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MORALITY BEFORE KNOWLEDGE

Land use transformation and sustainable spatial design lessons from a decade of regional development

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ABSTRACT

Background: North Tapanuli Regency in North Sumatra has unique characteristics as a region located in the highlands and cool climate, with a dominant wilderness. North Tapanuli is divided into 15 sub-districts, with 11 urban villages and 241 villages. Each sub-district has its own duties, with the capital of the district being in Taruntung. The largest sub-district in North Tapanuli is Adiankoting and the smallest is Sipoholong. **Methods:** This study employed a qualitative method with a literature review. **Findings:** In addition to referring to normative regulations referring to the central government and the provincial government, the development of Tapanuli in the ten-year period, namely from 2014 to 2014 was boosted through breakthroughs with the Nikson model or innovation, knowledge, synergy, operation, and norm as a model in regional development planning based on precise data. In one decade, Nikson-style development has reportedly made North Tapanuli Regency a barn for agriculture, fisheries, and forestry. However, this development has changed the spatial layout and environmental quality of North Tapanuli. **Conclusion:** The North Tapanuli region is still dominated by wilderness. The past ten years have shown significant development, but with the consequence of environmental change. **Novelty/Originality of this article:** Over time, the population of North Tapanuli has also increased, resulting in land use changes and increased waste volume.

KEYWORDS: nikson; North Tapanuli Regency; sustainable development; urban planning.

1. Introduction

North Tapanuli Regency, North Sumatra, is divided into 15 sub-districts, with 11 urban villages and 241 villages. Each sub-district in North Tapanuli is divided into 15 districts. The largest district in North Tapanuli is Adiankoting, and the smallest is Sipoholong. The North Tapanuli region is dominated by forests and shrubs, which serve as life support for various flora and fauna species and serve as important natural resources for the local community. Forests in North Tapanuli not only play a role in maintaining ecosystem balance but also provide economic benefits through the forestry, tourism, and agriculture sectors. However, spatial planning management in this region faces various challenges, particularly in the last ten years. Pressure on the environment has increased along with development in the regency.

Development in North Tapanuli has been intensified over the last ten years, from 2014 to 2015. The spatial planning of North Tapanuli refers to Law Number 11 of 2020 concerning Job Creation. This was then translated into long-term regional regulations, namely North Tapanuli Regency Regional Regulation No. 03 of 2017 concerning the Spatial

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Planning of North Tapanuli Regency for 2017-2037 and short-term regional government regulations concerning Amendments to the North Tapanuli Regency Medium-Term Development Plan/*Rencana Pembangunan Jangka Menengah Daerah* (RPJMD) for 2019-2024. Furthermore, North Tapanuli Regency introduced a development motto during that decade, under the leadership of Regent Nikson Nababan; the Nikson model, which stands for innovation, knowledge, synergy, operation, and norms.

Not only is development progressing in North Tapanuli, but over time, the population of North Tapanuli has also increased. In 2016, the population of North Tapanuli was 295,613, which increased to 312,578 in 2020. Population growth impacts the quality of environmental sustainability and balance in a region, as it creates a greater need for food and larger settlements. Both lead to land-use changes through agricultural activities, illegal logging, and the conversion of land into residential areas (Guloglu et al., 2021; Kouassi et al., 2021; Juniyanti et al., 2021). This land-use change disrupts both abiotic and non-biotic environmental factors, including the biodiversity of flora and fauna, the quality of freshwater, and the increased production of waste.

2. Methods

This study uses a qualitative descriptive approach supported by spatial analysis using a Geographic Information System (GIS). The study was conducted in North Tapanuli Regency, a highland area with diverse land use characteristics. Data collection mainly relied on secondary sources, including local regulations, strategic planning documents (RPJMD and Renstra), statistical data from the Central Statistics Agency/*Badan Pusat Statistik* (BPS), and geospatial data obtained through the Geospatial Information Agency portal. Additional references were taken from scientific journals, books, and policy reports to provide a theoretical and regulatory framework for spatial planning and sustainable development.

Spatial data was processed using ArcGIS (ArcMap) version 10.8 to analyze land use distribution and changes. Several thematic maps were produced, including administrative boundaries, rivers, forests, lakes, road networks, and settlement areas. Each attribute was digitized, categorized, and quantified to determine the shape, length, and area of the region. Comparative analysis was conducted to identify land use dynamics, particularly in residential areas, protected forests, agricultural land, and water resources.

To complement the spatial analysis, demographic and socioeconomic data covering the period 2016–2020 were examined, focusing on population growth, food availability, waste generation, and poverty levels. This data set was used to evaluate the relationship between spatial development, environmental carrying capacity, and community welfare. Data triangulation was applied by cross-referencing statistical reports, planning documents, and academic studies to ensure the validity and reliability of the findings.

Ethical considerations were taken into account by only using publicly available data sets and official documents to ensure transparency and accuracy in data processing and interpretation. The integration of GIS-based spatial analysis with policy and socioeconomic reviews enabled a comprehensive assessment of spatial planning outcomes and their implications for sustainable regional development.

3. Result and Discussion

Spatial planning is closely related to the concept of urban development (Berisha et al., 2021; Domingo et al., 2021; Liu & Zhou, 2021). Space is an ecosystem with materials, energy flows, and complex information systems, like any other ecosystem (Newman, 2009). Law Number 11 of 2020 concerning Job Creation defines space as a container encompassing land, sea, and airspace, including space within the earth as a unified territory, where humans and other creatures live, conduct activities, and maintain their survival. The same law also explains spatial planning as the manifestation of spatial structure and spatial patterns, while spatial planning is a system of spatial planning, spatial utilization, and

spatial utilization control (Liu & Zhou, 2021; Lowe et al., 2022; Wu et al., 2021). Wahid (2016) does not simply define spatial planning as an object, but rather defines spatial planning as a geographical expression that reflects the scope of policies made by society regarding economic, social, and cultural issues.

Law Number 11 of 2020 states that the principles and objectives of spatial planning in Indonesia are a systematic process of planning, utilization, and spatial control. Essentially, spatial planning is part of the process of land use and planning activities within a given space. The formulation of the objectives of spatial planning in Indonesia can be seen in Article 3 of Law Number 26 of 2007 concerning Spatial Planning. This provision is not amended in the Job Creation Law. According to Article 3 of Law Number 26 of 2007, the implementation of spatial planning aims to create a safe, comfortable, productive, and sustainable national space based on the archipelagic perspective and national resilience by realizing harmony between the natural and built environments; realizing integration in the use of natural and built resources, with attention to human resources; and realizing the protection of spatial functions and preventing negative environmental impacts resulting from spatial use.

Sustainable development, meanwhile, is defined as development based on a multidimensional agreement to achieve a better quality of life for all people, with economic, social, and environmental protection mutually reinforcing development (Akibu, 2025; Wiesli et al., 2021). Marten (2001) defines sustainable development as meeting current needs without sacrificing the needs of future generations. Sustainable development does not imply continued economic growth, as economic growth is impossible if it relies on the limited capacity of existing natural resources. The definition above demonstrates that the concept of sustainable development is founded on or supported by three pillars: economic, social, and environmental (Hajian & Kashani, 2021; Hariram et al., 2023; Nogueira et al., 2022). These three approaches are not stand-alone approaches, but are interrelated and influence one another (Munasinghe, 1995). Furthermore, the sustainable development is a development process that optimizes natural and human resources, harmonizing natural resources with humans in development. North Tapanuli Regency is one of the regencies in North Sumatra Province. Like other regencies throughout Indonesia, North Tapanuli has the flexibility to regulate land use spatial planning. Autonomous stakeholders can optimize the natural resources within their respective regions, thus increasing regional income (Li & Huang, 2023; Mulyadi et al., 2024; Tajima et al., 2022).

North Tapanuli Regency has unique characteristics dominated by highland areas, between 150-1,700 meters above sea level. Geographically, North Tapanuli Regency is flanked or directly borders five regencies, namely, to the north it borders Toba Samosir Regency, to the east it borders North Labuhan Batu Regency, to the south it borders South Tapanuli Regency and to the west it borders Humbang Hasundutan and Central Tapanuli Regencies. Astronomically, North Tapanuli Regency is located at 1o20'-2o41' North Latitude and 98o05'-99o16' East Longitude. The area of North Tapanuli Regency is 3,800.31 km^2 consisting of a land area of 3,793.71 km^2 and Lake Toba waters of 6.60 km^2. This area calculation is based on the mandate of Law Number 9 of 2003 concerning the Establishment of South Nias Regency, Pakpak Bharat Regency, and Humbang Hasundutan Regency, which mandates the division of North Tapanuli Regency into North Tapanuli Regency and Humbang Hasundutan Regency (Aziz et al., 2020).

The urban planning of North Tapanuli is planned in the 2020-2024 Renstra (Strategic Plan) of the Public Works and Spatial Planning Agency of North Tapanuli Regency. This is a Medium-Term Development Planning Document for Regional Work Units (*Rapat Umum Pemegang Saham*/RUPs). It is prepared in accordance with the duties and functions of the Public Works and Spatial Planning Agency of North Tapanuli Regency and is guided by the 2019-2024 Medium-Term Regional Development Plan of North Tapanuli Regency. This Renstra document serves as a planning guideline for implementing regional development in the Public Works and Spatial Planning Sector of North Tapanuli Regency for 2020-2024. It must be adhered to, as it represents a solution that reflects the agreement and

commitment of all relevant parties to address problems and capitalize on future opportunities.

In the long term, the spatial and regional planning of North Tapanuli is regulated in the Regional Regulation of North Tapanuli Regency No. 03 of 2017 concerning the Spatial Planning of North Tapanuli Regency for 2017-2037. The Spatial Plans/*Rencana Tata Ruang Wilayah* (RTRW) includes the Policy Plan and Program/*Kebijakan, Rencana, dan/atau Program* (KRP) simultaneously. The policy is contained in objectives, policies, and strategies. The regulation is then elaborated into plans consisting of the Spatial Structure Plan (Central System and Infrastructure), the Spatial Pattern Plan (Protected Areas and Cultivation Areas), and the Strategic Area Plan. In the 2019-2024 regency medium-term development plan of North Tapanuli Regency Changes, the urban system in the North Tapanuli Regency spatial plans Draft includes 15 main cities, namely (1) Tarutung acts as the Promotional Area Activity Center (PKW), Tarutung functions as the Primary Service Activity Center I (for all Districts in North Tapanuli Regency), (2) Siborongborong acts as the Local Activity Center/*Pusat Kegiatan Lokal* (PKL); functions as the Primary Service Activity Center II, (3) Pangaribuan and (4) Pahae Jae act as the Regional Service Center/*Pusat Pelayanan Daerah* (PPK) functions as the Secondary Service Activity Center (Supporting Primary Service Activity Centers I and II), then (5) Siatas Barita, (6) Sipoholon, (7) Parmonangan, (8) Adiankoting, (9) Muara, (10) Pagaran, (11) Garoga, (12) Sipahutar, (13) Purbatua, (14) Pahae Julu, and (15) Simangumban act as Local Service Center/*Pusat Pelayanan Lokal* (PPL). The largest land cover in North Tapanuli Regency is forest and agriculture, with the agricultural sector providing the majority of the community's livelihoods.

Referring to Tempo (2024), in the last ten years North Tapanuli has carried out large-scale development, both urban system development and infrastructure development. In the development of the 15 districts, over the last ten years, the development of North Tapanuli is believed to have experienced rapid changes. During that decade, in addition to referring to regional regulations and other regional administrative regulations, North Tapanuli uses a jargon introduced by Regent Nikson Nababan. The jargon was introduced with the name Nikson alias Nikson model or innovation, knowledge, synergy, operation, and norms. In the book released entitled Strong Village, Advanced Village, Independent Country it is stated (1) needs or needs are a development approach that pays attention to basic human needs, including issues of life, democracy, justice, and human rights, precise village data is collected based on community needs, (2) innovation or innovation is a combination of innovations in compiling precise village data. It is believed that the use of accurate data in North Tapanuli is a step forward in development planning, (3) knowledge shows that precise village data is used to produce better and more advanced development planning and knowledge of real conditions in the field becomes the basis for decision making, (4) synergy or synergy between various elements, including trust, effective communication, fast feedback, and creativity, is needed to create a harmonious and optimum balance, and (5) operation or operational is a development activity carried out based on precise village data planning so as to ensure efficient operations and in accordance with field conditions, and (6) norm or precise village data policy has similarities with the concept of smart city, because it is implemented by presenting data that has a high level of accuracy and precision. The increase in the pace of development is accompanied by pressure on the environment. In North Tapanuli there is also an increase in population from year to year. The high rate of population growth in an area is also followed by the rate of settlement growth. The number of new settlement growth continues to increase, causing high pressure on the environmental carrying capacity (Julimawati et al., 2014). This study was conducted to compare the spatial planning of North Tapanuli Regency over a ten-year period, from 2014 to 2024.

The 2019-2024 North Tapanuli Regency Medium-Term Development Plan considers the significant impact of development on environmental conditions, such as water resources, forests, and biodiversity. To maintain environmental sustainability, the percentage of development in protected and cultivated areas is regulated. The spatial

pattern of protected and cultivated areas in North Tapanuli is 37.1 percent for protected areas and the remainder for cultivated areas. Protected areas include protected forests, nature reserves, and local protected areas. Cultivated areas include production forests, limited production forests, drylands, wetlands, plantations, horticulture, and settlements. The development potential of the North Tapanuli region is assessed based on its geographic potential, population, regional economy, leading sectors, supporting sectors, investment, finance and financing, and transportation, using a regional policy approach. Referring to the 2019-2024 Amendment to the regency medium-term development plan of North Tapanuli Regency, the spatial development of North Tapanuli's potential is carried out through a policy for developing strategic district areas that refers to the North Tapanuli Regency spatial plans. From a review of reports and journals, problems were found in the implementation of development in North Tapanuli Regency regarding the results of regional development performance achievements over the past 10 years referring to economic, social, and environmental aspects. From the environmental aspect, North Tapanuli Regency shows a decline in environmental quality along with the progress of development. Among them, increasing environmental pollution, especially in household waste processing and decreasing carrying capacity of protected areas, and the unaddressed damage to natural resources, including the management of critical and less productive lands and protection of water resources. The critical area in North Tapanuli shows a decline. Data from 2016-2020 shows a decrease in the area of critical land in North Tapanuli, namely from 38,952.42 hectares to 127,620 hectares in 2020.

3.1 Research location map using ArcGis 10.8

This map depicts the administrative boundaries of North Tapanuli Regency in North Sumatra Province as of 2024, with a clear division into several subdistricts, each represented by a different color for distinction. The spatial layout shows the distribution of urban and rural areas, with larger subdistricts such as Adiankoting, Garoga, and Parmonangan occupying significant areas, while smaller subdistricts such as Tarutung, the regency capital, appear more densely populated. This visualization not only provides an overview of the division of the region, but also reflects its geographical diversity, from highlands to forested areas. Maps such as this are important for regional planning, as they support spatial analysis related to land use, infrastructure development, and environmental management, and ensure that the unique characteristics of each subdistrict are taken into account in sustainable development strategies.

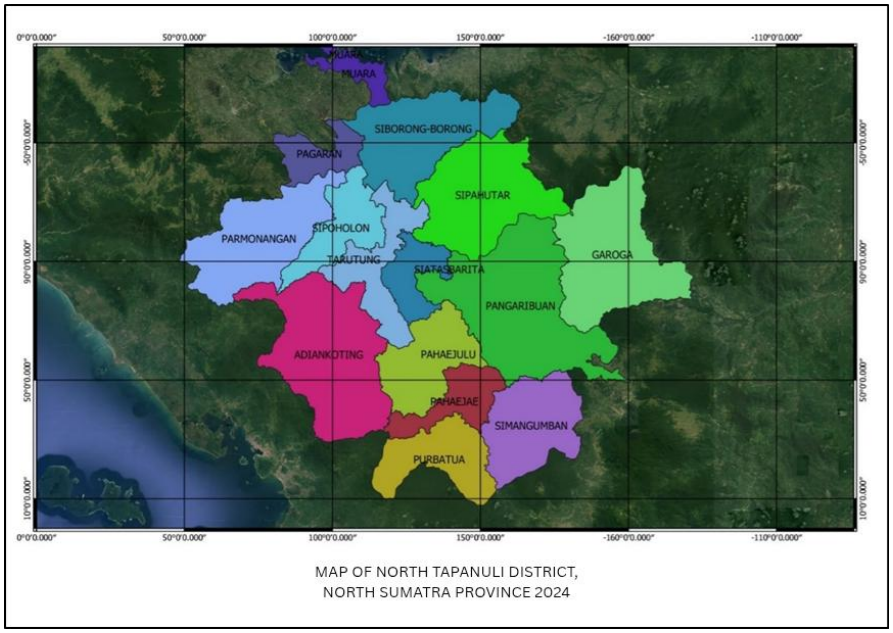


Fig. 1. Location map of North Tapanuli

Based on the location map above, an analysis of land use in the North Tapanuli area was conducted, yielding the following results. Using ArcMap software by ArcGiss version 10.8 and data sources downloaded from the Geospatial portal, the following results were obtained in Figure 2.

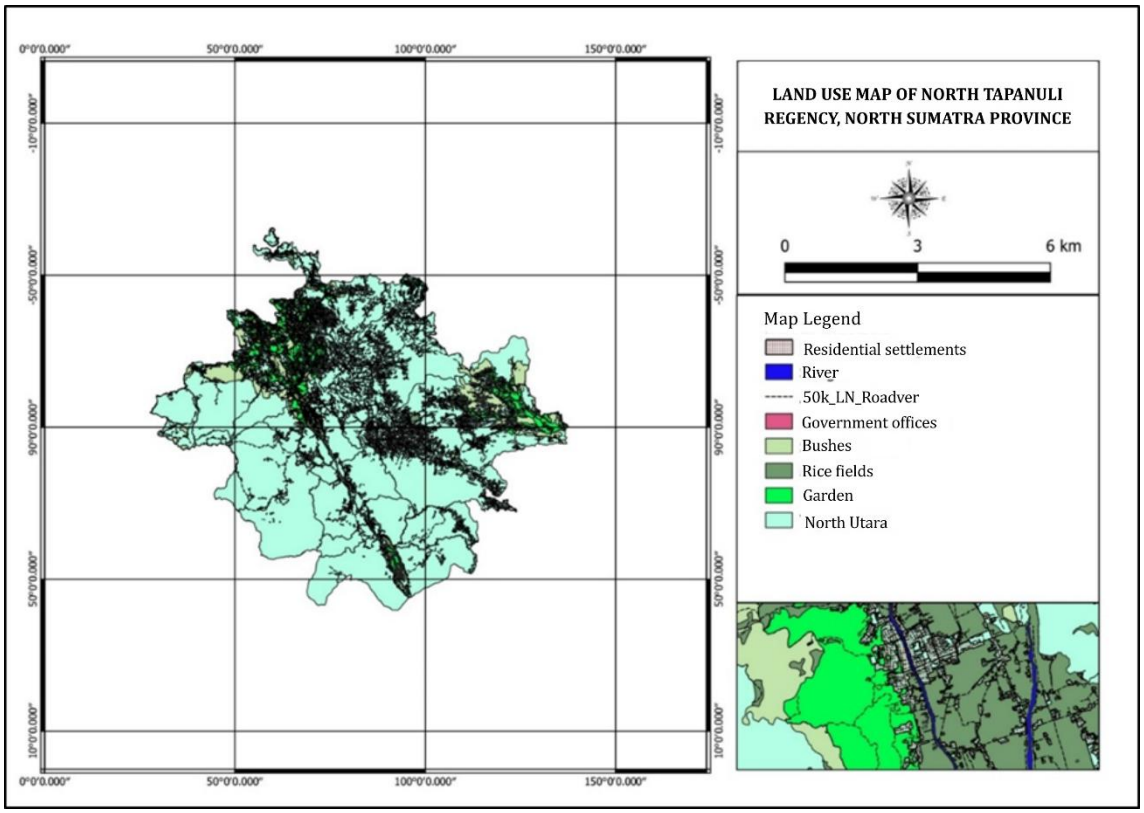


Fig. 2. Land use map of North Tapanuli Regency

From the land use map data above, several attributes were obtained with different color codes, such as residential areas, rivers, roads, government offices, shrubs, rice fields, and gardens. The image above shows the extent of land use in the North Tapanuli area. The following are the results of the analysis using ArcGIS (ArcMap) v 10.8 software. A sample calculation is attached below. It can be seen from the results above that there are several types of rivers with different Shape, Shape Leng, and Shape area. With the largest Leng Shape, it is found on the Batang Tour River with an area of 2,906124.

Table

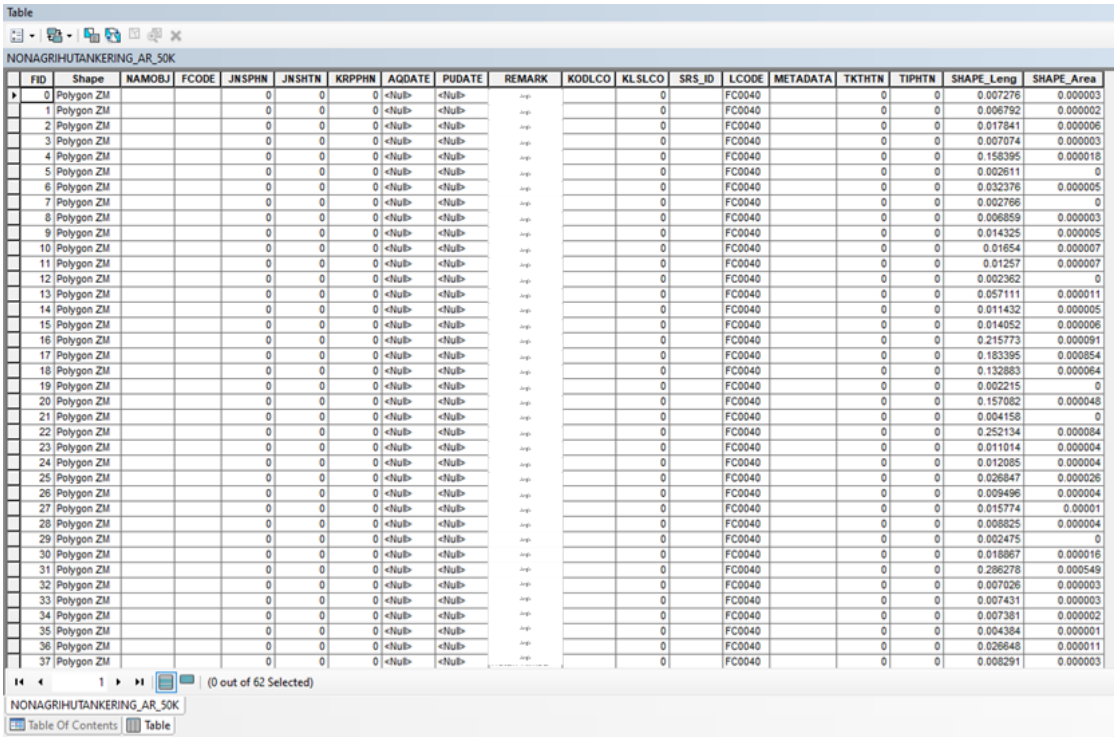
AR_50K

FID	Shape	NAMOBJ	JNSSNG	KLSSNG	FCODE	REMARK	SRS_ID	LCODE	METADATA	NAMWS	NAMDAS	SHAPE_Leng	SHAPE_Area
0	Polygon ZM	Aek Sibundong	0	0		River		DA0280				1.193218	0.000233
1	Polygon ZM	Aek Butar	0	0		River		DA0280				0.003165	0
2	Polygon ZM	Aek Puli	0	0		River		DA0280				0.007762	0.000001
3	Polygon ZM	Aek Puli	0	0		River		DA0280				0.546305	0.000047
4	Polygon ZM		0	0		River		DA0280				0.00259	0
5	Polygon ZM	Batang Toru	0	0		River		DA0280				2.906124	0.000722
6	Polygon ZM	Aek Sipolas	0	0		River		DA0280				0.094283	0.000021
7	Polygon ZM	Aek Sigoaon	0	0		River		DA0280				0.241165	0.000031
8	Polygon ZM	Aek Botik	0	0		River		DA0280				0.042706	0.000004

Fig. 3. River area

The image shows an attribute table of spatial data titled "NONAGRHUTANKERING_AR_50K" from a Geographic Information System (GIS), consisting of 62 polygon features labeled as "Polygon ZM." Each record represents a spatial unit with attributes such as FID, Shape, FCODE, LCODE, SHAPE_Leng, and SHAPE_Area, where the length and area values indicate the perimeter and size of each polygon, though most areas appear very small at the 1:50,000 map scale. Many attribute fields, including JNSPIN,

JNSHTN, KRPPN, and REMARK, contain null or zero values, suggesting limited descriptive data, with geometry-based attributes serving as the primary information. This dataset functions as a foundational spatial layer for mapping and analysis of non-agricultural dry forest areas, providing a basis for further environmental or land-use studies. The results above show several types of dry forests with varying shapes, lengths, and areas. Overall, it appears to be a jungle.



Table

NONAGRIHUTANKERING_AR_50K

FID	Shape	NAMOBJ	FCODE	JNSPHN	JNSHTN	KRPPHN	AQDATE	PUDATE	REMARK	KODLCO	KLSLCO	SRS_ID	LCODE	METADATA	TKTHTN	TIPHTN	SHAPE_Leng	SHAPE_Area
0	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.007276	0.000003
1	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.006792	0.000002
2	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.017841	0.000006
3	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.007074	0.000003
4	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.158395	0.000018
5	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.002611	0
6	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.032376	0.000005
7	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.002766	0
8	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.006859	0.000003
9	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.014325	0.000005
10	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.01654	0.000007
11	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.01257	0.000007
12	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.002362	0
13	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.057111	0.000011
14	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.011432	0.000005
15	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.014052	0.000006
16	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.215773	0.000091
17	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.183395	0.000854
18	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.132883	0.000064
19	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.002215	0
20	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.157082	0.000048
21	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.004158	0
22	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.252134	0.000084
23	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.011014	0.000004
24	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.012085	0.000004
25	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.026847	0.000026
26	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.009496	0.000004
27	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.015774	0.00001
28	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.008825	0.000004
29	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.002475	0
30	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.018867	0.000016
31	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.286278	0.000549
32	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.007026	0.000003
33	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.007431	0.000003
34	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.007381	0.000002
35	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.004384	0.000001
36	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.026648	0.000011
37	Polygon ZM			0	0	0	<Null>	<Null>			0		FC0040		0	0	0.008291	0.000003

1 (0 out of 62 Selected)

NONAGRIHUTANKERING_AR_50K

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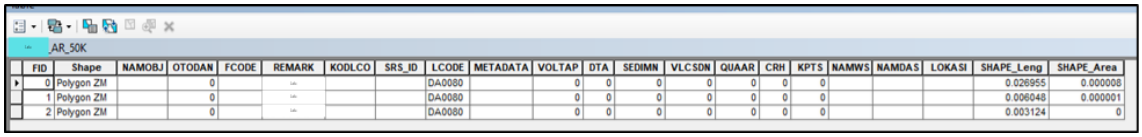
Fig. 4. Dry forest

The image displays an attribute table from a GIS dataset labeled “AR_50K”, consisting of three polygon features categorized as “Polygon ZM.” The table includes various attribute fields such as FID, FCODE, LCODE, SHAPE_Leng, and SHAPE_Area, along with other parameters like VOLTA P, DTA, SEDIMN, and QUAR; however, most of these fields contain zero or null values, indicating limited descriptive information. The geometric attributes show that each polygon has distinct perimeter lengths and very small areas, reflecting fine-scale mapping data at the 1:50,000 scale. This dataset likely represents specific spatial units related to land or resource classification, serving as a preliminary layer for further analysis in regional planning or environmental studies. Based on the analysis results, there are three types of lakes with different length shapes and different area shapes.

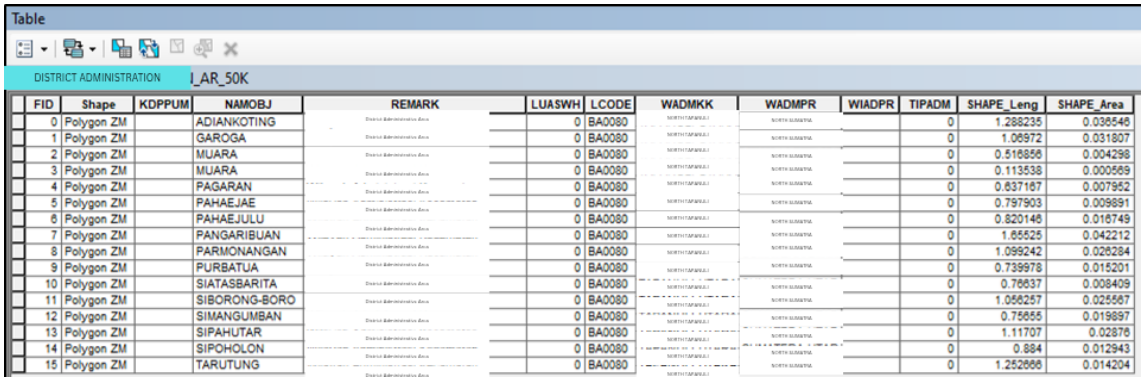


_AR_50K

FID	Shape	NAMOBJ	OTODAN	FCODE	REMARK	KODLCO	SRS_ID	LCODE	METADATA	VOLTAP	DTA	SEDIMN	VLCSDN	QUAAR	CRH	KPTS	NAMWS	NAMDAS	LOKASI	SHAPE_Leng	SHAPE_Area
0	Polygon ZM		0					DA0080		0	0	0	0	0	0	0				0.026955	0.000008
1	Polygon ZM		0					DA0080		0	0	0	0	0	0	0				0.006048	0.000001
2	Polygon ZM		0					DA0080		0	0	0	0	0	0	0				0.003124	0

Fig. 5. Lake area

The image shows a GIS attribute table of district administration boundaries, where each district is represented as a Polygon ZM with attributes such as district name, codes, and geometric data (SHAPE_Leng and SHAPE_Area). It provides essential spatial information for analyzing and managing administrative regions. For administrative areas, there are 15 types of areas located in North Tapanuli with the largest Shape Leng being the Adiankoting area with a Shape Leng of 1.288235 with a Shape Area of 0.036546 and the smallest area being the Sipoholong area with a Shape Leng of 0.884 with a Shape area of 0.012943.



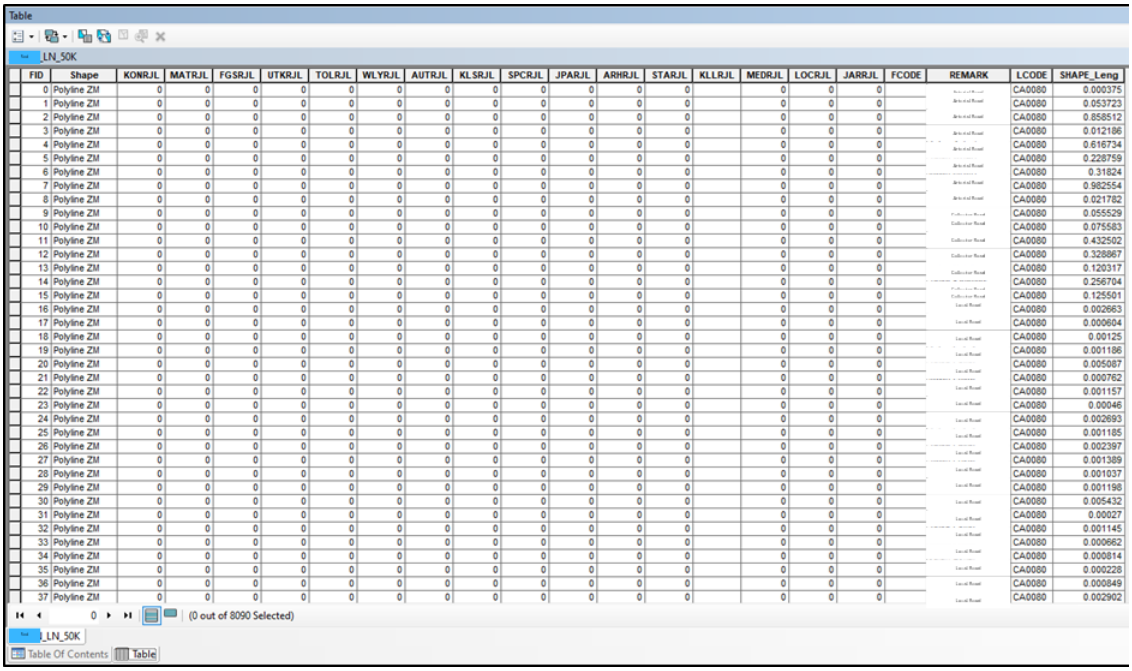
Table

DISTRICT ADMINISTRATION | I_AR_50K

FID	Shape	KDPPUM	NAMOBJ	REMARK	LUASWH	LCODE	WADMKK	WADMPR	WIADPR	TIPADM	SHAPE_Leng	SHAPE_Area
0	Polygon ZM		ADIANKOTING		0	BA0080				0	1.288235	0.036546
1	Polygon ZM		GAROGA		0	BA0080				0	1.06972	0.031807
2	Polygon ZM		MUARA		0	BA0080				0	0.516856	0.004298
3	Polygon ZM		MUARA		0	BA0080				0	0.113538	0.000569
4	Polygon ZM		PAGARAN		0	BA0080				0	0.637167	0.007952
5	Polygon ZM		PAHAEJAE		0	BA0080				0	0.797903	0.009891
6	Polygon ZM		PAHAEJULU		0	BA0080				0	0.820146	0.016749
7	Polygon ZM		PANGARIBUAN		0	BA0080				0	1.65525	0.042212
8	Polygon ZM		PARMONANGAN		0	BA0080				0	1.099242	0.026284
9	Polygon ZM		PURBATUA		0	BA0080				0	0.739978	0.015201
10	Polygon ZM		SIATASBARITA		0	BA0080				0	0.76637	0.008409
11	Polygon ZM		SIBORONG-BORO		0	BA0080				0	1.056257	0.025567
12	Polygon ZM		SIMANGUMBAN		0	BA0080				0	0.75655	0.019897
13	Polygon ZM		SIPAHUTAR		0	BA0080				0	1.11707	0.02876
14	Polygon ZM		SIPOHOLON		0	BA0080				0	0.884	0.012943
15	Polygon ZM		TARUTUNG		0	BA0080				0	1.252666	0.014204

Fig. 6. Administrative areas

The image presents a GIS attribute table of linear features represented as Polyline ZM, containing 8090 entries with attributes such as codes, classifications, and geometric measurements. The table primarily highlights LCode identifiers and SHAPE_Length values, which indicate the spatial extent of each polyline. This dataset is useful for analyzing and managing linear spatial elements such as roads, rivers, or utility networks within a mapped area. For administrative areas, there are many road areas located in North Tapanuli with different Leng Shapes and Area Shapes (as in the picture).



Table

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FID	Shape	KONRJL	MATRJL	FGSRJL	UTKRJL	TOLRJL	WLYRJL	AUTRJL	KLSRJL	SPCRJL	JPARJL	ARHRJL	STARJL	KLLRJL	MEDRJL	LOCRJL	JARRJL	FCODE	REMARK	LCODE	SHAPE_Leng
0	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.000375
1	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.053723
2	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.858512
3	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.012186
4	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.616734
5	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.228759
6	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.31824
7	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.982554
8	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.021782
9	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.055529
10	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.075583
11	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.432502
12	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.328867
13	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.120317
14	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.256704
15	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.125501
16	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.002663
17	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.000604
18	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.00125
19	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.001186
20	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.005087
21	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.000762
22	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.001157
23	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.00046
24	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.002693
25	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.001185
26	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.002397
27	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.001389
28	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.001037
29	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.001198
30	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.005432
31	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.00027
32	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.001145
33	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.000662
34	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.000814
35	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.000228
36	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.000849
37	Polyline ZM	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0			CA0080	0.002902

0 (0 out of 8090 Selected)

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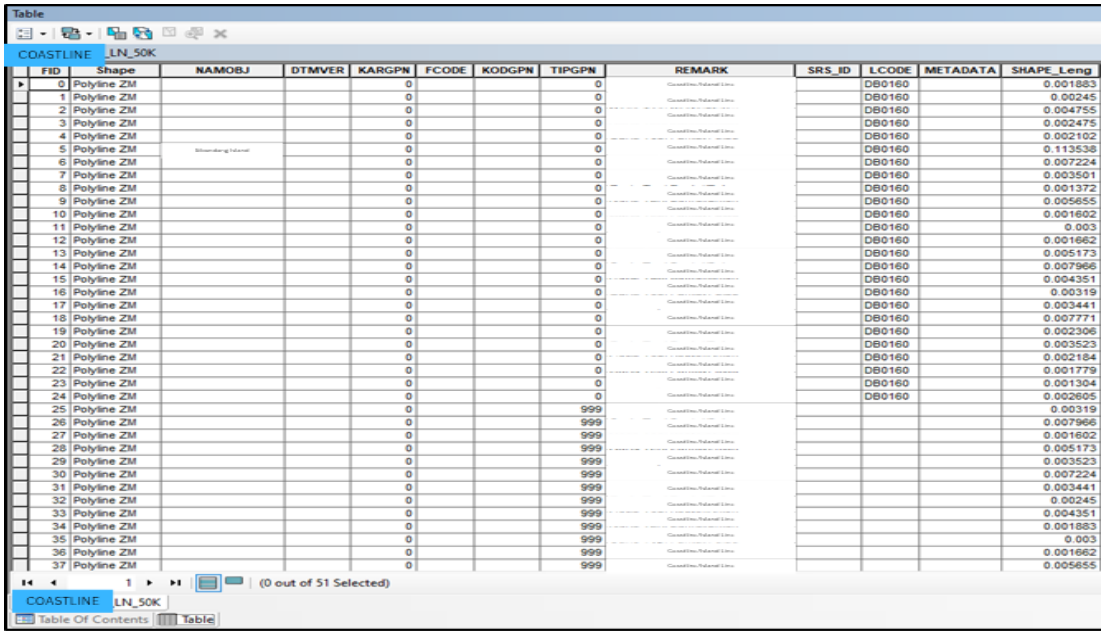
Fig. 7. Road area

The image displays a GIS attribute table labeled COASTLINE, consisting of 51 polyline features represented as Polyline ZM. Each record contains various attributes, including identification codes (FCode, LCode), metadata, and geometric data such as SHAPE_Length, which measures the length of each coastal segment. This dataset provides structured information for analyzing coastline features, supporting spatial studies related to coastal management, mapping, and environmental monitoring. Environmental quality also decreases as the population of North Tapanuli increases from year to year.



FID	Shape	NAMOBJ	DTMVER	KARGPN	FCODE	KODGPN	TIPGPN	REMARK	SRS_ID	LCODE	METADATA	SHAPE_Leng
0	Polyline ZM			0			0			DB0160		0.001883
1	Polyline ZM			0			0			DB0160		0.00245
2	Polyline ZM			0			0			DB0160		0.004755
3	Polyline ZM			0			0			DB0160		0.002475
4	Polyline ZM			0			0			DB0160		0.002102
5	Polyline ZM			0			0			DB0160		0.113538
6	Polyline ZM			0			0			DB0160		0.007224
7	Polyline ZM			0			0			DB0160		0.003501
8	Polyline ZM			0			0			DB0160		0.001372
9	Polyline ZM			0			0			DB0160		0.005655
10	Polyline ZM			0			0			DB0160		0.001602
11	Polyline ZM			0			0			DB0160		0.003
12	Polyline ZM			0			0			DB0160		0.001662
13	Polyline ZM			0			0			DB0160		0.005173
14	Polyline ZM			0			0			DB0160		0.007966
15	Polyline ZM			0			0			DB0160		0.004351
16	Polyline ZM			0			0			DB0160		0.00319
17	Polyline ZM			0			0			DB0160		0.003441
18	Polyline ZM			0			0			DB0160		0.007771
19	Polyline ZM			0			0			DB0160		0.002306
20	Polyline ZM			0			0			DB0160		0.003523
21	Polyline ZM			0			0			DB0160		0.002184
22	Polyline ZM			0			0			DB0160		0.001779
23	Polyline ZM			0			0			DB0160		0.001304
24	Polyline ZM			0			0			DB0160		0.002605
25	Polyline ZM			0			999					0.00319
26	Polyline ZM			0			999					0.007966
27	Polyline ZM			0			999					0.001602
28	Polyline ZM			0			999					0.005173
29	Polyline ZM			0			999					0.003523
30	Polyline ZM			0			999					0.007224
31	Polyline ZM			0			999					0.003441
32	Polyline ZM			0			999					0.00245
33	Polyline ZM			0			999					0.004351
34	Polyline ZM			0			999					0.001883
35	Polyline ZM			0			999					0.003
36	Polyline ZM			0			999					0.001662
37	Polyline ZM			0			999					0.005655

Fig. 8. Coastline

Referring to the 2019-2024 Revised Regional Medium-Term Development Plan (RPJMD) of North Tapanuli Regency, it shows that the level of food self-sufficiency for carbohydrate-based food from rice in the region reached between 2016 and 2020. This achievement of rice self-sufficiency in North Tapanuli Regency was not accompanied by self-sufficiency in animal protein foods derived from meat, milk, and eggs. Population growth also impacts the volume of waste generated. The volume of waste in North Tapanuli continues to increase year after year in line with the population growth. Waste production in North Tapanuli Regency increases annually, reaching 670,064 m^3 in 2020. This increase in waste volume is in line with the increase in population and business units.

Table 1. Population and food needs of North Tapanuli 2016-2020

No	Description	2016	2017	2018	2019	2020
1.	Population (people)	295,613	297,806	299,881	301,789	312,578
2.	Rice availability (tons)	108,471	97,543	122,333	137,720	123,534
3.	Meat (tons)	1,398	1,451	1,497	1,054	554

Currently, waste management has been carried out through the provision of waste management facilities and infrastructure, with 328 Temporary Disposal Sites (TPS) in 2020. Given the suboptimal waste management, waste management is implemented through community development, particularly in urban areas. Regarding public welfare, the number of poor people in North Tapanuli has decreased from 2016 to 2020. Referring to BPS data, in 2016 BPS as many as 33,200 people or 11.25 percent of the population of North Tapanuli were categorized as poor. This number decreased in 2020 to 28,410 people or 9.37 percent, but North Tapanuli still faces poverty problems, which are characterized by the number of people living below the poverty line and those vulnerable to a falling below the poverty line. When compared to North Sumatra Province, the poverty rate in a North Tapanuli Regency in 2019 was still higher at 0.54 percent. However, when compared to the national poverty rate, the poverty rate in North Tapanuli Regency in 2020 was still lower at 0.82 percent.

4. Conclusion

Based on these findings, this study concludes that spatial planning in North Tapanuli Regency over the past decade has significantly changed land use, demographic structure, and environmental conditions in the region. Development initiatives guided by regional and national regulations and the “Nikson model” have accelerated infrastructure growth,

improved accessibility, and expanded residential areas. These efforts have contributed positively to regional development and poverty alleviation, as reflected in the decline in poverty rates from 2016 to 2020. At the same time, North Tapanuli has made significant progress in agriculture, fisheries, and forestry, positioning itself as a regional resource center and strengthening its economic resilience.

However, rapid population growth and urban expansion have increased pressure on natural resources, resulting in forest degradation, land conversion, reduced environmental carrying capacity, and increased waste volumes. Although rice self-sufficiency has been achieved, the region still faces challenges in meeting protein-based food needs and establishing an effective waste management system. These dynamics illustrate both the opportunities and dilemmas of development: socioeconomic progress has been supported, but the environmental consequences remain urgent. Therefore, sustainable resource management, integrated waste solutions, and balanced spatial planning policies are essential to ensure long-term ecological resilience and community well-being.

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Author Contribution
The author independently conducted the research, including the design, data collection, analysis, and manuscript preparation.

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Not available.

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Conflicts of Interest
The author declare no conflict of interest.

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