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COASTAL ENVIRONMENTAL DYNAMICS IN PURWOREJO REGENCY, CENTRAL JAVA, INDONESIA

M.N. Airawati@ [1], Djati Mardiatno[2], Nurul Khakhim[2]

ABSTRACT: The coastal environment can change naturally or be influenced by human economic activities. Purworejo Regency, in Central Java, is a developing area being the vaname shrimp main activity of the coastal community's economy. Various anthropogenic factors and high sea waves in coastal areas make this area vulnerable to changes in shoreline and land cover. In this study, the shoreline was extracted from SPOT time series spatial data (2007, 2011, 2017, and 2020) using the on-screen digitization method, while land cover changes were analyzed using the overlay method. The most significant sedimentation increase occurred from 2011 to 2017 with an additional area of 29.67 ha, while the smallest sedimentation occurred from 2017 to 2020 with an additional area of 9.09 ha. The worst erosion was detected from 2017 to 2020, which caused the loss of an area of 17.52 ha. The type of land cover that is developing rapidly in Purworejo Regency is shrimp ponds, which have been widely developed since 2014. Cross-profile analysis concluded that there was no link between changes in shoreline and changes in land cover.

Keywords: shoreline, land cover, dynamic, shrimp pond, Purworejo.

RESUMO: *O ambiente costeiro pode sofrer alterações de forma natural ou ser influenciado por atividades económicas de origem antropogénica. A região de Purworejo, localizada em Java Central, encontra-se em processo de desenvolvimento, sendo a aquicultura de camarão vannamei (Litopenaeus vannamei) o principal vetor económico das comunidades costeiras. A ação combinada de diversos fatores antropogénicos, associada à forte agitação marítima nas zonas costeiras, confere a esta região uma elevada vulnerabilidade a alterações na linha de costa e na cobertura do solo. Neste estudo, a linha de costa foi extraída a partir de dados espaciais de séries temporais do satélite SPOT (2007, 2011, 2017 e 2020), por meio do método de digitalização em ecrã. As alterações na cobertura do solo foram analisadas utilizando o método de sobreposição de dados geoespaciais. O incremento mais expressivo de sedimentação foi registado entre 2011 e 2017, com um acréscimo de 29,67 hectares, enquanto o menor aumento ocorreu entre 2017 e 2020, com 9.09 ha adicionais. A erosão mais significativa foi observada no período de 2017 a 2020, resultando na perda de uma área de 17.52 ha. A forma de ocupação do solo que mais se tem expandido na região de Purworejo corresponde aos viveiros de camarão, amplamente desenvolvidos desde 2014. A análise de perfis transversais permitiu concluir que não existe uma correlação significativa entre as alterações na linha de costa e as modificações na cobertura do solo.*

Palavras-chave: costa, cobertura do solo, dinâmica, viveiro de camarão, Purworejo.

@ Corresponding author: mari016@brin.go.id

1 National Research and Innovation Agency - Indonesia.

2 Faculty of Geography, Gadjah Mada University.

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1. INTRODUCTION

Purworejo is a regency in Central Java Province, Indonesia (Figure 1). The shoreline in the coastal area of Purworejo Regency extends for 21 km and is used by the community for various activities such as fishing, tourism, settlements, ports, and industry. The dynamics of the use of the coastal zone as a transitional area cannot be separated from the interrelationship between the functions of land and sea. This connection causes very complex problems and can increase vulnerability in coastal areas (Zhao *et al*., 2021). Historically, this coastal area has experienced land dynamics, including areas designated for mining and shrimp farming, starting in 1987 and continuing to this day (Pelly *et al*., 2018). Research finding by Damayanti *et al*., (2019) show that settlements in the coastal areas of Purworejo Regency experienced development covering an area of 460 ha from 2002 to 2017. Land use patterns in coastal areas can influence the natural balance in this area or other related areas. For example, mangrove forests converted into ponds or residential areas can cause erosion due to reduced shoreline protection (Polidoro *et al*., 2010).

The susceptibility of coastal areas to abrasion or sedimentation is influenced by shoreline dynamics. Research on the rate of change in shorelines helps provide information on coastal areas planning and management process. Factors influencing shoreline changes include sediment movement, wind, tides, longshore currents, waves and land use. These factors cause shorelines to experience reduction (erosion) or accretion (sedimentation) (Cahyono *et al*., 2017; Raimundo Lopes *et al*., 2022; Yum *et al*., 2023).

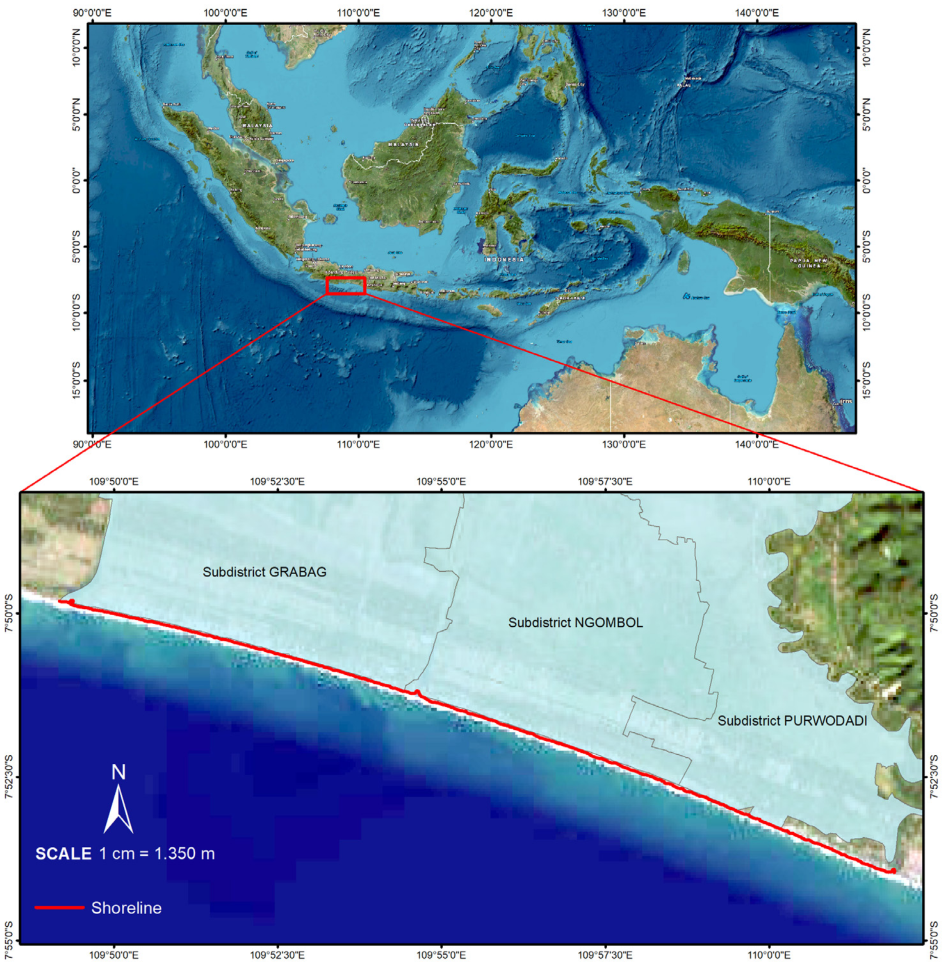


Figure 1. Location of Purworejo Regency.

Changes in shoreline can affect land cover, and conversely, land cover can affect the dynamics of the shoreline. Land cover reflects human activities in a specific area. In Purworejo Regency, human activities, particularly shrimp farming, are extensive. To understand the relationship between erosion or sedimentation susceptibility and land cover in this region, a spatio-temporal analysis is required. The results of this analysis can help to determine shoreline dynamics, which are indicators of erosion or sedimentation susceptibility.

The objective of this study was to evaluate the impact of shoreline dynamics susceptibility on land cover and shoreline changes in Purworejo Regency from 2007 to 2020. The findings of this research can inform decisions regarding coastal protection infrastructure and detailed coastal spatial planning (Taveira-Pint *et al*., 2022). The combination of remote sensing technology and Geographic Information Systems (GIS) has been widely applied to obtain quantitative and qualitative information regarding changes in coastal morphology in a region (De Freitas *et al*., 2019). This research investigates the relationship between changes in land cover, in particular shrimp farming, and changes in shoreline, a relationship that has not been fully explored.

2. METHODOLOGY

The methods used include image correction, shoreline digitization, land cover analysis and analysis of the relationship between shoreline dynamics and land cover. The research flowchart is shown in Figure 2. The spatial data used in this study uses SPOT imagery from 2007, 2011, 2017 and 2020 which were selected in the same time period (Mullick *et al*., 2020). The sharpening and geometry correction process uses PCI Geomatic software. Georeferencing all images used the Universal Transverse Mercator (UTM) 49 S zone projection and the WGS 1984 datum (Aldogom *et al*., 2020; Murali *et al*., 2015). Geometry correction of the SPOT satellite image used the orthorectification to reduce the influence of distortion. Geometry correction used the Ground Control Points (GCP) obtained from Indonesian topographic maps and Indonesian Digital Elevation Model (DEM) data from the Geospatial Information Agency (Loebis, 2015). This correction ensures that all images used in this study have the same spatial and temporal resolution.

2.1 Shoreline Digitization

Shoreline digitization uses a combination of red (R), green (G), and blue (B) color bands. On-screen digitization of the shoreline visually corresponds to the appearance of the dry and wet line boundaries seen in the image per year. The digitized and corrected shorelines were then analyzed to determine the rate of change using the DSAS plugin contained in ArcGIS software. The statistical methods used to calculate the rate of shoreline change are Net Shoreline Movement (NSM) and End Point Rate (EPR). The application of the DSAS methodology allows the resulting dataset to be easily compared with previously collected datasets (Rebêlo & Nave, 2022). The baseline for this research was created using a 2007 shoreline buffer of 75 m. Approximately 1335 transects were placed at 20 m intervals along the studied shorelines. The results of the shoreline digitization were then compared with the results of the field survey.

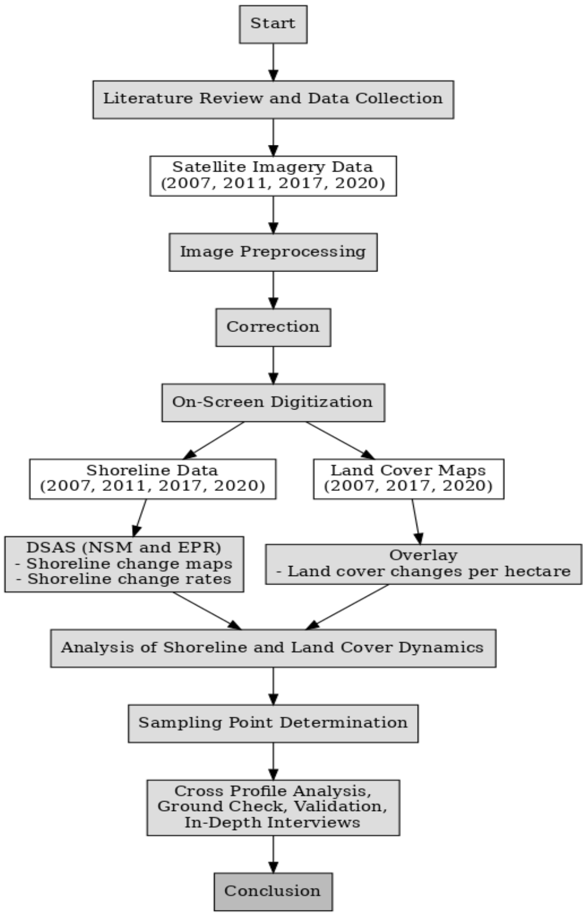


Figure 2. Flow chart of the research.

2.2 Land Cover Analysis

Classification of land types used in the analysis of land cover dynamics is based on the types of land contained in the land use map from the Department of Public Works and Spatial Planning of Purworejo Regency in 2016. The resulting land cover map was then analyzed to determine the extent of change in each land cover class. Data analysis was carried out using the overlay technique. The overlay method is used to obtain changes in the land cover area from year to year. The overlay technique is carried out with ArcGIS so that changes around each land cover can be known.

2.3 Analysis of the Relationship between Shoreline Dynamics and Land Cover

The relationship between shoreline dynamics and land cover in the coastal area of Purworejo Regency was analyzed using the modified cross-profile (Marfai *et al*., 2011; Pratama *et al*., 2021). Cross-profile samples were determined from the coast in each sub-district that experienced the highest levels erosion, sedimentation, and land cover dynamics.

3. RESULTS AND DISCUSSION

3.1 Analysis of Shoreline Dynamics

The shoreline used for calculating the rate of change in this study is the shoreline recorded by SPOT satellite imagery on April 8, 2007, March 1, 2011, May 18, 2017, and June 27, 2020. The shoreline changes in this study were measured and analyzed using the DSAS application with the NSM and EPR methods. The number of transects produced for this study was 1335, with an interval of 20 m for each transect. The map of shoreline changes in the Grabag, Ngombol and Purwodadi Districts can be seen in Figure 3. The results of the NSM measurements obtained showed that the shoreline changed more from 2007 to 2020, by 60.1 m and -29.24 m while the EPR result was 4.58 and -2.23 m/y.

Shoreline change analysis using SPOT imagery has been widely carried out. García-Rubio *et al*., (2015) and Ruiz-Beltran *et al*., (2019) used SPOT 5 imagery to identify shoreline changes in Progreso, Yucatàn, Mexico. The average Root Mean Square Error (RMSE) value obtained during the image accuracy test was 4.151.

The SPOT imagery used in this study can detect the shoreline and land cover dynamics. The land area in the coastal area of Purworejo Regency has increased and decreased in land area over 13 years. The total land area in 2007, 2017 and 2020, respectively, was 18,329.74 ha, 18,334.47 ha and 18,325.42 ha. Based on observations using remote sensing data, the area has significantly increased due to sedimentation in the river mouth. The shoreline began to experience significant changes from 2011 to 2017. The position of the shoreline in 2020 has shifted away from the 2007 shoreline towards the sea. The coastal area of Purworejo Regency has predominantly experienced accretion (sedimentation) over 13 years. The largest sedimentation process was obtained in Kertojayan Village, Grabag District. Sedimentation occurred on the eastern banks of the Wawar River from 2007 to 2020. According to data from the Public Works, Water Resources and Spatial Planning Service of Central Java Province in 2010, sedimentation occurred on the east side of the Wawar River estuary, and erosion occurred on the west side of the Wawar River. Based on the results of the analysis of shoreline changes, the highest sedimentation was experienced around the eastern part of the Wawar River estuary with an increase of the area 0.43 ha from 2007 to 2020.

The results of previous study (Saputro, 2013) state that shoreline dynamics are more dominant towards the sea or that the shoreline is progressing (sedimentation). Analysis conducted by Biantara *et al*., (2016) using Landsat satellite imagery in 2014 and 2015 also showed relatively high sedimentation results along the shoreline of the coastal area of Purworejo Regency with the highest sedimentation located east of the Wawar River. The most significant increase in sedimentation occurred from 2011 to 2017, with an additional area of 29.67 ha, while the least sedimentation occurred from 2017 to 2020, with an additional area of 9.09 ha. The rate of change in the shoreline in the coastal area of Purworejo Regency has an average change of 1.02 m per year, a high sedimentation class, according to Natesan *et al*., (2015). Shoreline has retreated towards land in Munggangsari Village with a value of -2.23 m/year indicating erosion. The most severe erosion was detected from 2017 to 2020, which caused the loss of an area of 17.52 ha, while the smallest erosion occurred from 2011 to 2017, which reduced the coastal area by 3.93 ha.

3.2 Analysis of Land Cover Dynamics

The classification of land cover changes is based on land cover maps published by the Department of Public Works and Spatial Planning of Purworejo Regency, which are classified into fields, vacant land, settlements, plantations, swamps, rice fields, bushes, ponds, and water bodies.

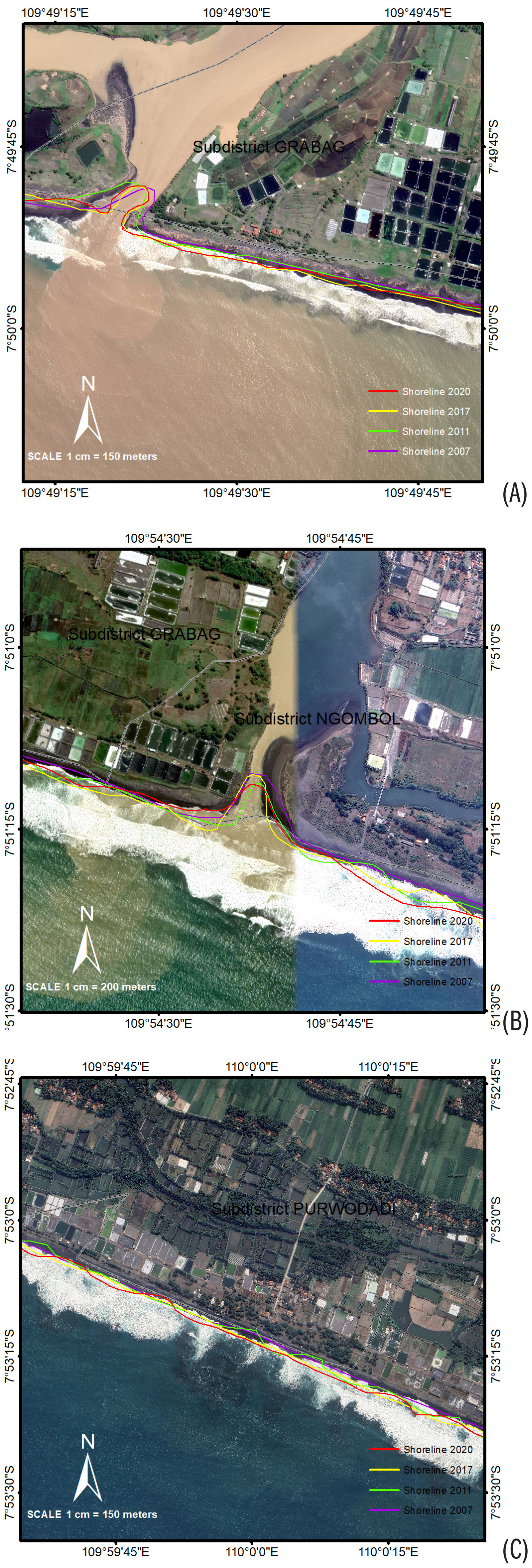


Figure 3. Shoreline Change. (A) Grabag Subdistrict; (B) Ngombol Subdistrict; (C) Purwodadi Subdistrict.

Table 1. Matrix of land cover change 2007 – 2017.

Category	2007		2017		Change in area (ha)
	Area (ha)	Percentage (%)	Area (ha)	Percentage (%)	
Agricultural land	345.99	1.9	1,899.08	10.4	1553.09
Bare land	645.57	3.5	42.8	0.2	-602.77
Settlement	4160.90	22.7	4,253.98	23.2	93.08
Plantation	1408.26	7.7	1,752.47	9.6	344.21
Swamp	354.57	1.9	27.39	0.1	-327.18
Rice Field	10832.70	59.1	9,605.92	52.4	-1226.78
Shrubs	194.54	1.1	60.37	0.3	-134.17
Water body	387.21	2.1	174.17	0.9	-213.04
Pond	-	-	518.29	2.8	518.29
	18329.74	100.0	18334.47	100.0	

Table 2. Matrix of land cover change 2017 – 2020.

Category	2017		2020		Change in area (ha)
	Area (ha)	Percentage (%)	Area (ha)	Percentage (%)	
Agricultural land	1,899.08	10.4	931.82	5.1	-960.26
Bare land	42.8	0.2	32.59	0.2	-10.21
Settlement	4,253.98	23.2	4,278.28	23.3	24.30
Plantation	1,752.47	9.6	1,755.68	9.6	3.21
Swamp	27.39	0.1	32.27	0.2	4.88
Rice Field	9,605.92	52.4	10,567.90	57.6	961.98
Shrubs	60.37	0.3	10.57	0.1	-49.80
Water body	174.17	0.9	190.65	1.1	16.48
Pond	518.29	2.8	525.66	2.9	7.37
	18334.47	100.0	18325.42	100.0	

The results of land cover map processing in the coastal area of Purworejo Regency were obtained from the interpretation of SPOT satellite imagery in 2007, showing that land cover in the area dominated by rice fields with an area of 10,832.7 ha (59.1%) (Table 1). The second largest land cover is settlements, with an area of 4,160.9 ha (22.7%) of the study area. The settlement land cover is becoming dense and spreading north of Daendels Highway. The dominant land cover in areas adjacent to the shoreline is vacant land. This vacant land is a coastal boundary area approximately 400 m from the shoreline. Small settlements are in 3 sub-districts in the coastal area: Jatimalang

Village, Ngentak, Girirejo, Wero, Pagak, Malang, Keburuhan and Kertojayan. In 2007, the coastal area in Grabag District entered the final phase of iron sand mining carried out by Antam Company. The implementation of iron sand mining activities began in 1987. In 2017, rice fields dominated the land cover in the coastal area of Purworejo Regency, covering 9,605.92 ha (52.4%). The area of rice fields decreased by around 7% compared to 2007. The second type of land cover is settlements, with an area of 4,254 ha (23.2%). The area of settlements increased slightly by around 90 ha compared to 2007.

The coastal land cover map of Purworejo Regency obtained from SPOT image interpretation shows that land cover in the form of rice fields in 2020 is still dominant, with an area of 10,567.90 ha (57.6%) (Table 2). The second largest land cover is settlements, with an area of 4,278.28 ha (23.3%). Changes in land cover in 2017-2020 also experienced additions and reductions in land. The land cover that experienced the most significant increase was rice fields and settlements, while fields and bushes experienced the most significant decrease in area. Ponds still experienced an increase in area compared to 2017, namely to 525.66 ha with an increase rate of around 2.5 ha per year.

The SPOT imagery used in this study can detect the dynamics of the shoreline and land cover that occur. The land area in the coastal area of Purworejo Regency has increased and decreased in land area over 13 years. The total land area in 2007, 2017 and 2020, respectively, was 18,329.74 ha, 18,334.47 ha and 18,325.42 ha. From the results of observations using ArcGIS tools, areas that experienced an increase in the average area were in coastal and river border areas, such as Kertojayan Village in Grabag District. Kertojayan Village, based on the results of the analysis of shoreline changes, experienced the highest sedimentation with an increase in the area around the eastern part of the Wawar River estuary of 0.43 ha from 2007 to 2020.

3.3 Relationship between shoreline and land cover dynamics

Observation of the relationship between the dynamics of changes the shoreline and land cover was done using the cross-profile method (Marfai *et al*., 2011; Pratama *et al*., 2021) in areas that have experienced the highest changes. The cross-profile method was carried out on several beaches, namely Kertojayan Beach and Munggangsari Beach in Grabag District, Keburuhan Beach and Wero Beach in Ngombol District, and Jatimalang Beach and Jatikontal Beach in Purwodadi District. These beaches were chosen because they experienced the most dynamic shoreline change and land cover compared to other beaches. The cross-profile method combines data on the rate of shoreline change, the slope of the beach shelf, landform, genesis, flora, economic activity, socio-culture, and land planning so that a comprehensive understanding will be obtained to prepare a coastal area management strategy (Pratama *et al*., 2021). Tables 3-8 contain the cross-profile profiles description of each beach. Figure 4 shows the cross profile of the beach with the types of land cover.

Munggangsari, Keburuhan, and Jatimalang beaches were selected as samples in the cross-profile because all of them have erosion conditions and genesis processes produced by marine processes. Jatimalang Beach is a priority tourist attraction in Purworejo Regency, while Munggangsari and Keburuhan beaches are mostly vaname shrimp ponds (Figure 5). Shrimp ponds in Jatimalang located behind the tourist area, while the shrimp ponds in Munggangsari are located directly opposite the beach. Shrimp Pond management in Munggangsari, Keburuhan, and Jatimalang is carried out intensively. From the analysis using remote sensing technology, the rate of change in the three shorelines shows an erosion trend, as evidenced by the presence of unused and damaged buildings on the beach

Kertojayan, Wero, and Jatikontal Beaches were selected as samples in cross-profile analysis because they all have sedimentation conditions Kertojayan Beach was formed from fluvio-marine processes, while Wero and Jatikontal Beach were formed from marine processes. The beaches in the coastal areas of Purworejo Regency that are close to rivers, such as the Kertojayan, Keburuhan, and Pasir Puncu Beaches, have a tendency toward sedimentation. Sedimentation happens because, during the dry season, the river water discharge will decrease, causing sediment to be unable to flow towards the sea and become trapped in the estuary area, then causing sedimentation on the surrounding beaches. Kertojayan, Wero, and Jatikontal Beaches have different socio-economic characteristics. Economic activities in Kertojayan Beach are fishing and shrimp farming, economic activities in Wero Beach are entirely shrimp farming, while economic activities in Jatikontal Beach come from tourism and shrimp ponds. Coastal environmental conditions of Kertojayan, Wero and Jatikontal Beaches can be seen in Figure 6.

Changes in land cover are inevitable to meet economic needs. This change also occurs in the coastal areas of Purworejo Regency, which is located on the south coast of Java Island. Changes in land cover occurred in the area under study; the most significant changes were observed in areas designated as ponds, of about 500 ha. Ponds located in the coastal areas of

Purworejo Regency are mainly used for vaname shrimp farming activities. In 10 years, from 2007 to 2017, the pond area grew by 518.29 ha or around 51 ha per year. From the results of the land cover analysis in 2007, ponds were yet to be available in the area. Based on interviews with related parties, shrimp ponds grew around 2014. In 10 years, the bare land area around the coastal boundaries was mainly turned into ponds.

Based on cross-profile analysis, it was found that there was no relationship between the dynamics of the shoreline and the dynamics of land cover. All beaches in Purworejo Regency that carry out shrimp farming activities show different patterns of coastal dynamics, namely sedimentation and erosion. Erosion usually occurs due to hydro-oceanographic factors such as waves that erode coastal areas. Shrimp cultivation must be considered as a primary factor in the preparation of coastal management strategies within Purworejo Regency. From the results of interviews with communities in the coast, the detrimental impacts of shrimp cultivation activities have begun to emerge, such as decreased rice harvests in rice fields due to intrusion and water pollution from shrimp waste, the pungent smell of ammonia that can be smelled in the shrimp pond area and river water around the shrimp which is indicated to be polluted by shrimp waste. The results of ammonia tests in water in Grabag District (Choeronawati *et al.*, 2019) showed that the levels exceeded the standard quality standards at all research location points. This ammonia comes from shrimp excretion and hydrolysis of feed protein dissolved in water.

Table 3. Cross-Profile of Kertojayan Beach.

Position	X1:370255.672 mT, Y1:9134169.886 mU X2:370281.978 mT, Y2: 9134265.827 mU
Shoreline change rate	+4.58 m/year
Landform	beach
Genesis	Fluvio-Marine
Flora	*Casuarina equisetifolia, Ipomoea pes-caprae, Cocos nucifera*
Cultural landscape	Wild fishery, shrimp pond
Settlement pattern	None
Economy	Capture fish, shrimp farming
Sosio - culture	Group of fishermen
Land cover	Pond, bare land
Land planning	Dryland agriculture, coastal setback

Table 4. Cross-Profile of Munggangsari Beach.

Position	X1:375807.809 mT, Y1: 9132860.483 mU X2: 375834.789 mT, Y2: 9132944.305
Shoreline change rate	-2.23 m/year
Landform	Beach
Genesis	Marine
Flora	*Casuarina equisetifolia, Ipomoea pes-caprae*
Cultural landscape	Shrimp pond
Settlement pattern	None
Economy	Shrimp farming
Sosio - culture	Group of fishermen
Land cover	Pond
Land planning	Dryland agriculture, coastal setback

Table 5. Cross-Profile Keburuhan Beach.

Position	X1:379762.131 mT, Y1: 9131682.514 mU X2:379785.026 mT, Y2: 9131778.893 mU
Shoreline change rate	-1.71 m/year
Landform	Beach
Genesis	Fluvio-Marine
Flora	*Casuarina equisetifolia, Ipomoea pes-caprae*
Cultural landscape	Shrimp pond
Settlement pattern	None
Economy	Shrimp farming
Sosio - culture	Group of fishermen
Land cover	Pond
Land planning	Coastal setback, riparian zone

Table 6. Cross-Profile Wero Beach.

Position	X1:384794.033 mT, Y1: 9129984.095 mU X2: 384841,704 mT, Y2: 9130081,938 mU
Shoreline change rate	+4.51 m/year
Landform	Beach
Genesis	Marine
Flora	*Ipomoea pes-caprae, Pandanus tectorius*
Cultural landscape	Shrimp pond
Settlement pattern	None
Economy	Shrimp farming
Sosio - culture	Group of fishermen
Land cover	Pond
Land planning	Coastal setback, riparian zone

Table 7. Cross-Profile Jatimalang Beach.

Position	X1:387839.135 mT, Y1: 9128834.627 mU X2: 387865.470 mT, Y2: 9128930.886 mU
Shoreline change rate	-1.36 m/year
Landform	Beach
Genesis	Marine
Flora	*Casuarina equisetifolia, Spinifex littoreus*
Cultural landscape	Tourism, wild fishery
Settlement pattern	Linear to the beach
Economy	Trade, wild fishery, shrimp farming
Sosio - culture	Group of fishermen
Land cover	Trading, pond, settlement
Land planning	Coastal setback, settlement and dryland agriculture

Table 8. Cross-Profile Jatikontal Beach.

Position	X1: 389739.462 mT, Y1: 9128070.173 mU X2: 389773.117 mT, Y2: 9128160,343 mU
Shoreline change rate	+2.24 m/year
Landform	Beach
Genesis	Marine
Flora	*Casuarina equisetifolia*
Cultural landscape	Wild fishery
Settlement pattern	Linear to the street
Economy	Trade, wild fishery, shrimp farming
Sosio - culture	Group of fishermen
Land cover	Bareland, trading, settlement, pond
Land planning	Coastal setback, riparian zone and dryland agriculture

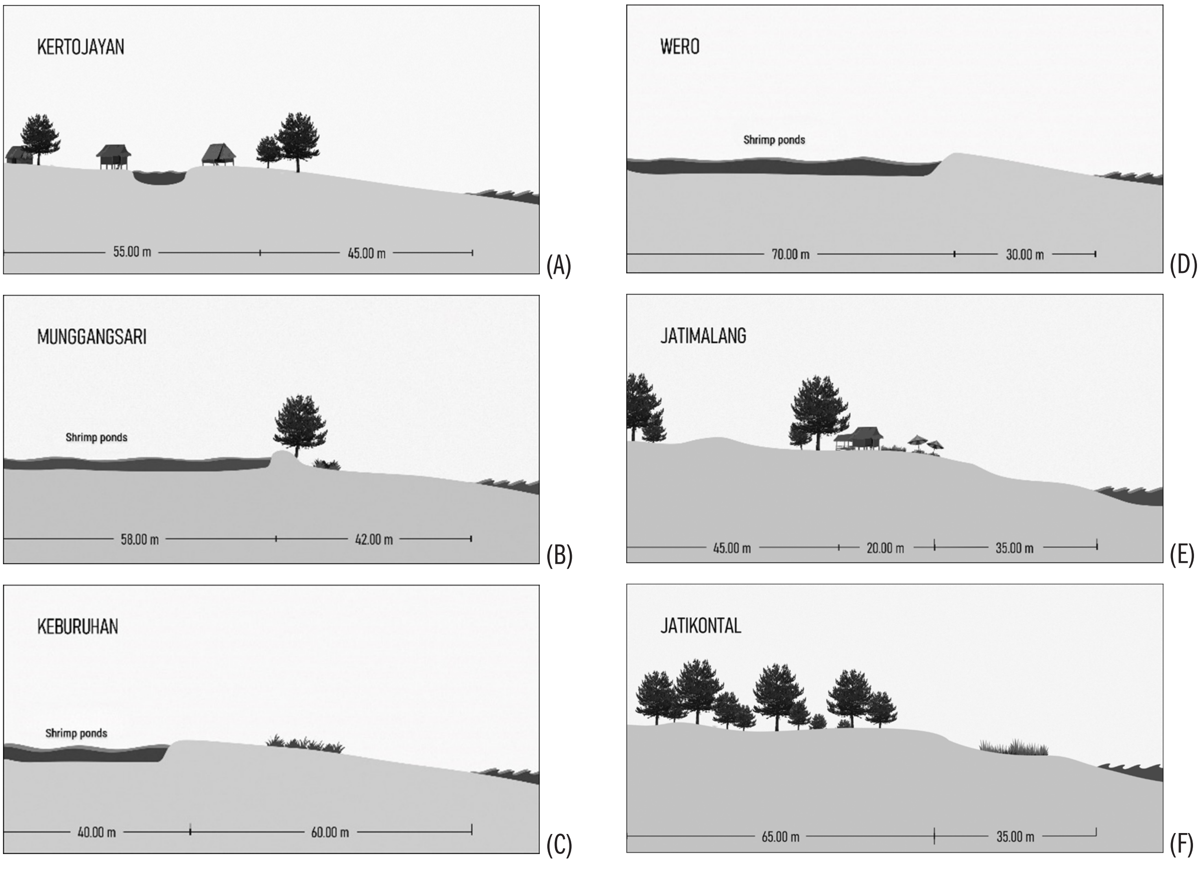
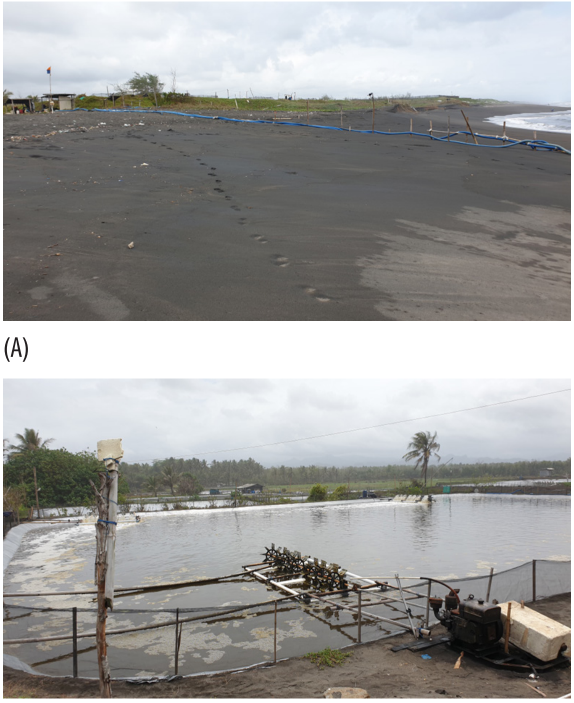


Figure 4. Cross-Profile Beach. (A) Kertojayan Beach; (B) Munggangsari Beach; (C) Keburuhan Beach; (D) Wero Beach; (E) Jatimalang Beach; (F) Jatikontal Beach.



(A)

(B)

Figure 5. Environmental Condition. (A) Munggangsari Beach; (B) Keburuhan Beach; (C) Jatimalang Beach.

(A)

(B)

Figure 6. Environmental Condition. (A) Kertojayan Beach; (B) Wero Beach; (C) Jatikontal Beach.

4. CONCLUSIONS

This study provides important insights into coastal dynamics and land cover changes in Purworejo Regency between 2007 and 2020. The findings indicate that shoreline changes during this period were largely driven by sedimentation processes, with the most significant sedimentation and erosion rates occurring in Grabag District at 9.06 and -2.08 m per year. Land cover in the area has undergone significant changes, which are closely related to economic growth. While rice fields dominated the area in 2007 and remained until 2020, the coastal border area experienced significant conversion to vannamei shrimp ponds, especially after 2014. Rapid aquaculture expansion has resulted in extensive changes in land use and has contributed to environmental degradation, including coastal pollution. The analysis of this study did not reveal a direct correlation between shoreline dynamics and land cover changes, as the same land cover type is associated with varying shoreline behavior. These results underscore the complexity of coastal systems and highlight the need for integrated coastal management and continuous environmental monitoring to support sustainable regional development.

This study has limitations in terms of data sources and information, and the images used are of medium resolution, which affects the level of detail of the analysis. Therefore, further research is needed on the natural and anthropogenic factors that determine the dynamics in coastal areas. Another limitation of this study is the lack of long-term data. Changes in shorelines and land cover in coastal areas are long-term and continuous processes. Therefore, this study is limited by using only short-term data. This can lead to a lack of precision and accuracy in predicting long-term trends or in formulating effective strategies for the long-term future.

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6. AUTHOR CONTRIBUTION

M.N. Airawati: Conceptualization, methodology, data collection, analysis and writing and editing manuscript; Djati Mardiatno: Methodology development, review of data analysis, manuscript writing and study advisor; Nurul Khakhim: Methodology development, data collection, review of data analysis and study advisor.

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