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Analysis of the Dynamics of Changes in the Coastline of Cirebon City in 2010-2025 Using Geographic Information System (GIS) Technology

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Abstract
Coastal areas are dynamic transition zones, experiencing continuous physical changes due to the interaction between natural processes and anthropogenic activities. As a coastal area on the north coast of Java, Cirebon City faces serious challenges related to shoreline dynamics influenced by sedimentation, abrasion, infrastructure development, and land use changes. This study aims to analyze the dynamics of shoreline change in Cirebon City during the period 2010–2025 using Geographic Information System (GIS) technology and remote sensing. This study applied a mixed-method approach that integrates spatial quantitative analysis and qualitative descriptive analysis. Multitemporal satellite imagery from Landsat 7 (2010 and 2015) and Sentinel-2 (2020 and 2025) was processed using the Normalized Difference Water Index (NDWI) algorithm to extract shoreline positions. Furthermore, the Digital Shoreline Analysis System (DSAS) method with End Point Rate (EPR) calculations was applied to determine the rate and spatial distribution of abrasion and accretion. The results of the study indicate that the Cirebon City coastline experienced significant spatial changes during the 15 years of observation, with accretion processes dominating most coastal segments. The average rate of shoreline change reached 5.66 meters/year, with the highest accretion rate of 40.95 meters/year and maximum abrasion of -4.63 meters/year. The most prominent changes occurred in Lemahwungkuk District, primarily due to sedimentation processes and anthropogenic activities such as coastal reclamation and port development. These findings confirm that the integration of GIS, remote sensing, and field observations provides an effective approach to monitoring shoreline dynamics and supporting sustainable coastal management planning in urban areas.

INTRODUCTION

Coastal areas are highly dynamic because they serve as the meeting point between terrestrial and marine ecosystems. As a transition zone, this region possesses high natural resource potential, but at the same time, it harbors significant physical vulnerability to natural changes and human activities. Globally, approximately 70% of the world's major cities are located in coastal areas, making them centers of economic growth and vulnerable to the impacts of climate change, such as sea level rise and coastal flooding. Cirebon City, located on the north coast of Java (Pantura), is a center of economic growth and a key transportation hub, highly dependent on its coastal space. Port activities, fishing settlements, and industrial areas along the coastline make spatial management in this area highly complex (Hapsari & Haryati, 2024; Islam et al., 2022; Nugraini et al., 2023; Parman, 2010).

The dynamics of Cirebon City's coastline are inextricably linked to the phenomena of abrasion (erosion) and accretion (land addition) (Abdurrahman et al., 2021; Triana et al., 2023). Both of these phenomena cause significant long-term changes to the coastline. Previous research has shown that shoreline changes in the north coast of Java, including Cirebon, are driven by hydro-oceanographic factors such as currents and waves, as well as anthropogenic activities around the coast. The physical impact of abrasion not only damages the landscape but also threatens public infrastructure and residential areas located directly along the coast (Aravantinos et al., 2024; Boateng et al., 2024). Furthermore, massive accretion processes also alter coastal landscapes, as seen in Lemahwungkuk District due to sedimentation and reclamation (Pattynama et al., 2025; Prameswari et al., 2014).

More broadly, these shoreline changes have a systemic impact on the social and economic conditions of communities (Prahmani et al., 2022; Witari et al., 2021). The loss of productive land such as fish ponds and the destruction of tourism-supporting facilities result in decreased income and economic vulnerability for residents who depend on coastal resources for their livelihoods (Ismiyanti & Buchori, 2021; Rayhani & Zalmita, 2023). From a Regional and Urban Planning perspective, dynamic changes in the physical profile of the shoreline can trigger coastal environmental degradation and threaten the existence of surrounding functional land. A study in the Rebana Metropolitan area, which includes Cirebon, showed that shoreline changes have a significant impact on land use, particularly fish ponds, which are most affected by abrasion and accretion.

Regular monitoring of shoreline changes is an urgent need to ensure the sustainability of urban spaces (Dewi, 2019). The use of remote sensing technology with the Normalized Difference Water Index (NDWI) algorithm offers an efficient and accurate solution for mapping land and water boundaries. Research by Triana et al. (2023) and Abdurrahman et al. (2021) have utilized this technology to analyze coastal dynamics in Cirebon, but these studies were limited to a specific time period and did not integrate a comprehensive analysis of causal factors. By analyzing multitemporal data from 2010 to 2025 using Landsat 7 and Sentinel-2 imagery, this study is expected to provide a more comprehensive picture of the rates of abrasion and accretion in Cirebon City.

The research gap lies in the suboptimal use of multitemporal data over the past 15 years to accurately monitor coastline change in Cirebon City, as well as the minimal integration of quantitative spatial analysis with field verification to identify the factors causing change. The resulting information is crucial as an accurate spatial information instrument for mapping critical area zones along the Cirebon City coast. The novelty of this research lies in the integration of the NDWI and DSAS methods for the period 2010-2025, complemented by field validation and a holistic analysis of the causal factors of shoreline change.

Based on the background outlined above, the coastal area of Cirebon City faces serious challenges in the form of highly dynamic shoreline changes. Although remote sensing technology has developed, the use of multitemporal data to accurately monitor these changes in Cirebon City still needs to be optimized to support coastal area management. Therefore, the research problem formulation in this study is how the dynamics of the rate of shoreline change (abrasion and accretion) occurring in the Cirebon City coastline over a 15-year period (2010–2025) using NDWI water index extraction, and what factors cause it, are determined.

The objectives and targets of this research are formulated to provide clear operational direction and boundaries in the analysis process. The primary objective of this research is to analyze the dynamics of shoreline change in Cirebon City during the period 2010–2025 using remote sensing technology and to examine the factors and impacts. This research is expected to contribute by providing a shoreline dynamics map as a spatial information instrument for spatial planning.

METHOD

Approaches and Types of Research

The research on the dynamics of coastline change in Cirebon City used a *mixed approach*, which integrated a spatial quantitative approach with a qualitative descriptive approach. The selection of this approach is based on the characteristics of the data and the research objectives that focus not only on numerical results, but also on the interpretation of spatial planning policies.

Spatial Quantitative Analysis

This approach is used in the early stages to process primary data in the form of multi-temporal satellite imagery (Landsat and Sentinel-2). Through a quantitative approach, pixel extraction was carried out using *the Normalized Difference Water Index* (NDWI) algorithm and statistical calculation of the area and rate of shoreline shift (abrasion and accretion) using *the Digital Shoreline Analysis System* (DSAS). The results of this approach are measurable, and produce *outputs* in the form of maps of coastline changes and rate of change.

Qualitative Descriptive Analysis

This approach is used to identify, confirm, and describe the triggering factors for coastal dynamics and their impact on the coastal physical environment based on field observation results and related secondary data.

Through the integration of these two approaches, this research is expected to produce outputs that are not only technically accurate in mapping, but can also be applied as recommendations for coastal planning in Cirebon City.

Data Needs and Sources

In research that focuses on spatial analysis and spatial planning, a series of accurate and relevant data is needed. Based on the nature and source, the data used in this study is classified into two, namely primary spatial data (primary data) and supporting institutional data (secondary data).

Spatial Data

The main spatial data is the raw spatial data that will be processed to produce the coastline boundaries. These data needs include:

1. Landsat 7 Satellite Imagery

This image was used to record the coastal conditions of Cirebon City in the period of 2010 and 2015. This data is downloaded through the *official United States Geological Survey* (USGS) Earth Explorer portal.

2. Sentinel-2 Satellite Imagery: Used to record coastal conditions in the period of 2020 and 2025. The selection of Sentinel-2 was based on its higher spatial resolution (10 meters) making it ideal for delineation of water and land boundaries. This data is sourced from the Copernicus Open Access portal.
3. Cirebon City Administrative Boundary Map: In the form of vector data (*shapefile*) that contains the boundaries of the area up to the sub-district level and the basic coastline as a reference. This data was obtained from the Geospatial Information Agency (BIG) portal.

Primary and Secondary Data

Primary and secondary data are needed as a reference in conducting evaluation analysis. This data includes:

1. Field Survey Observation Data

Primary data is in the form of current conditions in identifying *real conditions* at the location point in detail.

2. Previous Literature Review

Secondary data and previous studies provide a foundation for analyzing the natural and anthropogenic factors that cause coastal dynamics.

3. Spatial Observation Data

Satellite imagery and spatial data are used to identify infrastructure or human activity at coastal boundaries.

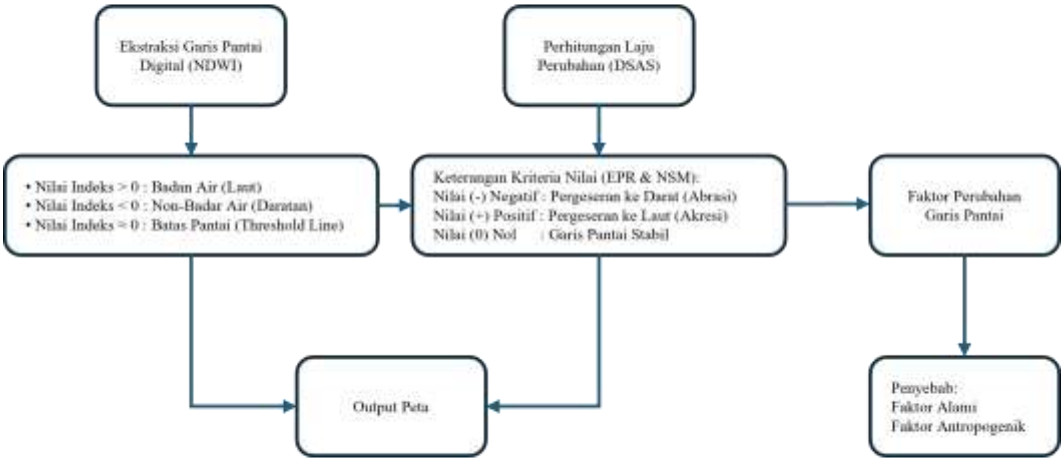

Figure 1. NDWI and DSAS Analysis Workflow Framework
Source: Author's Data Processing, 2026

Table 1. Research Matrix

Research Objectives	Research Objectives	Variables & Indicators	Data Types & Sources	Analysis Method
Analysis of the dynamics of coastline changes in Cirebon City during the period 2010–2025 using remote sensing technology and looking at factors and impacts	Temporally identify the coastline on the coast of Cirebon City in 2010, 2015, 2020, and 2025 through water index extraction using the *Normalized Difference Water Index* (NDWI) algorithm on Landsat and Sentinel-2 satellite imagery.	Variable: Waterline position Indicators: Pixel spectral values > 0 (Water) and ≤ 0 (Ground),	Secondary (Spatial) Data: - Landsat 7 satellite imagery (2010, 2015) - Sentinel-2 satellite imagery (2020, 2025)	Spatial Quantitative (*NDWI Index* Extraction)
	Quantitatively calculated the rate of shoreline change (abrasion and accretion) using *the Digital Shoreline Analysis System* (DSAS) method to determine the spatial	Variable: Rate of coastal shift. Indicators: Distance (m) and Speed (m/year) through NSM and EPR parameters.	Primary Data (Spatial): Temporal coastline vector (Target Output)	Spatial Quantitative (*DSAS Statistics Module)*

distribution of the most critical areas..			
Analyze the main factors and causes of coastal changes both from the natural side and human activities (anthropogenic) on the coast of Cirebon City.	Variables: Coastal physical factors, Triggers of shoreline changes. Indicators: Current conditions, waves, local bathymetry, infrastructure development activities and coastal natural phenomena.	Primary & Secondary Data: Literature study of other cities and results of direct field observation.	Qualitative Descriptive (Literature Comparison)
Compiling the output of a map of the dynamics of changes in the coastline of Cirebon City for the period 2010-2025 as a spatial information instrument.	Variables: Cartographic visualization. Indicators: Completeness of thematic maps and symbology of abrasion/accretion rates.	Synthesis Data: Results of spatial analysis of goal 1 and goal 2.	Spatial Visualization (*Geographic* Information System Layouting)

Source: Author's Methodological Synthesis, 2026

RESULTS AND DISCUSSION

Shoreline Extraction Analysis Using NDWI Algorithm

The application of the Normalized Difference Water Index (NDWI) algorithm on multi-temporal satellite images has been proven to provide firm object segmentation results between the seawater and land water compartments along the coast of Cirebon City. Through the use of green band and near-infrared (NIR Band) channels from the Landsat 7 (2010 and 2015 period) and Sentinel-2 (2020 and 2025 period) satellites, the spectral reflectance value of water was optimally isolated. The binary classification process uses thresholding values of < 0 for land and > 0 for waters to produce a precise and consistent waterline in each observation year. The results of the spatial extraction of multi-temporal coastlines over the past 15 years are presented in Figure 4.1.

Figure 2. Cirebon City Coastline Extract Line Map

Source: Ina Geoportal, Cirebon City RDTR (2021), & Author's Analysis (2026)

Based on the visualization in Figure 4.1, the fluctuation in the position of the coastline of Cirebon City from year to year shows a dynamic and non-uniform spatial shift in each beach segment. Cartographically, this dynamic is indicated by the arrangement of chronological lines represented by the linjes per year. In some areas, the lines are stacked tightly on each other, indicating relatively stable or constant coastal conditions. However, in most coastal segments, there is *a* fairly wide horizontal gap between the observation year lines.

The difference in horizontal distance between the colors of the line represents the magnitude of the change in the physical position of the coastline that occurs in the field (Islam et al., 2022; Nugraini et al., 2023; Pattynama et al., 2025). In the coastal area of Kejaksan District, the pattern of line shifting tends to show fluctuating movements due to the influence of daily wave dynamics and the existence of artificial beach protection buildings. Meanwhile, the most striking pattern of shift was seen on the coast of Lemahwungkuk District, where the 2025 line is far jutting out to sea leaving the 2010 line. This spatial gap phenomenon is a strong early indication that the coast of Cirebon City is undergoing a massive physical change process, with a tendency to add significant land (accretion) at several critical points.

Although the NDWI map in Figure 4.1 has succeeded in providing a spatial picture of the direction of the coastline shift temporally, this method has not been able to present numerical rate of change. Therefore, the interweaving of the water boundary line from NDWI extraction is used as the main input data (baseline and shoreline) to calculate the rate of change quantitatively annually in the next sub-chapter using *the Digital Shoreline Analysis System (DSAS) device*

Analysis of the Rate of Coastline Change Based on DSAS Calculations

Quantitative analysis of the coastal dynamics of Cirebon City for the period 2010 to 2025 was carried out to determine the magnitude and spatial distribution of the rate of coastal line change. The calculation of abrasion and accretion levels on an annual basis is based on the *statistical method of End Point Rate* (EPR) extracted using *the Digital Shoreline Analysis System* (DSAS). By applying a distance density between transects of 30 meters, this analysis was able to map in detail the variations in physical changes of the coastline along the study area. Recapitulation of the results of statistical calculation of the rate of coastal change for the entire coastal area of Cirebon City.

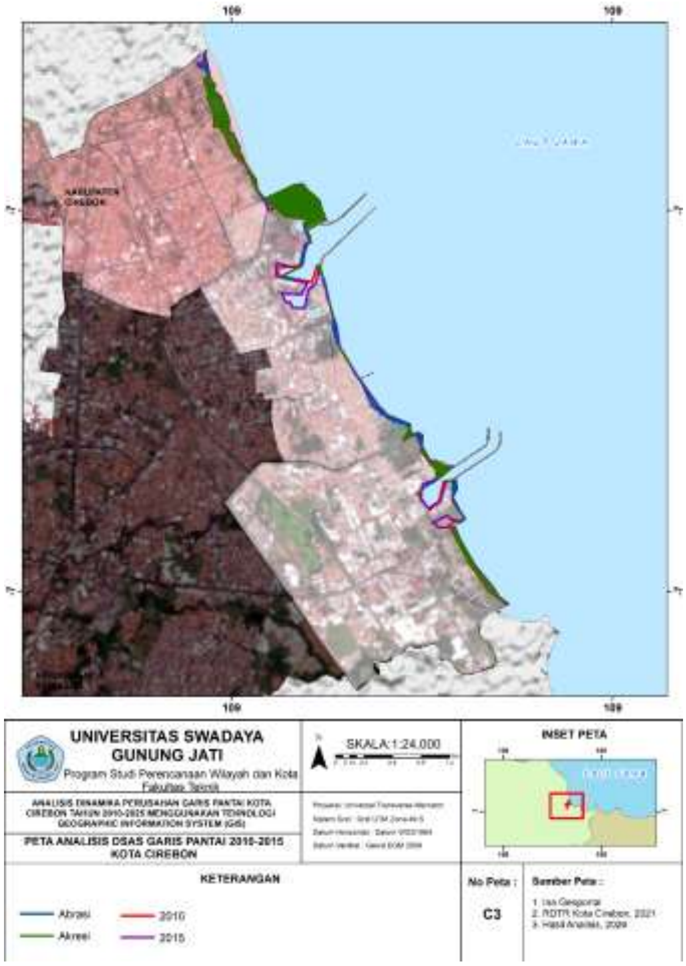

Figure 3. DSAS Analysis in 2010-2015

Source: Ina Geoportal, Cirebon City RDTR (2021), & Author's Analysis (2026)

Table 2. Coastline Rate Table 2010-2015

Total Number of *Transects*	Maximum Abrasion Rate (m/year)	Maximum Accretion Rate (m/year)	Average Change (m/year)
308	-14,42	85.31	7,55798

Source: *DSAS Analysis Output (DSAS Statistics Module), 2026*

Based on the results of the statistical calculation of the End Point Rate (EPR) in the first five-year period (2010–2015), the coastal area of Cirebon City shows a very high dynamic intensity with a tendency to dominate the accretion process. In this period, the average value of coastline change recorded the highest number compared to the periods after that, which was advancing as far as 7.56 meters/year towards the sea.

Although dominated by land addition, the phenomenon of coastal erosion still occurs with a maximum abrasion rate of -14.42 meters/year. On the other hand, the sedimentation process or the addition of land moves very massively, where the maximum accretion rate in this period is able to soar up to reach 85.31 meters/year. The high average rate of change (7.56 meters/year) indicates that in the 2010–2015 range sedimentation on several coasts of Cirebon City was in abundant conditions.

DSAS Analysis in 2015-2020

Figure 4. Map of DSAS Results of Cirebon City 2010-2015

Source: *Ina Geoportal, Cirebon City RDTR (2021), & Author's Analysis (2026)*

Table 3. Coastline Rate Table 2015-2020

Total Number of *Transects*	Maximum Abrasion Rate (m/year)	Maximum Accretion Rate (m/year)	Average Change (m/year)
379	-23,88	30,8	5,28545

Source: *DSAS Analysis Output (DSAS Statistics Module), 2026*

Entering the second five-year period (2015–2020), the characteristics of the coastal dynamics of Cirebon City have undergone a significant pattern shift. The level of physical threat in the form of land erosion experienced a sharp escalation, where the maximum abrasion rate reached the highest point during 15 years of observation, which was -23.88 meters/year. This figure shows that there are new critical areas that experienced very aggressive shoreline retreat during that period.

In line with the increasing rate of abrasion, the process of adding land decreases in intensity. The maximum accretion rate in this period decreased to 30.8 meters/year. As a result of this combination of increasing abrasion and slowing sedimentation, the average value of aggregate shoreline changes on the coast of Cirebon City shrank to 5.26 meters/year. Although the average value remains positive (indicating that land is still increasing in general), this decrease represents the presence of hydro-oceanographic pressures or human activities that are accelerating erosion in some coastal segments.

DSAS Analysis for 2020-2025

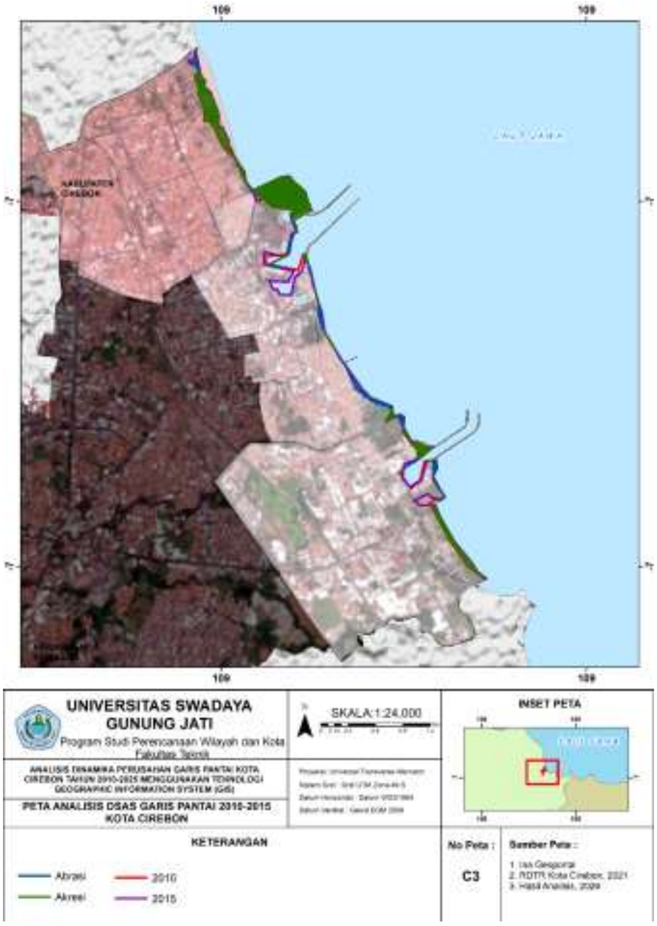

Figure 5. Map of DSAS Results of Cirebon City 2010-2015

Source: *Ina Geoportal, Cirebon City RDTR (2021), & Author's Analysis (2026)*

Table 4. Coastline Rate Table 2020-2025

Total Number of ***Transects***	Maximum Abrasion Rate (m/year)	Maximum Accretion Rate (m/year)	Average Change (m/year)
310	-17.46	41,26	2,922871

Source: *DSAS Analysis Output (DSAS Statistics Module), 2026*

In the last five-year period (2020–2025), the dynamics of coastline change in Cirebon City tend to show a more stable pattern or experience a decrease in spatial change energy with an average coastline change of 2.92 m/year and an accretion rate of 41.26 m/year. The rate of shoreline decline was significantly reduced, where the maximum abrasion rate was recorded at the lowest figure of the entire period, which was only -17.46 meters/year.

DSAS Analysis for 2010-2025

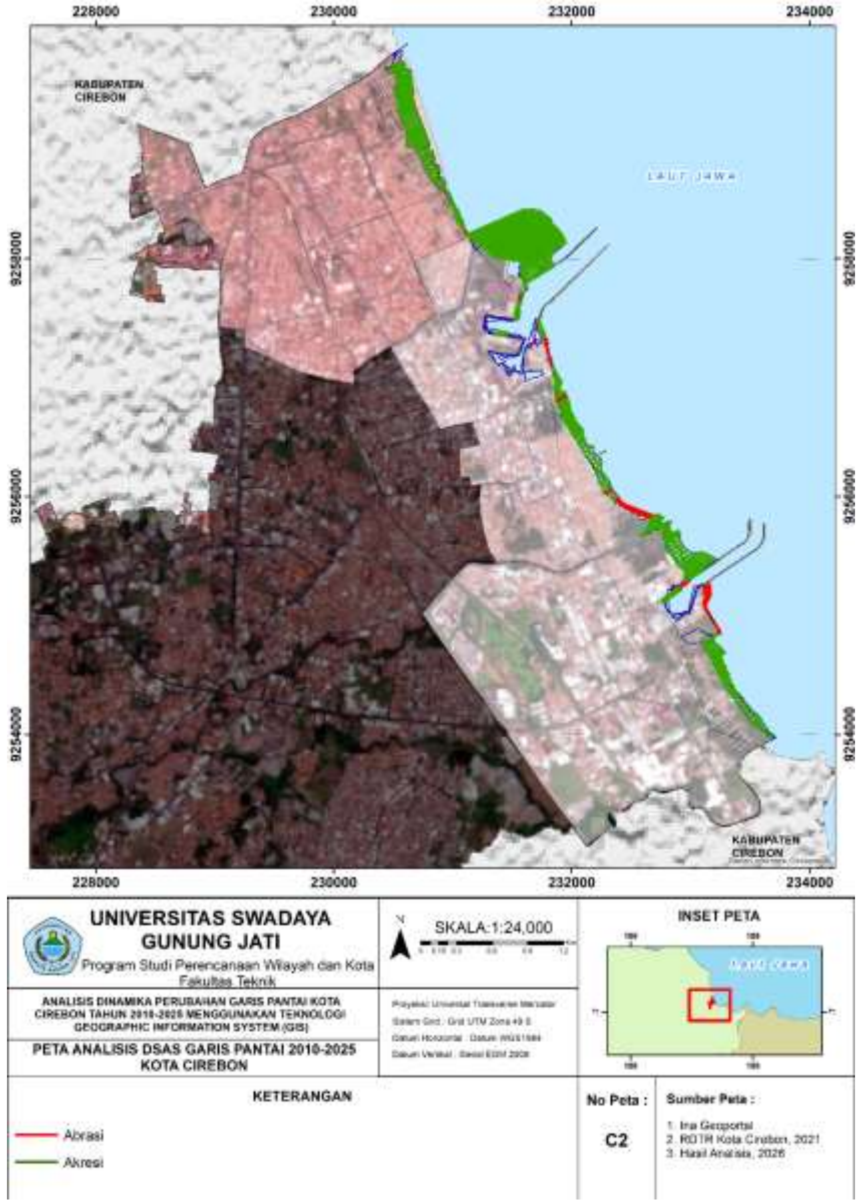

Figure 6. Cirebon City DSAS Analysis Map

Source: *Ina Geoportal, Cirebon City RDTR (2021), & Author's Analysis (2026)*

Based on the DSAS analysis carried out, it was found that the majority of the coastline of Cirebon City was affected by land accretion from 2010 to 2025. On the dark blue line, you can see a very significant accretion phenomenon, especially in the Lemahwungkuk District Area, which is famous for its beaches that have sprung up and sedimentation almost forming a small island in the middle of coastal waters.

Table 5. Cirebon City Coastline Change Rate 2010-2025 Recapitulation Table

Total Number of *Transects*	**Maximum Abrasion Rate (m/year)**	**Maximum Accretion Rate (m/year)**	**Average Change (m/year)**
303	-4,63	40,95	5.66

Source: *DSAS Analysis Output (EPR Analysis), 2026*

Based on the quantitative data in Table 4.1, it can be seen that the coastal area of Cirebon City analyzed using EPR analysis has 303 transect trajectories that show the level of active coastal dynamics. The most extreme rate of shoreline decline (abrasion) in Cirebon City reached -4.63 m/year, while the highest rate of land addition (accretion) reached 40.95 m/year. In aggregate, the average change in the coastline in Cirebon City is at 5.66 m/year. This positive mean number represents the accumulation of effects (*net effect*) where the process of sedimentation or land addition in general is more dominant than the erosion process in the coastal belt over the last 15 years.

Analysis of the Main Factors and Causes of Changes in the Coastline of Cirebon City

Analysis Analysis of changes in the coastline in the coastal area of Cirebon City was carried out through the integration of temporal literature study and field validation (ground check). The existing observations are focused on 4 (four) main areas represented by 2 sub-districts in Cirebon City from Lemahwungkuk and Kejaksan Districts, namely the Kesenden Area, the Kebonbaru Area, the Cangkol Area, the Kalijaga River Estuary Area, and Kejawanan Beach.

The dynamics of coastline change in the five regions are generally influenced by the complex interaction between natural factors and anthropogenic activity. Natural factors (hydro-oceanography) include the influence of seasonal wave blowing, tidal fluctuations of seawater (tidal flooding), unstable mud substrate characteristics, and strong sediment supply from river mouths that trigger the accretion process. Meanwhile, anthropogenic factors are characterized by the intensity of human activities, such as the conversion of coastal land into densely populated areas for fishermen, conversion of mangrove forests, construction of artificial coastal protection infrastructure (seawall) and land reclamation projects (reclamation). These two main factors affect each other's physical conditions in each specific location, which will be elaborated in more depth in the following sub-analysis:

Hydro-Oceanography and Vegetation Analysis (Natural Factors)

Changes in the coastline in Cirebon City do not only occur due to human activity factors. Natural factors from oceanographic dynamics also greatly affect accretion and abrasion activities on the coast of Cirebon City. These natural factors are triggered by local hydro-oceanographic characteristics, such as the characteristics of sloping muddy beaches, the strong supply of suspension sediments from river mouths, tidal fluctuations of seawater (tidal floods), and seasonal wave current and blow patterns that continue to erode the land's edge.

Based on the form of physical and environmental observation, the natural conditions in each location are described as follows:

Kebonbaru Area

Figure 7. Beach Conditions in the Kebonbaru Area

Source: *Field Survey and Ground Check Documentation, 2026*

Based on the results of environmental physical observation (fisling), the Kebonbaru Coastal Area has the characteristics of a muddy beach that is sloping. Local hydro-oceanographic factors in the region are dominated by severe accretion and sedimentation processes.

When sea water conditions experience tides, a thick mud expanse of high color will rise to the shallow sea level.

The existence of natural mangrove vegetation in this area is limited. Hydrodynamically, the reduction of the surrounding natural green belt zones decreases the effectiveness of the environment in mechanically damping the energy of large waves at high tide.

Kesenden Area

Figure 8. Condition of Kesenden Beach

Source: *Field Survey and Ground Check Documentation, 2026*

Based on the results of a thorough physical observation of the environment, the Kesenden Coastal area has a type of beach typology that is muddy and sloping with a dense mangrove forest system.

Gang Cangkol Area

Figure 9. Condition of the Cangkol Area Beach

Source: *Field Survey and Ground Check Documentation, 2026*

The Gang Cangkol area has abrasion points that look severe with the condition of mangrove forests that have been damaged. This beach is classified as a type of muddy beach.

Figure 10. Kalijaga Beach Area

Source: *Field Survey and Ground Check Documentation, 2026*

On Kalijaga Beach, the beach condition shows a type of beach that is muddy and has mangrove forests as an antidote to natural abrasion with forest conditions that are not too tight.

Anthropogenic Factor Analysis of Shoreline Change (Human Factors)

Changes in the coastline in Cirebon City are significantly influenced by anthropogenic factors in the form of human activity intervention and development in coastal areas. One of the most obvious forms of intervention is the existence of large-scale infrastructure such as Cirebon Port. The physical structure of coastal buildings, such as *breakwaters*, piers, and port shipping channel engineering, indirectly interact with natural hydro-oceanographic processes. These man-made buildings act as a barrier or barrier.

The locations that make the human activity factor cause the shifting of the coastline:

Port Area of PT Gamatra Trans Ocean Shipyard

An example of the cause of anthropogenic factors is the formation of new land that appears on the coast of Cirebon City is on the border of Kejaksan District with Lemahwungguk District, specifically an artificial port owned by PT Gamatara Trans Ocean Shipyard which is built on reclaimed land.

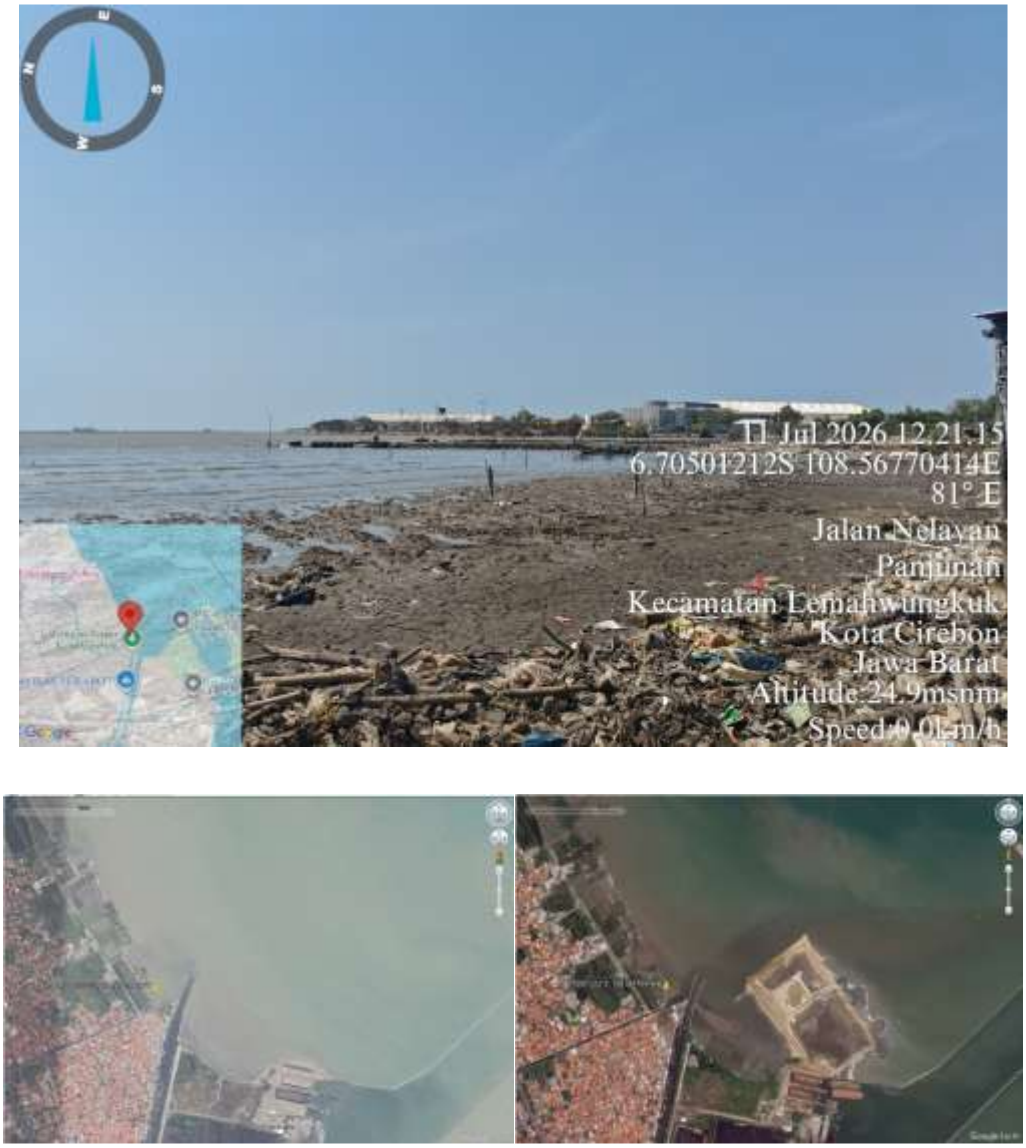

Figure 11. Sighting of the Port Over the New Land from a Distance

Source: *Field Documentation & Google Earth Satellite Historical Imagery (Maxar Technologies), 2026*

Artificial Land when viewed from *History* Satellite imagery in 2011, there was no massive activity in the construction of the port at that time. Based on the history of satellite imagery in 2015, it began to be seen that the reclamation of the port began to see soil sediments that began to appear in the area, this is the location point where the extreme accretion rate in the coastline analysis in the period of 2010-2015 is located.

Gang Cangkol Settlement

Figure 12.Physical Condition of the Coastline of Gang Cangkol, Lemahwungkuk District

Source: *Field Survey and Ground Check Documentation, 2026*

The findings of subsequent observation surveys in the Cangkol area, Lemahwungkuk District show that there is a coastline that is directly adjacent to the Residents' Settlement without the presence of Mangrove plant vegetation that protects the land. This condition is exacerbated by the large amount of garbage scattered around the edge of the border of the settlement with the beach and the sedimentation of the rising tide covering the drainage base in the Cangkol settlement itself.

Figure 13. Satellite Imagery of the Cangkol Area

Source: *Google Earth Satellite Imagery (Airbus), 2025/2026*

Based on the appearance of satellite images, dense settlements in the Cangkol area are directly adjacent to the coastline without water wave protection such as breakwater or seawalls. This condition reflects the high intensity of anthropogenic activity in the form of dense settlements that are

The pattern of settlement development that is too overhanging and tight to touch the seawater boundary causes the land to lose buffer zones. As a result, without the protection of natural vegetation and artificial barriers such as embankments, the dense residential area in Cangkol is in a very high risk zone of vulnerability to the threat of active abrasion and daily inundation of floods due to the phenomenon of sea tides.

Kebonbaru Area Beach

Figure 14. Anthropogenic Activity Track Conditions in the Kebonbaru Area

Source: *Field Survey and Ground Check Documentation, 2026*

The Kebonbaru area reflects the activities of local residents with the construction of a semi-permanent goat cage in front of the embankment *Seawall* which was triggered by the existence of Goat Farmers, and also fish ponds.

Kalijaga Beach Area

Figure 15. Buildings on the edge of Kalijaga Beach

Source: *Field Survey and Ground Check Documentation, 2026*

In this area, the Kalijaga Beach area is a recreational commercial area where there are buildings such as stalls and semi-permanent. The existence *of Seawalls* around Kalijaga Beach is almost non-existent because this beach is next to the mouth of the river bordering Mundu District, Cirebon Regency.

CONCLUSION

This study successfully analyzed the dynamics of shoreline change in the coastal area of Cirebon City over the past 15 years (2010–2025). This study integrates remote sensing technology (NDWI and DSAS) and field observations to analyze the factors causing change throughout the coastal area. In general, it can be concluded that Cirebon City's coastline is experiencing highly dynamic spatial changes, dominated by accretion (land addition) with a cumulative average of 5.66 m/year. Lemahwungkuk District is the area with the most striking changes. This physical dynamic is driven by the interaction between natural hydro-oceanographic factors, such as muddy shorelines and sedimentation, and anthropogenic interventions such as reclamation activities at the PT Gamatara Trans Ocean Shipyard Port and other coastal infrastructure development. These changes in coastal profiles have resulted in the threat of active abrasion in densely populated fishing settlements that have lost mangroves and green belts, such as in Gang Cangkol, increasing the risk of daily tidal flooding. In more detail, the results of observations and modeling in the analysis of NDWI, DSAS, and factors causing changes in the coastline of Cirebon City for the period 2010-2025 show that: (1) coastline extraction using NDWI successfully maps spatial changes in the coastline temporally; (2) the highest rate of change occurred in the period 2010-2015 with an average of 7.56 m/year; (3) maximum abrasion occurred in the period 2015-2020 (-23.88 m/year); (4) the highest accretion occurred in Lemahwungkuk District due to port reclamation; and (5) anthropogenic factors such as infrastructure development and land conversion are the main drivers of coastline changes in addition to natural factors. Suggestions for further research are to conduct a projection analysis of coastline changes for the next 10-20 years using predictive methods such as Linear Regression Rate (LRR) in DSAS, as well as integrating a deeper analysis of the impact of coastline changes on the socio-economic aspects of coastal communities. In addition, further research needs to consider ecosystem-based mitigation scenario analysis, such as mangrove rehabilitation and green infrastructure development, to support sustainable coastal management in Cirebon City.

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