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Analysis of Mangrove Land Transformation in Medan Belawan, Medan Labuhan and Medan Marelan Districts

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ABSTRACT

Mangrove land transformation refers to the change in mangrove land use from its original condition to a different form, which often involves the conversion of mangrove land into other land uses that are more used by humans. Some of the consequences of mangrove transformation are the loss of habitats that are important for various types of organisms, including fish, birds, and crustaceans. This can result in a decrease in biodiversity and even the extinction of certain species, mangrove areas are more susceptible to abrasion, deterioration of water quality, reduced green open space for water catchment areas, drought, lack of oxygen levels and impact on people's livelihoods Many people living around mangrove forests depend on these ecosystems for their livelihoods, such as fishermen and collectors of non-timber forest products. The conversion of mangrove land can threaten the sustainability of their livelihoods. The use of mangrove land in Medan Belawan, Medan Labuhan and Medan Marelan Districts continues to change to other land uses, this study aims to examine the dynamics of mangrove land transformation based on policies from time to time, examine the change of mangrove land use in Medan Belawan, Medan Labuhan and Medan Marelan Districts and examine the suitability of the implementation of the RTRW spatial polar plan to the use of existing mangrove land. The method used in this study is qualitative descriptive, the research is carried out through a survey of changes in mangrove land use and identified through data processing with the Geographic Information System.

Keywords:
Land Transformation, Mangrove Land, Medan City

I. INTRODUCTION

Indonesia is an archipelagic country with a large coastal area and many marine biological and abiotic resources. One of Indonesia's marine and coastal resources is the mangrove ecosystem that is found in almost all coastal areas along the coast of Indonesia with the highest biodiversity in the world. The area of mangroves in Indonesia is 3,489,140.68 Ha. This number represents 23% of the world's mangrove ecosystem which covers an area of 16,530,000 hectares, (Onrizal, 2010).

Mangrove forest areas can store five times more carbon and greenhouse gases than mountainous tropical forests. The function and advantage of the existence of mangrove areas is that they are able to withstand sea currents that erode coastal land, mangrove forests also function as habitats for various types of marine life and as wetland resources in coastal areas, life support systems and very valuable natural resources. Therefore, efforts are needed to protect, preserve and utilize them in a sustainable manner for the benefit of local communities. (Lugo & Snedaker, 1974)

However, recently these resources are now degraded due to pollution pollution from industry, households, agriculture, and overfishing, making the function of mangroves as a natural defense of the coast weak. Globally, Indonesia is the largest contributor to the destruction of mangrove ecosystems, namely the east coast of northern Sumatra. The factors that cause mangroves include the conversion of land into oil palm plantations, the extraction of mangrove wood for charcoal, ponds and encroachment into illegal fields by the community, these conditions are exacerbated by the lack of seriousness of the government to reduce the rate of destruction of mangrove areas.

North Sumatra has cities and regencies that are directly adjacent to the sea, one of which is the city of Medan, which is on the east coast of Sumatra, has a coastline length of 63.97 km (BIG, 2023). The Medan City area which is located in the coastal area or that has a mangrove area includes three sub-districts, namely Medan Belawan District, Medan Labuhan District and Meadan Marelan District.

Briassoulis (2019) Scientific interest and interest in land use change has a long history, because humans have never used land and its resources without causing losses. Studying changing landscape patterns has important implications for sustainable urban planning. These changes may be beneficial, or have adverse effects or consequences. Although land development is important for human progress, its impact results in the degradation of ecosystem services, which are not only local and regional but also global. To achieve better land management, human behavior in land use must be fully studied and understood. (Mitsuda & Ito, 2011).

II. LITERATURE REVIEW

A. Definition of Mangrove

Mangrove forests are a group of trees that generally grow in coastal areas affected by sea tides or in areas that experience the accumulation of organic matter and sludge. Claridge and Burnett, Djamaluddin R. (2018) The origin of the term 'mangrove' is not known for sure. Some say that the term "mangrove" comes from the Malay word "mangimangi" or "mangin". There are also those who say that the term is a combination of Portuguese and English words such as "mangue" and "grove", which when combined becomes "mangrove" (Macnae, 1968). Mangroves are dicot plants that live in brackish waters. Mangrove habitats are found at the confluence of estuaries and seawater. This place then became a protective place for the land from large sea waves. In general, mangrove growth is divided into four zones, namely the open zone, the middle zone, the zone that has rivers with brackish to fresh water, and the freshwater plain zone. (Al Idrus et al, 2018).

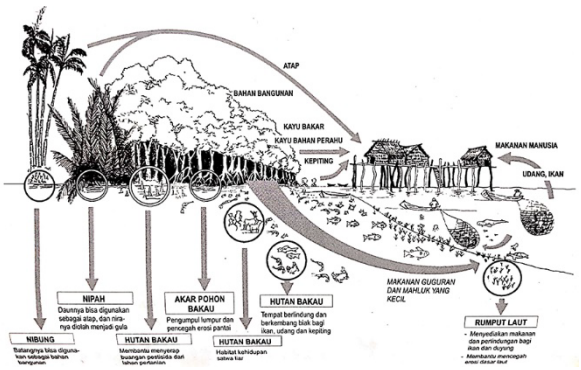
B. Benefits of Mangroves

Mangrove ecosystems have a very important role in the economic and ecological aspects of the surrounding environment, both as natural resources and as environmental protectors (Santoso and H.

W. Arifin, 1998). The function of mangrove forests can be classified into three parts: physical function, ecological function, and economic function.

a. Physical benefits include maintaining the stability of the coastline and river banks from erosion and abrasion, as well as accelerating land expansion by absorbing mud deposits carried by rivers into mangrove forest areas and also protecting against the dangers of waves, strong winds, and tsunamis.
b. The ecological benefit is that mangroves play a role as a habitat, spawning ground, breeding ground for various types of animals, a food source for marine life and absorbing CO2 and producing a relatively large amount of O2.
c. The economic benefits of mangroves are that they can produce firewood, charcoal, building materials and tourist attractions. Tourism activities in the mangrove forest area can also improve the economy of the surrounding community by creating jobs and business opportunities around the mangrove ecosystem area.

Mangroves have many benefits for humans and the environment. For coastal communities, mangroves have long been used for various purposes. Mangrove forests provide direct benefits such as timber, trees, fish, and crabs, which are a source of economic livelihood. In addition, mangroves also have indirect benefits such as resisting abrasion and being a place for fish to spawn and spawn (Sofian et. al., 2012).



Source : Rusila Noor et al (2006)

Picture. 1 Illustration of Food Nets in Mangrove Forest Ecosystems and Their Benefits

C. Types of Mangroves

In general, more than 110 species of mangroves are known. Of these, only 54 species spread across 16 families and 20 genera make up true mangroves. The rest will be used as an additional mangrove area. According to Tomlinson (1986), mangrove species are classified into three groups:

a. True mangroves generally include species of several types, such as *Rhizophora, Avicennia* and *Sonneratia* This group of true mangroves is important because they are a key component in the mangrove forest ecosystem, providing habitat for various organisms, protecting the coast from erosion, and providing a variety of ecological and economic benefits to local and global communities.

b. Inauthentic mangrove groups, i.e. smaller mangrove groups, do not represent the main part of the mangrove community, occupy the banks and rarely form pure stands. The species that belongs to this group is *Excoecaria agallocha*,
c. Mangrove association group This mangrove association group grows in areas far from the coast, found in the group of terrestrial plants, such as: *Acanthus* sp., *Hibiscus tillaceus*, and *Pandanus* sp.

Several types of mangroves that are still found in the mangrove ecosystem area in Medan City include; *Sonneratia alba*, *Sonneratia caseolaris, Rhizophora stylosa, Rhizophora apiculata, Rhizophora mucronata, Bruguiera gymnorrhiza, Bruguiera hainessii, Ceriops tagal, Xylocarpus granatum, Avicenia alba, Avicenia marina, Nypa.*

D. Land Transformation

Mangrove land transformation refers to the change in mangrove land use from its original condition to a different form, which often involves the conversion of mangrove land into other land uses that are more used by humans. In terms of land use, suburban areas are areas whose land use has undergone significant changes, especially due to the influence of development in neighboring cities (Eko & Sri Rahayu, 2012). Mangrove land transformation can occur for various reasons, such as fisheries expansion, agriculture, settlements, industry, tourism, coastal reclamation, or infrastructure development. The impact of mangrove land transformation can be very significant. Some of the negative impacts of mangrove land transformation are the loss of habitats that are important for various types of organisms including fish, birds, and crustaceans, ecosystem damage such as coastal erosion, seawater intrusion, and deterioration of water quality, loss of ecosystem benefits including coastal protection from storms and waves, provision of habitat for fish and wildlife, as well as carbon sequestration and impact on the livelihoods of communities such as fishermen, salt farmers, or collectors of non-timber forest products. The conversion of mangrove land can threaten the sustainability of their livelihoods.

Land transformation can be controlled in a variety of ways, for example through proper environmental and social planning and considerations, and through the involvement of local communities. The role of the government can also be in the form of establishing strict regulations to control land use change and ensuring that the changes are carried out in an appropriate and appropriate manner so that it benefits the community.

E. Factors Affecting Land Transformation

a. Population Growth

The development of the times affects the pattern of people's lives, including population growth. Population growth can be fast, slow, or stagnant, and has an impact on increasing the need for facilities such as education centers, health facilities, public facilities, housing, shopping centers, and recreational places. The construction of this facility requires land, while the availability of land is limited. (Al Rosyid, 2021).

b. Land Ownership Status

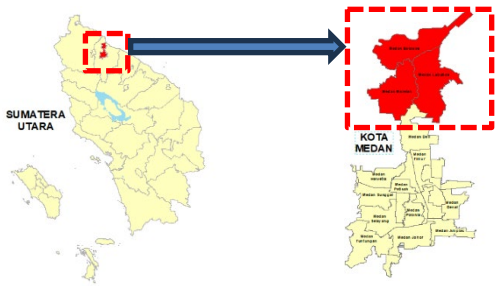
Mangroves are the last bastion of coastal areas, but the problem of mangrove land change still occurs, including in Medan City. These changes are often related to land ownership that drives the

transfer of functions. The government needs to pay more attention to this problem by socializing it to coastal communities. Research by the Nusantara Nature Conservation Foundation (YKAN) shows that changes in mangrove use often occur not only for livelihoods, but also for land claims. The larger the land that is converted into ponds or settlements, the greater the land claims by the community.

III. METHOD

A. Research Region and Time

The location of the research area covers the Northern Region of Medan City. The northern area of Medan City with an area of approximately 9534.04 hectares consisting of three sub-districts, namely Medan Belawan District, Medan Labuhan District and Medan Marelan District, geographically the area is between 3o 40' – 3o 48' North Latitude and 98o 36' – 98o 44' East Longitude.



Picture. 2 Oroentation of Research Location

B. Research Approach

This study was conducted using a general strategy to conclude and analyze data (Abdiyanto, 2020) with a qualitative descriptive method that uses a GIS geospatial-based exploration approach using the ArGIS 10.8 application to interpret the use of mangrove land at the research site.

C. Research Variables

In conducting a study on mangrove land transformation in the northern region of Medan City, the researcher conducted a study on land use change in the mangrove area of Medan City in three sub-districts, namely Medan Belawan District, Medan Labuhan District and Medan Marelan District. The research was conducted by collecting the data needed including:

1. Map of Dutch Commodity Land in 1920
2. Map of the Department of Transmigration of the Republic of Indonesia 1987

3. Map of Mangrove Areas of the Ministry of Environment and Forestry in 2021
4. Medan City RTRW Spatial Pattern Plan for 2010 and 2022
5. Medan City Mnagrove Spatial Data in 2023 as a result of satellite image interpretation

D. Preliminary Survey

This preliminary survey is to review the general condition of the research location, to the change of mangruve land that occurred in Medan Belawan, Medan Labuhan and Medan Marelan Districts.

E. Research Data

In completing this study, the data used by the researcher consisted of primary data and secondary data, primary data is data collected by the researcher himself in the form of data from field surveys. Field surveys were carried out to obtain photos, coordinates of the location where land use changes occurred and the actual condition of the research object. Secondary data, which are supporting data, were collected by researchers through literature studies, Google, Spot, Sentinel-2 and Pleiades satellite image data in 2023 as well as the Regional Spatial Plan (RTRW) archives.

F. Data Analysis

The data analysis used in this study is a spatial analysis of existing mangrove land which is then superimposed with the RTRW Spatial Pattern Plan and previous policies so that it can be compared with the current existing conditions. The stages of data analysis are explained in more detail as follows:

a. Interpretation of Satellite Imagery

Interpretation/digitization of satellite images begins with the process of cropping images based on the boundaries of the research area using the Global Mapper 17 application. The next process is to visually digitize directly on the computer monitor (on screen interpretation) using the ArcGIS 10.8 application. The digitization process is carried out by limiting areas that have different interpretation element characteristics. This shows the existence of mangrove areas at this time. The process of interpreting this satellite image produced a peril map of existing mangrove land in the research area.

b. *Ground Check*

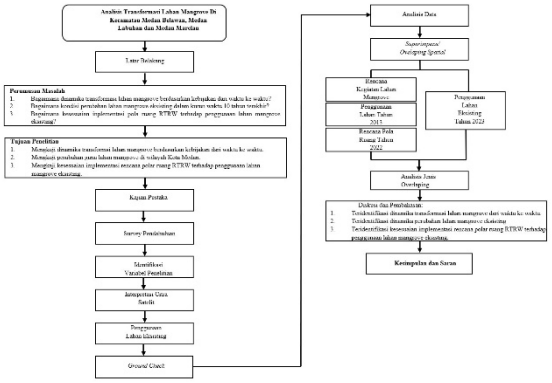
Ground checks are carried out to validate the correctness of the object of change in the existing mangrove area on actual conditions in the field. This validation was carried out by recording several samples of changes in existing mangrove land with the guidance of the results of the interpretation of satellite images that have been carried out. The results of this validation are in the form of spatial data on changes in the final existing mangrove land and field documentation.

c. Superimpose *Analysis (Overlapping)*

In analyzing the distribution of mangrove land use change or use change using the Superimpose (Overlaping) method using spatial data of existing mangrove land from the results of satellite image interpretation in 2023 and spatial data of existing mangrove land from the results of satellite image interpretation several years earlier. From the results of the superimpose analysis, it is known that the area of mangrove land use has changed. The processed literature data is strengthened with primary data in the form of field survey results to obtain data on changes and the effects of mangrove land use changes that occur in the northern region of Medan City.

G. Design and Flow of Research

This study is designed to meet the research objectives by using a qualitative descriptive method that uses a survey and exploration approach spatially with the analysis of geographic information systems. This research was conducted to follow the research orientation where each objective is supported by relevant literature reviews, appropriate data, data processing techniques, and results that are in accordance with the objectives. The types of data, data collection and processing techniques will be outlined in the sub-chapters below. The research flow chart can be seen in Figure 3



Picture. 3 Research Flow Chart

IV. DISCUSSION RESULTS

A. Analysis of Mangrove Land Transformation Dynamics

1. Map of Dutch Commodity Land in 1920

During the Dutch colonial period, Medan developed into one of the most important plantation centers in North Sumatra. In 1920 the Dutch issued a Map of the East Coast cultural area of Sumatra and East Aceh presented in Figure 4.

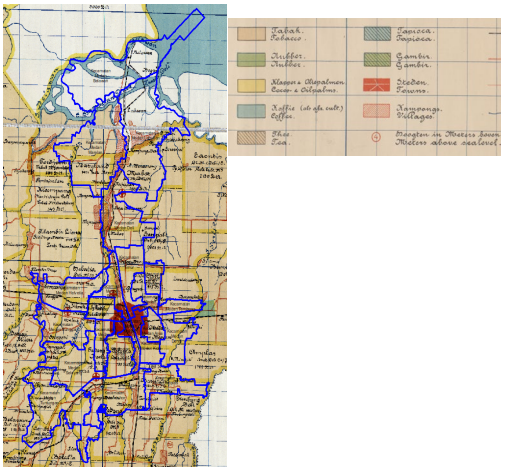


Figure 4. Map of Dutch Commodity Land

Changes in mangrove land use in Medan City, especially in Medan Belawan, Medan Labuhan, and Medan Marelan Districts, reflect an increase in human activities and development that leads to the degradation of mangrove ecosystems. During the Dutch colonial period, most of the mangrove land was preserved, except in a few areas that were converted to tobacco plantations. Currently, these changes are intensifying with the conversion of land for industrial purposes, settlements, and ponds. For more clarity, it can be found in Table 1 and Figure 5.

Table 1 Dutch Land Commodity in 1920

District	Dutch Commodity Land in 1920	Existing Land Use in 2023	Broad
Medan Belawan	Mangrove	Water Bodies	9,68
		Road Bodies	35,45
		River Border Bush	0,36
		Industrial/Warehousing	414,04
		Mangrove	983,56
		Funeral	4,71
		Trade and Services	24,79
		Office	7,30
		Plantation	9,15
		Settlements	291,09
		Hankam	16,38
		SPU	23,77
		Bush	268,49
		Garden	28,02
		Ponds/Ponds	287,33
Medan Labuhan	Mangrove	Water Bodies	22,12
		Road Bodies	19,55
		River Border Bush	16,89
		Industrial/Warehousing	60,60
		Fields/Tegalan	57,90
		Mangrove	207,72
		Funeral	2,91
		Trade and Services	27,45
		Office	1,51
		Plantation	10,79
		Settlements	161,06

District	Dutch Commodity Land in 1920	Existing Land Use in 2023	Broad
		SPU	13,13
		Bush	234,14
		Garden	14,12
		Ponds/Ponds	874,33
Medan Marelan	Mangrove	Water Bodies	0,00
Grand Total			**4128,36**

Based on the table, significant changes in mangrove land use in three sub-districts in Medan City are clearly visible. In Medan Belawan District, the area of mangroves maintained is only 983.56 hectares from the initial 2,404.14 hectares, with 414.04 hectares converted into industrial or warehousing areas. In Medan Labuhan District, only 207.72 hectares of mangroves have been preserved, with 161.06 hectares converted into residential areas. In Medan Marelan District, almost the entire mangrove area has been converted into plantation commodity land. This reduction in mangrove area has a negative impact on coastal ecosystems, reduces natural habitats for various animals, increases the risk of coastal erosion, and impacts the livelihoods of local communities. To maintain the balance of the ecosystem and the sustainability of mangroves, conservation and rehabilitation efforts need to be increased in the city of Medan.

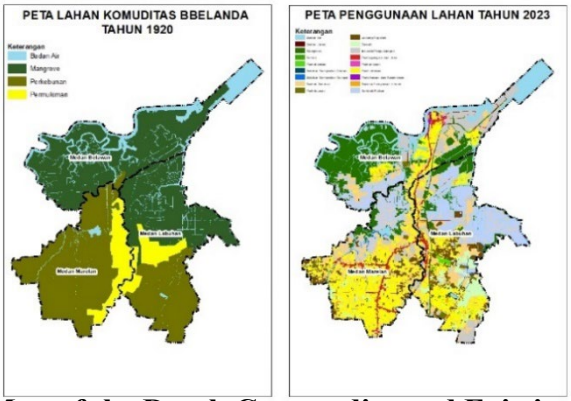


Figure 5. Map of the Dutch Commodity and Existing Land Use

2. Map of Indonesia's transmigration in 1988

The 1988 map of Indonesia's transmigration shows various transmigration locations spread across various provinces in Indonesia. The transmigration program in that era was mainly aimed at reducing population density on the island of Java and its surroundings by moving the population to

less densely populated areas such as Sumatra, Kalimantan, Sulawesi, and Papua. In this relationship, the influence of settlement development on the environment is first taken into account by paying attention to the potential of Regional Development so that in determining the location, the criteria related to regional development are important considerations based on its contribution to regional development and environmental carrying capacity without exceeding the maximum limit of environmental ecological capability.

In order to maintain the carrying capacity of the environment so that it does not exceed the maximum limit of environmental ecological capacity, the Directorate General of Settlement Preparation of the Department of Transmigration issued a map of the Sumatra Land System RePPProt (Regional Physical Planning Programme for Transmigration) made in 1988 with a scale of 1:250,000, as seen in Figure 6.

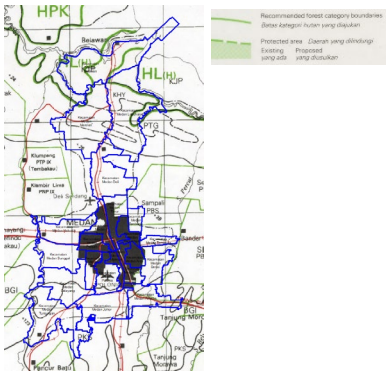


Figure 6. Land System Map

From the map, it is known that the Directorate of Program Development of the Directorate General of Settlement Preparation of the Department of Transmigration maintains the mangrove area as a protected forest which also has peatland characteristics, important to maintain the balance of the ecosystem. The city of Medan has significant peatland ecosystems, including the KHY (Kahayan), KJP (Kajapah), and PTG (Putting) areas, which serve as carbon stores, habitats for various species, and water regulators, making them important for biodiversity protection and flood risk reduction. With the designation of mangrove areas as protected forests, it is hoped that peatlands can be protected and used sustainably, which is very important to maintain environmental balance and ecosystem sustainability in the region. For more clarity, see Table 2 - 3 and Figure 7.

Table 2 Protected Forest Area in 1987

District	Protected Forest Area	Land Use in 2023	Broad
Medan Belawan		Water Bodies	297,41

District	Protected Forest Area	Land Use in 2023	Broad
	Protected Forest	Road Bodies	9,03
		River Border	
		Bush	0,28
		Industrial/Warehousing	112,12
		Mangrove	879,19
		Funeral	1,33
		Trade and Services	3,57
		Office	1,37
		Settlements	96,03
		Public Service Facilities	3,52
		Bush	168,33
		Garden	10,81
		Ponds/Ponds	213,57
Medan Labuhan	Protected Forest	Water Bodies	108,21
		Road Bodies	2,86
		River Border	17,47
		Bush	12,13
		Industrial/Warehousing	43,47
		Fields/Tegalan	145,30
		Mangrove	1,86
		Trade and Services	0,21
		Office	5,52
		Plantation	

District	Protected Forest Area	Land Use in 2023	Broad
		Settlements	50,35
		Public Service Facilities	3,33
		Paddy	43,90
		Bush	123,39
		Garden	3,07
		Ponds/Ponds	373,78
Medan Marelan	Protected Forest	-	0
Grand Total			**2731,41**

From the table above, we know that in Medan Belawan District, the protected forest area which until now is still maintained as a mangrove is 879.19 Ha of the area of protected forest area depicted on the 1988 land system map of 1796.56 Ha and the change in the protected forest area that was built significantly in the industrial/warehousing area is 112.12 Ha. In Medan Labuhan District, the protected forest area that is still maintained is 145.30 Ha and the biggest change in the built-up area is in the use of residential land of 50.35 Ha. Meanwhile, in Medan Marelan District, the entire area is not used as a protected forest.

Table 3 Peatland area in 1987

District	Peat Ecosystem	Broad
Medan Belawan	KJP (Kajapah)	1317,90
Medan Labuhan	KHY (Kahayan)	875,82
	KJP (Kajapah)	934,85
	PTG (Putting)	811,10
Medan Marelan	KHY (Kahayan)	619,23

	PTG (Putting)	1029,38
Grand Total		**5588,28**

From the table above, we know that in Medan Belawan District there is one peat ecosystem, namely KJP (Kajapah) with an area of 1317.90 Ha, in Medan Labuhan District there are three KHY (Kahayan) ecosystems with an area of 875.85 Ha, KJP (Kajapah) 934.85 Ha and PTG (Putting) with an area of 811.10 Ha. Meanwhile, in Medan Marelan District, there are two peat ecosystems KHY of 619.23 and PTG of 1029.38 Ha.

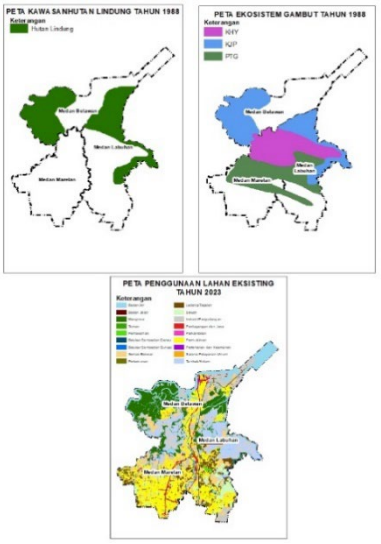


Figure 7. Map of Protected Forest Areas, Peat Ecosystems and Existing Land Use

3. National Mangrove Map in 2021

In 2021, the Ministry of Environment and Forestry issued a National Mangrove Map with two groups of land cover in the mangrove ecosystem, namely the closure of existing mangrove land (existing mangroves) and land cover which is the potential habitat of mangroves. Together, the two are part of the theme of the national mangrove map. For existing mangroves, it is divided into three classifications, namely dense mangroves, which is a type of forest (typical vegetation community) that grows in tidal areas (especially on sheltered beaches, lagoons, river estuaries) that are inundated at high tide and free from inundation at low tide whose plant communities are tolerant of salt, with a percentage of canopy density >70%), medium mangroves with a canopy density percentage of 30 - 70% and mangroves with a canopy density percentage of <30% and land cover which is a potential mangrove habitat are divided into five classifications, namely open areas, abraded mangroves, open land, ponds and embossed land (accretion), (MoEF, 2021). It can be seen in Table 3 - 4 and Figure 8.

Table 3 Existing Mangrove Areas

District	Existing Mangroves	Land Use in 2023	Broad
		Water Bodies	48,71

District	Existing Mangroves	Land Use in 2023	Broad
Medan Belawan	Dense Mangroves	Road Bodies	0,34
		Industrial/Warehousing	1,14
		Mangrove	939,67
		Funeral	0,68
		Settlements	2,14
		SPU	0,07
		Bush	105,58
		Garden	0,39
		Ponds/Ponds	10,69
	Medium Mangrove	Water Bodies	6,26
		Mangrove	21,49
		Settlements	0,08
		Bush	11,56
		Ponds/Ponds	22,10
	Rare Mangroves	Water Bodies	0,33
		Mangrove	1,25
		Bush	0,38
		Ponds/Ponds	4,67
Medan Labuhan	Dense Mangroves	Water Bodies	14,86
		Road Bodies	0,01
		River Border Bush	5,88
		Industrial/Warehousing	0,09
		Mangrove	171,92
		Settlements	0,65
		Bush	36,88
		Garden	1,00
		Ponds/Ponds	17,91
	Medium Mangrove	Water Bodies	1,03
		River Border Bush	0,13
		Mangrove	0,74
		Settlements	0,00
		Bush	1,42
		Ponds/Ponds	4,27
	Rare Mangroves	Water Bodies	2,24
		Mangrove	0,24
		Bush	1,45
		Ponds/Ponds	7,82
Medan Marelan	Dense Mangroves	Water Bodies	9,23
		Lake Border Bush	1,44

District	Existing Mangroves	Land Use in 2023	Broad
		River Border Bush	4,51
		Industrial/Warehousing	0,01
		Fields/Tegalan	0,02
		Mangrove	141,86
		Settlements	0,55
		Bush	19,37
		Ponds/Ponds	15,53
		Water Bodies	2,99
		River Border Bush	0,31
		Fields/Tegalan	0,07
	Medium Mangrove	Mangrove	12,14
		Trade and Services	0,00
		Settlements	0,26
		Bush	40,76
		Ponds/Ponds	35,59
Grand Total			**1730,73**

Table 4 Mangrove Potential Areas

District	Mangrove Potential	Land Use in 2023	Broad
Medan Belawan	Pond	Water Bodies	3,90
		Mangrove	7,27
		Settlements	0,23
		Bush	33,87
		Ponds/Ponds	209,96
	Embossed Land	Water Bodies	1,98
		Mangrove	0,00
Medan Labuhan	Pond	Water Bodies	9,44
		Road Bodies	0,00
		River Border Bush	0,87
		Industrial/Warehousing	0,37
		Fields/Tegalan	0,76
		Mangrove	10,75
		Plantation	0,00
		Settlements	0,56
		Bush	58,93
		Garden	0,02
		Ponds/Ponds	799,65
	Pond	Water Bodies	0,44

District	Mangrove Potential	Land Use in 2023	Broad
		Lake Border Bush	0,03
		River Border Bush	1,87
		Fields/Tegalan	0,73
Medan		Mangrove	5,98
Marelan		Funeral	0,00
		Settlements	0,15
		Bush	62,13
		Ponds/Ponds	276,58
Grand Total			**1486,47**

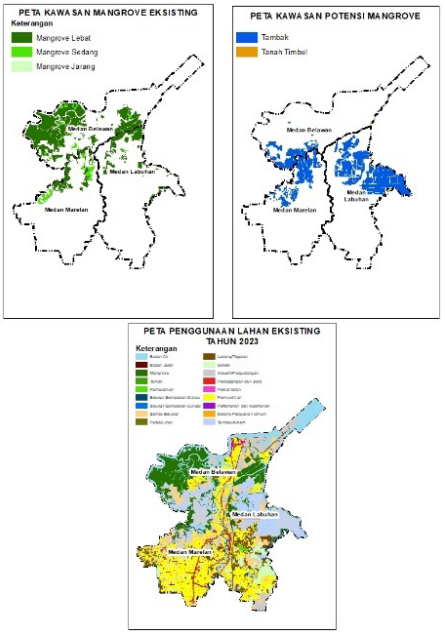


Figure 8. Existing Mangrove Habitat, Mangrove Potential in 2021 and Land Use in 2023

From the table above, it is known that in Medan Belawan District, the existing mangrove area is divided into three, namely dense mangroves with an area of 1109.40 Ha, but if overlapped with the use of existing land, the area of land that has been converted into built land has been converted to built land, the largest area of land that has been converted is the use of residential land of 2.14 Ha, in medium mangroves there are around 21.49 Ha of mangrove land that still survives and in rare mangroves 1.25 Ha is still an area mangroves exist and in the mangrove potential area of Medan Belawan District is dominated by tamabak/ponds with an area of 209.96 Ha, while in embossed land it is dominated by water bodies of 1.98 Ha.

In Medan Labuhan District, existing mangrove land with dense mangrove classification, the area of land that has been transformed into a pond/pond area of 17.91 Ha, medium mangrove 4.27 Ha and rare mangrove area of 7.82 Ha and in mangrove potential is dominated by ponds/ponds of 799.65 Ha, but if we look at the existing land use, the pond area is also quite large, which is 10.75 Ha of mangroves.

In Medan Marelan District, mangrove land is still maintained in the classification of dense mangroves covering an area of 141.86 hectares and medium mangroves covering an area of 12.14 hectares, while in the mangrove potential of the existing area that dominates is the pond/pond area with an area of 276.58 hectares.

4. Map of the Spatial Pattern Plan in 2011

In the Regional Regulation of Medan City Number 13 of 2011 concerning the Spatial Plan of the City of Medan for 2011-2031, it is stipulated that protected forests are in the form of mangrove forests which aim to improve and maintain the microclimate, permeate water, create balance and harmony of the physical environment of the region, and support the preservation of Indonesia's biodiversity. Mangrove forests as referred to are stipulated in Medan Belawan and Medan Labuhan Districts, the regional regulation also stipulates a fairly large Green Open Space area in the mangrove area. It can be seen in Table 5 and Figure 9.

Table 4 Mangrove Areas and Green Open Spaces in the Spatial Pattern of RTRW in 2011

District	2011 Spatial Pattern Plan	Land Use in 2023	Broad
Medan Belawan	Mangrove Area	Water Bodies	36,53
		Road Bodies	0,31
		Mangrove	754,79
		Funeral	0,08
		Settlements	5,13
		Public Service Facilities	0,17
		Bush	62,17
		Ponds/Ponds	41,12
	Green Open Space	Water Bodies	34,97
		Road Bodies	1,30
		Industrial/Warehousing	15,45
		Mangrove	161,53
		Funeral	0,60
		Trade and Services	1,20
		Plantation	9,12
		Settlements	5,96
		Public Service Facilities	1,13
		Bush	70,59
		Ponds/Ponds	219,84
		Water Bodies	10,97

District	2011 Spatial Pattern Plan	Land Use in 2023	Broad
Medan Labuhan	Mangrove Area	Road Bodies	0,49
		River Border Bush	0,74
		Mangrove	107,06
		Settlements	2,31
		Public Service Facilities	0,10
		Paddy	0,06
		Bush	33,48
		Garden	0,54
		Ponds/Ponds	116,87
	Green Open Space	Water Bodies	8,13
		Road Bodies	0,02
		River Border Bush	3,19
		Mangrove	4,40
		Settlements	0,29
		Public Service Facilities	2,59
		Bush	19,66
		Garden	1,26
		Ponds/Ponds	154,33
Medan Marelan	Green Open Space	Water Bodies	33,32
		Lake Border Bush	3,67
		River Border Bush	6,22
		Industrial/Warehousing	0,05
		Fields/Tegalan	15,63
		Mangrove	132,83
		Funeral	0,01
		Trade and Services	0,01
		Plantation	2,00
		Settlements	24,28
		Public Service Facilities	0,27
		Paddy	3,01
		Bush	105,52
		Ponds/Ponds	271,13
Grand Total			**2486,43**

In the table, it can be seen that in the 2011 RTRW Spatial Pattern Plan, Medan Belawan District has 1,061.83 hectares of mangrove land that is maintained, covering both mangrove area and green open space plan patterns. In Medan Labuhan District, the mangrove land that is maintained covers an area of 277.03 hectares, while in Medan Marelan District, the mangrove land that is maintained covers an area of 132.83 hectares.

However, the overlay results show that many mangrove areas have been converted into built-up areas. In Medan Belawan District, mangrove land that has been converted into built land reaches 5.30 hectares, while in Medan Labuhan District, the area of mangroves that have been converted into built land is 2.42 hectares. This indicates that there is pressure from development, both for settlements and public service facilities, which has an impact on reducing the area of mangrove land that is maintained. Conservation efforts need to be increased to maintain the sustainability of mangrove areas in these areas.

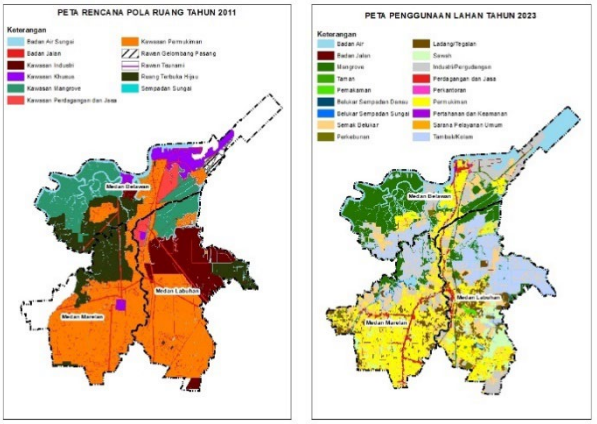


Figure 9. 2011 RTRW Spatial Pattern Plan and 2023 Land Use

5. Spatial Pattern Plan Map in 2022

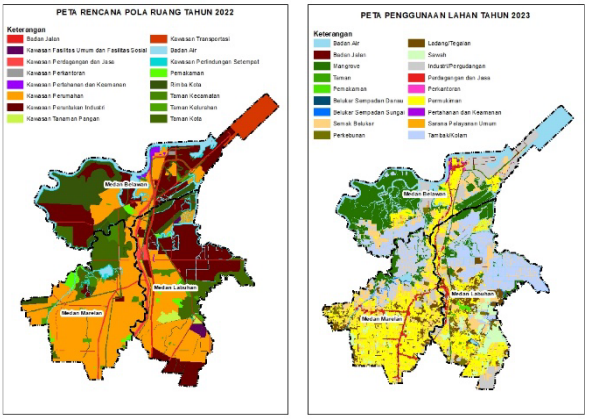
Medan City Regional Spatial Plan (RTRW) for 2022-2042. In this RTRW, a policy has been formulated, including a policy for the development of industrial areas in Medan Belawan, Medan Labuhan and Medan Marelan Districts.

The area of industrial designation areas in Medan Belawan, Medan Labuhan and Medan Marelan Districts is planned to be 2108.81 hectares. And one of the designated industrial areas is on mangrove land. The area of mangrove land planned as an industrial area is approximately 372.95 Ha, with the highest area of mangrove land designated as an industrial area in Kec. Medan Belawan is 304.49 Ha. For more clarity, see Table 5 and Figure 10.

Table 5 2022 Industrial Designation Plan Area and 2023 Land Use

District	Industrial Estate Plan 2022	Land Use in 2023	Broad
Medan Belawan	Industrial Allocation Area	Water Bodies	22,42
		Road Bodies	5,10
		Industrial/Warehousing	330,80

District	Industrial Estate Plan 2022	Land Use in 2023	Broad
		Mangrove	304,49
		Funeral	0,49
		Office	2,26
		Plantation	7,28
		Settlements	16,08
		Public Service Facilities	2,35
		Bush	137,70
		Garden	4,32
		Ponds/Ponds	110,96
Medan Labuhan	Industrial Allocation Area	Water Bodies	24,89
		Road Bodies	3,43
		Industrial/Warehousing	133,71
		Fields/Tegalan	27,39
		Mangrove	68,47
		Funeral	0,28
		Trade and Services	1,64
		Plantation	12,40
		Settlements	71,58
		Public Service Facilities	6,96
		Paddy	12,64
		Bush	156,78
		Garden	1,42
		Ponds/Ponds	615,76
Medan Marelan	Industrial Allocation Area	Water Bodies	0,03
		River Border Bush	0,19
		Industrial/Warehousing	7,93
		Fields/Tegalan	0,28
		Funeral	0,08
		Settlements	2,40
		Bush	12,21
		Garden	0,78
		Ponds/Ponds	3,34
Grand Total			**2108,81**



Meanwhile, what is maintained as mangroves in Medan Belawan District, Medan Labuhan and Medan Marelan are planned as Rimba Kota with an area of 932.88 Ha, with the largest area in Medan Belawan District with an area of 506.14 Ha and the smallest area in Medan Marelan District with an area of 3.53 for more clarity see Table 6 and Figure 9.

Table 6 Urban Forest Plan Areas in 2022 and Land Use in 2023

District	City Forest Plan 2022	Land Use in 2023	Broad
Medan Belawan	City Forest Plan	Water Bodies	116,14
		Industrial/Warehousing	7,62
		Mangrove	506,14
		Settlements	4,56
		General SPU	0,33
		Bush	18,21
		Ponds/Ponds	58,73
Medan Labuhan	City Forest Plan	Water Bodies	7,27
		Road Bodies	1,36
		Lake Border Bush	0,18
		River Border Bush	1,31
		Industrial/Warehousing	0,52
		Fields/Tegalan	2,04
		Mangrove	62,08
		Funeral	0,10
		Plantation	0,38
		Settlements	10,93
		SPU	0,49
		Paddy	5,66
		Bush	10,69

District	City Forest Plan 2022	Land Use in 2023	Broad
		Garden	0,44
		Ponds/Ponds	37,77
Medan Marelan	City Forest Plan	Water Bodies	7,77
		Road Bodies	0,07
		River Border Bush	1,09
		Fields/Tegalan	13,37
		Mangrove	3,53
		Funeral	0,46
		Trade and Services	0,01
		Plantation	7,14
		Settlements	14,41
		SPU	0,38
		Paddy	0,40
		Bush	20,20
		Ponds/Ponds	11,11
Grand Total			**932,88**

Figure 10. 2022 RTRW Spatial Pattern Plan and 2023 Land Use

B. Mangrove Land Change Analysis

The analysis of mangrove land use change was carried out by identifying trends in land use change, especially looking at changes in mangrove land use in three sub-districts. The data used in this analysis is based on the interpretation of aerial photographs from 2013 to 2023. Based on the results of the analysis, it is known that the area of mangroves has decreased between 2013 and 2023 which is inversely proportional to the increasing conditions of residential land use and ponds, because this can be seen more clearly in the following land use conversion graph.

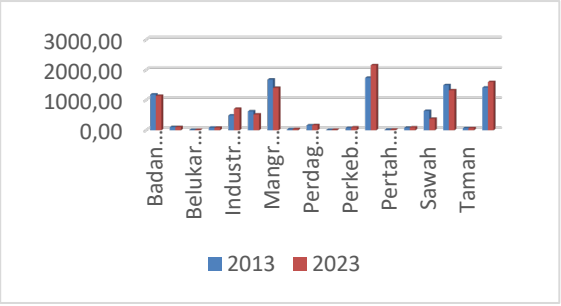


Figure 11. Land Use Change Graph

The city of Medan as one of the metropolitan cities in Indonesia is also part of the east coast area in North Sumatra which still has mangrove land. In general, this mangrove land cover is located in the northern part of Medan City with the current area of 1401.93 Ha. From the data obtained, it is known that the area of this mangrove land has decreased from year to year. The condition of mangrove land use in 2013 in Medan Belawan, Medan Labuhan and Medan Marelan Districts with an area of 1680.03 hectares when compared to 2023 data is 1401.93 hectares or has experienced a change in the area of mangrove land use covering an area of 278.10 hectares. The most widespread change occurred in Medan Labuhan District, namely mangroves which switched to an area of 274.31 hectares. For more clarity see Table 7 and Figure 12.

Table 7 Comparison of Mangrove Land Use Area in 2013 and 2023

District	Land Use	Area 2013 (Ha)	Area 2023 (Ha)	Difference
Medan Belawan	Mangrove	1016,60	1014,74	1,86
Medan Labuhan	Mangrove	494,62	220,31	274,31
Medan Marelan	Mangrove	168,81	166,88	1,93
Grand Total		**1680,03**	**1401,93**	**278,10**

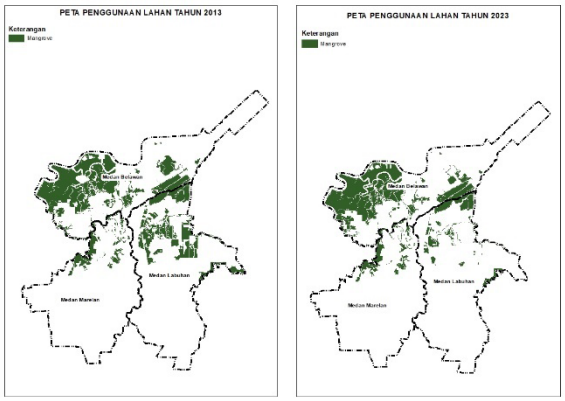


Figure 12. Mangrove Land Use Conditions in 2013 and 2023

Based on the results of the analysis and several literature studies, there are two factors that trigger the conversion of mangrove land in Medan City. These triggering factors include population growth and land ownership status.

a. Population Growth

The increase in the number of people both due to birth rates and urbanization triggers a high need for boards such as housing and various other supporting facilities. This directly affects the

development of development which has an impact on changes in the conversion of mangrove land that are difficult to avoid.

Based on BPS data on the results of the 2013 Population Census (SP) and the September 2023 Population Census, the trend of annual population growth in these 3 sub-districts can be said to have increased quite rapidly. The highest population growth is in Medan Marelan District, where in 2013 the population of Medan Marelan District was still 147318 people, then in 2023 it has reached 189,469 people with a population increase of around 42151 people. If averaged per year, the population growth in Medan Marelan District for 10 years is 4215 people/year. This growth rate is a category of rapid growth rate because the population growth rate reaches more than 2% every year. This increase in population in general will have implications for increasing demand for land needs both for housing, economic activities and supporting infrastructure. For a more detailed picture of population growth based on sub-districts located in the coastal area of Medan City, you can see the graph below.

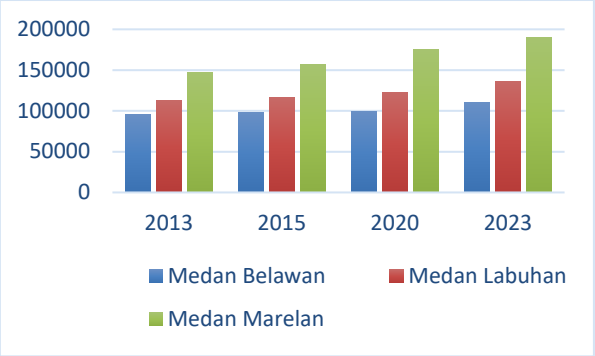


Figure 13. Population Growth Graph

b. Land Ownership Status

Mangroves are the last bastion of coastal areas. However, a number of problems of mangrove land change are still found in several areas, including in Medan City. The occurrence of changes in mangrove land is related to land ownership which can encourage land conversion. Therefore, the Government is expected to pay more attention to these conditions by socializing to the community, especially in coastal areas.

Based on the results of digitization in 2023, the area of mangroves in Medan City is 1,401.93 hectares, with a dense density of around 50 percent, which is generally found in Medan Belawan District. This condition shows that mangroves in Medan Belawan are still relatively good and are included in the medium category. This density indicates a healthy mangrove ecosystem, serves as a habitat for animals, a natural protector against coastal abrasion, and provides economic benefits such as fisheries, mangrove timber, and ecotourism. Despite environmental pressures, mangroves in Medan Belawan still function well in maintaining the balance of the coastal ecosystem. Therefore, conservation and rehabilitation efforts must continue to be carried out to ensure the preservation of mangroves in the city of Medan, especially in Medan Belawan.

From the data obtained, the status and ownership of mangrove land on the coast of Medan City is not part of the forest area. In general, the status and ownership of mangrove land are entirely controlled personally by community members, although based on the data obtained, the status of

mangrove land is currently dominant and still not registered. The status of mangrove land that has not been registered is currently around 931.03 hectares or 50% of the total mangrove land area. Then the ownership status in the form of property rights covering an area of 248.38 hectares or 36% of the total mangrove land area, more clearly can be seen in Table 8 and Figure 14.

Table 8 Status of Mangrove Land Ownership in Medan City

District	Mangrove Area	Type of Rights	Broad
Medan Belawan	1014,73	Building Rights	5,03
		Proprietary	203,65
		Right of Use	1,38
		Management Rights	3,62
		Empty	172,37
		Not Registered	628,69
Medan Labuhan	220,31	Building Rights	10,69
		Proprietary	0,67
		Empty	5,27
		Not Registered	203,68
Medan Marelan	166,88	Building Rights	15,81
		Proprietary	45,17
		Right of Use	0,34
		Empty	2,77
		Not Registered	102,79
Grand Total			**1401,93**

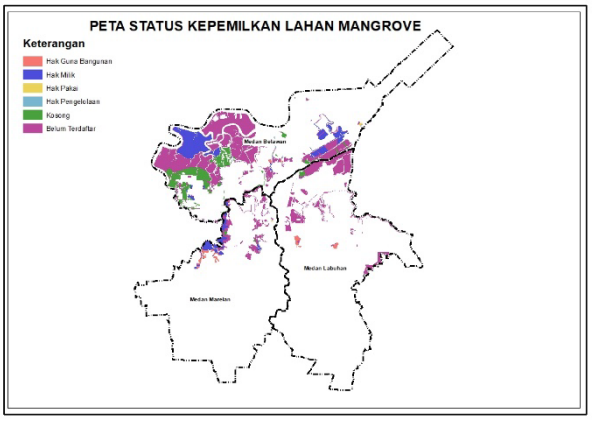


Figure 14. Map of Mangrove Land Ownership Status

C. Analysis of the Feasibility of the Implementation of the RTRW Spatial Pattern Plan on the Use of Existing Mangrove Land

The industrial sector has an important role in accelerating economic development in the city of Medan. The contribution of the industrial sector to the economy in Medan City is quite good, this can be seen from the contribution of the industrial sector to the GDP of Medan City tends to increase from 2016 to 2023. Industrial activities in Medan City are generally located in industrial estates that have been provided by the Medan City Government. The location of the industrial area in Medan City is precisely in the northern part and is a very strategic location, because it is adjacent to the infrastructure of Belawan Port as a sea port gateway for the entry and exit of various industrial products. In addition, this area is also divided by two toll roads from Medan City to Belawan port and to Kuala Namu Airport through the Belmera Toll Road.

Strategically, this position has changed the direction of the strategic area development policy in Medan City. Based on the 2021-2026 Medan City RPJMD, it is determined that the policy direction for the development of strategic areas in Medan City will be directed to areas that will provide added value in supporting the growth of Medan City, one of which is the development of Industrial Designated Areas (KPIs) in the northern part. This policy direction is determined in order to support the function of the City of Medan as part of the National Activity Center for the Mebidangro Urban Area (Medan, Binjai, Deli Serdang and Karo) including as a center for industrial activities.

In addition to the development directions in the RPJMD, another policy that is also a driver of mangrove land change is the Medan City Regional Spatial Plan (RTRW) for 2022-2042. In this RTRW, a policy has been formulated, including a policy for the development of industrial areas in the northern region of Medan City.

The area of industrial designation area in Medan City is planned to be 2108.81 hectares. And one of the designated industrial areas is on mangrove land. The area of mangrove land planned as an industrial area is approximately 372.95 Ha, with the highest area of mangrove land designated as an industrial area in Medan Belawan District, which is 304.49 Ha. For more clarity see Table 5 and Figure 15.

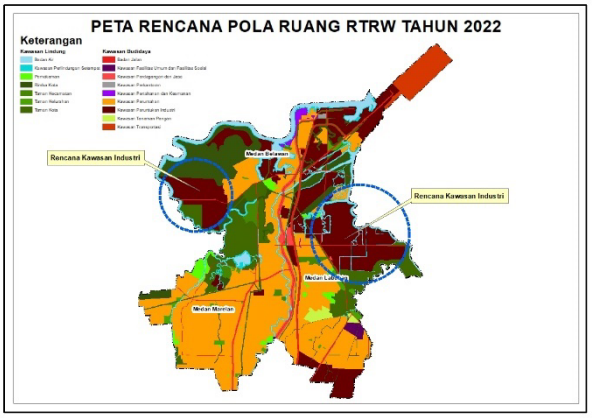


Figure 15. 2022 RTRW Spatial Pattern Plan

The direction of government policy has a significant impact on land use in an area. Clear guidelines provide guidance to local governments, developers and communities for sustainable land management in line with development goals. The impact of this policy includes spatial planning that regulates land use for various purposes such as housing, industry, agriculture, conservation and recreation, as well as zoning that determines the type of land use. Strong environmental policies support the protection and restoration of mangroves and protect ecosystems from destructive activities. Sustainable development policies ensure that economic growth does not come at the expense of ecosystems, while well-planned infrastructure can help protect Managrove's forests. The government can also provide economic incentives to encourage conservation efforts, develop sustainable ecotourism, and involve local communities in mangrove management. Examples of policies that have an impact on mangroves include environmental protection laws, national strategic plans, zoning regulations, and mangrove restoration programs. Clear and targeted policies ensure that the use of mangrove land supports economic development, ecological sustainability, and community welfare. For more details, please see Table 9 and Figure 16 below.

Table 9 Utilization of Mangrove Land for Other Purposes

District	Land Use in 2023	Cultivation Area PR Plan	Broad
Medan Belawan	Mangrove	Road Bodies	11,30
		Hankam Area	0,72
		Residential Areas	71,81
		Industrial Allocation Area	304,49
	Mangrove	Road Bodies	5,73

Medan Labuhan		Trade and Service Zone	7,66
		Hankam Area	0,00
		Residential Areas	9,62
		Industrial Allocation Area	68,47
Medan Marelan	Mangrove	Road Bodies	5,52
		Residential Areas	16,39
Grand Total			**501,71**

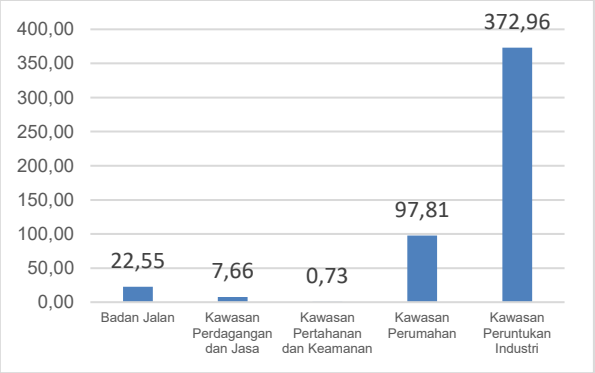


Figure 16. Built-up Area Plan for Existing Mangrove Land

Based on pictures and graphs, it is known that the plan for cultivation on the largest mangrove land is intended as an industrial area of 372.96 hectares, then followed by the designation as a residential area with an area of around 97.81 hectares.

In addition to other allocation plans for mangrove land, another policy direction that can be a driver of mangrove land change is the determination of service center development policies. Based on the 2022-2042 Medan City RTRW, Medan Labuhan District is designated as a City Service Center in the northern part of Medan City with the function of a regional service and trade activity center, a transportation service center, a socio-cultural activity center, and an industrial activity center and a security defense center centered at TOD Labuhan which serves the northern region of Medan City. In addition to Medan Labuhan District, Medan Belawan District has also been designated as a City Service Sub-Center with one of its functions as a center for industrial activities and a center for fishery activities.

The existence of this policy direction will certainly make this area have a very big role for development, where its contribution as a service center to meet the living needs of its residents and

the existence of other allocation plans for mangrove land will have implications for increasing infrastructure development which will have an impact on urban space, especially on land demand in the northern part of Medan City which still has a fairly large area of mangrove land.

If this is not controlled comprehensively, it will be able to give birth to various problems, including the existence of existing mangrove lands. Therefore, what has been stipulated in the 2022-2042 Medan City RTRW needs to be reconsidered, especially in maintaining the existence of mangrove land, considering the function of mangroves which has an important role for the environment in Medan City.

V. COVER

A. Conclusion

Based on the results of the research and discussion of each analysis, several conclusions can be drawn as follows:

1. Analysis of Mangrove Land Transformation Dynamics.
   a. The results of the analysis of the dynamics of mangrove land transformation show that during the Dutch colonial period in 1920, at that time mangrove land in Medan City was still maintained as a mangrove area. In Medan Belawan District, mangrove land on the Dutch commodity map is 2404.14 Ha, Medan Labuhan District covers an area of 1724.22 Ha and in Medan Marelan District, almost the entire area is used as a plantation commodity.
   b. In 1988, the Directorate General of Settlement Preparation, Department of Transmigration, issued a map of the Sumatra Land System RePPProt (Regional Physical Planning Programme for Transmigration) of Medan Belawan District, a protected forest area of 1796.56 hectares, Medan Labuhan District, a protected forest area of 934.85 hectares, and in Medan Marelan District, the entire area was not used as a protected forest.
   c. In 2021, the Ministry of Environment and Forestry issued a National Mangrove Map with two groups of land cover in the mangrove ecosystem, namely the closure of existing mangrove land (existing mangroves) and land cover which is the potential habitat of mangroves. Medan Belawan District, the existing mangrove area is divided into three, namely dense mangroves with an area of 1109.40 Ha, medium mangroves with an area of 61.50 Ha and rare mangroves of 6.63 Ha.In Medan Labuhan District, existing mangrove land with a classification of dense mangroves covering an area of 249.21 Ha, medium mangroves of 7.60 Ha and rare mangroves covering an area of 11.75 Ha and in Medan Marelan District, mangrove land in the classification of dense mangroves covering an area of 192.52 Ha and medium mangroves covering an area of 92.11 Ha.
   d. The results of the analysis on the 2011 RTRW Spatial Pattern Plan in Medan Belawan District, the mangrove land that is maintained covers an area of 1061.83 Ha both in the mangrove area plan pattern and in the green open space, in Medan Labuhan District the mangroves are maintained in an area of 277.03 Ha and Medan Marelan District is 132.83 Ha.
   e. In the 2022 RTRW Spatial Pattern Plan, the mangrove land maintained in Medan Belawan District, Medan Labuhan and Medan Marelan is planned as the City Forest with an area of

932.88 Ha, with the largest area in Medan Belawan District with an area of 506.14 Ha and the smallest area in Medan Marelan District with an area of 3.53 Ha.

2. The results of the Mangrove Land Change Analysis showed that there was a significant change in mangrove land use in Medan Belawan, Medan Labuhan and Medan Marelan Districts. These changes mainly occurred on land that was previously a mangrove. The use of mangrove land in 2013 was 1680.03 Ha and in 2023 with an area of 1401.93 Ha there was a change in the area of mangrove land use covering an area of 278.10 hectares. The most widespread change occurred in Medan Labuhan District, namely the mangrove which changed its function covering an area of 274.31 hectares, the change was used for other purposes such as housing and pond development.
3. From the results of the analysis of the feasibility of the implementation of the RTRW spatial pattern plan on the use of existing mangrove land, namely the Regional Spatial Plan (RTRW) of Medan City for 2022-2042. In this RTRW, a policy has been formulated, including a policy for the development of industrial areas in the northern region of Medan City. The area of industrial designation area in Medan City is planned to be 2108.81 hectares. And one of the designated industrial areas is on mangrove land. The area of mangrove land planned as an industrial area is approximately 372.95 hectares, then followed by designation as a residential area with an amount of around 97.81 hectares. with the highest area of mangrove land designated as an industrial area in Medan Belawan District, which is 304.49 Ha.

B. Suggestion

In order to preserve the importance of mangrove land use in the northern region of Medan City, the government must implement good conservation and management measures to maintain the quality of the environment in the area. Make appropriate policies to assess the development of mangrove ecosystem areas such as industrial land development, settlements and pond cultivation. Communicate with local communities and other stakeholders about the benefits of mangrove ecosystems and local community awareness to maintain the status of mangrove ecosystems in Medan Belawan, Medan Labuhan and Medan Marelan Districts. Taking action against violations of the Spatial Plan. Through the Spatial Plan, the City Government can control development in the northern region of Medan City. Research on Mangrove Land Transformation Analysis in Medan Belawan, Medan Labuhan and Medan Marelan Districts can be used as a reference for further research.

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