

Analysis of Non-Conformity of Space Utilization in the Corridor of the Deli River Basin in Medan City

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ABSTRACT

Increased population growth causes land needs to increase and forces underprivileged people to live in inappropriate areas such as river banks. The purpose of this research is to identify the types of spatial utilization and the dynamics of spatial utilization of non-conformity to spatial planning regulations in the Deli River border corridor in Medan City. This research uses a descriptivequalitative approach with Geographic Information System (GIS)-based spatial analysis method, particularly overlay technique, to compare the regulation of Medan City Regional Regulation on Regional Spatial Plan Year 2022-2042. The analysis in 2024 showed significant discrepancies between the existing space utilization and the planned spatial pattern of the RTRW, indicating deviations between planning and actual conditions that may affect ecological and economic functions and hinder sustainable development. The identification of mismatches in various areas shows that incompatible land uses can disrupt the balance of the ecosystem and require more effective spatial adjustments.

Keywords:

Deli River Border, Medan City RTRW 2022-2042, Space Utilization Incongruity, Spatial Information System.

Introduction

Population growth has forced underprivileged communities to settle in riverside areas, due to limited urban land and high land prices. These conditions lead to social and environmental problems, including lack of access to basic services and the risk of flooding (Rahmadi et al. 2023). According to Government Regulation No. 38/2011 on Rivers, a river border is an area located between the left and right lines of a river body. This area is designated as a protection and buffer zone to maintain a balance between land and river ecosystems, so that river functions and human activities do not interfere with each other.

Sustainable landscape theory emphasizes the importance of considering the environment and optimal land use, in accordance with traditional restrictions. Land management includes areas such as rivers and forests, with traditional values applied in sustainable landscapes that have created livable areas (Nuraini, 2016).



The development of settlements along the Deli River was triggered by economic and social factors, as well as by the rapid population growth rate. This has led to the clustering of people along the riverbanks. (Marpaung et al. 2019).

Several studies related to the environment and spatial planning in the Deli River corridor in Medan City have not covered the entire Deli River segment in Medan City. Therefore, a comprehensive study of the suitability of spatial utilization in the Deli River corridor is needed as a monitoring tool for the implementation of the RTRW, evaluating the impact of spatial policies that have been implemented, and ensuring the suitability of the RTRW with existing conditions to support sustainable development.

Literature Review

A. Regional Regulation of Medan City Number 1 Year 2022 on the Regional Spatial Plan of Medan City Year 2022-2042

The RTRW of Medan City 2022-2042 contains a spatial structure plan, spatial pattern plan, strategic area plan, spatial control provisions, and program indications. The spatial pattern plan is the distribution of spatial designations within an area that includes spatial designations for protection functions and spatial designations for cultivation functions. Protection areas are protected areas that are ecologically an ecosystem located in the city area, protected areas that provide protection to subordinate areas located in the city area, and other protected areas which according to the provisions of laws and regulations the management is the authority of the city government. On the border of the Deli River there is a spatial pattern plan including protected areas and cultivation areas.

B. Regulations during the Dutch East Indies Period

The law of the Dutch East Indies Government applied the principle of concordance, which meant basing the application of European law or Dutch law at that time also on the European Group in the Dutch East Indies (Indonesia at that time). In the application of foreign (Dutch) legal systems and systems in Indonesia, the principle reflects the original legal situation of the legal system.

Regulations governing the management of watersheds and river borders during the Dutch East Indies Government were contained in Staatsblad van Nederlandsch-Indië 1938 Number 194. This regulation was designed to maintain the safety and stability of rivers, prevent erosion, and protect river ecosystems from potentially damaging activities, as an effort to manage water resources sustainably and protect the environment.

C. Regulation of the Government of the Republic of Indonesia

Regulations on river boundaries in Indonesia are currently more comprehensive and tailored to national conditions. Some of the regulations governing river boundaries include:

• Government Regulation No. 38/2011 on Rivers.

River is a natural and/or artificial waterway or container in the form of a water flow network and the water in it, starting from the upstream to the estuary, which is limited on the right and left by a border line. A boundary line is a virtual line on the left and right of a riverbed that is set as a river protection boundary.

• Regulation of the Minister of Public Works No. 28/PRT/M/2015 on the Determination of River Boundary Lines and Lake Boundary Lines.

Based on the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 28/PRT/M/2015 concerning the Determination of River Boundary Lines and



Lake Boundary Lines, the determination of river boundary lines aims to ensure that river functions are not disturbed by activities that develop around it, utilization activities and efforts to increase the value of the benefits of existing resources in the river can provide optimal results while preserving river functions and the destructive power of river water to the environment can be limited.

D. Complexity of Riverbank Area Space Utilization

Land is an area on the Earth's surface with stable or predictable attributes, which include the biosphere, atmosphere, soil, geology, hydrology, and past and present human activities. These attributes significantly influence current and future land use (Mokodompit et al. 2019). Land use is human intervention in the management of natural resources and infrastructure

with the aim of meeting material and spiritual needs (Saifuddin et al. 2024).

Urban planning must take into account environmental impacts in addition to economic benefits by regulating land use through zoning regulations, permits, incentives, disincentives, and sanctions (Jesica et al. 2023). Evaluation of the suitability of space utilization reveals misalignment between current space use and spatial pattern plans, especially related to the regulation of river protection areas. (Turnip et al. 2022).

Settlements on riverbanks often occur due to economic and land constraints. Despite the prohibition, many development violations occur in Medan City's rivers such as the Deli River and others. This reflects the government's failure in spatial planning, negatively impacting the environment, health, and living standards of residents (Sianturi et al. 2024).

E. Geographic Information System (GIS)

Geographic Information System (GIS) is a system for collecting, storing, editing, analyzing, organizing, and displaying geographic data. GIS is used in the study of geographic information and is divided into two categories of spatial data: primary and secondary. Technologies such as remote sensing and GPS allow the conversion of recorded data to digital format quickly, producing accurate data for GIS (Irwansyah, 2013).

The focus on advanced spatial analysis, such as spatial modeling, overlay analysis, and spatial linkage techniques, emphasizes the need for in-depth understanding. The integration of GIS in decision-making is emphasized through the development of models and algorithms to improve efficiency and accuracy. Challenges such as data complexity and interoperability can be overcome by standardizing geographic data and using integrated platforms (Rahmawati, 2024).

Methods

A. Research Approach

This research used a descriptive-qualitative method combined with Geographic Information System (GIS)-based geospatial analysis. Spatial analysis was conducted using overlay techniques, to evaluate land use suitability. This approach also helps identify potential conflicts or synergies in land use, thus supporting more sustainable and efficient planning (Kurniawan et al. 2024).

A spatial analysis approach was chosen in this study to compare the Medan City Regional Regulation on the Regional Spatial Plan (RTRW) with the spatial map of existing land use. With this approach, the researcher can clearly identify areas of spatial overlap or overlap.

B. Research Design and Flow





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The research was systematically designed by combining spatial exploration and field observation approaches. Each objective was supported by a relevant literature review, ensuring the analysis was based on sound theories and concepts. The data collected, including information from Medan City RTRW and field observations, were carefully selected to meet the research needs. Data processing techniques were designed to produce accurate and informative analysis, which was then compared with the research objectives to ensure the results obtained answered the research questions. The research focused on specific data related to spatial utilization in the Deli River riparian corridor, enabling analysis of the conformity between spatial plans and existing conditions as well as identification of potential conflicts or gaps.

C. Research Variables

The variables in this study are the regulation of the spatial pattern plan of Medan City RTRW 2022-2042 and spatial data as input in the analysis of the suitability of space utilization which has an area dimension in units of hectares to determine the suitability of land use classified in the appropriate class, conditionally appropriate and inappropriate class. The spatial variables are as follows:

- Google Satellite Imagery; and
- Spatial pattern plan and narrative content of Medan City RTRW 2022-2042.

D. Research Data

The object of this research is the condition of existing space utilization in the Deli River corridor of Medan City. The data collected in this study consisted of secondary data and primary data. The secondary data used is in the form of Medan City Regional Regulation No. 1 Year 2022 on the Medan City Spatial Plan Year 2022-2042 and Google satellite image data. Meanwhile, primary data is data obtained directly from the original source, without media. In this study, primary data was obtained by direct observation in the field by obtaining the results of identification of space utilization activities in the study area.

E. Data Analysis

The data analysis used in this research is a spatial analysis of the actual condition of existing space utilization change activities in 2013-2024 and identification of the incompatibility of space utilization in 2024 with the spatial pattern plan of Medan City RTRW 2022-2042. The actual condition of space utilization activities was obtained from interpretation and digitization of satellite images to obtain spatial delineation of land parcels of existing space utilization activities. The stages of data analysis are described as follows:

- Satellite Image Interpretation;
- Ground Check; and
- Superimpose (Overlay) Analysis.

Discussion

A. Overview of the Research Area

The area in this study was carried out with a 100-meter buffer method on aerial photos/satellite imagery of the left and right areas of the Deli River border corridor, which has a river length of 38.48 kilometers with a research area obtained of 839.58 hectares and its position can be described as a river flow in Medan City which flows in nine sub-districts.



The Deli River in Medan City, which is affected by tropical weather patterns, faces challenges such as pollution and degradation due to industrial activities and domestic waste. Urbanization and population increase put additional pressure on the river, which also plays an important role in daily life and reflects the city's history. Revitalization and preservation efforts are crucial to maintain the river's sustainable benefits.



Figure 1. Map of the Research Area of the Deli River Basin Corridor in Medan City in 2024

B. Type of Existing Space Use 2013-2024 Period

Analysis of satellite image digitization and Superimpose/Overlay techniques with ArcGIS showed that between 2013 and 2024, there was a significant shift in spatial utilization in the Deli River riparian corridor, where conservation and non-developed land turned into built- up areas due to increased urbanization. The data in table 1 and figure 2 show the changes in spatial utilization, important for sustainable planning and in accordance with spatial planning regulations.

Medan City 2013-2024						
No.	Existing Space Utilization	Year (Ha)		D:ffamor as (IIa)		
		2013	2024	Difference (Ha		
1	Water Body	100,69	100,76	0,06		
2	Mangroves	41,68	40,55	-1,13		
4	Garden	6,37	10,93	4,56		
5	Funeral	9,57	9,57	-		
6	Riverbank Scrub	112,94	107,23	-5,71		
8	Shrubs	108,45	77,25	-31,2		

Difference of Changes in Existing Space Utilization in the Deli River Frontage Corridor in Medan City 2013-2024

Table 1.



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No.	Existing Space Utilization	Year (Ha)		Difference (IIe)	
		2013	2024	Difference (fra)	
9	Plantation	1,54	0,85	-0,69	
10	Field/Field	29,71	25,16	-4,55	
12	Ponds/Ponds	0,57	1,87	1,3	
13	Road Body	12,72	13,52	0,8	
14	Settlements	265,44	278,72	13,28	
15	Public Service Facilities	19,98	25,88	5,9	
16	Office	7,61	7,91	0,3	
17	Defense and Security	0,53	0,53	-	
18	Trade and Services	62,28	68,91	6,63	

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Source: Researcher Year 2024

The 2024 analysis reveals significant changes in space utilization in the Deli River riparian corridor from 2013 to 2024. The table above shows a major conversion of the shrubbery area which in 2013 covered 108.45 hectares to residential (22.25 hectares) and industrial/warehousing (4.71 hectares), reducing the area of shrubbery by 31.20 hectares. In addition, the settlement area, which in 2013 covered 265.44 hectares, has now expanded with the addition of public service facilities, trade, and industry, increasing by 13.28 hectares. These changes reflect rapid urbanization and diversification of land use, with impacts on environmental quality and reduction of water catchment areas.

C. Land Use Change 2013-2014

Through the analysis of satellite image digitisation and the application of Superimpose/Overlay techniques on spatial utilization data in the Deli River border corridor from 2013 to 2024, the transformation of previously undeveloped areas into built-up areas, reflects the increasing pressure of urbanization and the need for infrastructure and residential development along the Deli River corridor. Further details can be seen in table 2 below.

			<u> </u>		
Built un Land	Land A	rea (Ha)	Difforence	0/_	
Dunt-up Lanu	Year 2013	Year 2024	Year 2024		
Non-built	411,52	374,16	-37,36	-9,08%	
Built	428,06	465,42	37,36	8,73%	
Total	839,58	839,58	0	0,00%	

Table 2.Land Use Change in the Deli River Frontage Corridor of Medan City 2013-2024

Source: Researcher Year 2024

The results of the analysis show an increase in built-up land area of 37.36 hectares (8.73%) in the Deli River riparian corridor between 2013 and 2024. This increase reflects significant intensification of development and urbanization, which can reduce green areas, increase flood risk, and disrupt ecosystem balance.

D. Built-up Land in the Local Protection Area Plan 2013-2024

Analysis using the Superimpose/Overlay method of existing spatial utilization data in the Deli River border corridor between 2013 and 2024 shows a significant change, with previously undeveloped areas now becoming built-up areas in local protection areas, visualized in table3. emphasizes the importance of balanced spatial planning to maintain the environment around the river corridor.

Table 3.



Built_un Land	Land A	Land Area (Ha)		0/2
Dunt-up Land	Year 2013	Year 2024	Difference	/0
Non-built	93,22	88,47	-4,75	-5,10%
Built	20,34	25,09	4,75	23,35%
Total	113,56	113,56	0	0,00%

Land Use Change in the Local Protection Area Plan 2013-2024

Source: Researcher Year 2024

The analysis results for 2024 show an increase in the area of built-up land in the local protection area along the Deli River riparian corridor in Medan City, from 20.34 hectares in 2013 to 25.09 hectares in 2024, representing a growth of 23.35%.

E. Spatial Pattern Plan of Medan City RTRW 2022-2042 Towards the Medan City Deli River Basin Corridor

The identification of the Medan City Regional Regulation No. 1 Year 2022 on the Medan City Spatial Plan Year 2022-2042 revealed two main spatial pattern plans in the Deli River boundary corridor. For more details, it can be seen in the following table 4.

Table 4.Spatial Pattern Plan of Medan City Spatial Plan 2022-2042 Towards the Deli River FrontierCorridor by Segment of Research Area

Spatial Pattern Plan	River Corridor Segment				
RTRW	Upstream	Center Segment	Downstream	a	%
	Segment		Segment	(Ha)	
Protected Area	58,98	71,50	148,36	278,84	33,21%
Cultivation Area	158,02	205,15	197,56	560,74	66,79%
Total	217,01	276,65	345,93	839,58	100,00%

Source: Researcher Year 2024

The cultivation spatial pattern plan dominates the study area, covering 560.74 hectares or about 66.79% of the total area, spread across the upstream, middle, and downstream segments. Meanwhile, the protected area spatial pattern plan covers 278.84 hectares or 33.21% of the area, also divided into three segments. These protected areas are designed to protect areas of high ecological value from the impacts of development.

F. Incompatibility of Spatial Pattern Plan of Medan City RTRW Year 2022-2042 Against Existing Type of Space Utilization of Medan City Deli River Frontage Corridor Year 2024

Based on the results of the researcher's analysis in 2024, there are significant discrepancies between the existing space utilization and the spatial pattern plan stipulated in the Medan City Regional Regulation No. 1 Year 2022 on the Medan City Spatial Plan 2022-2042. These mismatches include various types of land use that are not in accordance with the regulated designations. In the water body area, the non-conformities include land use for cemetery of

0.01 ha, road body of 0.06 ha, settlement of 1.58 ha, public service facility of 0.02 ha, trade and service of 0.01 ha, and industry/warehousing of 0.01 ha.

In the local protection area, there are incompatible activities such as ponds covering 0.03 ha, offices covering 0.44 ha, trade and services covering 3.89 ha, and industry/warehousing covering 1.35 ha. In the urban jungle area, non-conforming land uses include ponds covering

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0.49 Ha and settlements covering 1.47 Ha. In the city park, non-conformities include 0.06 Ha of ponds, 2.98 Ha of settlements, 0.18 Ha of public service facilities, 0.36 Ha of trade and services, and 0.03 Ha of industry/warehousing.

In sub-district parks, there are incompatible uses, such as 0.02 Ha of settlements and 0.08 Ha of trade and services. In the kelurahan park, there is a mismatch for settlements covering 0.65 Ha and industry/warehousing covering 0.01 Ha. In the cemetery area, non-conforming space utilization includes settlements covering 3.18 Ha, public service facilities covering 0.46 Ha, and trade and services covering 0.22 Ha.

On the road, there are non-conforming land uses, including parks covering 2.76 ha, shrubs covering 2.26 ha, ponds covering 0.12 ha, settlements covering 1.09 ha, public service facilities covering 0.38 ha, offices covering 0.17 ha, and defense and security covering 0.11 ha. Non- conformity is also found in the trade and service area with land use for parks covering 0.38 hectares, cemeteries covering 0.26 hectares, river border scrub covering 1.02 hectares, shrubs covering 6.01 hectares, road body covering 0.40 hectares, and offices covering 2.86 hectares. In the industrial allotment area, there is a land use that is not suitable, namely manrove covering an area of 4.33 Ha. This mismatch indicates a discrepancy between actual land use and planned designation, which can disrupt ecosystem balance and hinder the achievement of sustainable development in accordance with established spatial principles.

Conclusion

The designation of river areas is often misinterpreted by the community and becomes a national issue, including the community in Medan City in the Deli River border area. The conclusions obtained in this study based on the results of the identification and analysis carried out include:

- The 2024 analysis shows a significant mismatch between the existing space utilization and the RTRW plan, with a difference of 110.99 hectares or 13.22% of the total area. The largest mismatch occurs in cultivated areas (92.67 hectares or 16.53%), while in protected areas it reaches 18.32 hectares or 6.57%. These deviations can affect ecological and economic functions and hinder the achievement of sustainable development.
- The 2024 analysis shows significant discrepancies between the existing space utilization and the spatial plan in Medan City Regional Regulation No. 1 Year 2022. Many areas, including water bodies, protection areas, urban parks, and industrial areas, experience land use that is inconsistent with the plan, which may disrupt the balance of the ecosystem and hinder sustainable development. This highlights the need for more effective spatial adjustments.

Suggestions to future research on the non-conformity of spatial utilization at the Deli River border, it is recommended to analyze the causes of non-conformity, evaluate its impact, and conduct case studies in critical locations. Involving stakeholders, developing flexible planning models, and using the latest technologies such as GIS and satellite monitoring are also important. Specific policy recommendations need to be designed to address non-conformities and adjust regulations.

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