiba, M. A. (2023b). Spatial-Temporal Variation of Land Use Changes In Ambon City. *Rekayasa*, *16*(1), 84–95. https://doi.org/https://doi.org/10.21107/rekayasa.v16i1.18799

Liao, X., Fang, C., & Shu, T. (2022). Multifaceted land use change and varied responses of ecological carrying capacity: A case study of Chongqing, China. *Applied Geography*, *148*, 102806. https://doi.org/https://doi.org/10.1016/j.apgeog.2022.102806

Liu, S., Xiao, W., Ye, Y., He, T., & Luo, H. (2023). Rural residential land expansion and its impacts on cultivated land in China between 1990 and 2020. *Land Use Policy*, p. *132*, 106816. https://doi.org/https://doi.org/10.1016/j.landusepol.2023.106816

Mahfudin, A., & Kurniawati, U. F. (2023). Arahan Pemanfaatan Lahan Melalui Pendekatan Telapak Ekologis Di Kabupaten Lamongan. *Jurnal Teknik ITS*, *12*(1), 1–8. https://doi.org/10.12962/j23373539.v12i1.99646

Mardiansjah, F. H., & Rahayu, P. (2019). Urbanisasi dan Pertumbuhan Kota-Kota Di Indonesia: Suatu Perbandingan antar-Wilayah Makro Indonesia. *Jurnal Pengembangan Kota*, *7*(1), 91–110. https://doi.org/10.14710/jpk.7.1.91-108

Muhammad, S., Long, X., Salman, M., & Dauda, L. (2020). Urbanization and international trade affect CO2 emissions across 65 Belt and Road Initiative countries. *Energy*, *196*, 117102. https://doi.org/https://doi.org/10.1016/j.energy.2020.117102

Mungkasa, O. (2020). *Perencanaan Tata Ruang Sebuah Pengantar*.

Muta'ali, L., & Nugroho, A. R. (2019). *Permukiman kumuh di Indonesia dari masa ke masa: perkembangan program penanganan*. UGM PRESS.

Prihandono, A. (2020). Penyediaan Ruang Terbuka Hijau (RTH) Menurut UU No. 26/2007 tentang Penataan Ruang dan Fenomena Kebijakan Penyediaan RTH Di Daerah. *Jurnal Permukiman*, *5*(1), 13. https://doi.org/10.31815/jp.2010.5.13-23

Rahmawati, A., & Arif, N. (2023). Analisis Dampak Perubahan Penggunaan Lahan Terhadap Lingkungan Pemetaan mobilitas penduduk di kawasan pinggiran Kota Kualitas Bandung Permukiman. *Majalah Geografi Indonesia*, *37*(2), 114–123. https://doi.org/10.22146/mgi.70636

Roy, S. C. (2023). *Anthropogenic Disturbances on Climate Change, Global Warming, Ecosystem and*

COVID-19 Pandemic BT - Economic, Environmental and Health Consequences of Conservation Capital: A Global Perspective (R. C. Das (ed.); pp. 155–170). Springer Nature Singapore. https://doi.org/10.1007/978-981-99-4137-7_12

Rupini, A. A. A. D., Dewi, N. K. A., & Sueca, N. P. (2017). Implikasi Alih Fungsi Lahan Pertanian Pada Perkembangan Spasial Daerah Pinggiran Kota (Studi Kasus: Desa Batubulan, Gianyar). *Jurnal Ilmiah Arsitektur*, *5*(2), 9–18. https://doi.org/https://doi.org/10.22225/undagi.5.2.405.9-18

Septian, A., Elvarani, A. Y., Putri, A. S., Maulia, I., Damayanti, L., Pahlevi, M. Z., & Aswad, F. H. (2020). Identifikasi Zona Potensi Banjir Berbasis Sistem Informasi Geografis Menggunakan Metode Overlay dengan Scoring di Kabupaten Agam, Sumatera Barat. *Jurnal Geosains Dan Remote Sensing*, *1*(1), 11–22. https://doi.org/https://doi.org/10.23960/jgrs.2020.v1i1.25

Setyoko, P. I. (2022). Implementasi Peraturan Daerah Kabupaten Banyumas Nomor 6 Tahun 2019 Tentang Rencana Detail Tata Ruang Kawasan Perkotaan Purwokerto. *Jurnal Administrasi Negara*, *28*(2), 198–216. https://doi.org/https://doi.org/10.33509/jan.v28i2.1818

Song, X. P., Hansen, M. C., Stehman, S. V., Potapov, P. V., Tyukavina, A., Vermote, E. F., & Townshend, J. R. (2018). Global land change from 1982 to 2016. *Nature*, *560*(7720), 639–643. https://doi.org/10.1038/s41586-018-0411-9

Sorker, R., Khan, M. W., Kabir, A., & Nawar, N. (2023). Variations in ecosystem service value in response to land use changes in Dhaka and Gazipur Districts of Bangladesh. *Environmental Systems Research*, *12*(1), 32. https://doi.org/10.1186/s40068-023-00316-5

Sutikno, M. A. F., Rahmawati, D., Prahmani, Y. S., Haris, A., Wulandari, T. D., & Astutianingtyas, D. F. (2023). Program Penguatan Ketahanan Pangan, Pengelolaan Sampah, Air dan Sanitasi Guna Mewujudkan Kampung Iklim Kelurahan Tugurejo. *Jurnal Pemberdayaan Masyarakat*, *2*(2), 89–99. https://doi.org/10.46843/jmp.v2i2.291

Takyi, S. A., Amponsah, O., Sarko, S. B., & Senior, A. Y. (2023). The effects of urban sprawl on the livelihoods of settler communities: lessons from selected municipalities in Ghana. *GeoJournal*, *88*(5), 4827–4854. https://doi.org/10.1007/s10708-023-10897-4

Tan, F., Yang, L., Lu, Z., & Niu, Z. (2022). Impact of urban innovation on green development in China's Yangtze River Economic Belt: perspectives of scale and network. *Environmental Science and Pollution Research*, *29*(49), 73878–73895.

https://doi.org/10.1007/s11356-022-21042-y

Turner, B. L., Lambin, E. F., & Reenberg, A. (2007). The emergence of land change science for global environmental change and sustainability. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(52), 20666–20671. https://doi.org/10.1073/pnas.0704119104

Van der Meer, J., Callier, M., Fabi, G., van Hoof, L., Nielsen, J. R., & Raicevich, S. (2023). The carrying capacity of the seas and oceans for future sustainable food production: Current scientific knowledge gaps. *Food and Energy Security*, *12*(4), e464. https://doi.org/https://doi.org/10.1002/fes3.464

Veldkamp, E., Schmidt, M., Powers, J. S., & Corre, M. D. (2020). Deforestation and reforestation impacts on soils in the tropics. *Nature Reviews Earth and Environment*, *1*(11), 590–605. https://doi.org/10.1038/s43017-020-0091-5

Yunus, H. S. (2005). *Manajemen Kota Dari Perspektif Spasial*. Yogyakarta.

Zhang, D., & Chen, Y. (2021). Evaluation on urban environmental sustainability and coupling coordination among its dimensions: A Shandong Province, China case study. *Sustainable Cities and Society*, p. *75*, 103351. https://doi.org/https://doi.org/10.1016/j.scs.2021.103351

Zhao, Z., Li, W., Ciais, P., Santoro, M., Cartus, O., Peng, S., Yin, Y., Yue, C., Yang, H., Yu, L., Zhu, L., & Wang, J. (2021). Fire enhances forest degradation within forest edge zones in Africa. *Nature Geoscience*, *14*(7), 479–483. https://doi.org/10.1038/s41561-021-00763-8