REPUBLIC OF INDONESIA
Ministry of Public Works and Housing

Project for Coastal Disaster Risk Reduction Plan Study on the North Coast of Java Island in the Republic of Indonesia

Final Report

July 2024

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
YACHIYO ENGINEERING CO., LTD.
FUTABA CO., LTD.
MITSUI CONSULTANTS CO., LTD.

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Note: The printed version of this report does not include Appendix.

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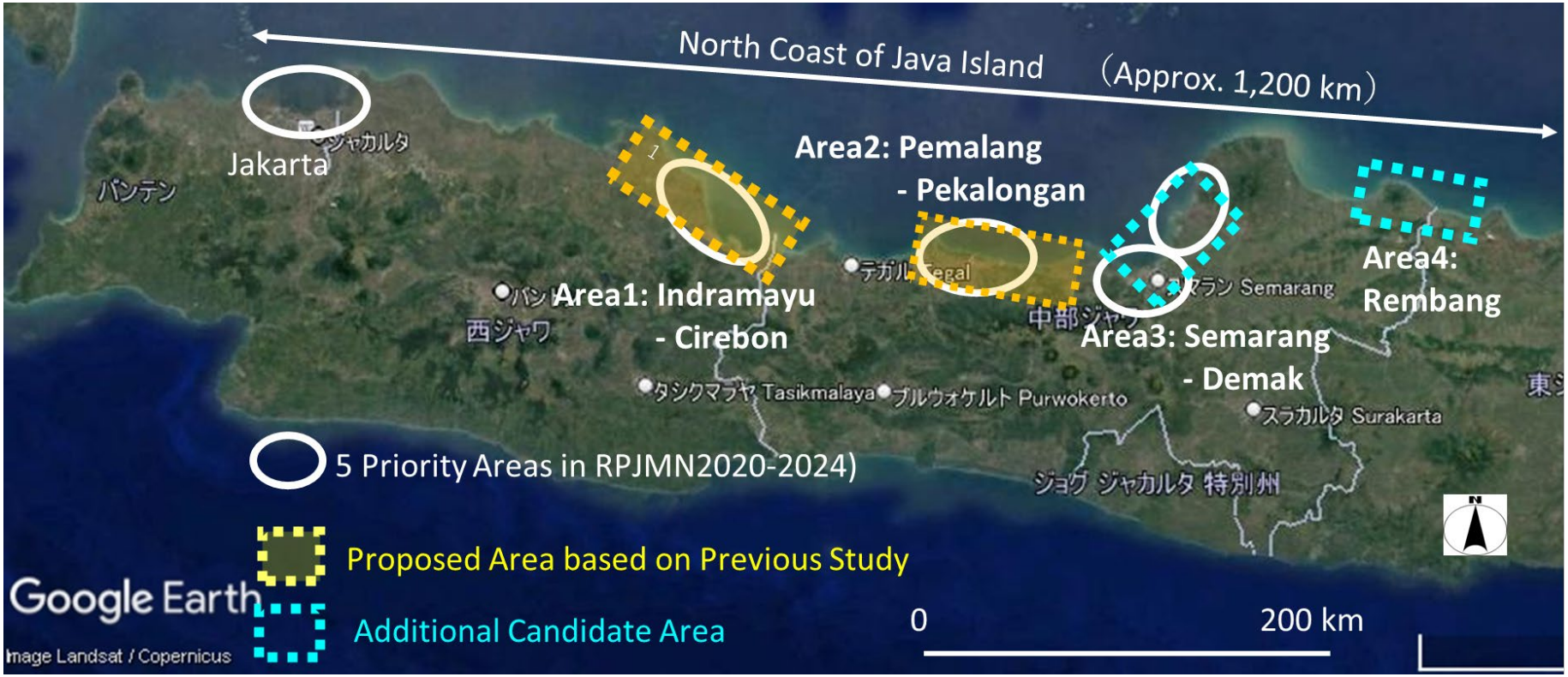
Abbreviation

Abbreviation	English / Indonesian
AMDAL	Environmental Impact Assessment / Analisis mengenai Dampak Lingkungan
ATR	Ministry of Agrarian Affairs and Spatial Plannning / Kementerian Agraria dan Tata Ruang
BAPPEDA	Regional Development Planning Agency / Badan Perencanaan Pembangunan Daerah
BAPPENAS	National Development Planning Agency / Badan Perencanaan Pembangunan Nasional
BBWS	River Basin Headquater / Balai Besar Wilayah Sungai
BNPB	National Disaster Management Authority / Badan Nasional Penanggulangan Bencana
BPSPL	Coastal and Marine Resource Management Office / Balai Pengelolaan Sumber Daya Pesisir dan Laut
BWS	River Basin Office / Balai Wilayah Sungai
C/P	Counterpart
DGWR	Directorate General of Water Resources / Direktorat Jenderal Sumber Daya Air
DINAS PU	Public Works Agency /Dinas Pekerjaan Umum
F/S	Feasibility Study
GOI	the Government of Republic of Indonesia
ICZM	Integrated Coastal Zone Management
IDR	Indonesian Rupiah
ITB	Bandung Institute of Technology
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JKT	Jakarta
KKP	Ministry of Marine Affairs and Fisheries / Kementerian Kelautan dan Perikanan
KLHK	Ministry of Environment and Forestry / Kementerian Lingkungan Hidup dan Kehutanan
NCICD	National Capital Integrated Coastal Development
NGO	Non-Governmental Organization
Permen	Ministerial Regulation/ Peraturan Menteri
PerPres	Presidential Decree / Peraturan Presiden
PP	Government Regulation / Peraturan Pemerintah
PUPR	Ministry of Public Works and Housing / Kementerian Pekerjaan Umum dan Perumahan Rakyat
RPJMN	National Medium-Term Development Plan / Rencana Pembangunan Jangka Menengah Nasional
SHM	Stakeholder Meeting
SEA	Strategic Environmental Assessment
UNEP	United Nations Environment Programme
UU	Law / Undang-Undang

Study Area Map



CHAPTER 1 Project Overview

1.1 Background

Current Condition of the North Coast of Java Island:

The north coast of Java Island is a priority area in Indonesia where people, assets, and important infrastructure facilities are particularly concentrated due to the rapid economic development in recent years. In the project "Data Collection Survey on Coastal Conservation in the Republic of Indonesia" (hereinafter referred to as the Previous Study) conducted prior to the Project, the current condition of the north coast of Java Island was analyzed from different types of satellite images and various collected materials and information. The main results are shown as below.

(1) The north coast of Java Island has an extremely small rates of natural beaches compared to other coasts and most of the coastal areas are used as agriculture area, fishponds, residential areas, infrastructure development, etc.

(2) Changes of the shoreline is large compared to other coastal areas, and most coasts are experiencing significant coastal erosion.

(3) While there are many low-elevation lands, further land loss, inundation damage due to land subsidence have apparently occurs.

Current Condition of the Coastal Sector:

In the north coast of Java Island, various coastal problems such as coastal erosion, land subsidence, and inundation damage due to coastal development have occurred and countermeasures against these problems are urgently needed. The Ministry of Public Works and Housing (hereinafter referred to as PUPR), the Ministry of Marine Affairs and Fisheries (hereinafter referred to as KKP), and the Ministry of Environment and Forestry (hereinafter referred to as KLHK) are responsible for coastal measures, each of which has its own role under the jurisdiction of each ministry. Most of implementation are local post-measures after the problem occurs. In addition, the construction of infrastructure facilities such as harbors and individual local coastal facilities due to coastal development, has a great impact on the surrounding beaches, causing further deterioration of coastal conditions. It has led to a decline in the three functions of "Protection", "Environment", and "Utilization" which natural beach has.

Necessity of Coastal Management Based on a Plan from a Wide-Area Perspective:

In order to consider coastal conservation while maintaining the above-mentioned three functions, it is necessary to understand the mechanism of coastal phenomena such as littoral drift and to conduct coastal management based on the development plan and the impact of development.

1.2 Objectives

- To conduct a survey based on the Record of Discussion (hereinafter referred to as R/D) related to the "Coastal Disaster Risk Reduction Plan Study on the North Coast of Java Island"
- By carrying out the survey above, a draft of the "Basic Policy for Coastal Management " and "Basic Coastal Management Plan" will be formulated, and the "Coastal Facility Plan" will be formulated considering harmonization of coastal conservation, environment, utilization, and development.

1.3 Project Objectives and Outcomes

1.3.1 Impact (Goals Expected to be Achieved in the Medium to Long Term by the Proposed Plan After Completion of the Project)

- Coastal conservation project(s) will be implemented in the Northern Coast of Java

1.3.2 Outcomes (Goals Expected to be Achieved in the Short Term After Project Completion by Achieving the Outputs)

- Pre-feasibility studies will be conducted for the selected priority projects

1.3.3 Output

- Draft of the Basic Coastal Management Plan for 3 areas on the north coast of Java Island (amended from 2 areas to 3 areas according to the revised R/D)
- Coastal Facility Plans for the selected Sections (4 Sections)
- Draft of Basic Policy for Coastal Management
- Technology transfer to relevant officials of the government

1.4 Survey Items (Major Items)

- Phase 0 Detailed planning study
- Phase 1 Survey to gather the basic information and identification of the coastal issues
- Phase 2-1 Preparation of draft of Basic Coastal Management Plan for selected 3 areas
- Phase 2-2 Preparation of Coastal Facility Plan for selected sections
- Phase 2-3 Preparation of draft of Basic Policy for Coastal Management
- Technology transfer to relevant officials of the government

1.5 Related Organization

1.5.1 Counterpart (C/P)

Directorate General of Water Resources (hereinafter referred to as DGWR), PUPR

1.5.2 Other Related Organization

- Ministry of Marine Affairs and Fisheries, KKP
- Ministry of Environment and Forestry, KLHK
- Ministry of Agrarian Affairs and Spatial Planning, ATR
- National Development and Planning Agency, BAPPENAS
- National Disaster Management Authority, BNPB

1.6 Composition of JICA Study Team and Corresponding Assignment

The composition of the JICA study team and the corresponding assignment are shown in Table 1.6.1.

Table 1.6.1 Composition of JICA Study Team and Assignment Period

No.	Position	Name	Affiliation	Assignment Period
1	Team Leader/Coastal Planning & Management 1	Susumu ONAKA	Nippon Koei Co., Ltd.	1) 2022/6/17~7/8 2) 2022/8/7~8/13 3) 2022/10/4~10/15, 2022/10/23~11/4 4) 20232/2/1 ~ 2/22 5) 2023/5/15 ~ 6/1 6) 2023/7/25 ~ 7/28 2023/8/1 ~ 8/3 2023/8/7 ~ 8/10 2023/8/7 ~ 8/10 7) 2023/10/15 ~ 10/31 8) 2024/1/10 ~ 1/25 9) 2024/6/5 ~ 6/20
2	Deputy Team Leader/Coastal Planning & management 2	Shingo ICHIKAWA	Nippon Koei Co., Ltd.	1) 2022/10/11~10/24 2) 2023/2/7 ~ 2/22 3) 2023/7/25 ~ 7/28 2023/8/11 ~ 8/12 4) 2023/10/15 ~ 11/1 5) 2024/1/10 ~ 1/26 6) 2024/6/5 ~ 6/21
3	Costal Conservation/Costal Utilization・Development	Shubun ENDO	Futaba Co., Ltd.	1) 2022/6/23~7/8 2) 2022/10/2~11/1 3) 2023/2/1 ~ 2/22 4) 2023/5/14 ~ 6/1 5) 2023/7/25 ~ 8/10 6) 2023/10/15 ~ 10/26 7) 2024/1/10 ~ 1/25 8) 2024/6/8 ~ 6/20
4	Integrated Coastal Zone Management (ICZM)/River & Sediment Management	Toshimitsu TAKAGI	Yachiyo Engineering Co., Ltd.	1) 2022/6/23~7/8 2) 2022/10/2~10/28 3) 2023/2/5 ~ 2/22 4) 2023/5/14 ~ 6/2 5) 2023/7/25 ~ 8/10 6) 2023/10/15 ~ 10/27 7) 2024/1/10 ~ 1/26 8) 2024/6/10 ~ 6/19
5	Hydraulic Analysis (Littoral Drift, Storm Surge, Flood)	Makoto YONEKURA	Yachiyo Engineering Co., Ltd.	1) 2022/6/23~7/8 2) 2022/10/11~11/5 3) 2023/2/5 ~ 2/22 4) 2023/5/22 ~ 6/1 5) 2023/7/25 ~ 8/10 6) 2023/10/15 ~ 11/1
6	Design of Costal Measures (Structure and Non-Structure)	Tomohiro MORI	Nippon Koei Co., Ltd.	1) 2022/6/17~7/8 2) 2022/8/7~8/13 3) 2022/10/1~11/5 4) 2023/2/1 ~ 2/23 5) 2023/5/15 ~ 6/2 6) 2023/7/25 ~ 8/10 7) 2023/10/15 ~ 10/31 8) 2024/1/10 ~ 1/26 9) 2024/6/5 ~ 6/21
7	Facility Design/ Construction Planning & Cost Estimate	Nobuhiro OCHI	Nippon Koei Co., Ltd.	1) 2022/10/23~11/5 2) 2023/2/1 ~ 2/22

8	Coastal Maintenance	Hiroaki YAMANAMI	Mitsui Consultants Co., Ltd.	1) 2022/10/11~10/22 2022/10/29~11/5 2) 2023/2/1 ~ 2/22 3) 2023/5/15 ~ 6/2 4) 2023/7/25 ~ 8/10
9	Coastal Disaster & Disaster Prevention	Masatoshi IZUMI	Futaba Co., Ltd.	1) 2022/10/2~11/5 2) 2023/2/9~ 2/22 3) 2023/5/14~ 6/2 4) 2023/7/25~ 8/10 5) 2023/10/15~ 10/27
10	Institutional & Social Analysis	Hiroshi HIGASHIGUCHI	Mitsui Consultants Co., Ltd.	1) 2022/6/23~7/8 2) 2022/10/11~11/5 3) 2023/2/1~ 2/22 4) 2023/5/15~ 6/2 5) 2023/7/25~ 8/10 6) 2024/1/14 ~ 1/21 2024/1/24 ~ 1/24 7) 2024/6/9 ~ 6/15
11	Environmental and Social Consideration	Shinichi TAKAO	Nippon Koei Co., Ltd.	1) 2022/6/23~7/8 2) 2022/10/12~11/17 3) 2023/2/6 ~ 2/22 4) 2024/1/14 ~ 2/3
12	Financial Analysis	Takeshi MURAKAMI	Nippon Koei Co., Ltd.	1) 2022/6/23~7/8 2) 2022/10/16~10/29 3) 2023/2/1 ~ 2/17 4) 2023/5/21 ~ 6/2 5) 2024/1/14 ~ 1/26
13	Oceanographic & Coastal Survey	Koki MIYAGAWA	Nippon Koei Co., Ltd.	1) 2022/6/23~7/8 2) 2023/2/1 ~ 2/22 3) 2023/5/16 ~5/30 4) 2023/7/25 ~ 8/10 5) 2023/10/15 ~ 11/31 6) 2024/1/10 ~ 1/26 7) 2024/6/5 ~ 6/21

Source: JICA Study Team

1.7 Schedule and Progress

Table 1.7.1 shows the project study items and the progress of the study for each item.

In the detailed planning study (Phase 0), the number of priority areas (candidate areas) for the Project was changed from two to three because of discussions with the Counterpart (hereinafter referred to as C/P) and government officials. The R/D revision proposal including this change was basically agreed at the Joint Coordination Committee (hereinafter referred to as JCC) meeting held in February 2023. The participants of JCC also discussed and agreed on the necessity of establishing Working Groups (WGs) and Close Group Discussions (CGDs) with key stakeholders of the relative organizations to discuss and review the plans.

In the basic survey (Phase 1), data collection and field survey were conducted to select priority Areas for coastal management plan, which was finally three Areas.

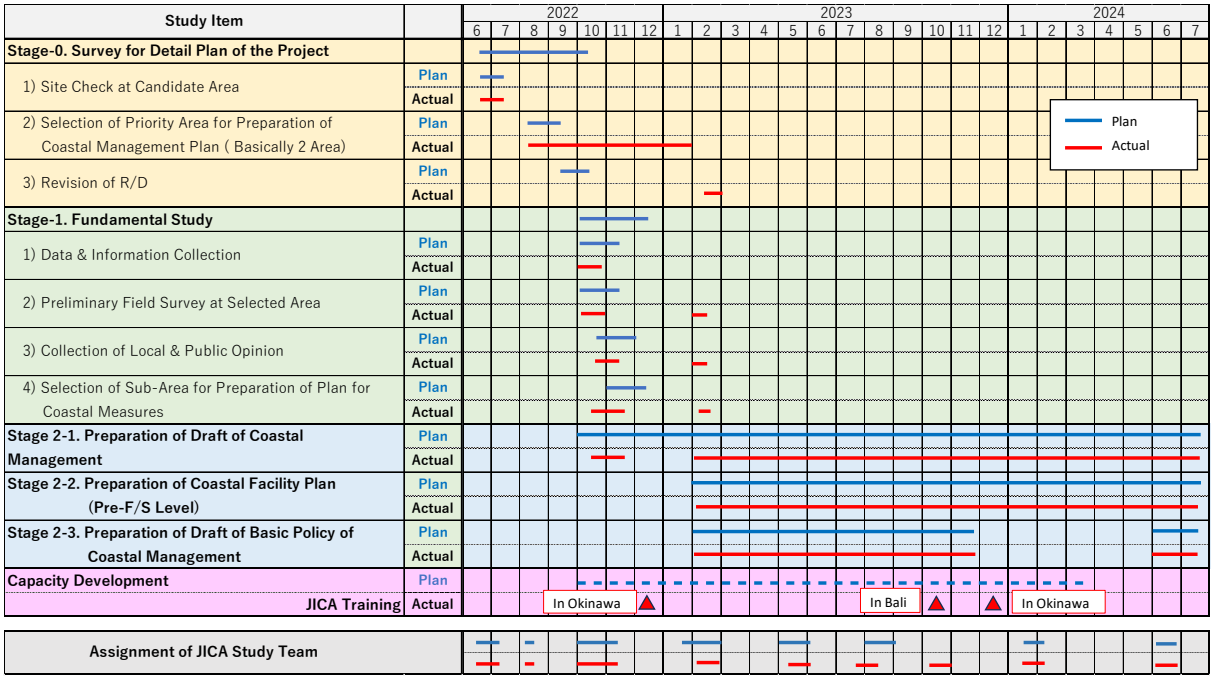
As for the draft of Basic Coastal Management Plan (Phase 2-1) of the priority Areas (3 areas), basic contents were confirmed and discussed in WG and CGD on January 17, 2024. After receiving the comments on the plan from the stakeholders, the final draft reflecting them was prepared and confirmed in WG and CGD in June 2024. Furthermore, at the 3rd JCC held in the same month, it was agreed that Indonesia side would conduct a detailed review of the final draft, and that the draft would be finalized after extracting and reflecting comments. At the JCC, it was agreed that the Indonesian side would complete extracting comments and prepare method and schedule to institutionalize Basic Coastal Management Plan by September 2024.

The Coastal Facility Plan (Phase 2-2) had been prepared at four Sections based on the above Basic Coastal Management Plan. Members discussed and confirmed the facility layout, types of structures, cost and so on through WG and CGD in January 2024. The final draft, which reflects the comments from the discussions, was confirmed in WG and CGD in June 2024. At the 3rd JCC held in the same month, it was confirmed that Coastal Facility Plan would be launched as a implementation project in 2026, and that coordination among PUPR, BAPPENAS, and JICA would be initiated targeting for future Yen-loan project.

Contents of the draft of Basic Policy for Coastal Management (Phase 2-3) was basically agreed through WG in October 2023. The draft reflecting comments through the discussions was submitted to Indonesian side in November 2023. At the 3rd JCC in June 2024, it was agreed that the Indonesian side would proceed with discussions to finalize this Basic Policy for Coastal Management, and that the final draft of the policy and an action plan for the legalization of the policy would be prepared by September 2024.

As a part of capacity building of relevant organizations, the training course on coastal conservation was conducted in Bali in September 2023, jointly with Maldivian government officials. In addition, training courses on coastal protection measures were held in Okinawa Prefecture, Japan in 2022 and 2023 (Knowledge Co-Creation Program “Sustainable Coastal Protection Measures at Island Countries”). Members from related ministries and agencies, including PUPR, participated in the program, and as a result of the training, action plans were formulated for each participant to practice in their own organizations.

Table 1.7.1 Implementation Schedule



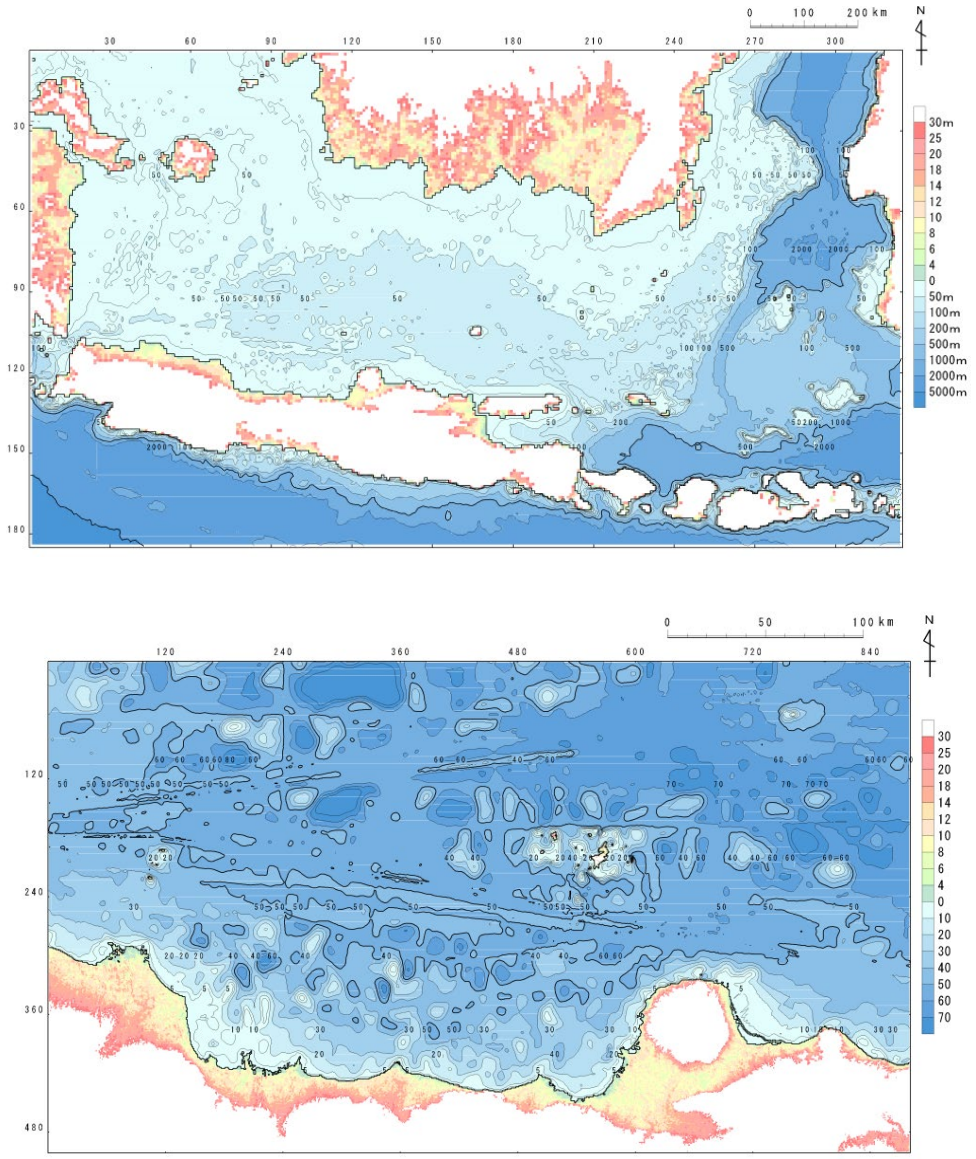
Source: JICA Study Team

CHAPTER 2 Basic Survey

2.1 Natural Characteristics of the North Coast of Java Island

2.1.1 Topography

Figure 2.1.1 shows the bathymetry around the Java Sea based on Seamless Digital Elevation Model (DEM) and National Bathymetry. The Java Sea, which faces the north coast of Java Island, is a very shallow waters area with a depth of 50 m at the maximum depth. The Java Sea is a closed water area with Sumatra Island to the west, Kalimantan Island to the north, and Sulawesi Island to the east.



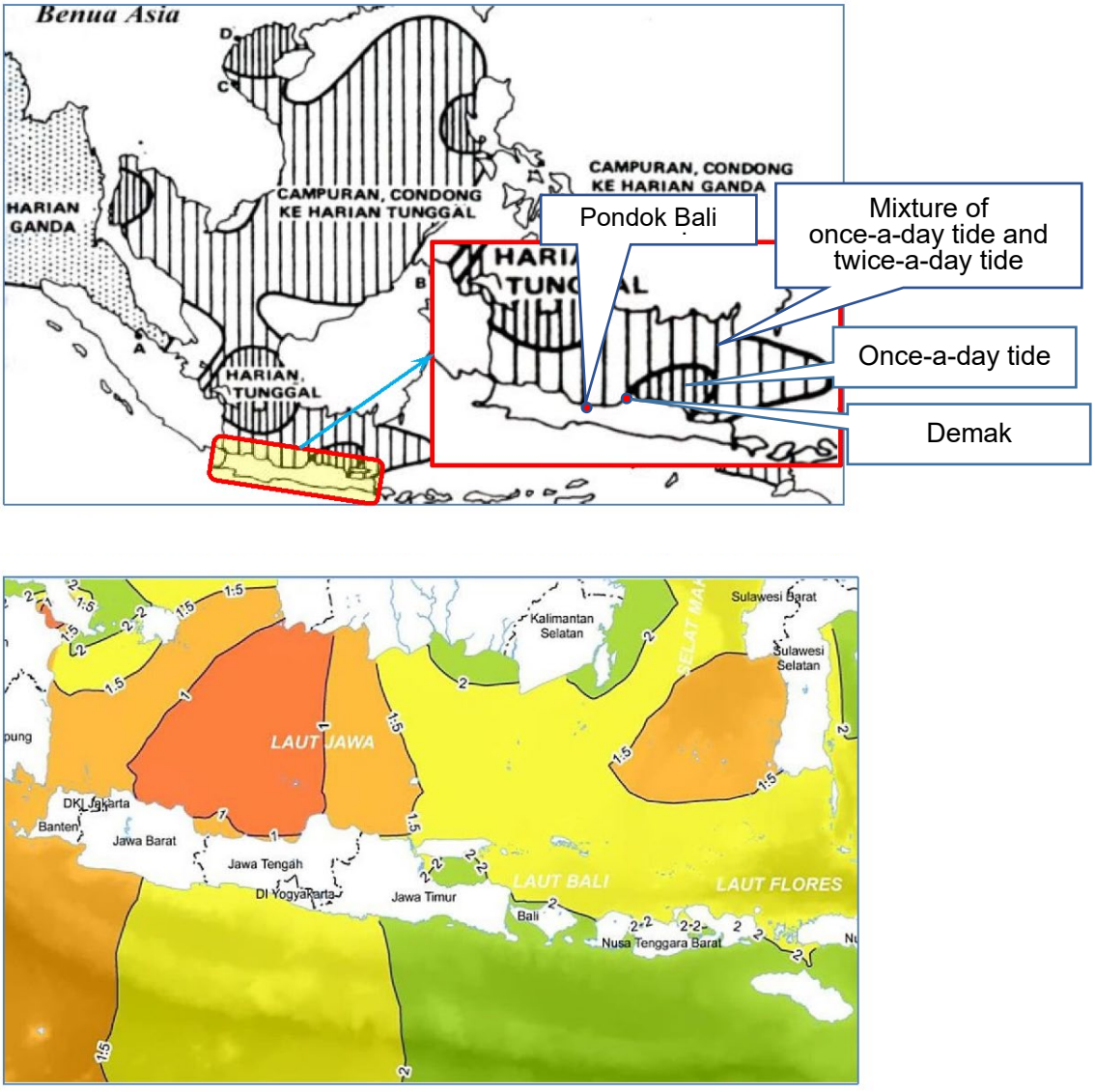
Source: Edited JICA Study Team based on BATNAS

Figure 2.1.1 Bathymetry of the Java Sea

(Top: Created from 5 km Grid, Bottom: Created from 500 m Grid)

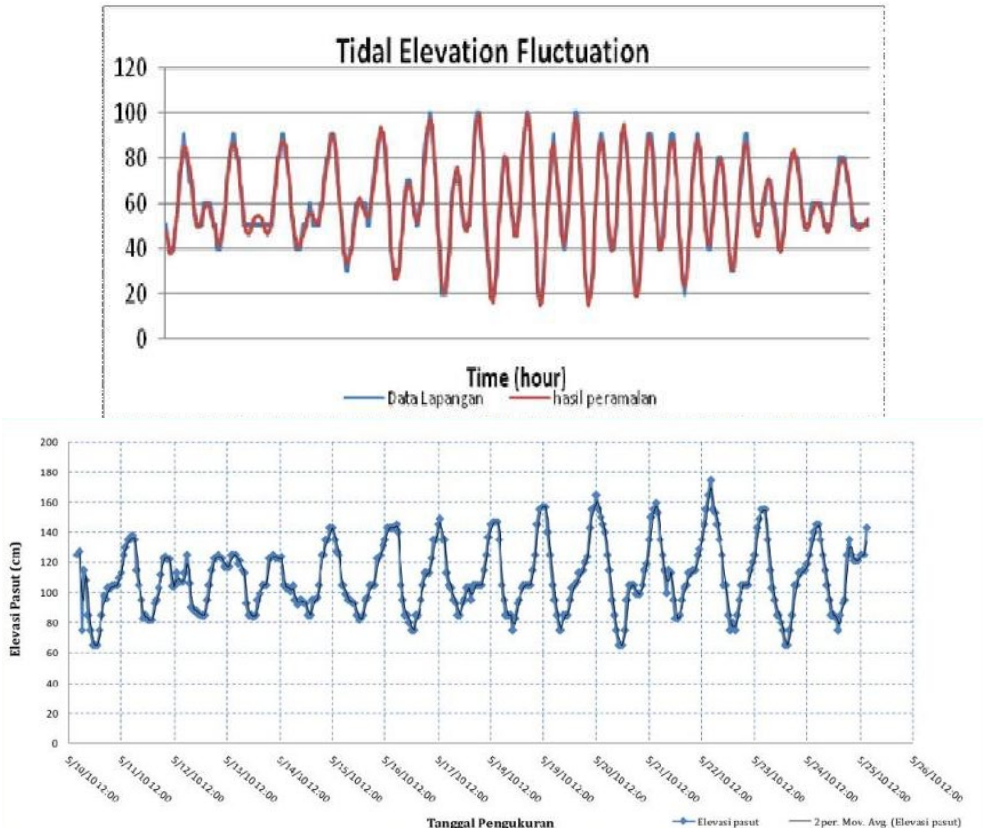
2.1.2 Tide

The tides of Java Sea facing are mostly a mixture of once-a-day tides that ebb and flow once a day and twice-a-day tides that ebb and flow twice a day. Some areas near Demak are considered to have once-a-day tides (Figure 2.1.2 above). Supporting this, Figure 2.1.3 shows that Pondok Bali, located on the west side, experiences twice-a-day tides (unequal daily tides), while Demak, located on the east side, seems to have once-a-day tides. The tidal range along the north coast of Java Island is about 1 m (Figure 2.1.2 bottom). However, near Rembang, located on the east side of Java Island, the tidal range tends to be larger, ranging from 1 to 1.5 m.



Source: Haryano,et al,2004 (top), KKP,2009 (bottom)

Figure 2.1.2 Tide Type (Top) and Distribution of Maximum Tidal Range (Bottom)



Source: Hendra Achiari et al., Study Erosion and Coastal Destruction at Pondok-Bali, North Coast-West Java of Indonesia, International Journal of Management and Applied Science, 2015 (top), KKP, 2012 (bottom)

Figure 2.1.3 Time Series of Tidal Level for 15 Days (Top: Pondok Bali, Bottom: Demak)

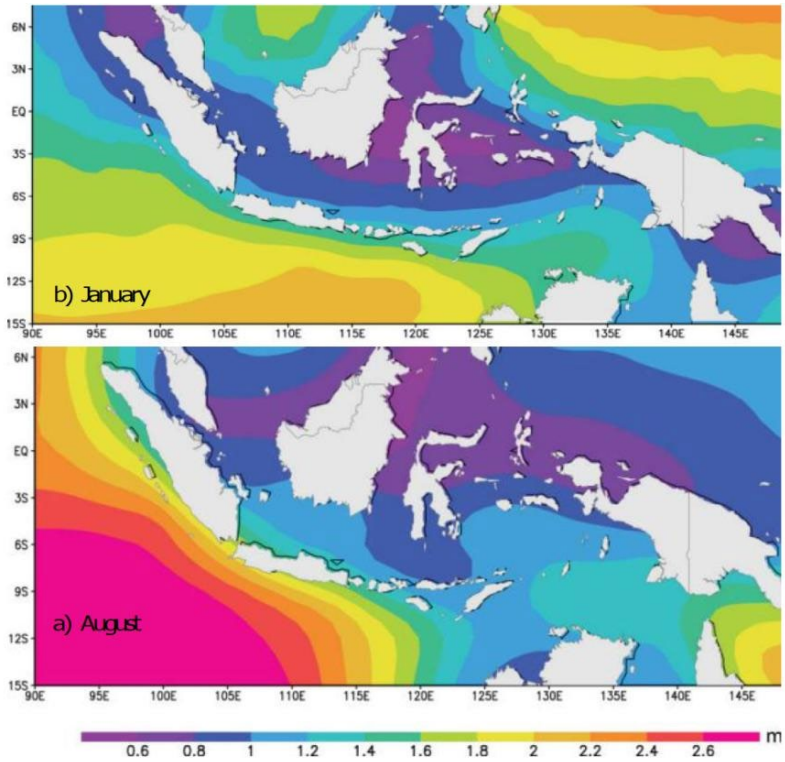
2.1.3 Waves

The waves that come to the north coast of Java Island are wind-driven waves that grow in the Java Sea. The characteristics of the waves consists of the northwest monsoon from November to March and the southeast monsoon from May to September. The monthly mean wave height distributions for January, representing the northwest monsoon, and August, representing the southeast monsoon, are shown in Figure 2.1.4. It shows the three-year (January 2006 to December 2008) average monthly mean significant wave heights for January and August derived from the altimeter data of significant wave heights (SWH) based on the Indonesia Climate Change Sectoral Roadmap(ICCSR). According to this data, wave heights during August are slightly higher along the north coast of Java, ranging from 1.2 to 1.4 m, compared to about 1.0 to 1.2 m in January.

The direction of waves is influenced by the monsoon, and the wind direction distribution shown in Figure 2.1.5 indicates that waves are predominantly from the east direction during the southeast monsoon season from May to September, and from the west direction during the northwest monsoon season from November to March.

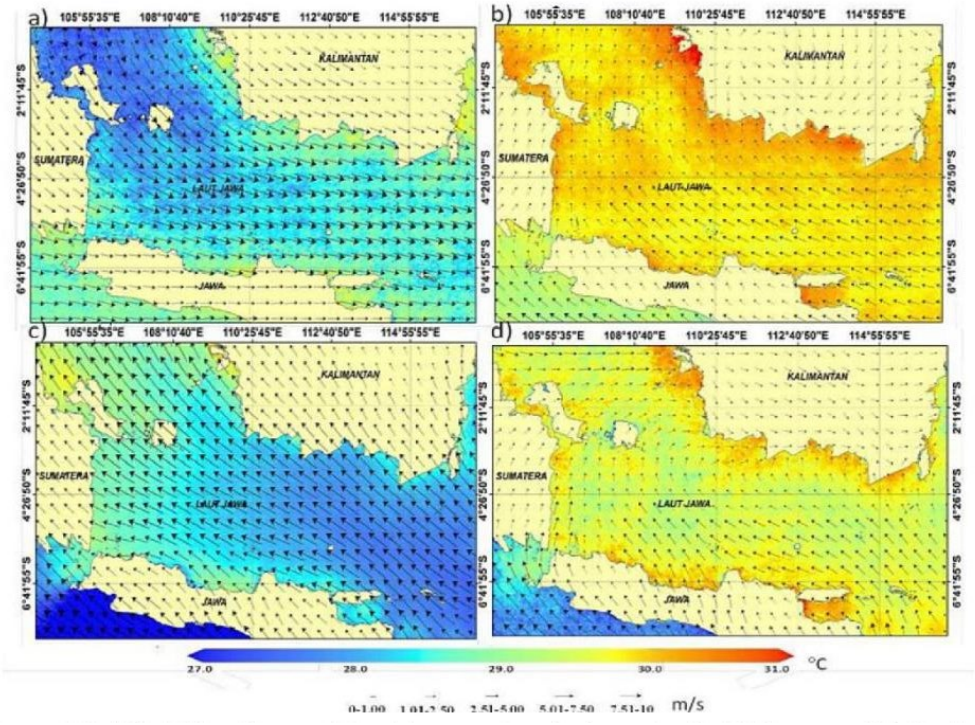
The wave period can be estimated by the SMB method, assuming that the fetch is about 400~1,000 km, since the waves that come to the northern coastal area of Java Island are waves that develop in the closed

Java Sea, which is surrounded by islands. Since the average monthly wave height is about 1.0~1.4 m (Figure 2.1.7), the corresponding period is estimated to be about 5~6 s.



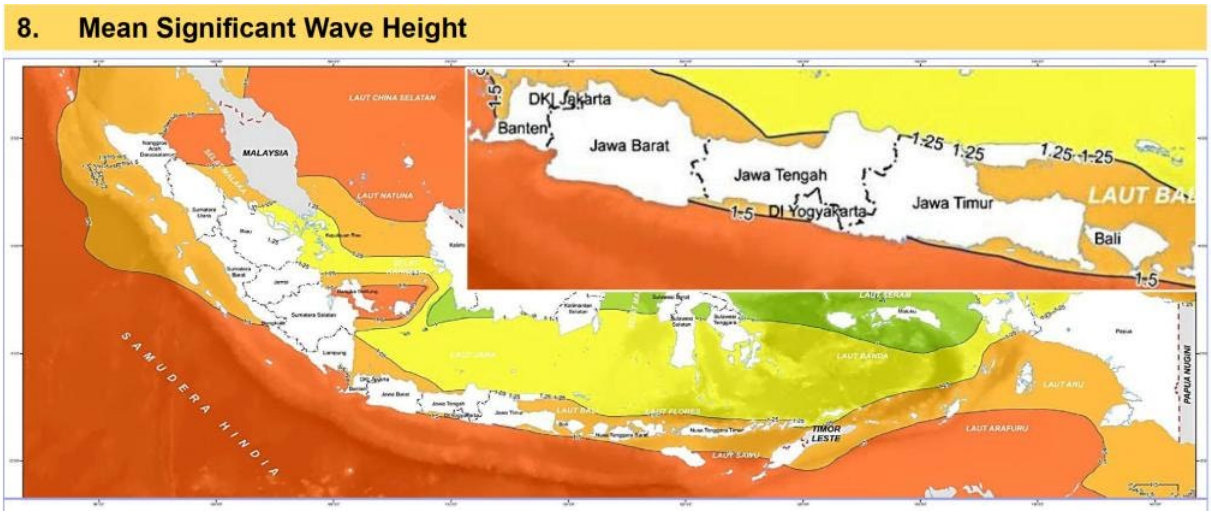
Source: ICCSR-BAPPENAS, 2010

Figure 2.1.4 Monthly Mean Significant Wave Height (Top: January, Bottom: August)



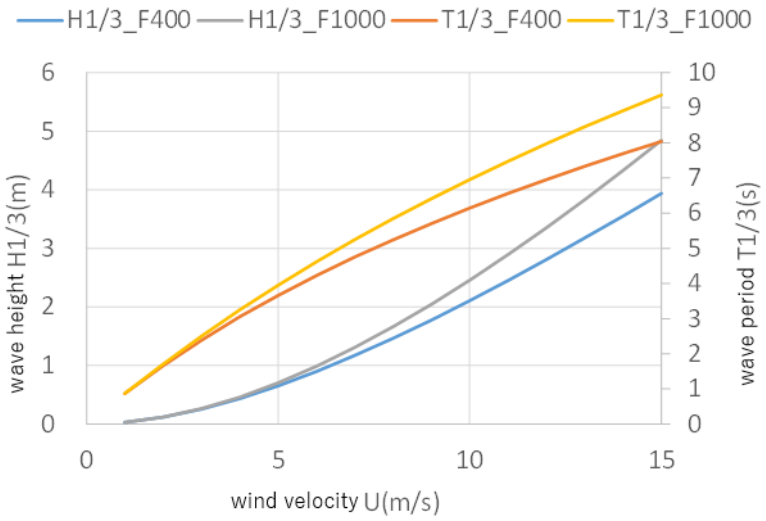
Source: A.Wirasatriya et al. in Earth & Environmental, 2018

Figure 2.1.5 Wind Direction and Sea Surface Temperature in the Java Sea (Top Left: January, Top Right: April, Bottom Left: August, Bottom Right: November)



Source: KKP, 2009

Figure 2.1.6 Distribution of Mean Significant Wave Heights Around Java Island

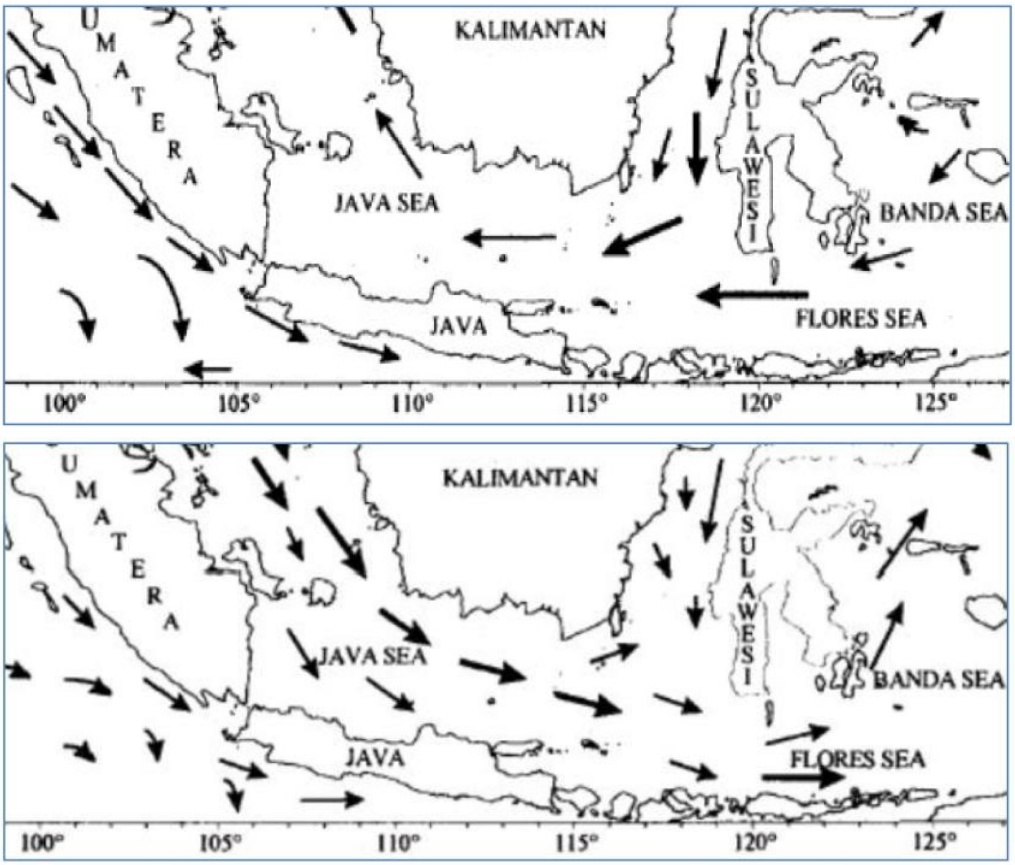


Source: JICA Study Team

Figure 2.1.7 Wave Estimation Result by SMB Method

2.1.4 Sea Current

The seasonal sea current pattern of the Java Sea is shown in Figure 2.1.8. The sea current in the Java Sea is influenced due to the predominant winds depending on the season. During the southeast monsoon season from May to September, the predominant winds are from the east, resulting in a predominant sea current from east to west direction. During the northwest monsoon season from October to March, the predominant winds are from the west, resulting in a predominant sea current from west to east direction. The eastward current of the southeast monsoon is slightly prominent off the northern coast of Java.



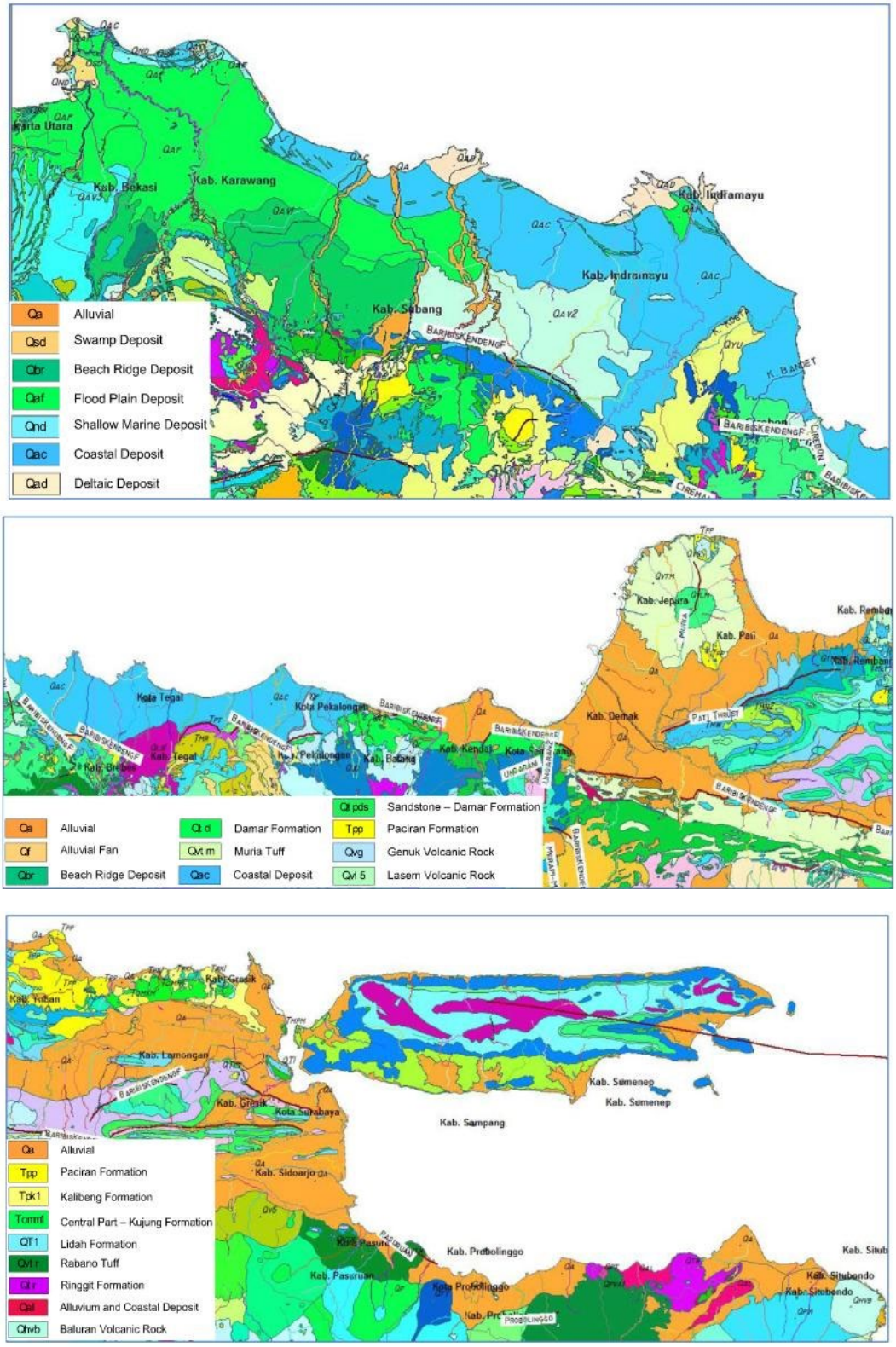
Source: Wyrtki, Nugroho et al, 2007

Figure 2.1.8 Sea Current in the Java Sea (Top: Southeast Monsoon, Bottom: Northwest Monsoon)

2.1.5 Geology and Sediment

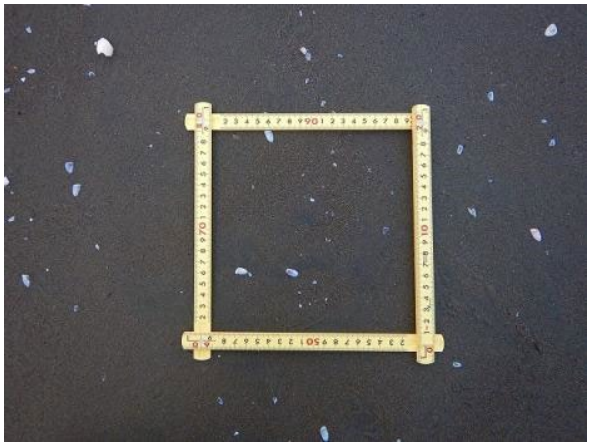
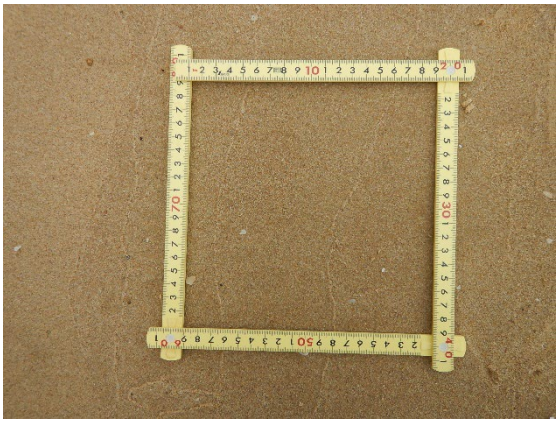
The geology that constitutes the coastal area is shown in the distribution map shown in Figure 2.1.9 according to the Previous Study. Most of the subject beach is classified as coastal sediment (Qac) and contain fine sand or silt and clay.

The beach sediment conditions based on the site reconnaissance survey (June-July 2022) are summarized in Figure 2.1.10.



Source: MEMR,2012

Figure 2.1.9 Geological Map (Top: West Java, Middle: Central Java, Bottom: East Java)

Behind Offshore Breakwaters in Indramayu	West Side of Pemalang
Silty Sand	Very Fine Sand
	
East Side of Pemalang	Rembang
Very Fine Sand	Very Fine Sand
	
West Side of Tuban	East Side of Tuban
Fine Sand	Fine Sand
	

Source: JICA Study Team

Figure 2.1.10 Sediment Conditions on the Beach at the Time of the Site Survey

2.2 Characteristics of the Natural Environment of the Coast and Its Usage

2.2.1 Administrative and Population

There are five provinces along the North Coast of Java Island. DKI Jakarta which is in the middle of the economy in Indonesia is located here so that it is a concentrated population and industry. The outline of the five provinces is shown in Table 2.2.1.

Table 2.2.1 Outline of Five Provinces of North Java Coast

Province	Banten	DKI Jakarta	West Java	Central Java	East Java
Administrative	4 cities 4 regencies	5 cities 1 regency	5 cities 18 regencies	6 cities 29 regencies	6 cities 29 regencies
Area（km2）	9,662.92	664.01	35,377.76	32,800.69	47,803.49
Population (people, 2021)	12,061,480	10,609,700	48,782,400	36,742,500	40,878,800
Poverty (people)	867,230	501,920	4,195,340	4,109,750	4,572,730

Source: DKI Jakarta, 2022

Table 2.2.2 shows the regencies and cities along the north coast of Java Island of the five provinces. The disclosed data by each regency or city is used for the environment and social consideration survey in priority areas.

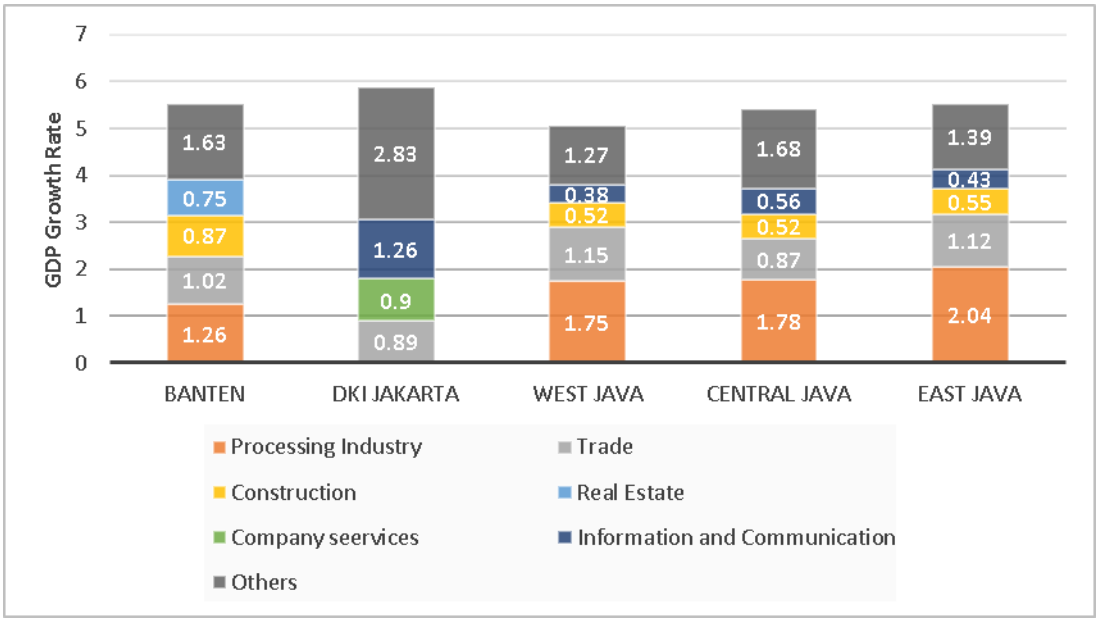
Table 2.2.2 Regencies and Cities along the North Coast of Java Island

Province	Regency and City
Banten	Regency: Tangerang, Serang City: Serang, Cilegon
DKI Jakarta	North Jakarta City
West Java	Regency: Bekasi, Karawang, Subang, Indramayu, Cirebon City: Cirebon
Central Java	Regency: Brebes, Tegal, Pemalang, Pekalongan, Batang, Kendal, Demak, Jepara, Pati, Rembang City: Pekalongan, Tegal, Pemalang
East Java	Regency: Tuban, Lamongan, Gresik, Sidoarjo, Pasuruan, Probolinggo, Situbondo City: Pasuruan, Surabaya, Probolinggo

Source: JICA Study Team

2.2.2 Economics

The ratio of industrial sectors to GDP growth rate of the five provinces along the north coast of Java Island is shown in Figure 2.2.1. The information and communication sector accounts for the largest share in DKI Jakarta, while manufacturing and processing industries account for the largest share in the other provinces. “Others” include primary industries such as agriculture and fisheries.



Source：Edited by JICA Study Team

Figure 2.2.1 Ratio of Sectors to GDP Growth Rate

In addition, one of the industries considered most vulnerable to coastal projects is the fishing industry. The fisheries industries in the five provinces along the north coast of Java Island are summarized in Table 2.2.3. In particular, Central Java has a large fish catch and numerous fishing ports. Therefore, it is assumed that many fishermen are working on the coast on a daily basis and could be affected by the Project.

Table 2.2.3 Fishery Status in Five Provinces along the North Coast of Java Island in 2020

Items		Banten	DKI Jakarta	West Java	Central Java	East Java
Fishing Port		27	2	49	76	57
Fish Market (auction)		27	2	41	74	44
Catch	Average ton/day	90.6	322	259.2	828.8	630.7
	Price (IDR 1,000)	102,445 810	2,403,658,824	670,410,064	2,013,362,712	1,562,036,347

Source: Statistics of Fishing Port, 2020, Statistic Indonesia (BPS)

2.2.3 Ethnicity and Religion

The ethnic distribution on Java Island consists of mostly Javanese, mainly in the eastern and central parts, and Sundanese, who are living in the western part. The Indramayu-Cirebon Region has a high mixture of Javanese and Sundanese. Although both Javanese and Sundanese have modernized their lifestyles, traditional customs such as weddings remain. The religions of Java Island residents include Christianity and Buddhism, in addition to Islam, which accounts for more than 90 %.

Another ethnic group/community living on the north coast of Java Island is called Dayak Losarang in Krimun Village, located about 15 km west of Indramayu. They have formed a community since the 1970s, with their customs and beliefs, and they do not carry ID cards (KTP), because they do not fit into the government's six religions. Kudus, Pati, Rembang, Blora, Bojonegoro, and Ngawi Regency also have an ethnic group called Samin. Their largest community is located in the mountainous area of Blora, 30 kilometers south of the urban area of Rembang. Many of them are engaged in agriculture and have the custom of not sending their children to school. However, these two ethnic groups/communities are not registered in the list of the Customary Territory Registration Agency, BRWA (Indonesian NGO).

2.2.4 Cultural Heritage

There are no World Heritage Sites along the north coast of Java Island. However, the Tentative List of World Heritage Sites includes the old city of Jakarta, coastal islands, and the old city of Semarang, and the registration process is currently underway.

In addition, the legal UU No. 11 of 2010 stipulates that buildings, structures, locations, and areas that need to be preserved from the viewpoint of history, science, education, religion, and culture shall be registered as national cultural heritage. National cultural heritage sites located by local governments in the north coast of Java Island are shown in Chapter 6.2.

2.2.5 Tourism Resources

The north coast of Java Island has tourism resources such as sandy beaches, cultural heritage sites such as mausoleums, recreational facilities such as swimming pools, and ecotourism sites that utilize mangrove forests. Tourism facilities located in the coastal area of Northern Java are described in Chapter 6.2.

2.3 Related Organizations Related Laws, Regulations, Organizations, and Responsibilities

2.3.1 National and Central Government-Level Organizations

The jurisdiction of coastal business-related organizations at the national and central government levels will be organized. The jurisdiction of each ministry is specified by the presidential decree relating to each ministry based on Presidential Decree No. 165 of 2014, "Tasks and Functions of the Ministries" or Presidential Decree No. 67 of 2019 "Tasks and Functions of Ministries from 2019~2024". In addition, the jurisdiction within the ministry is stipulated by the presidential decree for the directorate general and the ministerial decree for the directorate below it. Table 2.3.1 lists the organizations associated with coastal operations.

Table 2.3.1 Organizations Related to Coastal Operations (National and Central Government Level)

Organization	Role Related to Coastal Operations	Laws and Regulations Governing the Roles
Ministry of National Development Planning (BAPPENAS)	Formulation, coordination, and implementation of national medium-term development plans	Presidential Decree No.65 of 2015
Coordinating Ministry for Maritime and Investments Affairs (Kemenko Marves)	Inter-agency coordination on marine policy and marine infrastructure development policy Ministries under the jurisdiction are the Kemenhub, KKP, Kemenparekraf, and ESDM	Presidential Decree No.71 of 2019
Coordinating Ministry for Economic Affairs (Kemenko Perekonomian)	Planning for economic policy and coordination among relevant ministries and agencies Ministries under the jurisdiction are the PUPR, ATR, KLHK, Ministry of Finance, Ministry of Industry, Ministry of Trade, Ministry of Agriculture, Ministry of Manpower, Ministry of Small and Medium Scale Business, State Ministry of State Owned Company	Presidential Decree No.8 of 2015
Ministry of Public Works and Housing (PUPR)	Policy formulation, implementation, and management related to coastal flood control and the development and maintenance of coastal infrastructure	Presidential Decree No.27 of 2020
Ministry of Marine Affairs and Fisheries (KKP)	Policy formulation, implementation, management, and preparation of standards for coastal space planning, structural development in coastal conservation areas, integrated coastal management, disaster prevention measures, etc.	Presidential Decree No.16 of 2015
Ministry of Environment and Forestry (KLHK)	Policy formulation, implementation, and management of marine conservation, mangrove conservation, and national management of marine protected areas	Presidential Decree No.92 of 2020
Ministry of Agrarian Affairs and Spatial Planning (ATR)	Planning, implementation, and management of national land spatial planning, land use, and land regulation	Presidential Decree No.17 of 2015
Ministry of Energy and Mineral Resources (ESDM)	Policy formulation, implementation, and management related to the development of oil and gas resources in the seabed and the management and regulation of resource extraction such as sea sand	Presidential Decree No.68 of 2015
Ministry of Tourism and Creative Economy (Kemenparekraf)	Policy formulation, implementation, and management related to the development and management of marine tourism	Presidential Decree No.96 of 2019
Ministry of Transportation (Kemenhub)	Policy formulation, implementation, and management related to the management and regulations of marine transport	Presidential Decree No.40 of 2015
National Disaster Mitigation Agency (BNPB)	Policy formulation, implementation, and management related to the disaster mitigation including tidal flood	Presidential Decree No.1 of 2019

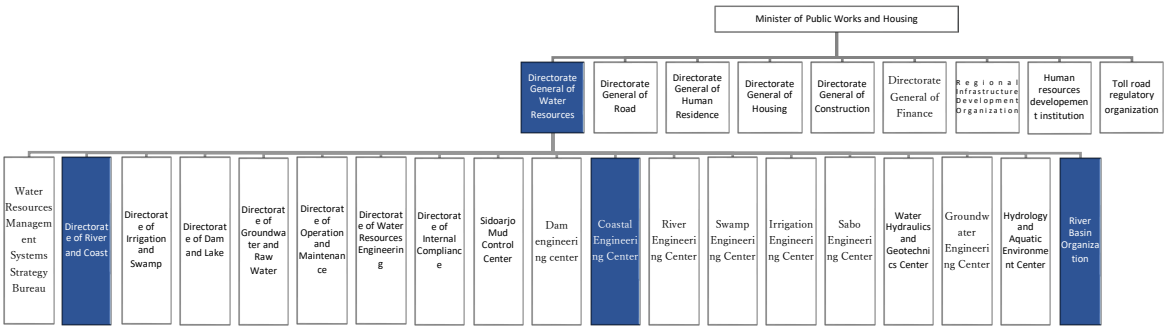
Source: JICA Study Team

Among the above, PUPR, KKP, and KLHK are listed as organizations deeply involved in the implementation of coastal conservation. The outline of these organizations is summarized below.

Ministry of Public Works and National Housing (PUPR)

PUPR is responsible for managing water resources, including coastal area.

Coastal management fall under the jurisdiction of the Directorate General of Water Resources (DGWR), with the Directorate of River and Coast being in charge of coastal operations and the Coastal Engineering Center providing technical support. In addition, the River Basin Organization Headquarter/Office (BBWS, BWS) implements coastal operations in each region under its charge.



Source: Final Report, the Previous Study (October 2021, JICA)

Figure 2.3.1 Organizational Chart of PUPR

The functions of DGWR are formulation, implementation, compilation of standards, and business evaluation of policies related to the conservation of water resources, the use of water resources, and the management of flood damage. Of these, the content related to the coast is “management of flood damage”. According to PUPR Regulation No. 7 of 2015, the task of “coastal conservation” is to protect against erosion and sedimentary damages from coasts and estuaries. The protection targets are coastal housing, public facilities, and areas with high economic or historical value, and national strategic value. From the information, it is conceivable that the focus is on the so-called “protection”, focusing on erosion countermeasures.

The jurisdiction of the Directorate of River and Coast includes planning, design, formulation of maintenance plans, preparation of technical standards, technical support of local governments, and monitoring evaluation of major drainage channels of rivers, coasts, and cities. The Directorate of River and Coast is divided into a total of four departments: Sub-Directorate of River and Coastal Technical Planning and the three Sub-Directorates of Region that divide the whole country of Indonesia into three categories. Each department is composed of about 15 staff members (12 engineers and 3 administrative assistants). All engineers are in charge of both rivers and coasts.

The Balai Teknik Pantai provides technical services such as testing, evaluation, inspection, and certification related to coastal management technology. Its predecessor was a research institute of the PUPR, which was established under DGWR in 2020. There are 13 staff members (8 engineers and 3 administrative assistants) as of May 2021.

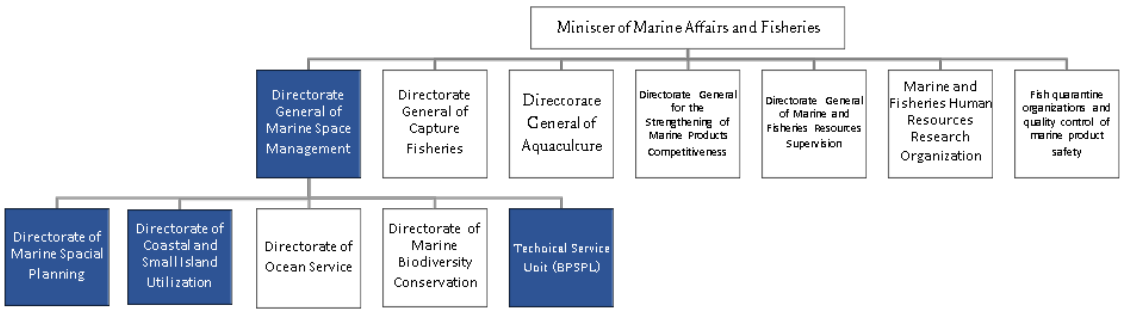
The River Basin Management Organization is the local secretariat of the DGWR, and it has a large basin control office (BBWS) and a small basin control office (BWS). Although the functions of BBWS and BWS

are mainly water resource control and river control, they also include the implementation of flood control measures on the coast.

Ministry of Marine Affairs and Fisheries (KKP)

Marine space management and coastal and small islands management are the jurisdictions related to the coastal management of KKP.

The Directorate General of Marine Space Management is in charge of coastal management within KKP, in which the Directorate of Marine Spatial Planning is in charge of the management of marine space planning Additionally, the Directorate of Coastal and Small Islands Utilization is in charge of integrated coastal management. Moreover, the Technical Service Unit, a regional office, is in charge of coastal management in each region under its charge.



Source: Final Report, the Previous Study (October 2021, JICA)

Figure 2.3.2 Organizational Chart of KKP

The Directorate General of Marine Space Management has a wide range of jurisdictions, including spatial planning of territorial waters, coastal and small island zoning, structural development and utilization of coastal conservation areas, protection of biodiversity, integrated coastal management, rehabilitation, reclamation, disaster prevention measures for coastal and island disasters, formulation, implementation, and compilation of standards, and evaluation of policies in the field of marine services. Major functions related to coastal management include activities related to the utilization of the coast, such as the formulation of the marine space plan and integrated coastal management. On the other hand, there are overlaps with PUPR's jurisdictions, such as disaster management.

The Directorate General of Marine Space Management has five departments, each of which has a system for preparing standards on space planning, coastal management, marine utilization, biological conservation, etc., and a system for implementing management based on those standards in the Technical Service Unit. Table 2.3.2 provides a summary of each department.

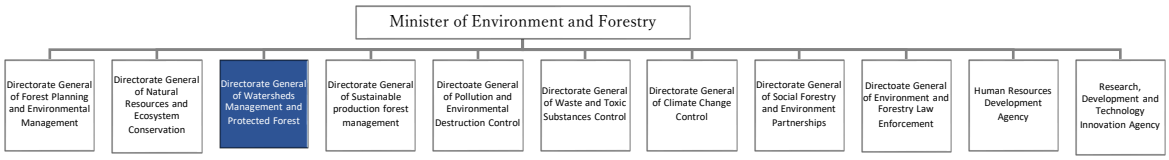
Table 2.3.2 Overview of Departments of the Directorate General of Marine Space Management of KKP

Department	Overview of Task
Directorate of Marine Spatial Planning	Policies and standards development, supervision, evaluation, etc., related to marine spatial planning (RZWP-3-K)
Directorate of Coastal and Small Islands Utilization	Integrated coastal management, rehabilitation, disaster prevention, and climate change adaptation policies, standards development, supervision, evaluation, etc.
Directorate of Marine Services	Policies and standards development, supervision, evaluation, etc. related to seawater utilization, installation of offshore buildings, tourism, shipwrecks, landfills, etc.
Directorate of Marine Biodiversity and Conservation	Setting and utilization of conservation areas, policies and standards development, supervision, evaluation, etc., related to biodiversity conservation
Technical Service Unit	Implementation of coastal utilization management, coastal conservation, disaster prevention, marine pollution control, and control of protected areas in the area under the charge of the four regional offices (BPSPL) nationwide.

Source: Final Report, the Previous Study (October 2021, JICA) Ministry of Environment and Forestry (KLHK)

Reforestation, including mangrove forests, is under KLHK's jurisdiction related to coastal management.

Within the KLHK, the department related to coastal management is the Directorate General of Watersheds Management and Protected Forest, which is engaged in mangrove forest conservation projects. The outline of the organization is described below.



Source: Final Report, the Previous Study (October 2021, JICA)

Figure 2.3.3 Organizational Chart of KLHK

As a control of the General Bureau of Watershed Management and Conservation Forests related to coastal management, there are conservation and regeneration of forests. The “National Strategy Plan and Policy on Mangrove Ecosystem Management” is carried out with the bureau as the center. The plan's action plan is to regenerate mangrove forests in 60,000 ha by 2045. Conservation and regeneration of forests are under the jurisdiction of the Directorate General of Watersheds Management and Protected Forest, which is related to coastal management. The directorate is taking the lead in implementing the “National Strategy Plan and Policy on Mangrove Ecosystem Management”. As an action plan, mangrove forest regeneration of 60,000 ha/year until 2045 is planned.

KLHK cited the following as the relevant departments in formulating the coastal conservation plan in this project. Table 2.3.3 provides a summary of each department.

Table 2.3.3 Outline of Coastal Conservation-related Departments of KLHK

Department	Overview of Task
Directorate of Coastal and Marine Pollution and Damage Control	Preparation and implementation, coordination and synchronization of policies on coastal marine pollution damage management, technical guidance and evaluation, supervision, etc.
Directorate of Regional and Sectoral Environmental Impact Prevention Policy	Formulation and implementation, coordination and synchronization of policies on regional and sectoral environmental impact prevention policies, technical guidance and evaluation, supervision, etc.

Source: JICA Study Team

2.3.2 Local Government-Level Organizations

At the provincial, regency, and municipality levels, the organizations involved in coastal management are the provincial government's Dinas Kelautan dan Perikanan (DKP) and the province's, regency's, and municipal's Directorate of Public Works (Dinas PU).

The general responsibility of DKP over coastal management is the formulation and implementation of policies for marine and coastal management. The general responsibility of the Dinas PU over coastal management is development and maintenance related to coastal management facilities.

Table 2.3.4 Overview of the Jurisdiction for Coastal Management by the Local Government

Department	Duties Related to Coastal Conservation
Department of Marine and Fishery (DKP, provincial government organization)	Policy formulation and implementation of marine and coastal management
Directorate of Public Works (Dinas PU)	Operations related to coastal management (development and maintenance)

Source: Final Report, the Previous Study (October 2021, JICA)

2.3.3 Implementation System

In Indonesia, decentralization was implemented in January 2001 based on Law No. 22 of 1999, "Local Government Law", and No. 25 of the same year, "Central and Local Finance Equilibrium Law". Water resource management, including coastal management, has also been transferred to local governments.

The system for implementing coastal control (protection) related to PUPR is stipulated in Law No. 23 of 2014 concerning local government, and the jurisdictions of the central and local governments are regulated by operation areas, as shown in Table 2.3.5. Local offices of the central government, such as BBWS, are supposed to take charge of projects in the area under the jurisdiction of the central government, but in reality, there are cases in which projects in the area under the jurisdiction of the local government are being implemented.

Table 2.3.5 Spatial Jurisdiction of Water Resource Management (Including Coastal Protection)

Subject Area	Central Government	Provincial Government	Regency/City Government
Water Resources Management (Including coastal protection)	Water resources management and coastal protection structure in inter-provincial river basin, trans-national river basin, and nationally strategic river basin	Water resources management and coastal protection structure in the river basin crossing regency/city region	Water resources management and coastal protection structure in the river basin, which is in one region of regency/city.

Source: Final Report, the Previous Study (October 2021, JICA)

Table 2.3.6 shows the implementation system of coastal management (mainly in terms of utilization) related to KKP. Management of coastal utilization is under the jurisdiction of the provincial government. On the other hand, it is clearly stated that the land will be managed by the regency or city government under the direction of the provincial government. However, there are cases where the regency or city manages areas that are legally defined as coastal areas, such as sandy beaches, and there is a possibility that strict operation is not being carried out.

Table 2.3.6 Jurisdiction of Coastal Management

Subject Area	Central Government	Provincial Government	Regency/City Government
Marine fishery	Management of marine space beyond 12 miles from the shoreline and in the National Strategic Area, issuance of permits for the use of such areas, determination of conservation areas, and management of databases (of coastal and small islands)	Management of marine space within 12 miles of the coastline (excluding oil and gas), issuance of licenses for use of the above areas (excluding oil and gas), and strengthening of coastal and small island communities	No description of coastal use (fisheries and aquaculture licensing, business support, market management, etc.)

Source: Created by JICA Study Team based on UU No.23 2014

2.4 Coastal Management and Related Laws and Regulations

2.4.1 Laws and Regulations Concerning Coastal Conservation

Laws and regulations related to coasts in Indonesia include, UU No. 27 of 2014, UU No. 1 of 2014, and UU No. 17 of 2019, These laws define coastal areas (UU No. 27 of 2014 and UU No. 1 of 2014), and the role of coastal areas as part of water resource management (UU No. 17 of 2019). In addition to these laws, there are ministerial ordinances issued by relevant ministries, such as regulations on coastal protection by PUPR, regulations on coastal management by KKP, and regulations on mangrove management by KLHK and the Coordinating Ministry for Economic Affairs.

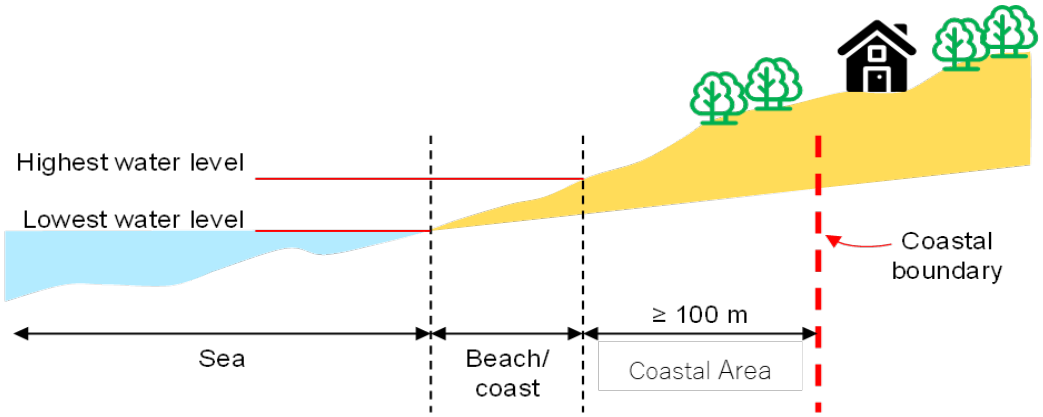
Table 2.4.1 Laws on Coastal Conservation

Type		Law Number, etc.	Main Contents
Undang-Undang (UU) Legal/Peraturan Pemerintah Pengganti Undang-Undang (PERPU)		PERPU No. 2 of 2022 UU No. 1 of 2014 UU No. 27 of 2007	Definition, management and use of coastal zones
		PERPU No. 2 of 2022 UU No. 17 of 2019	Management and conservation of water resources including coastal areas
Peraturan Pemerintah (PP) Cabinet Order		PP No. 64 of 2010	Matters concerning disaster mitigation in coastal areas and small islands
Peraturan Presiden (Perpres) Presidential Decree		Perpres No. 18 of 2020	RPJMN 2020-2024 National Medium-Term Development Project
		Perpres No. 51 of 2016	Determination of coastal areas of local governments
		Perpres No. 73 of 2015	Coordination of coastal and small island coastal management
		Perpres No. 121 of 2012	Rehabilitation of coastal areas and small islands by governments, local governments and stakeholders
Peraturan Menteri (Ministerial Regulation)	PUPR	Permen PUPR No. 7 of 2015	Coastal protection against storm surges, coastal erosion, estuarine sedimentation, etc.
		Permen PUPR No. 9 of 2010	Coastal protection guidelines
	KKP	Permen KP No. 21 of 2018	Procedures for determining and calculating coastal areas Coastal and small island management plans by local governments
		Permen KP No. 23 of 2016	Coastal and small island management plans by local governments
		Permen KP No. 24 of 2016	Rehabilitation of coastal areas and small islands
		Permen KP No. 1 of 2016	Data and information management in coastal and small islands
		Permen KP No. 17 of 2013 Permen KP No. 28 of 2014	Permission for reclamation of coastal areas and small islands
	Coordinating Ministry for Economic Affairs	Permen Kemenko perekonomian No. 4 of 2017	Policies, strategies, programs, and performance indicators for national mangrove ecosystem management
	KLHK	Permenhut No. 32 of 2009 Permenhut No. 35 of 2010	Procedures for establishing technical plans for the rehabilitation of forests and watersheds, including mangroves
	ATR	Permen ATR No. 17 of 2016	Regulation of land use in coastal and small islands

Source: JICA Study Team

2.4.2 Definition of Coastal Areas

The coastal setback is defined in Presidential Decree No. 51 of 2016 as the land on beachside with proportional width to the coast's shape and physical condition, and a minimum width of 100 m from the highest water level. Provincial and city/regency governments are obligated to determine their coastal setback in their RTRW (Rencana Tata Ruang Wilayah, Spatial Plans). Setback determination is aimed at ecosystem and resource conservation/sustainability, protection from disaster, and public space. The width of setback depends on the characteristics of topography, biophysics, hydro-oceanography, and among others. The calculation method is described in Permen (Peraturan Menteri, Ministerial Regulation), where the risk of disaster must be considered.



Source: Final Report, the Previous Study (October 2021, JICA)

Figure 2.4.1 Determination of Coastal Boundary Based on Presidential Decree No.51 of 2016

2.4.3 Coastal Management

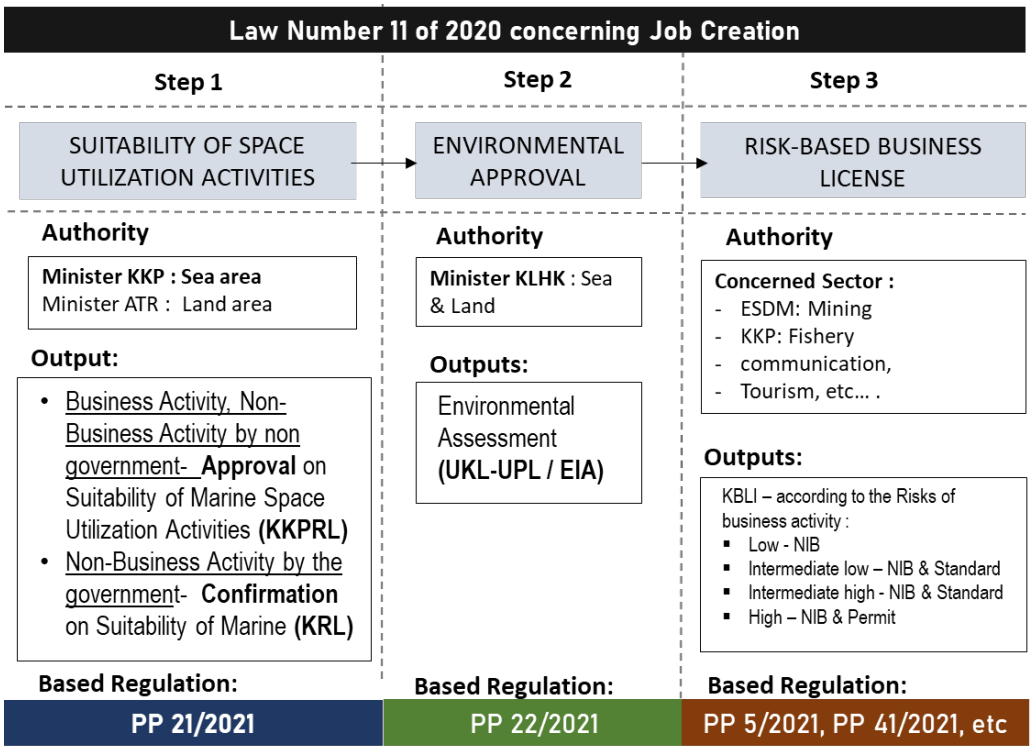
In Indonesia, there is no plan that shows the future coastal conservation plan for the purpose of protection, utilization and environmental conservation like the coastal conservation basic plan in Japan. On the other hand, there is a spatial plan (RTRW) which is put together in each province and KKP manages the plan, similar to the coastal conservation basic plan in Japan and is called "Spatial Plan for Water Area (RZWP-3-K)". This shows the zoning according to the characteristics and use of each area in the water areas up to 12 miles from the shoreline. It should be noted that KKP began to centrally manage spatial planning of the sea areas after 2017, when the operation started following the enforcement of the law (UU No.23/2014) in 2014, Before that, it was formulated individually by each province and each regency. The purpose is to unify the definition on the spatial planning of each island in Indonesia, to unify information, and to unify and simplify the licensing. Therefore, when planning a project such as construction in the water area within this area, it is necessary to confirm the consistency with this spatial plan and to carry out necessary licensing procedures (Refer to 2.4.4 for details).

Previously, the water area from 0 ~ 4 miles from the shoreline was under the jurisdiction of the regency, and the water area from 4 to 12 miles from the shoreline was under the jurisdiction of the province., However, in response to the abovementioned regulation (UU No.23 of 2014), the water area from 0 ~12 miles from the shoreline has become under the jurisdiction of the province since 2017. Spatial plans for sea areas are prepared for each province and approved by the governor of the province, but the prepared draft of the spatial plan is monitored and confirmed by KKP before being formally enacted. However, as KKP has only recently

established a centralized management system for spatial planning, work is currently underway to establish it. Furthermore, the revision of the act (UU No.11 of 2020) stipulates that spatial planning (RTRW) in the land area managed by the ATR and spatial planning in the sea area by the KKP should be integrated. Procedures for enacting the integrated spatial planning are being advanced in each province.

2.4.4 Procedures for the Use of Coastal Space

According to Law No. 11 of 2020 concerning Job Creation (Article 16(2)), all users of coastal space are required to obtain a business permit related to maritime use from the central government. The approval process for space utilization is outlined in three steps: In Step 1, approval for space utilization is to be obtained from KKP for sea areas and from ATR for land areas. In Step 2, approval related to the environment is to be obtained from KLHK. In Step 3, a business license is to be obtained from relevant ministries and agencies based on the content of the business to be applied for. The approval procedure for the use of space in Step 1 is explained below.



Source: JICA Study Team

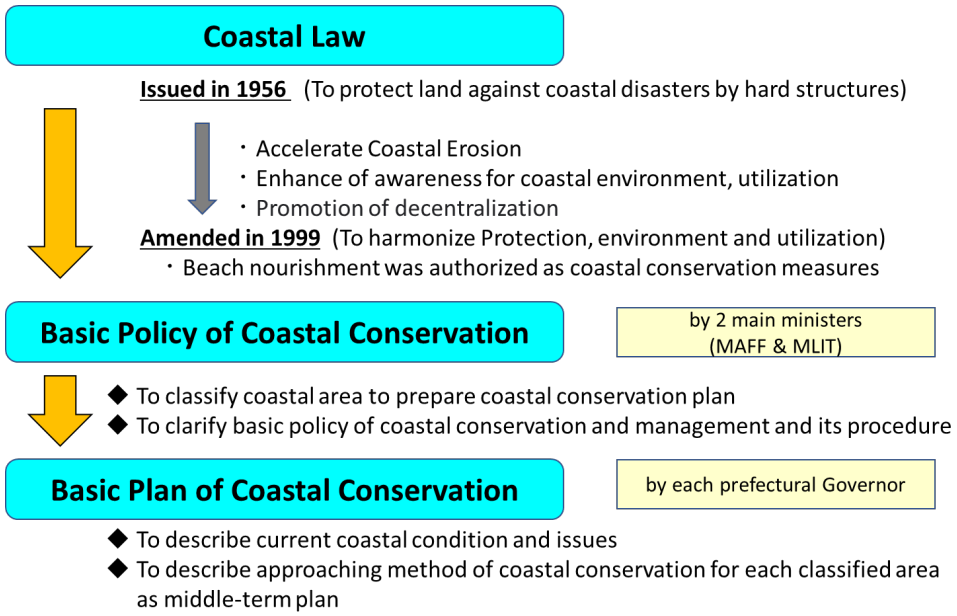
Figure 2.4.2 Procedures for Obtaining the Permit for Business in Coastal Areas

In accordance with the KKP Ordinance No. 28/ KP/2014, approval of "KKPRL: Kesesuaian Kegiatan Pemanfaatn Ruang Laut (Suitability of Marine Space Utilization Activities)" or confirmation of "KRL: Kesesuaian Ruang Laut (Suitability of Marine Space) is mandatory, as the approval procedure for space utilization in Step1. The procedure depends on the activity and the applicant, as shown in the table below. Verification by KRL is required for non-governmental activities. The difference between KKPRL and KRL procedures is whether or not taxable state revenues (PNBP: Penerimaan Negara Bukan Pajak (Non-Tax State Revenue)) are paid, and payment is not required in KRL. In the coastal conservation project by PUPR, the verification procedure by KRL is required.

2.4.5 Laws Concerning Coastal Conservation in Japan and Indonesia

The coast is a unique space where the land and the sea meet. It is a valuable place where a variety of organisms live and breed. It is also an important space used for various human activities from the past to the present and into the future.

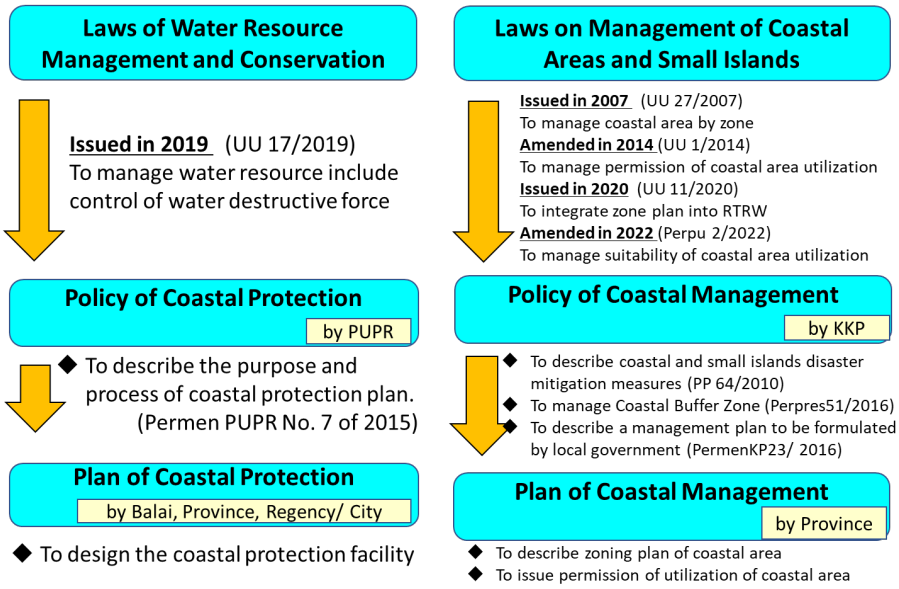
In order to manage these coasts, Japan has enacted the Coast Act, which protects the coasts from damage caused by tsunamis, storm surges, waves, and other changes in seawater or ground. Additionally, it, aims to improve and preserve the coastal environment and promote the proper use of the public coasts, thereby contributing to the conservation of the national land. The Japan's Coast Act, in addition to the definition of coastal protection facilities and public coasts, and the provisions of coastal managers, clearly states that the "Basic Policy on Coastal Protection" and the "Basic Plan for Coastal Protection" regarding the conservation of coasts in the Coastal Protection Area must be established, along with the designation of the Coastal Protection Area, as described in 3.3.2. Based on such policies and plans, it is also stipulated that the management of the costal conservation area shall be carried out by the prefectural governor who controls the area where the costal conservation area belongs.



Source: JICA Study Team

Figure 2.4.3 Legal Framework for Coastal Conservation in Japan

In Indonesia, there are laws and regulations related to the coast, including UU No.27 of 2014, UU No.1 of 2014, and UU No.17 of 2019. However, each of them only defines coastal areas (UU No.27 of 2014 and UU No.1 of 2014) and describes coastal areas as part of water resources management (UU No.17 of 2019). The formulation of plans for coastal protection, utilization, and environmental protection, such as Japan's Coastal Protection Plan, is neither stipulated, nor is specified in the respective ministerial ordinances. The closest plan to a coastal conservation plan is "the Spatial Plan for Water Area (RZWP-3-K)", centrally managed by the KKP, but it only shows zoning. In Indonesia, although the concept of Integrated Coastal Zone Management (ICZM) exists, it is only a list of comprehensive and across-the-broad development plans for various development projects. It is not an integrated concept that shares the objectives of short- and medium-term coastal conservation, utilization, and protection.



Source: JICA Study Team

Figure 2.4.4 Legal Framework for Coastal Conservation in Indonesia

Table 2.4.2 shows the differences in coastal protection laws between Japan and Indonesia. In Japan, protection, environment, and maintenance are advocated in one coastal law, and each ministry, such as the Ministry of Land, Infrastructure, Transport and Tourism (PUPR) and the Ministry of Agriculture, Forestry and Fisheries (KKP), is touted as the implementing agency. On the other hand, Indonesia'scoastal conservation and coastal protection are regulated by separate laws. Since KKP is responsible for coastal conservation, and PUPR is responsible for coastal protection, each implementing agency is considered to be the root cause of the lack of integration of protection, environment, and utilization.

In the Japanese law, the basic coastal policy specifies the policy on coastal protection, coastal environment, and coastal use. In accordance with this policy, the prefectural governor formulates a basic plan for coastal conservation. Based on the basic plan, each related organization carries out its own conservation projects and conservation activities.

On the other hand, as mentioned above,coastal conservation and coastal protection in Indonesia are implemented under separate laws and policies, which is considered to be one of the major factors that make it difficult to balance protection, utilization, and the environment.

Table 2.4.2 Differences between Japan and Indonesia in the Items and Contents of Laws Related to Coastal Protection

Main Items	Description in Coastal Act of Japan	Description in Related laws/Regulation in Indonesia
Purpose of the Act	The objective is to protect the coast from damage caused by tsunamis, storm surges, waves, and other changes in the sea or ground, and to contribute to the conservation of the national land by promoting the development and conservation of the coastal environment and the proper use of the coast by the public.	This law provides the management of coastal and small island areas, and one of the objectives of management is to protect, conserve, restore, use, and enrich the resources and ecosystems of coastal and small island areas (UU No. 27 of 2014 and UU No. 1 of 2014) This law governs water resources management in the entire country; water resources management includes conservation, utilization, and control of the destructive power of water. It states that the conservation of water resources must be carried out in various water bodies, including coastal areas. (UUNo.17 of 2019)
Definition	Definition of coastal conservation facilities, public coast, general public coastal zone (coastal conservation area, etc.), and coastal managers	Language definition for management of coastal areas and small islands, coastal areas, coastal waters, strategic plans, zoning plans, management plans, coastal boundaries, etc. (UU No. 1 of 2014)
Basic Policy for Coastal Conservation	A competent minister shall formulate the “Basic Policy on Coastal Conservation” for the conservation of the coastal conservation area, etc.	There is no description on the policy of coastal conservation. A strategic plan is a plan that includes cross-cutting policy directions for a planned development area and sets broad goals, objectives, strategies and targets. (UU No. 1 of 2014)
Basic Plan for Coastal Conservation	A prefectural governor shall formulate a “Basic Plan for Coastal Conservation Plan” for the conservation of coasts in the coastal conservation area, etc. based on the basic policy for coastal conservation.	The zoning plan is analogous to the coastal conservation master plan. The plan determines the direction of resource use in each planning unit, determines the spatial structure and pattern within the planning area, and includes activities that can and cannot be implemented, and activities that can be implemented after obtaining permission. (UU No. 1 of 2014)
Designation of Coastal Conservation areas	A prefectural governor can, when he/she finds it necessary to establish or otherwise manage coastal conservation facilities in order to conserve the coast, designate a certain area pertaining to the coast to be protected as a coast preservation area. The designation shall be the minimum necessary and shall not exceed 50 meters from the coastline at high tide on land and from the coastline at low tide on the water surface. Provided, however, that when it is deemed to be unavoidable due to such circumstances as topography, geology, tide level, tidal current, etc., the designation may be made at a distance exceeding 50 m respectively.	Coastal zone is a transitional area between land and sea ecosystems affected by changes in land and sea. Coastal boundary is the land along the edge with a width proportional to the physical shape and condition of the coast, and a distance of at least 100 meters from the point of highest tide to the land. (From UU No.1 of 2014)

	Prefectural governors shall publicly notify the coastal conservation areas and report to the competent minister to that effect.	
Management of Coastal Conservation areas	The management of the coastal conservation areas shall be undertaken by the prefectural governors who supervise the areas where the coastal conservation areas exist.	It is stipulated that the governor shall submit the final document for the management plan of the coastal zone and small island of the province to the minister and the relevant mayor of the province (UU No.1 of 2014). However, there are no management plans similar to Japanese coastal conservation, and in reality, the zoning plan (spatial structure plan and spatial pattern plan) shown in Table 2.3.2 is being used as the main plan.

Source: Final Report, the Previous Study (October 2021, JICA)

2.5 Status of Coastal Development and Improvement and Future Plans

2.5.1 Ongoing and Future Development Plan in Coastal Area

Regarding the development plans for ports, toll roads, etc. in the north coast of Java Island, Table 2.5.1 summarizes the ongoing projects in the coastal and hinterland areas, and Table 2.5.2 summarizes the future development plan in the coastal and hinterland areas.

Projects currently being implemented in coastal areas include, port development, which is in progress in Subang, offshore breakwaters in Indramayu, toll roads in Kendal and Semarang and Demak, and fishing ports in Rembang. For projects in the hinterland, toll roads are implemented in Tangerang, the northern part of Java, Bekasi, Demak, Tuban, and flood countermeasures, wastewater projects, water supply projects, among others, are implemented in others.

Table 2.5.1 Ongoing Projects in Coastal Area

Activities/Area Regency/City	On Going Project (2022)	
	Coastal Area	Hinterland
1. Serang City		
2. Serang Regency	Estuary Protection of Cidurian River	
3. Tangerang Regency	NCICD	***Toll Road Cengkareng - Batu Ceper - Kunciran***
4. North Jakarta	NCICD (Pembangunan Pengaman Pantai di Pesisir Teluk Jakarta Tahap 6 Paket 1 - 6) (MYC)	***Toll Road Cengkareng - Batu Ceper - Kunciran***
		Access Road Tanjung Priok Port/ New Priok Eastern Access (NPEA)
5. Bekasi Regency	NCICD	***Toll Road Cibitung - Cilincing***
6. Karawang Regency		
7. Subang Regency	Patimban Port (stage II 2022 - 2024)	
8. Indramayu Regency	Breakwater Construction at near Port Area of Dadap Village	***Upgrading Kilang Eksisting (RDMP) dan Industri Petrokimia Balongan (MYC 2022-2027)***
	Breakwater Construction at Krangkeng, Indramayu	River Dike for Flood Controll of Cimanuk River at Rambatan Kulon Village
	Groin Construction at Pantai Glayem, Juntinyuat, Indramayu	***Revitalization of Salt Public Warehouse***
9. Cirebon Regency	Estuary Protection of Mundu River, Cirebon	
10. Cirebon City		
11. Brebes Regency		
12. Tegal City		
13. Tegal Regency		
14. Pemalang Regency		
15. Pekalongan Regency	Coastal Protection of Pekalongan City (1,3 Km by Central Java Province)	Flood and Tidal Flood Control Silempeng - Sengkarang and Bremi- Meduri River (MYC)
16. Pekalongan City	Coastal Protection of Slamaran 400 m & Degayu 1200 m (MYC)	Water Supply Intake Construction of Pekalongan City
		Barrage and Retention Pond Construction of Loji river
		Flood control and Tidal Flood of Loji - Banger River (MYC)
17. Batang Regency		***Development of Batang Industrial Area***
		Water Supply of Urang River
18. Kendal Regency	***Toll Road Semarang Harbour (26,2 km from Semarang - Kendal)***	
19. Semarang City	***Toll Road Semarang - Demak (integrated with sea dyke)***	
	Toll Road Semarang Harbour (26,2 km from Semarang - Kendal)	
	Tidal Dyke of Terboyo-KBT (East Canal)	System of Water Supply of West Semarang
	Semi Permanent Dyke of Tanjung Mas Port	Bringin Flood Controll
	Flood and Tidal Controll of Tambaklorok Area (MYC)	Development of Drainage At Ngepreh (900 m), Babon River (3100 m)
	Development of Drainage for Tambak Lorok Area	***SPAM Semarang Barat***
		Flood Controll of Penggaron River, Semarang City
20. Demak Regency	Toll Road Semarang - Demak (integrated with sea dyke) (multiyear contract)	Development of Drainage at Sayung River (4350 m)
		Toll Road Demak-Tuban ESP-ADB
21. Jepara Regency		
22. Pati Regency		
23. Rembang Regency	Coastal Protection of Karanganyar and Sarang Beach (3.5 km) (Multiyears Contract) ***Development of Fishery Port of Tasikagung, Rembang (using Central Java Province budget)***	***Revitalization of Salt Public Warehouse***
24. Tuban Regency		***Development of Tuban Oil Rifinery***
		Toll Road Demak-Tuban ESP-ADB
25. Lamongan Regency		
26. Gresik Regency		Flood Control of Lamong River

Source: JICA Study Team

Meanwhile, the future development plan in the coastal areas includes the development plan of Patimban Port in Subang, the fishing port improvement plan in Pekalongan, and the toll-road plan in Semarang and Demak. Future development projects in the hinterland include toll roads in Subang, Semarang, Demak and Tuban, as well as industrial area development in Subang and Brebes, flood control, drainage, and water supply projects in others.

Table 2.5.2 Future Development Plans in Coastal Areas

Activities/Area Regency/City	Future (2023-)	
	Coastal Area	Hinterland
1. Serang City		
2. Serang Regency		
3. Tangerang Regency	NCICD	
4. North Jakarta	NCICD (Pembangunan Pengaman Pantai di Pesisir Teluk Jakarta Tahap 6 Paket 1 - 6) (MYC)	
5. Bekasi Regency	NCICD	
6. Karawang Regency		
7. Subang Regency	***Patimban Port (stage II 2022 - 2024)***	***Access Toll Road of Patimban Port***
		Construction Main Drainage of Batang Industrial Area
8. Indramayu Regency		***Upgrading Kilang Eksisting (RDMP) dan Industri Petrokimia Balongan (MYC 2022-2027)***
9. Cirebon Regency		Cisanggarung River work: Dredging & Dike Improvement (ADB)
10. Cirebon City		
11. Brebes Regency	Brebes Coastal Protection (ADB Project)	***Development of Brebes Industrial Area***
	Cisanggarung Coastal Protection and Fresh Water Lagoon (ADB Project)	Cisanggarung River work: Dredging & Dike Improvement (ADB)
12. Tegal City		
13. Tegal Regency		
14. Pemalang Regency		
15. Pekalongan Regency	***Development and Dredging at Wonokerto Fishery Port (2023)***	Flood and Tidal Flood Control Silempeng - Sengkarang and Bremi- Meduri River (MYC)
16. Pekalongan City	Coastal Protection of Slamaran 400 m & Degayu 1200 m (MYC)	
	Construction of On-shore Pekalongan Fishery Port 2023-2025 (JICA)	
		Flood control and Tidal Flood of Loji - Banger River (MYC)
17. Batang Regency		Watersupply System and Pipeline of KIT Batang
		Wastewater Network of KIT Batang
18. Kendal Regency		
19. Semarang City	***Toll Road Semarang - Demak (integrated with sea dyke)***	
	Flood and Tidal Controll of Tambaklorok Area (MYC)	
20. Demak Regency	***Toll Road Semarang - Demak (integrated with sea dyke) (multiyear contract)***	
		Toll Road Demak-Tuban ESP-ADB
21. Jepara Regency		Flood Controll Serang - Wulan River (ADB)
22. Pati Regency		Flood Controll Juana River (ADB)
23. Rembang Regency	Coastal Protection of Karanganyar and Sarang Beach (3.5 km) (Multiyears Contract) 2023	
24. Tuban Regency		***Development of Tuban Oil Rifinery***
		Toll Road Demak-Tuban ESP-ADB
25. Lamongan Regency		
26. Gresik Regency		Flood Control of Lamong River

Source: JICA Study Team

2.5.2 Existing Plans Related to Coastal Management

Major Coastal Development Plans in the North Coast of Java Island

Regarding to coastal protection in the north coast of Java Island, Table 2.5.3 summarizes the existing plans for the 24 coasts as the target areas as mentioned above.

KKP mainly implements some countermeasures such as hybrid engineering, concrete structure measures, and mangrove plantation. Meanwhile, PUPR carries out the coastal measures by National Capital Integrated Coastal Development (NCICD) in Banten and DKI Jakarta. Additionally, there are existing projects by the Strategy Plan of PUPR in Pekalongan and Semarang.

Table 2.5.3 List of Previous Coastal Conservation Projects in the North Coast of Java Island

			Coastal conservation/development project				
Adominstrative		Name of City/regency	KKP (2015-2019)			PUPR	
province	regency/city		Hybrid Engineering (HE) System (11.8km)	Countermeasure by concrete structure (1.04km)	Planting mangroves (4.2 million)	Natinal Capital Integrated Coastal Development (NCICD)(Holand and S. Korea)	PUPR Strategy Plan: 2014－2019
BANTEN	3	Tangerang regency				○	
DKI JAKARTA	4	North Jakarta				○	
WEST JAVA	5	Bekasi regency				○	
	6	Karawang regency+A:A:O			○		
	8	Indramayu regency			○		
	9	Cirebon regncy	○		○		
CENTRAL JAVA	11	Brebes regency			○		
	12	Tegal city					
	14	Pemalang regency		○			
	15	Pekalongan regency					
	16	Pekalongan City					●
	17	Batang regency		○			
	18	Kendal regency			○		
	19	Semarang city					●
	20	Demak regency	○		○		
	21	Jepara regency					
	22	Pati regency		○	○		
	23	Rembang regency	○				
EAST JAVA	24	Tuban regency					
	26	Gresik regency	○		○		
	27	Surabaya city					
	28	Sidoarjo regency					
	31	Probolinggo regency			○		
	33	Situbondo regency					
		West Jakarta					

Source: An Overview of the North Coast of Java Island (Preliminary Survey and Data Collection)

Ministry of Marine Affairs and Fisheries (KKP)

KKP is conducting coastal restoration projects on the north coast of Java Island as a major activity in the mid-term plan of 2014 - 2019.

i) Implementation of erosion measures with the length of 11,800 m by hybrid-engineering (HE) system in Demak, Serang, Gresik, Rembang, and Cirebon

ii) Installation of shore protection facilities with the length of 1,040 m by concrete structures in Pati, Lamongan, Batang, and Pemalang

iii) Implementation of rehabilitation by transplanting mangroves in 10 regencies on the north coast of Java Island (Serang, Karawang, Indramayu, Cirebon, Brebes, Kendal, Pati, Demak, Probolinggo, Gresik)

iv) Establishment of disaster prevention information system and adaptation to climate change

Ministry of Public Works and Housing (PUPR)

PUPR prepared a strategic plan for 2014 - 2019 and implemented the following priority projects, led by BBWS.

i) Jakarta, Bekasi, and Tangerang

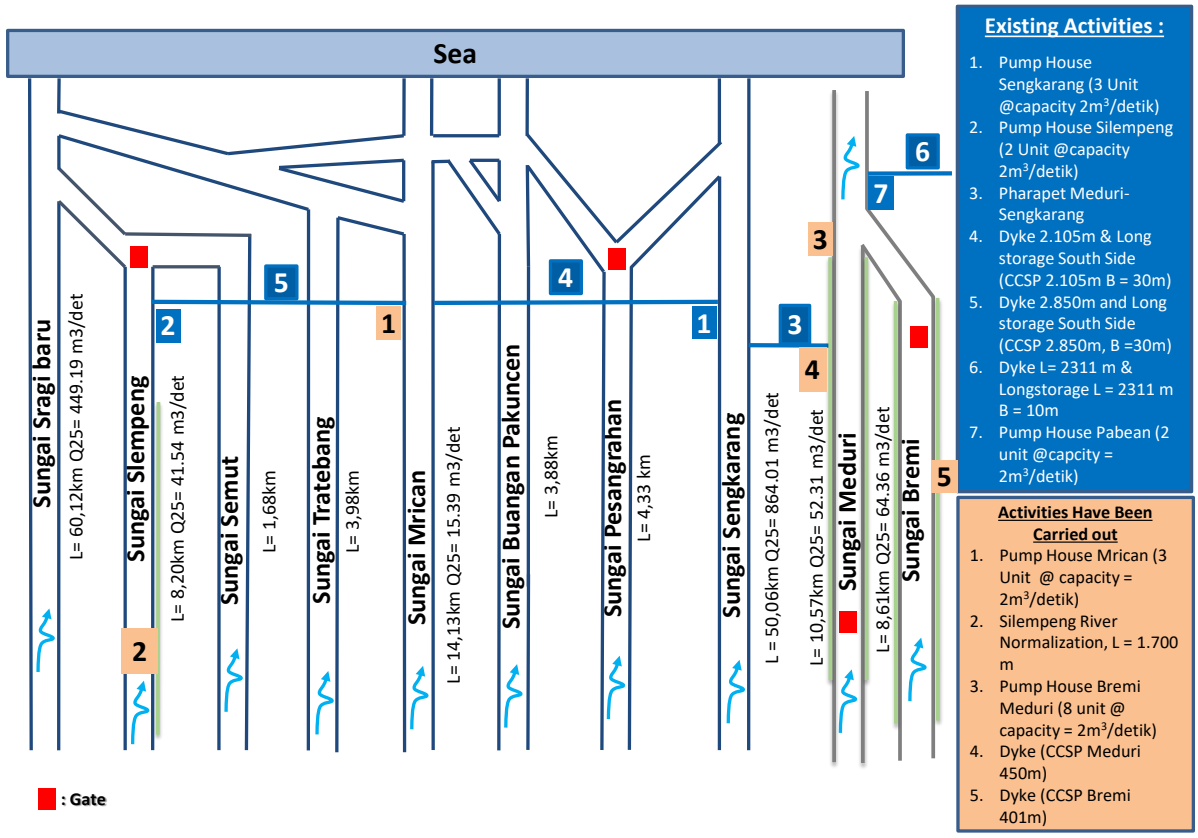
National Capital Integrated Coastal Development (NCICD) (funded by the Dutch and Korean Governments)

ii) Pekalongan

Figure 2.5.1 shows the outline of the flood or tidal flood measures projects for Pekalongan by BBWS Pemali Juana.

iii) Semarang

Figure 2.5.2 shows an outline of the current status and scheduled activities of flood and tidal flood management projects for Semarang by BBWS Pemali Juana.



Source: BBWS Pemali Juana, 2021

Figure 2.5.1 Overview of Flood/Tidal Flood Management Project in Pekalongan

Source: BBWS Pemali Juana, 2021

Figure 2.5.2 Overview of Flood/Tidal Flood Management Project in Semarang

2.5.3 Future Plan in the Coastal Area

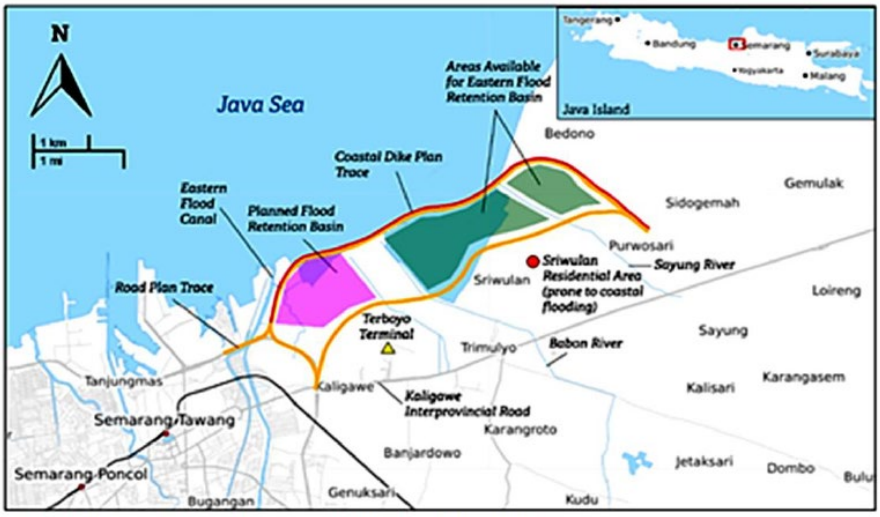
As one of the development agendas of the National Medium-Term Development Program (RPJMN) for 2020-2024, GOI pays great attention to disaster and resilience to climate change by focusing on the issues of environmental protection, disaster resilience and climate change mitigation. Especially on the north coast of Java Island, the BAPPENAS has formulated priority projects focusing on the protection of five urban coasts. Major priority projects include.

i) Jabodetabek Area
   - Construction of giant seawall with a length of 18.5 km in the north of Jakarta Bay (NCICD) (funded by the Dutch and Korean governments)

ii) Cirebon Raya
   - Construction of coastal protection facilities with the length of 5.85 km in Cirebon Raya

iii) Pekalongan, Kendal, Semarang, and Demak
   - Additional raw water extraction of 0.47 m^3/sec and building 10 water quality monitoring stations in Pekalongan Regency
   - Development and improvement of river dike with a length of 7.26 km in Pekalongan City
   - Construction of coastal protection facilities with a length of 6 km in Kendal Regency
   - Construction of sea dike with a length of 1.5 km in Semarang City
   - Construction of Sriwulan sea dike with a length of 15 km in Demak Regency
   - Construction of integrated sea dike and toll road with a length of 8 km in Semarang-Demak
   - Construction of coastal protection facilities in Kedung Semat, Kendal, Demak and Rembang

Figure 2.5.3 shows a schematic diagram of the Semarang-Demak sea dike, toll road, and reservoir plan to be implemented by BBWS Pemali Juana based on RPJMN for 2020-2024.

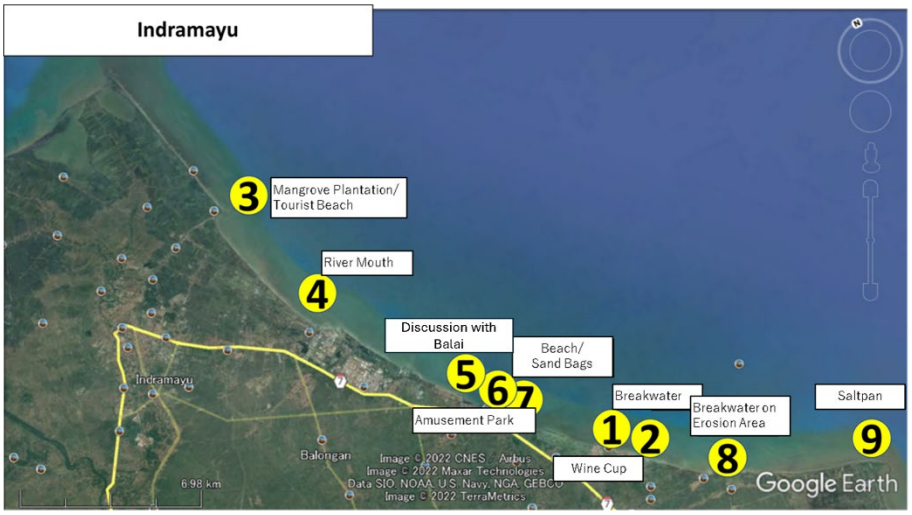


Source: BBWS Pemali Juana, 2021

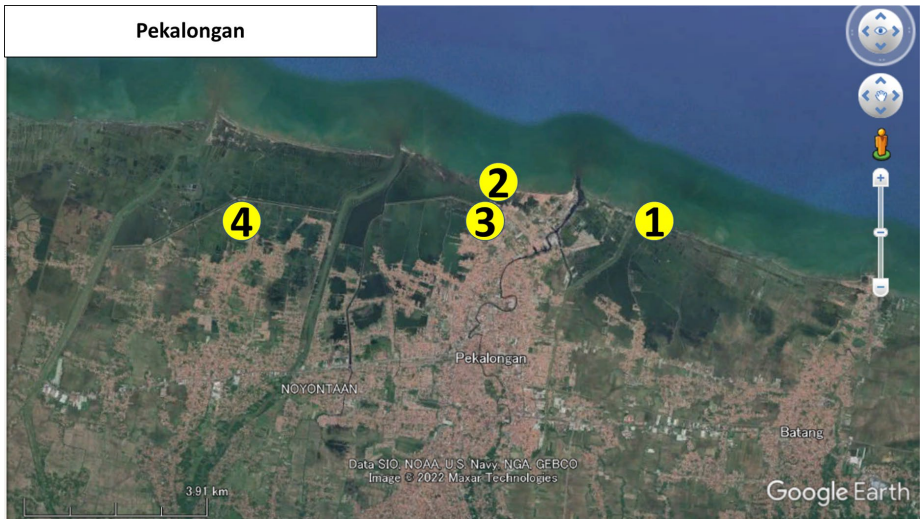
Figure 2.5.3 Plan of the Sea Dike, Toll Road and Reservoir in Semarang – Demak

2.5.4 Project and Development Plans in Coastal Areas Based on the Results of Site Survey

The following table shows the existing projects identified by the site survey conducted in June 2022:

Indramayu	● Area 5: Offshore breakwaters with 550 m in length were constructed by BBWS in 2021. ● Area 7: Offshore breakwaters have been constructed since 2022. In eastern area with serious erosion are protected by geotubes. ● Area 2: Existing offshore breakwaters were constructed in 2009 and 2010. Tombolo was formed in some areas. At present, the offshore breakwater with +2.5 m in height is being constructed. The offshore breakwaters will be extended to the west side. The cross section of the breakwater was proposed by local consultants.  Source: Edited by JICA Study Team based on Google Earth

Semarang	● The total length of toll road is about 10 km, which consist of 6 km is sea dike structure and others are pile type construction. ● The total project cost is 714 USD million, which is funded by China. ● The crest height of the sea dike is set considering MSL + Highest Tide + Land Subsidence (5 cm × 10 year =50 cm) + Sea Level Rise. The cross section consists of 13 layers of bamboo mat + geotextile + soil. Bamboo is difficult to corrode under water. ● Area 2: The capacity of the drainage pump is 10 m^3/sec. x 5 base =50 m^3/sec. Maintenance is performed once in three months. ● Area 3: A sea dike is being constructed to extend 1.2 km since 2017. The crest height is +1.9 m for sea dike, +0.8 m for walkway and + 1.1 m for parapet. Land subsidence is about 10 cm/year. ● Area 5: The capacity of drainage pumps is 35 m^3/sec. (5 m^3 × 7 bases). The land has subsided about 1m in 10 years, and the pump facilities which were improved by JICA has fallen, and the drainage is hindered. The position of the drainage outlet is needed to be raised in the future.  Source: Edited by JICA Study Team based on Google Earth
Rembang	● Area 1: Currently, seawalls are planned and under construction (500 kg~2 tons stone is installed). ● According to the typical cross section, crest height = +2.7 m, HHWL = +0.90 m, MSL = +0.00 m, and LLWL = -0.76 m. The crest width is 3 m, the onshore side slope is 1:2 (height 2 m), and the offshore side slope is 1:2.  Source: Edited by JICA Study Team based on Google Earth

Pekalongan	● Area 1: There is a protection project plan for coasts and rivers against tidal flooding. Total operating costs are IDR 100 billion (equal to USD 75 million), for a period of two years, and there are seven companies for 3 packages. ● The crest height is 3.3 m (equal to + 1.6 m (HWL) + 0.6 m (Design Wave) + 1.0 m (Free Board) + 0.7 m (Subsidence). Concrete piles against scouring slip are installed in front of the new seawall. The wave-dissipating block is 500 kg. The stone is procured from Budan. ● Area 2: There are existing seawalls, planned to be raised from + 0.8 m to + 2.1 m during fiscal year 2022. ● Area 3: There are existing seawalls, planned to be raised from + 0.5 m to 2.3 m (west side) and from + 0.4 m to 2.3 m (east side) during fiscal year 2022. ● Area 4: Revetment along the river was constructed in 2019. Three wastewater pumps were constructed in 2021.  Source: Edited by JICA Study Team based on Google Earth
East of Pemalang	● Area 2: There is a plan of offshore breakwater, and a plan of seawall construction behind the sandy beach.  Source: Edited by JICA Study Team based on Google Earth

West of Pemalang	● Area 1: Within the coastal extension of 1.4 km, 10 groins (2009), 6 groins (2010) and revetments (2010) on the east side were constructed by BBWS. It tends to erode from this section to the Water Park of the eastern 2 km. ● Area3: The cost of the dredging is IDR 1.2 billion /year. Due to the high cost, it changed from a river jurisdictional of Dinas KKP to Dinas PU in 2017.  Source: Edited by JICA Study Team based on Google Earth

2.5.5 Main Coastal Development Plans of Indonesia

Table 2.5.4 shows the development plans at the national and central government levels related to coastal conservation.

Table 2.5.4 Development Plans for Coastal Conservation (National and Central Levels)

Classification	Plan, Source	Overview
In length Development Plans, etc.	2020-2024 National Medium-Term Development Plan (RPJMN BAPPENAS)	In the National Medium-Term Development Program (2020-2024), coastal conservation in five cities in the north coast of Java Island (North Jakarta, Semarang, Pekalongan, Demak, Cirebon) is one of the priority issues. The related projects are as follows: ● Installation of 104 units of land subsidence monitoring equipment ● Implementation of structural measures by sea dike and other coastal protection with 100.9 km in length ● Development of Centralized Domestic Wastewater Treatment System (SPALDT) for 592,637 Households ● Installation of 100 water quality monitoring stations ● Construction of a toll road between Semarang-Demak with 27 km in length
	2020-2024 Strategic Plan of PUPR (draft), PUPR	The north coast of Java Island, which is the center of the socio-economy, is threatened by the risk of floods, land subsidence, and coastal erosion, and the following strategies was set up: ● Improving the quality of disaster-resistant infrastructure ● Disaster-resistant infrastructure development in Northern Java Island and priority basin ● Development of integrated system for land subsidence monitoring ● Development of integrated water supply and sanitation systems
	POLA (Water Resources Management Strategic Plan), PUPR	As a basic framework for water resource management, BBWS stipulated POLA, Water Resources Management Strategic Plan. The principles of the POLA are the integration of surface water and groundwater and the balance between conservation and use of water resources. The following countermeasures for the coastal conservation are proposed as follows. ● Ciliwung-Cisadane Strategy for coastal protection and conservation: design and construction of protective structures against estuarine and coastal erosion. ● Cimanuk-Cisanggarung Strategy for the conservation of water resources in coastal areas: greening of coastal erosion area. ● Cimanuk-Cisanggarung Revegetation with mangrove forests to prevent coastal erosion.
	KKP	Major activities in the Strategic Plan 2014-2019 include coastal conservation and regional revitalization in the north coast of Java Island.
	NCICD	Comprehensive coastal development in the capital Jakarta

Source: JICA Study Team

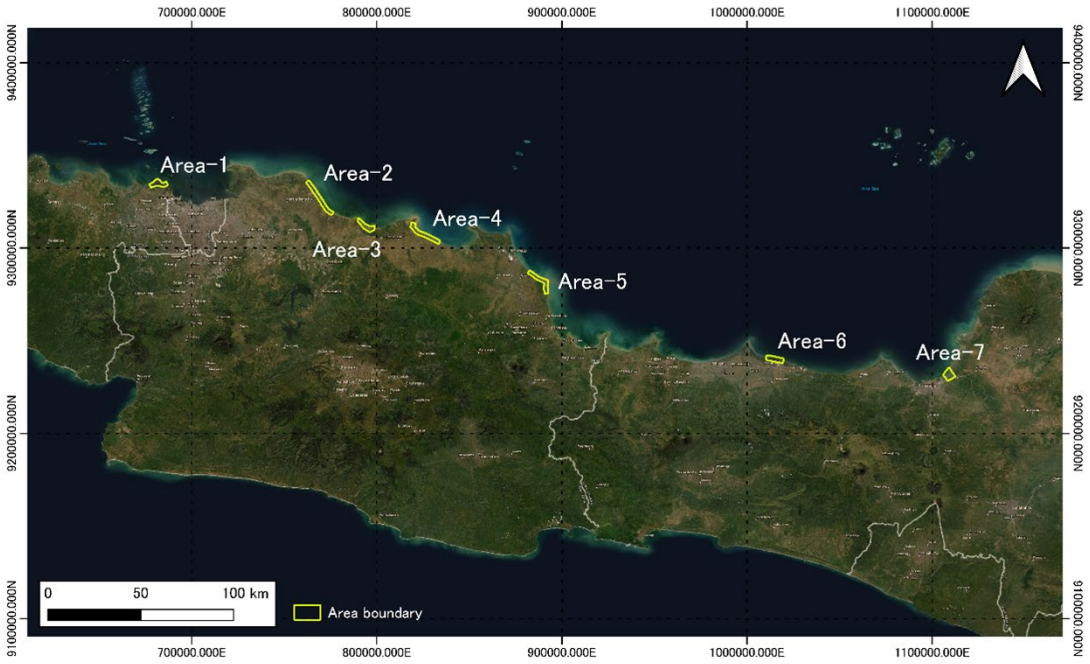
2.6 Coastal Issues and Coastal Disasters in the North Coast of Java Island

2.6.1 Previous Study

In Table 2.6.1, regarding coastal issues and coastal disasters in the north coast of Java Island, the Previous Study summarizes the risks and factors of coastal disasters in the seven areas covered by the Project (Figure 2.6.1). Areas with more colored cells represent higher risk of coastal disasters.

Within factors of coastal disasters, this survey was conducted to collect information focusing on the following elements which change variously in the seven areas:

- Coastal Erosion
- Land Subsidence
- Tidal Flood Damage



Source: Final Report, the Previous Study (2021, JICA)

Figure 2.6.1 Seven Areas in the North Coast of Java Island

Table 2.6.1 Comparison of Risk Factors for Coastal Disasters in Seven Areas in the North Coast of Java Island (Analysis Area of WV)

Risk factors in coastal areas \ Case study coastal		Kramat, Tangerang (L=11km)	Sungaibuntu, Karawang (L=22km)	Muaratjilamaja, Subang (L=11km)	Pamanukan, Subang (L=13km)	Karangampel, Indramayu (L=13km)	Pekalongan (L=10km)	Demak (L=5km)	Remarks
Hazard	Maximum tide level	+1.5m	+1.0m	+1.0m	+1.0m	+1.5m	+1.5m	+1.5m	Agency of Fisheries and Marine,2009
	Sea level rise	2mm/y	2mm/y	2mm/y	2mm/y	2mm/y	2mm/y	4mm/y	Actual figures, Fig 4.7,P30,ICCSR
	High wave	Mean significant wave height: 0.5m-1.0m, +20% (last 20 years)							ERA5 Analysis (JICA Survey Group)
	Coastal erosion (shoreline retreat)	・Coast (house):- (no room) ・Coast (agricultural land):140m	・Coastal (residential) :10	- (Significant erosion without)	・Coastal (residential): 270m(12 year)	・Coastal (residential) :300m ・Coast (agricultural land):200m	・Coast (house):- (no room)	・Coast (house):- (no room)	Google images, WV analysis Marked erosion area in the area is a pond 18-year fluctuation if not stated
	Ground subsidence	15cm/y	2cm/y	2cm/y	0cm/y	0-10cm/y	4.8-10.8cm/y ・The back (house) was submerged.	8-15cm/y ・Coastal area (housing) submerged	H.Andreas,2017, JICA survey team, etc.
Exposure	Area (ha) of property (buildings, etc.)	10ha	40ha	0.8ha	32ha	43ha	52ha	55ha	WV Analysis (2020), JICA Research Group
	Rate of increase in assets (buildings, etc.) (past 17 years)	-2%	-3%	+13%	+27%	+17%	+10%	+10%	WV Analysis (2003-2020), JICA Research Group
	Expansion of assets (residential areas, aquaculture ponds) to the sea side	・Fish pond :+400 m	・Fish pond :+200 m (Combined use of afforestation: + 370m)	・Fish pond :+1,200 m	-	-	-	-	WV Analysis (2003-2020), JICA Research Group
Vulnerability	Fluctuating effects of sediment supply from river mouths	Large Cisadane River (1,526km2)	Large Citarun River, etc. (>7,000km2)	Large Cilamaya River, etc. (1,500km2)	Normal Cilangan River, etc. (300km2)	Normal Bobos River, etc. (770km2)	Large K. Sragi River (1,032km2)	Large Tuntang River (2,000km2)	When a river is located in the vicinity (within 10km). Classification by basin area. Large: 1,000km2 or higher.
	Impact of large-scale coastal structures (Ports and fishing ports)	- (without structure)	- (without structure)	- (without structure)	Y (Port: Offshore 700m)	Y (Fishing port: Offshore 400m)	- (without structure)	- (without structure)	
	Negative impact of coastal structures	- (without structure)	- (without structure)	- (without structure)	- (without structure)	Y (Detached breakwater: L = 1.6km, breakwater)	Y (Leading bank: Offshore coast 400m, Tidal levee :L=5 km))	- (without structure)	Detached breakwaters, breakwaters, seawalls, guided levees
	Increase or decrease of buffer zone (green zone)	+5%	+60%	+200%	+11%	+13%	-60%	-55%	WV Analysis (2003-2020), JICA Research Group
								*Coloring of items considered particularly high risk	

Source: Final Report, the Previous Study (2021, JICA), partially revised by JICA Study Team

Coastal Erosion and Sedimentation

Based on satellite image analysis, the results of the area ratio of sedimentation and erosion by province in the north coast of Java Island are as shown in Table 2.6.2. In the north coast of Java Island, the sedimentary zone is 54 %, while the percentage for erosion is 46 %, indicating a slight tendency for sedimentation in the north coast of Java Island. West Java and East Java are particularly noticeable in their sedimentary areas, particularly the East Java area, which comprises 75 %. On the other hand, Banten and Central Java are remarkable for having an eroded area exceeding the sedimentary area by 53 % and 56 %, respectively.

Table 2.6.2 Ratio of Sedimentation and Erosion Areas by Province in the North Coast of Java Island

Province	Banten	Jakarta	West Java	Central Java	East Java	Overall
Accretion area	47%	–	55%	44%	75%	54%
Erosion area	53%	–	45%	56%	25%	46%

Source: Final Report, the Previous Study (2021, JICA)

Table 2.6.3 shows the sedimentation area and erosion area of 11 littoral drift systems of the sandy beach. The following 4 areas tend to erode: Tegal City, Pekalongan Regency, Batang Regency in Central Java, and Indramayu Regency in West Java. Especially, Indramayu Regency and Pekalongan Regency are facing erosion significantly, with calculated area changes of 96.0 ha in 18 years and 52.6 ha in 14 years, respectively. The main erosion factors were examined with a focus on these two coasts. On the other hand, sedimentation is significantly seen on the Pati Regency and Rembang Regency coasts in Central Java, with an area change of 213.8 ha in 9 years and 195.3 ha in 17 years, respectively. Rembang Regency and Tuban Regency tend to have sedimentation generally, but coastal erosion is also noticeable in some areas.

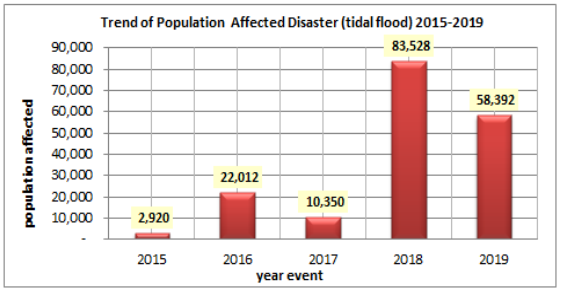
Table 2.6.3 Sedimentation and Erosion Areas on the North Coast of Java Island

Adoministrative		Name of City/regency	Major coastal characteristics	Shore extension in the drifting sand system	Year to compare	Period of change	Sedimentary area in the drifting sand system	Erosion area in the drifting sand system	Total area change in the drifting sand system
province	regency/city			(km)		年	(ha)	(ha)	(ha)
WEST JAVA	6	Karawang regency+A:A:O	Sand Coast	11.9	2000/6-2020/9	20	8.1	-	8.1
	8	Indramayu regency	Sand Coast	10.4	2002/10-2020/9	18	-	-96.0	-96.0
CENTRAL JAVA	12	Tegal city	Sand Coast	14.8	2004/6-2020/11	16	3.8	-11.5	-7.7
	14	Pemalang city	Sand Coast	2.6	2004/10-2020/7	16	13.3	-	13.3
	15	Pekalongan regency	Sand Coast	14.5	2006/10-2020/8	14	-	-52.8	-52.8
	16	Pekalongan City	Sand Coast	-	-	-	-	-	-
	17	Batang regency	Sand Coast	4.6	2009/8-2020/8	11	-	-4.1	-4.1
	22	Pati regency	Sand Coast	12.1	2011/7-2020/9	9	215.1	-1.3	213.8
	23	Rembang regency	Sand Coast	11.9	2003/8-2020/1	17	195.3	-76.7	118.5
EAST JAVA	24	Tuban regency	Sand Coast	18.5	2005/6-2021/3	16	115.6	-20.4	95.2
	33	Situbondo regency	Sand Coast	10.5	2004/8-2019/9	15	4.5	-4.5	-0.0

Source: Final Report, the Previous Study (2021, JICA), partially revised by JICA Study Team

Tidal Flood Damage

Tidal flood damage on the north coast of Java Island is severe due to the high tide inundating the land as the effect of land subsidence. It has mainly been tangible in urban areas in recent years. Figure 2.6.2 shows the change in the number of people affected by tidal flood in the north coast of Java Island. Tidal floods have affected more than 80,000 people in 2018 and more than 50,000 people in 2019. It is expected to increase with the progress of land subsidence.

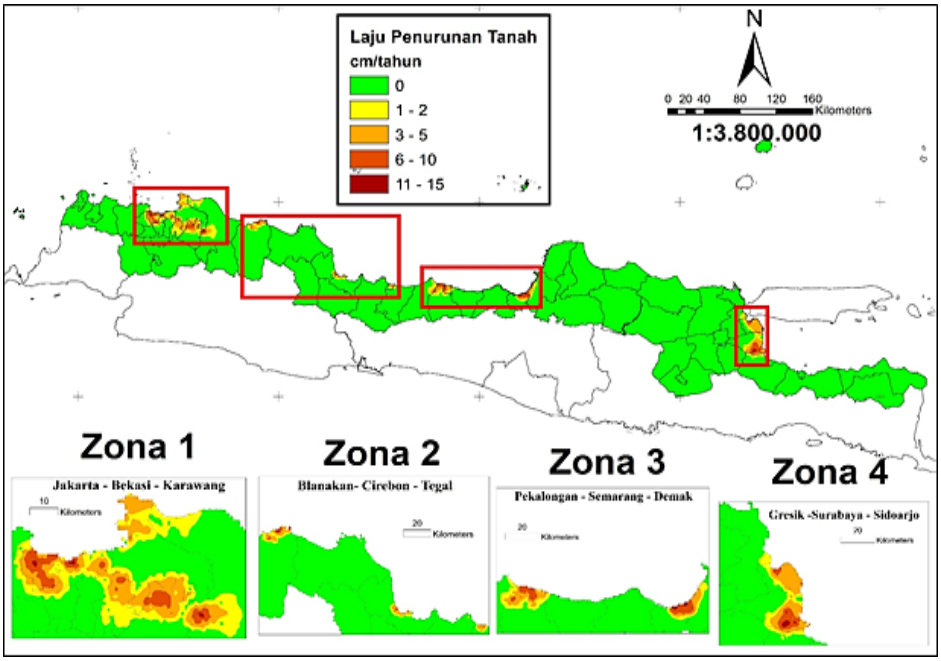


Source: National & Regional Disaster Risk (processed), Photo: Antara Photo, CNN Indonesia

Figure 2.6.2 Change in the Number of People Affected by Tidal Flood in the North Coast of Java Island (Left) and the Damage Situation (Right)

Land Subsidence

As shown in Figure 2.6.3, land subsidence is apparent in Jakarta, Semarang, Demak, Pekalongan, and Surabaya in the north coast of Java Island. According to this figure, land subsidence of 15 cm/year occurs on the coastal area of Jakarta and Demak and 10 cm/year at the coastal area of Pekalongan and Cirebon. Land subsidence is a hazard that causes coastal erosion and floods in the coastal area. The map below depicts the areas in the north coast of Java Island where massive floods occur side by side with serious land subsidence.



Source: Andreas et.al-Institute Technology of Bandung, 2017
(Presentation material for Bappenas Meeting "Land Subsidence of Pantura", 2020)

Figure 2.6.3 Condition of Land Subsidence in the North Coast of Java Island (cm/year)

Since it is generally said that the amount of land subsidence due to natural factors rarely exceeds 1 cm/year, the land subsidence on the north coast of Java Island is considered to happen mainly due to human factors. These anthropogenic factors are 1) excessive extraction of groundwater and 2) consolidation from building load. In 1), taking excessive groundwater causes the aquifer to be consolidated, which causes subsidence of the surface layer.

2.6.2 Issues and Disasters in Coastal Area Based on the Previous Study and Site Survey

The site survey was conducted in June 2022, with reference to the Previous Study. Table 2.6.4 is an overview of the site survey results of coastal issues and coastal disasters in each area.

Table 2.6.4 Overview of Coastal Disasters and Their Expected Factors Obtained from Site Survey

Area Name	Coastal Erosion	Tidal Flood Damage	Land Subsidence
Indramayu-Cirebon	・It is presumably caused by the imbalance of littoral drift. ・The littoral drift source is estimated to be a large river located at the western edge because the eastward littoral drift is predominant.	・The inundation is assumably caused by the loss of berm topography (raised barrier near the shoreline) due to coastal erosion, which originally protects the hinterland from sea water intrusion.	・No subsidence has been observed in Indramayu. ・Cirebon is observed to have a land subsidence rate of 0.5 -2 cm/year.
Pemalang-Pekalongan	・Erosion in Pemalang is assumably due to the reduced sediment supplies from a river, considering by the predominant direction of littoral drift (westward on the western coast and eastward on the eastern coast). ・Although there is no predominant littoral drift, Pekalongan is assumed to be locally sedimented and eroded by groins and offshore breakwaters.	・The east coast of Pemalang and Pekalongan are at high risk of tidal flooding. In these area, coastal erosion causes the disappearance of sandy beaches and mangrove forests near the shoreline, which leads seawater intrusion to fishing pond connected to inland waterways, eventually rising the inland water level, and increasing inland inundation risk. ・Although seawall is planned in Pekalongan, with the crest height problem, it is presumed that flood risks are not completely removed.	・Pemalang is observed to have a land subsidence rate of 0.5 - 3 cm/year. ・Pekalongan is observed to have a land subsidence rate of 1 - 10 cm/year.
Semarang-Demak	・The coastline, which remained relatively stable between 2003 and 2007, has receded significantly from 2007 to 2009. ・Ahigh wave and the disappearance of the sandbar assumably cause the rapid erosion, quantitative analysis is still insufficient.	・Land subsidence and shoreline retreat increase the frequency of tidal flood in recent years. ・Land subsidence cause the functional degradation of dike, and it rises inundation risk even at normal high tides.	・It is considered to be 1 - 17 cm/year around the Semarang Port. Significant land subsidence occurs in northern Semarang. ・It is considered to be 1 - 15 cm/year around the Demak. Significant land subsidence is occurring in Sayung District, Demak. According to the interview, the land subsidence rate in recent years is about 10 cm/year, which is comparable to that in the northern part of Semarang.

Rembang-Tuban	・Waves from the northeast direction are predominant, and therefore westward littoral drift is predominant as a whole. ・Due to the construction of groins, there is sedimentation upstream while the downcoast erodes.	・Compared with other regions, the difference in tide level and wave height are large; thus, the frequency of seawater intrusion into the hinterland due to erosion is increasing, and the risk of tidal flood is rising.	・In Rembang and Tuban, it is estimated that there is no land subsidence.

Source: JICA Study Team

Land Subsidence in Each Area

Based on the results of the existing surveys and the field survey, the current status of land subsidence in each area was summarized in Table 2.6.5. The current status of land subsidence in each area is as follows

Indramayu-Cirebon

・No subsidence has been observed in Indramayu.

・Cirebon is observed to have a land subsidence rate of 0.5 -2 cm/year. Monitoring wells for land subsidence are planned to be developed at 12 locations in the RPJMN.

Pemalang-Pekalongan

Pemalang is observed to have a land subsidence rate of 0.5 - 3 cm/year.

Pekalongan is observed to have a land subsidence rate of 1 - 10 cm/year. Monitoring wells for land subsidence are planned at 10 locations in the RPJMN and are currently under construction at two locations. According to existing studies, it is inferred that the main cause of land subsidence in Pekalongan is groundwater pumping for batik industrial and agricultural uses.

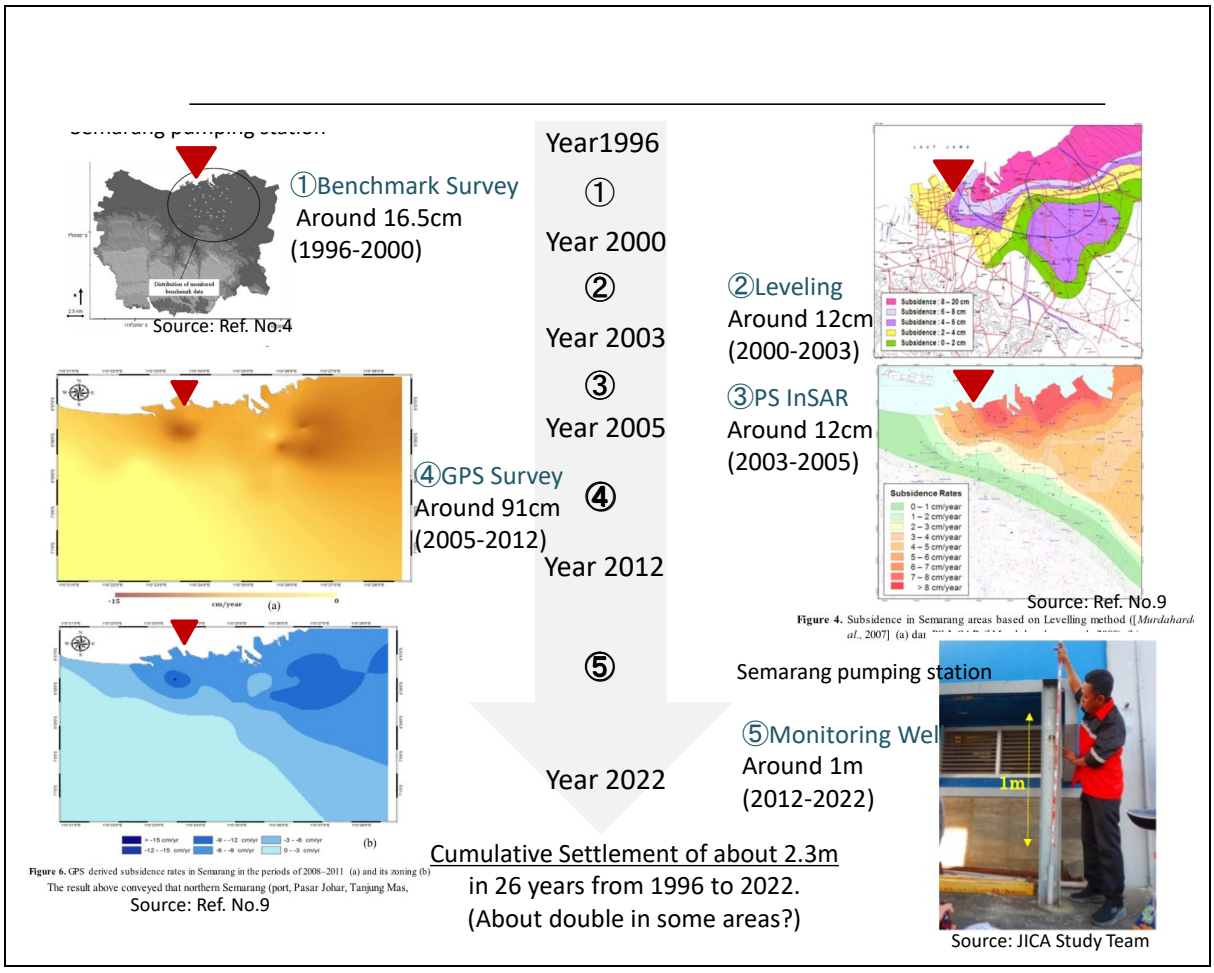
Semarang-Demak

・Land subsidence is considered to be 1 - 17 cm/year around the Semarang Area. Significant land subsidence occurs in northern Semarang. Cumulative settlement at the Semarang pumping station is estimated at about 2.3 m (about 9 cm/year) over a period of about 26 years from 1996 to 2022. (Figure 2.6.4) There is one existing monitoring well, and 16 monitoring wells (including Demak) are planned in the RPJMN. According to the existing studies, building loads, groundwater pumping, and natural consolidation of the alluvium are inferred to be factors in the land subsidence.

・Land subsidence is considered to be 1 - 15 cm/year around Demak. Significant land subsidence is occurring in Sayung District, Demak. According to the interview, the land subsidence rate in recent years is about 10 cm/year, which is comparable to that in the northern part of Semarang. Monitoring wells for land subsidence are planned in Demak in the RPJMN. (16 total in Semarang-Demak, unknown number in Demak)

Rembang-Tuban

- It is estimated that Rembang has no land subsidence.
- It is estimated that Tuban has no land subsidence.



Source: Prepared by JICA Study Team based on existing reference documents and site visit.

Figure 2.6.4 Estimated Cumulative Settlement at the Semarang Pumping Station Site

Table 2.6.5 Current Status of Land Subsidence in Each Area

Priority Area		Area-1		Area-2		Araa- 3		Araa-4
Provice		West Jawa		Central Java				
Location		Indoramayu	Cirebon	Pemalang	Pekalongan	Semarang	Demak	Rembang -Tuban
Location		Regency	City	Regency	Regency&City	City	Regency	Regency
Cumulative land subsidence		—	—	—	—	Around 2.3m(estimate) (26years：1996 to 2022)	—	—
Land Subsidence Rate	Outline*2	—	0.5~2cm/yr	—	1~10cm/yr	1~17cm/yr	1~15cm/yr	—
	Benchmark &Leveling	—	—	—	—	Max 16cm/yr(1997-2000) *4 1-17cm/yr(1999-2003)*10	—	—
	GPS Survey	—	—	—	—	1~19cm/yr(2008-2011)*10	0.8 to 17.91cm/yr （2015-2018)*5	—
	Satellite image (InSAR)	—	—	—	—	8cm/yr(2002~2006)*10	4.7 to 19.5 cm/yr(2015-2017)*5	—
		—	—	0.5~3cm/yr (2007~2009)*8	4.8~10.5cm/yr(2007-2009)*8	4.8~13.0cm/yr(2007~2009)*8		
		—	—	—	7cm/yr(2016~2020)*3	8cm/yr (2016~2020)*3	8cm/yr (2016~2020)*3	
	Microgravity	—	—	—	—	1~15cm/yr(2002–2005)*10	—	—
Monitoring Status	Existing	—	—	—	Satellite image analysis (InSAR) (2007－2009、2016-2020) *3, *8	Benchmark(1984～1997)*4 GPS(2008-2011) *10 Satellite image analysis (InSAR) *3, *8 Monitoring well(2015.6～, Depth 30m,100m,Kali Banger)	GPS(2015-2017)*5 Satellite image analysis (InSAR)(2015-2017)*5	—
	Under Develpoment	—	—	—	Monitoring well ： 2 sites(125m)	—	Monitoring well ：2sites (125m)	—
	RPJMN 2020-2024	—	Monitoring GW & LS: 12 Units	—	Monitoring GW & LS: 10 units	Monitoring GW & LS: 16 Units		—
Factor		—	—	—	Groundwater pumping -Batik industry*2 -Agricultural water*8	1. Building load*6 2. Groundwater pumping*4 3. Natural consolidation of alluvial Soil*4	—	—
Regulation		—	—	—	Groundwater pumping regulations (Pekalongan City's ordinance, 2022.6)	Groundwater Pumping Regulations in Northern Semarang*6	Groundwater pumping restrictions (expired 2018 - should be confirmed)6*	—

* :References No.

Source: JICA Study Team

2.7 Current Status of Coastal Infrastructure, Facility, and Structure

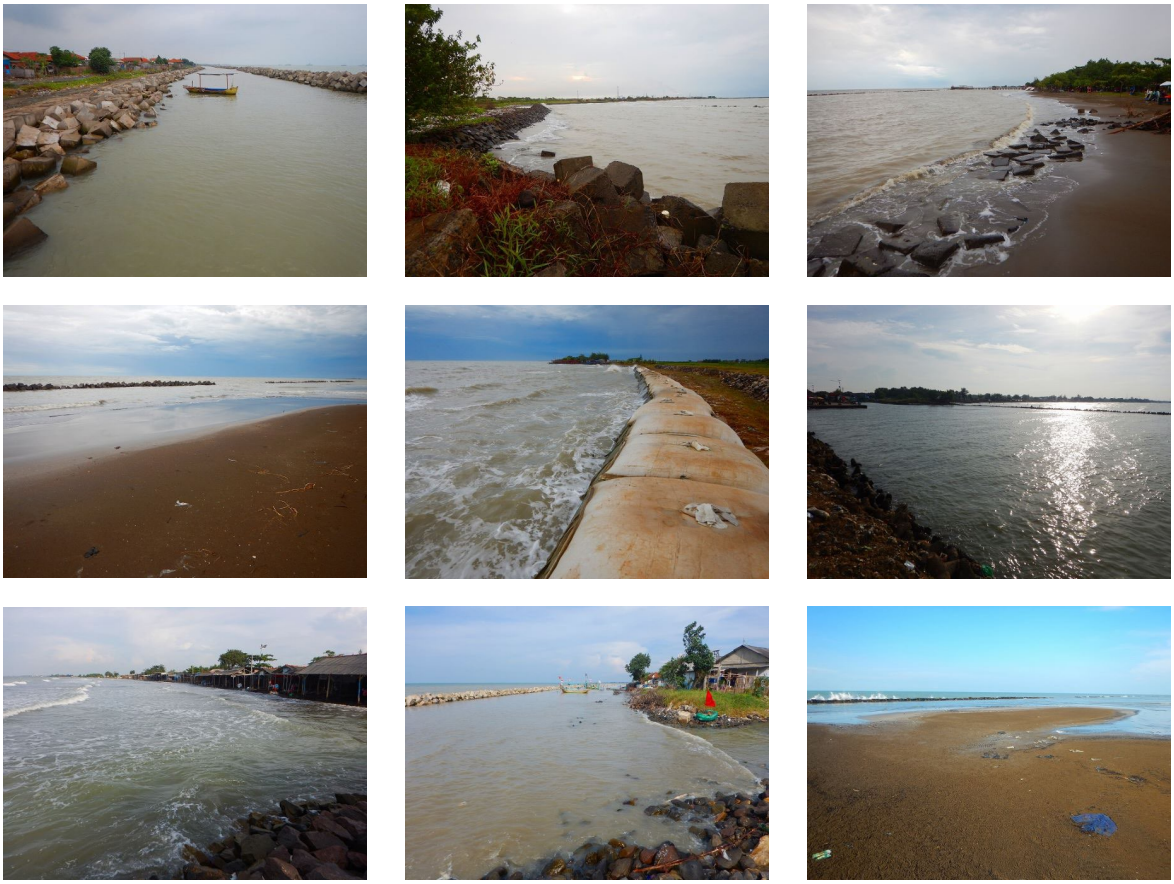
2.7.1 Gray Infrastructure

Indramayu

In the coastal area in Indramayu, the terrain is low-elevation plains that consists of silty ground, with a mix of densely populated residential areas, tourism zones such as marine parks, and agricultural and fishery-related lands such as rice paddies and fish farms. As coastal measures against coastal erosion, rubble revetments and vertical seawalls have been installed near the shoreline. However, some of the rubble revetments have subsided or scattered, and some of the vertical seawalls are collapsing.

Source: JICA Study Team

Figure 2.7.1 Coastal Protection in Indramayu West (October 2022)



Source: JICA Study Team

Figure 2.7.2 Coastal Protection in Indramayu East (June 2022)

Pemalang-Pekalongan

In Pemalang West, although the shoreline generally are mains stable in both long and short terms, the area is characterized by predominant westward littoral drift. Consequently, there are structures such as groins to obstruct this drift, and coastal erosion is progressing downcoast of these groins, causing issues in the living environment and coastal utilization in the eroded areas.

Pekalongan has densely populated residential zones, which are currently protected by seawalls. However, due to significant land subsidence, the height of these seawalls is insufficient in which crown height is being increased. Additionally, a large-scale embankment has been constructed inland to protect the hinterland from tidal flood.

Source: JICA Study Team

Figure 2.7.3 Coastal Protection in Pemalang West (June 2022)

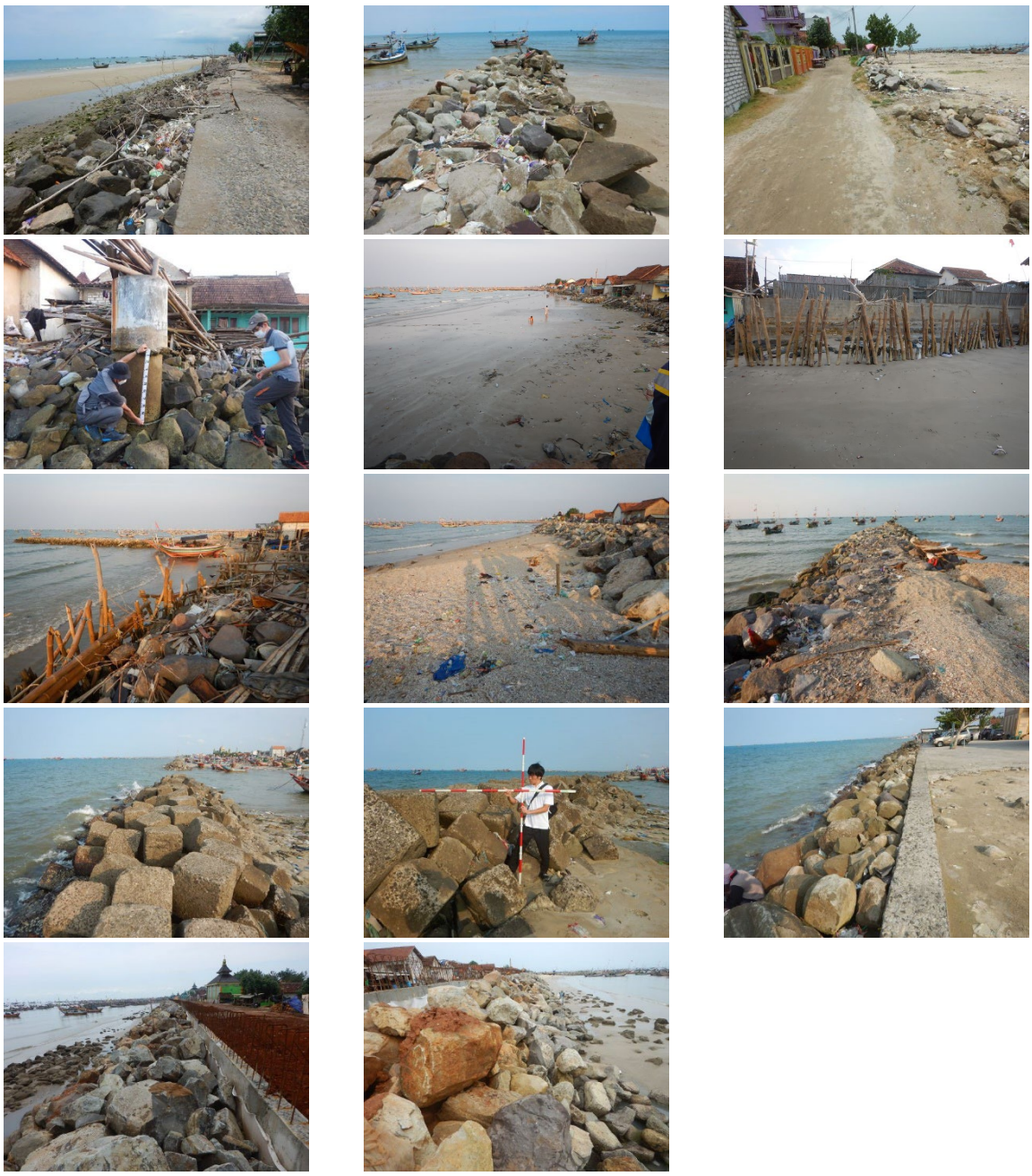
Source: JICA Study Team

Figure 2.7.4 Coastal Protection in Pekalongan (October 2022)

Rembang-Tuban

In the western part of Rembang, westward littoral drift is predominant. Coastal erosion, which is due to an insufficient supply of littoral drift, is progressing downcoast of coastal structures such as groins installed as mooring facilities for fishing boats and the offshore breakwaters. Thus, to prevent coastal erosion, some coastal measures have been taken to trap the littoral drift by adopting groups of groins. However, in some areas, the effects of these measures are not sufficient, and the living environment and utilization of the hinterland are being affected by waves and other factors.

In the western part of Tuban, generally sandy beaches exist, and the risk of coastal erosion is likely low. However, locally, some sandy beaches are narrow, and there are residential areas that have been damaged by wave run-up. Due to future coastal development, there is a concern that erosion may progress. Therefore, it is necessary to closely monitor this area.



Source: JICA Study Team

Figure 2.7.5 Coastal Protection in Rembang West (October 2022)

Source: JICA Study Team

Figure 2.7.6 Coastal Protection in Tuban (October 2022)

2.7.2 Green Infrastructure

Indramayu

Coastal ecosystems such as mangroves have several functions to mitigate the effects of coastal erosion caused by wave action. On beaches with muddy-seabed, mangrove roots bind the sediments. The dense trunks of mangroves also function to reduce or attenuate wave energy, thereby reducing the impact of waves and other factors from affecting sediment transport in coastal areas.

The seabed condition where mangroves grow is generally muddy, and in Indramayu, mangroves near the coast area mainly distributed in the central part. In Indramayu, two types of coastal facility using mangroves have been identified in the field surveys, such as green infrastructure and grey infrastructure.

First is Hybrid Engineering (HE), proposed by Deltares from Netherlands, which involves creating permeable dams using bamboo and wood (Figure 2.7.7).

The project involving HE structures was initiated by KKP in 2013, and is currently progressing especially on muddy coast in various regions (Table 2.7.1). This HE (Hybrid Engineering) structure aims to stabilize the ground by calming the wave field behind the structure and promoting sediment deposition, thereby eventually facilitating the transplantation and proliferation of mangroves. (Figure 2.7.8).

Table 2.7.1 Implementation Status of HE in Indonesia

Implementation Year	Implementation Area (Extension of Facility in m)
2013-2014	Demak (620 m)
2015	Cirebon (2,910 m), Brebes (910 m), Kota Semarang (3,145 m), Demak (915 m) Jepara (3,140 m), Pati (3,140 m)
2017	Cirebon (1,850 m), Rembang (1,100 m), Demak (3,300 m), Gresik (1,200 m)
2019	Lombok Timur (200 m), Bone (600 m), Bombana (1,100 m)

Source: 5 Tahun Hybrid Engineering oleh, KKP 2020

Souce: Solusi Rekayasa Berbasis Ekosistem untuk Restorasi Kawasan Pesisir

Figure 2.7.7 Case-1: Permeable Dams Installed as Hybrid Engineering (HE)

Source: Solusi Rekayasa Berbasis Ekosistem untuk Restorasi Kawasan Pesisir

Figure 2.7.8 Case-2: Permeable Dams Installed as Hybrid Engineering (HE)

The second facility is a coastal protection structure (green infrastructure + grey infrastructure) in the Losarang area, combining an offshore breakwater with mangroves. This offshore breakwater that was constructed between 2012 and 2014 by BBWS, is made of concrete cubes and extends 2.6 km in length. It has been reported that the calm wave field was formed behind the breakwater and facilitated the natural growth and colonization of mangroves.

Source: Pengamanan Pantai Balai Besar Wilayah Sungai Cimanuk Cisanggarung

Figure 2.7.9 Coastal Facility Combining Offshore Breakwater and Mangroves in Indramayu

Pemalang-Pekalongan

In Pemalang-Pekalongan, coastal facilities utilizing mangroves such as gray infrastructure and green infrastructure are not identified through the basic survey.

Rembang-Tuban

In Rembang-Tuban, the coast is predominantly sandy, and currently, there are no coastal facilities by mangroves such as grey infrastructure and green infrastructure. Tireman Village on the western side of Rembang is designated as mangrove protection area. Around this river mouth, an HE structure extending approximately 1.18 km was installed by KKP in 2017.

2.8 Current Status of Monitoring on Coastal Facility

2.8.1 Maintenance System

Regarding coastal facilities, each agency such as KKP, BBWS, local government (province, regency, city), and DINUS PU is responsible for their development and maintenance based on their jurisdiction. The agency that developed the facility is also responsible for its maintenance.

The current status and issues related to the maintenance of coastal facilities, as identified through the hearing surveys with coastal management agencies and departments, are as follows:

Responsible Agency and Department of Coastal Facility

・The main agencies, which develop coastal facilities on the north coast of Java Island, are KKP, BBWS, DINAS PU, However while the demarcation of their respective areas of responsibility is not clearly defined.

・Although the principle is to transfer the maintenance of developed coastal facilities to the requesting entities (such as province, regency, or other civic groups), the methods of transfer (timing and procedural methods) are not clearly defined.

・In KKP, which is responsible for the entire coastal area, there is a recognition that there are no departments that have assigned roles and responsibilities to the transfer destinations, which is presumed to be the fundamental reason for the absence of maintenance responsible parties.

・Although there is an understanding of the principle that the owner is responsible for maintenance, the transfer of the ownership from the builder has not been smoothly conducted, resulting in unclear responsibility for the maintenance of the coastal facilities.

Table 2.8.1 Results of Hearing Survey on Responsible Department for Maintenance of Coastal Facilities

Organization		Opinions and Intentions
KKP		There is no basis for strictly specifying the jurisdictional areas, and therefore, no jurisdictional maps exist. As a result, the coastal management areas and their extents for facility development and maintenance have not been defined. Some transfer destinations lack departments with assigned roles and responsibilities, or the departments exist but have no assigned personnel.
PUPR-BBWS	BBWS Citarum	In Indramayu, although there are four departments for operation and maintenance (OP), none of them is responsible for coastal facilities. While there is an understanding of the principle that the facility owner is responsible for maintenance and management, there is also a perception that the builder (not the owner) and the maintenance manager are the same. This is likely because there have been no (or very few) instances of ownership transfer after development.
	BBWS Cimanuk Cisanggarung	There are four departments for operation and maintenance (OP), and OP2 and OP3 are responsible for river and coast. It is understood that the developer maintains the facility, with no recognition of maintenance responsibilities after ownership transfer.
	BBWS Pemali Juana	Four operation & Maintenance (OP) departments exist, of which OP2 and OP3 are responsible for the coast. OP2:Rembang, OP3:Pemalang, Pekalongan, OP4:Semarang (No coast) It is understood that the maintenance of developed river and coastal facilities is the responsibility of the requesting entity, not the builder. However, it is unclear whether the transfer of ownership has been conducted smoothly. In OP2, although there are 180 personnel, all are assigned to river facilities, with no personnel dedicated to coastal facilities. In Pekalongan, under SDA budget of PUPR, the management of coastal facilities designed and constructed by BBWS has been requested to be transferred to the provincial government, the legal manager, but this has not been realized. The principle is that facilities built by BBWS is transferred and managed by the requesting entity. However, in deed, the requesting entity doesn't have maintenance budget, and the transfer of the management is limited, and generally most of the facilities (mainly river facilities) built by BBWS are maintained by BBWS itself.
	BBWS Bengawan Solo	Four operation and maintenance (OP） departments exist, of which OP4 is responsible for the downstream of the river and coasts. The principle that the facility owner (developer) is responsible for maintenance applies to this coast as well, so BBWS has the recognition that they are responsible for maintaining the structures they have built.
Dinas PU		Under Dinas PU jurisdiction, the principle is that the builder maintains the constructed coastal facility. There is no awareness of transferring maintenance responsibilities due to ownership transfer.

Source: JICA Study Team

Current Status of Budget Allocation for Maintenance of Coastal Facility

・Due to the lack of budget allocation for maintenance, maintenance activities are not being carried out.

・All management agencies/department recognize the necessity of maintenance and are requesting budget allocation. However, they believe it is impossible to secure the budget independently. Some of the agencies/department request budget, but based on the principle that the coastal facility owner conducts maintenance, the ministry does not allocate maintenance budgets.

Table 2.8.2 Results of Hearing Survey on Budget Allocation for Maintenance of Coastal Facilities

Organization		Opinions and Intentions
KKP		・Except for two coastal facilities, hybrid engineering and geo tube, in which maintenance is conducted directly by the ministry, maintenance is generally not implemented, and therefore no maintenance budget is allocated.
PUPR-BBWS	Citarum	・There is no department responsible for coast, thereby, there are no records of maintenance and budget allocation.
	Cimanuk Cisanggarung	・There are records of river maintenance (cleaning and waste disposal), but there are no records of coastal facility maintenance. ・The necessary expenses have been requested to SDA, PUPR but never approved, thus maintenance cannot be carried out.
	Pemali Juana	・Under BBWS-Pemali Juana, coastal maintenance has not been conducted so far, and there is no dedicated department for coastal maintenance.
	Bengawan Solo	・The average annual maintenance budget for 8 km of coastal facility length is IDR 400,000,000/year (Approximately JPY 400 million/year or JPY 0.5 million/km year)
Dinas PU		・Annual headquarters budget (average JPY 7 million/year), of which annual maintenance budget (none).

Source: JICA Study Team

Inspection Methods

・Inspection methods have been manualized under PUPR and recognized by the management unit.

・Due to the budget limitation, in general, only patrols are conducted.

Table 2.8.3 Results of Hearing Survey on Budget Allocation for Maintenance of Coastal Facilities

Organization		Opinions and Intentions
KKP		—
BBWS	Citarum	- A checklist is available, but due to the lack of budget, only patrols are effectively conducted.
	Cimanuk Cisanggarung	
	Pemali Juana	
	Bengawan Solo	
Dinas PU		—

Source: JICA Study Team

2.8.2 Budget Allocation for Maintenance

The coastal management budget for Indonesia, as stated in the Strategic Plan 2020-2024 of the Directorate General of Water Resources of PUPR, is as shown in the table below. It includes the budgets of the coastal management implementing agencies, BBWS and BWS. According to this, the proportion of maintenance and management costs in the total coastal project costs of PUPR is around 5 %. Meanwhile, although this direct comparison cannot be made, in Japan, the proportion of maintenance and renewal costs for social infrastructure under the jurisdiction of the Ministry of Land, Infrastructure and Transport has remained around 20 % of the total project costs, during the period from high economic growth period to the 1990s. This social infrastructure includes roads, ports, airports, sewage systems, urban parks, flood control, and coasts. From this, the proportion of maintenance cost in Indonesia, 5 %, is likely insufficient. Additionally, in the beach nourishment project, Bali Beach Conservation Project, which is a Japanese ODA loan project, despite an agreement on the responsibility and implementation system for maintenance after nourishment, adequate maintenance has not been realistically performed, remaining a challenge.

Table 2.8.4 Coastal Management Budget of DGWR of PUPR (Above: Million Rp. Below: Million USD)

Item	2020	2021	2022	2023	2024	Total
1. Construction of Coastal Protection Facilities	1,277,056	1,518,500	1,822,200	2,429,600	1,518,500	8,565,856
	79.6	94.6	113.5	151.4	94.6	533.7
2. Rehabilitation of Coastal Protection Facilities	9,600	26,500	34,100	27,000	18,900	116,100
	0.6	1.7	2.1	1.7	1.2	7.2
3. Maintenance of Coastal Protection Facilities	82,941	82,941	82,941	82,941	82,941	414,705
	5.2	5.2	5.2	5.2	5.2	25.8
Total of the above 1, 2, 3	1,369,597	1,627,941	1,939,241	2,539,541	1,620,341	9,096,661
	85.3	101.4	120.8	158.2	100.9	566.7
Percentage of Maintenance Budget (%)	6.1 %	5.1 %	4.3 %	3.3 %	5.1 %	4.6 %
Total Budget of DGWR	43,975,216	87,878,956	91,858,651	89,470,243	84,018,457	397,201,523
	2,739.7	5,474.9	5,722.8	5,574.0	5,234.3	24,745.7

(1 Rp=0.0000623USD) Source：Prepared by the JICA Study Team based on the Strategic Plan (RENSTRA 2020-2024) of the DGWR of PUPR

Table 2.8.5 shows the 5years maintenance budget, described in BBWS Sttrategic Plan for each BBWS (Citarum,Cimanuk Cisanggarung,Pemali Juana,Bengawan Solo) for the north Coast of Java Island for the period from 2020 to 2024. Regarding BBWS Citarum and BBWS Cimanuk Cisanggarung, no maintenance budget was identified. BBWS Pemali Juana plan only 1-year maintenance budget during the 5years strategic period. BBWS Bengawan Solo planned each year during the 5years, and the proportion of maintenance budget to the total coastal project is 4.3 %.

Table 2.8.5 Maintenance Budget for BBWS (Above: Million Rp. Below: Million USD)

BBWS	Citarum	Cimanuk Cisanggarung	Pemali Juana	Bengawan Solo
Maintenance Budget	NA	NA	900	4,712
	NA	NA	0.06	0.29
Total Budget for Coastal Project	600,907	514,000	332,900	108,712
	37.44	32.02	20.74	6.77
Proportion of Maintenance Budget to the Total	-	-	0.3 %	4.3 %
	NA	NA	900	4,712

(1 Rp=0.0000623USD) Source: Prepared by JICA Study Team based on BBWS Strategic Plan (RENSTRA2020-2024)

<Chapter 2 References >

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CHAPTER 3 Field Survey

3.1 Survey and Sediment Analysis

3.1.1 Outline

Topographic survey and bathymetric survey were carried out in the priority Areas; Area-I (Indramayu) , Area-II (Pemalang-Pekalongan), and Area-III (Rembang-Tuban) (Figure 3.1.1), which were selected in Chapter 4. In addition, the grain size of sediment taken from the beach was analyzed by sieve analysis test. The objectives of these surveys were shown as follows.

- To utilize the result for planning and basic design of coastal facility plans and beach nourishment in the priority areas
- To understand the geomorphic characteristics and grain size of representative beaches in the priority areas

Source: Edited by JICA Study Team based on Google Earth

Figure 3.1.1 Survey Areas

In order to obtain a representative coastal profile of the survey areas, a cross-sectional topographic survey using RTK-GPS was conducted. To convert the survey data into MSL standard, the adjacent benchmarks were used as the starting points for each topographic survey. The locations of each survey line were set in consideration of the differences in geographical locations and the target areas of Coastal Facility Plan. The numbers of surveyed lines were six in Area-I(Indramayu) and five in Area-II (Pemalang-Pekalongan) and Area-III (Rembang-Tuban) respectively. The location map of the survey lines is shown in Figure 3.1.2. Sediment samples were collected from the H.W.L. on the beach at each of the survey line, and grain size of sediment was measured by sieve analysis test. In addition, the bathymetric survey was conducted at the same time as the topographic survey. The bathymetric survey was conducted up to a depth of about 15 m using an echosounder setting on a boat. To obtain the continuous topographic profile data from the sea side to the beach side, the bathymetric survey was conducted on the same line as the topographic survey. Two lines were set up in each area as representative topography, considering the differences in geographic locations. Specifically, as indicated by the red lines in Figure 3.1.2, the bathymetric surveys were conducted on Line-3 and Line-5 in Indramayu, Line-2 and Line-4 in Pemalang-Pekalongan, and Line-2 and Line-5 in Rembang-Tuban. In order to convert the bathymetric data to the MSL standard as well as the topographic survey data, a tide gauge whose elevation had been measured in advance was installed during the bathymetric survey. Photographs of the work during the topographic survey and the bathymetric survey are shown in Figure 3.1.3.

Source: Edited by JICA Study Team based on Google Earth

Figure 3.1.2 Locations of the Survey Line in the Three Areas

(Yellow: Topographic Survey, Red: Bathymetric Survey)

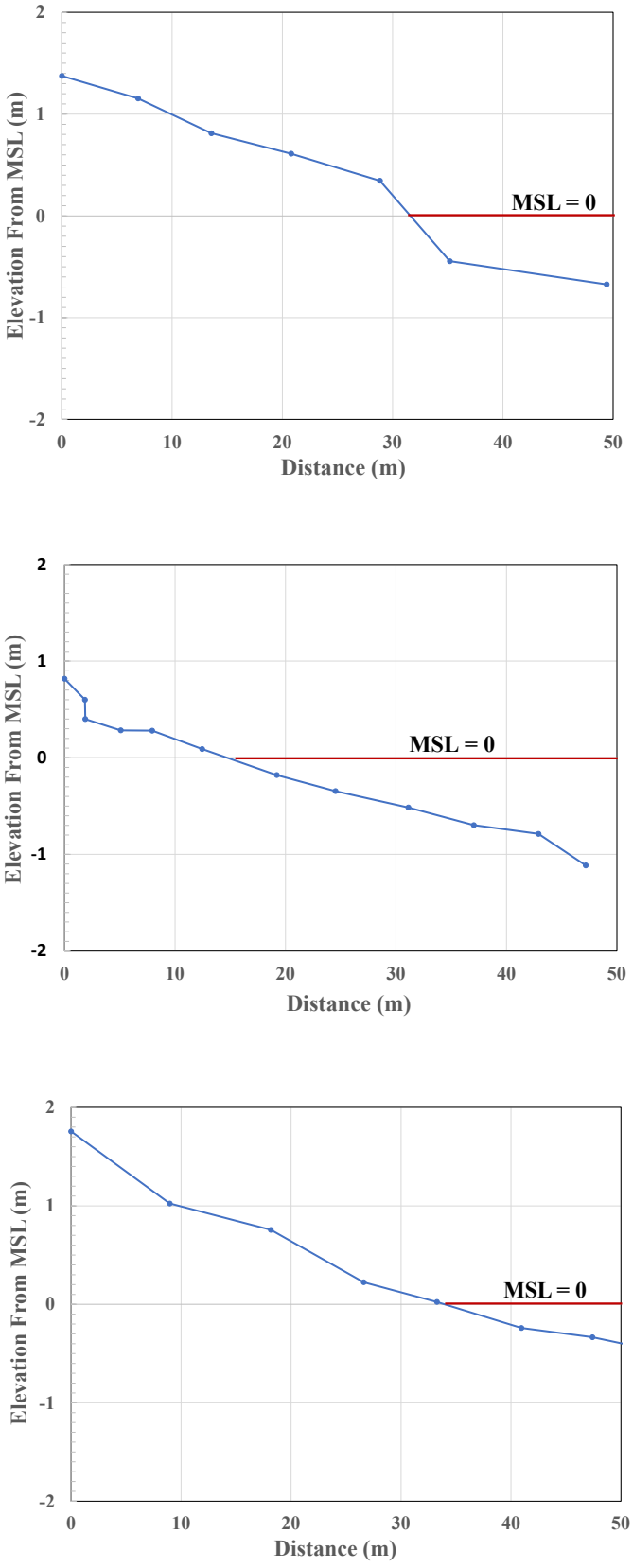
Source: JICA Study Team

Figure 3.1.3 Survey Work (Left: Topographic Survey, Right: Bathymetric Survey)

3.1.2 Results and Discussion

(1) Topographic Survey and Sediment Analysis

Figure 3.1.4 shows the coastal profiles of the representative natural beaches in Indramayu, Pemalang-Pekalongan, and Rembang-Tuban. The top of the figure is the cross-sectional topography on Line-3 in Indramayu, the center is on Line-3 in Pemalang-Pekalongan and the bottom is on Line-1 in Rembang-Tuban. Table 3.1.1 shows the foreshore slope and median grain size D50 of the beach sediment in the three areas. The foreshore slopes are about 1:20 in Indramayu, 1:30 in Pemalang-Pekalongan, and 1:25 in Rembang-Tuban. The median grain size D50 from the sieve analysis test is also 0.15 to 0.20 mm, indicating that the beach sediment in the three areas is classified as fine sand. The foreshore slope is relatively mild slope, because beach sediment in three areas is mainly composed of fine sand mixed with silt.



Source: JICA Study Team

Figure 3.1.4 Coastal Profiles of Representative Natural Beaches in the Three Areas

(Top: Indramayu, Center: Pemalang-Pekalongan, Bottom: Rembang-Tuban)

Table 3.1.1 Foreshore Slope and Median Grain Size in the Three Areas

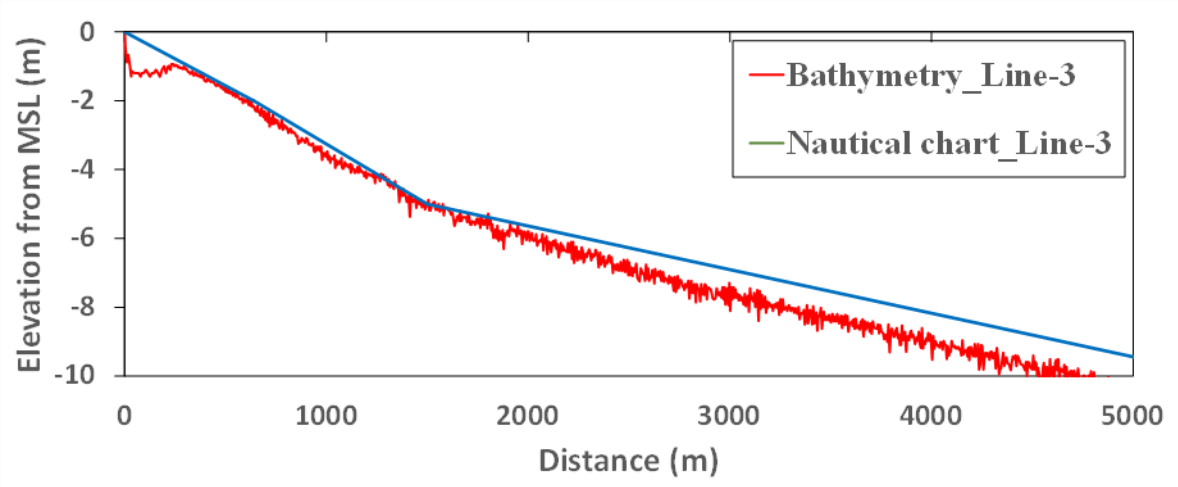
Sampling Location	Foreshore Beach slope	Median Grain Size D50
Indramayu_Line-3	1:20	0.18 mm
Pemalang-Pekalongan_Line-3	1:30	0.15 mm
Rembang-Tuban_Line-1	1:25	0.20 mm

Source: JICA Study Team

(2) Bathymetric Survey

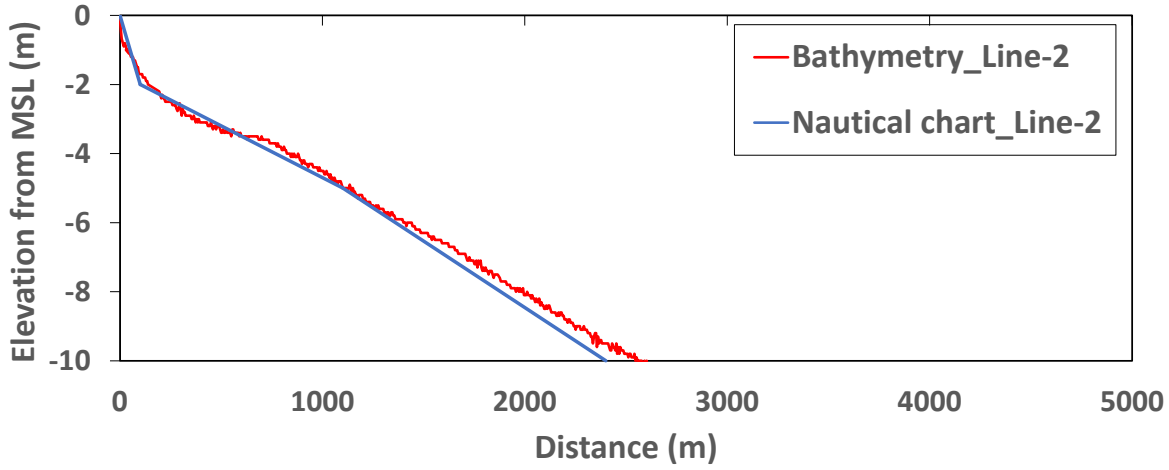
As an example of the results of the bathymetric survey, Figure 3.1.5 shows the bathymetry on Line-3 up to a depth of 10 m in Indramayu, and Figure 3.1.6 shows the bathymetry on Line-2 in Pemalang-Pekalongan. The red line in each graph indicate the survey results and the blue line is based on the nautical chart. From Figure 3.1.5, it is found that the topography of Line-3 in Indramayu is flat for approximately 200 m, ranging from 1 to 1.3 m depth, with a seabed slope of about 1/300 down to 5 m depth and a gentler slope of about 1/800 from 5 to 10 m depth. The water depth is 5 m at 1.5 km offshore from the coastline and the water depth is shallow at about 10 m even at 4.8 km. The topography on Line-2 in Pemalang-Pekalongan shows that the seabed slope is about 1/100 from 1 to 2 m water depth and the gradient is a gentler slope of about 1/300 at 2 to 10 m water depth. The water depth is 5 m at 1.1 km offshore from the coastline and the water depth is as shallow as 10 m even at 2.4 km. The survey result shows the seabed slope in the three areas changes more gentle offshore from a certain depth, 2 to 5 m, depending on the location of the survey line.

To confirm the validity of the nautical chart data for the three areas obtained in this study, the cross-sectional topography from the nautical charts was compared with the results of this bathymetric survey. A simplified cross-sectional topography indicated by the blue lines shown in Figure 3.1.5 and Figure 3.1.6 was created by reading the offshore distance from the shoreline at the 2 m, 5 m and 10 m depth contour lines on the nautical charts. In both graphs, the depth profiles created from the bathymetry and nautical charts are in good agreement at depths deeper than 2 m. However, it should be noted that the nautical charts cannot accurately represent topographic features shallower than 2 m owing to the rough resolution of the nautical charts. Therefore, in the next stage of the basic facility design study at far from survey area, we will use the nautical chart data at depths deeper than 2 m, will be adopted if necessary.



Source: JICA Study Team

Figure 3.1.5 Example of Bathymetric Survey Results (Line-3 in Indramayu)



Source: JICA Study Team

Figure 3.1.6 Example of Bathymetric Survey Results (Line-2 in Pemalang-Pekalongan)

3.2 Wave Observation

3.2.1 Overview

The purposes of the wave observations are described asfollows:

i) To understand long-term wave characteristics based on the wave observation in the north coast of Java Island.

ii) To confirm the applicability of reanalysis data (ERA5) in adjacent marine area.

i): In Indonesia, long-term and regular wave observation has been not carried out, and knowledge and data regarding incoming waves to the target coasts as insufficient. Therefore, wave observation was conducted to understand the annual wave characteristics, particularly the seasonal wave characteristics influenced by the monsoon.

ii): In Indonesia, it is common to use reanalysis data, ERA5, in the adjacent sea area, in order to determine design wave for coastal facility. However, such reanalysis data (ERA5) have not been sufficiently validated for local applicability.

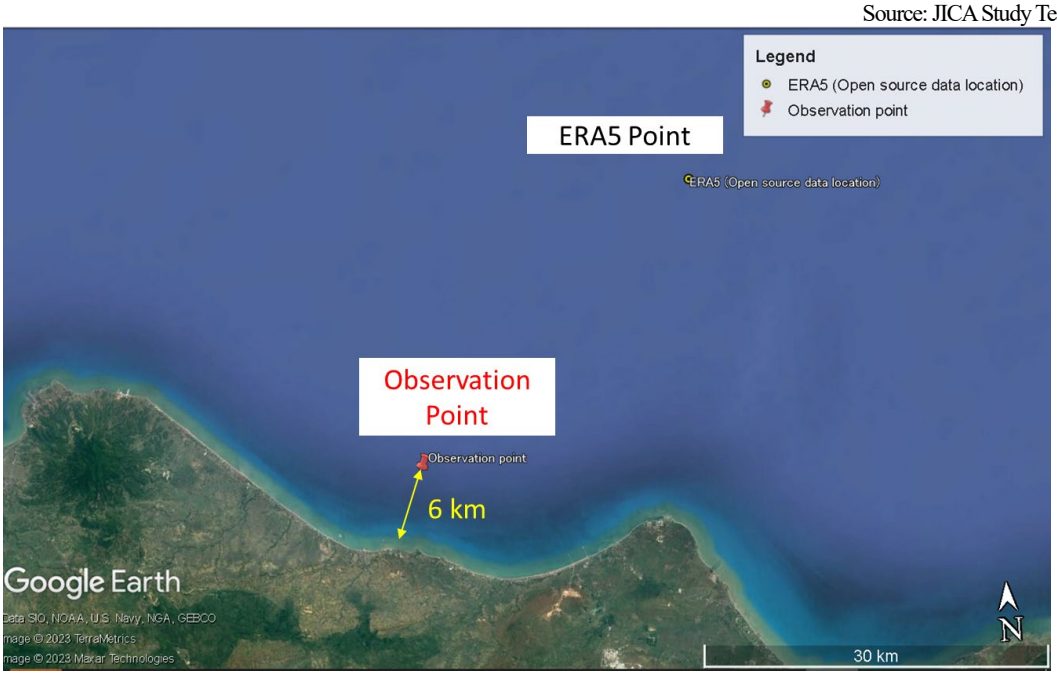
Therefore, the reanalysis data (ERA5) was compared and verified with wave observation data in the adjacent sea area to assess the applicability to target coasts on the north coast of Java Island.

Table 3.2.1 shows the overview of the wave observation such as observation period and observation location.

Table 3.2.1 Overview of Wave Observation

Items	Wave Observation
Observation Period	2022/10/17 ~ 2023/2/17 (mainly, the Northwest Monsoon) 2023/5/27 ~ 2023/11/30 (mainly, the Southeast Monsoon)
Observation Location	At a point 6 km offshore from the Rembang-Tuban Coast (Figure 3.2.1). Figure 3.2.1 shows the data extraction point of the reanalysis data, ERA5, used for the comparison with the wave observation. Note: Although the wave observation equipment was installed in the other areas, i.e., Indramayu and Pemalang, the data is only obtained in Rembang-Tuban due to the loss of the observation equipment.
Water Depth	16.5 m
Observation Equipment	Seabed-mounted type and ultrasonic type wave height meter (Figure 3.2.2)

Source: JICA Study Team



Source: Edited by JICA Study Team based on Google Earth

Figure 3.2.1 Wave Observation Point in Rembang-Tuban

Source: JICA Study Team

Figure 3.2.2 Photos of Wave Observation Equipment after Collection on February 2022 and Field Work by SCUBA Divers

3.2.2 Results and Discussion

(1) Result of Wave Observation in Rembang-Tuban

Table 3.2.2 shows the statistical value of the wave height and wave period during the observation period. Figure 3.2.3 shows the observation data such as the maximum wave height, the significant wave height, the significant wave period, and the mean wave direction. Comparing with the wave data for two times of the observation periods, significant differences in wave direction were observed. Waves from the northwest were dominant during the Northwest Monsoon, while waves from the east-northeast were dominant during the Southeast Monsoon. Although the maximum wave height during the observation period occurred during the Northwest Monsoon, the waves were generally larger during the Southeast Monsoon.

During the observation period, from late December 2022 to early January 2023, high waves were observed, and flooding occurred in some coastal areas of the north coast of Java Island. The time series plot also shows an increase in wave height during this period. Analysis of the past 40 years of reanalysis data (ERA5) also shows that the annual maximum wave heights often occur between December and February, which is consistent with the trends (Referred to Appendix 6-2).

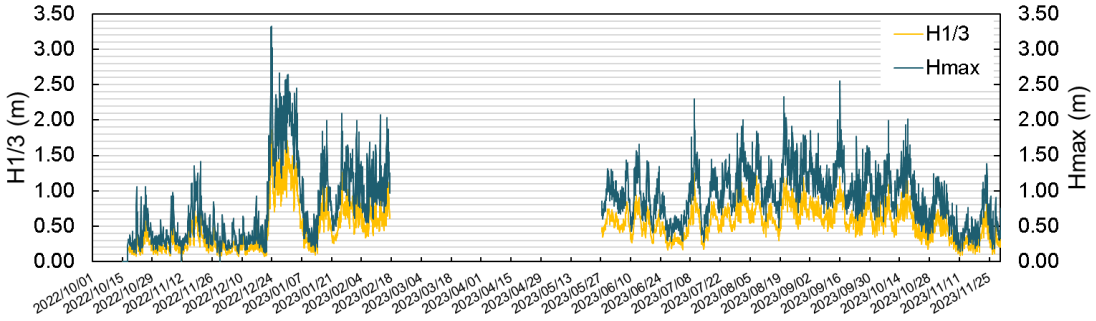
Table 3.2.2 Statistical Values of Wave Height and Wave Period from the Wave Observation

		Hmax	Tmax	H1/10	T1/10	H1/3	T1/3	Hmean	Tmean
		(m)	(sec)	(m)	(sec)	(m)	(sec)	(m)	(sec)
Entire Observation Period 2022/10 -2023/2 2023/5 -2023/11	max	3.33	9.40	2.35	8.00	1.86	8.00	1.20	6.00
	mean	0.87	4.37	0.65	4.34	0.52	4.24	0.34	3.47
Northwest Monsoon (2022/10 -2023/2)	max	3.33	9.40	2.35	8.00	1.86	8.00	1.20	6.00
	mean	0.77	4.28	0.57	4.22	0.46	4.10	0.30	3.34
Southeast Monsoon (2023/5 -2023/11)	max	2.55	8.00	1.54	6.30	1.25	6.20	0.81	5.20
	mean	0.94	4.42	0.69	4.42	0.56	4.33	0.36	3.55

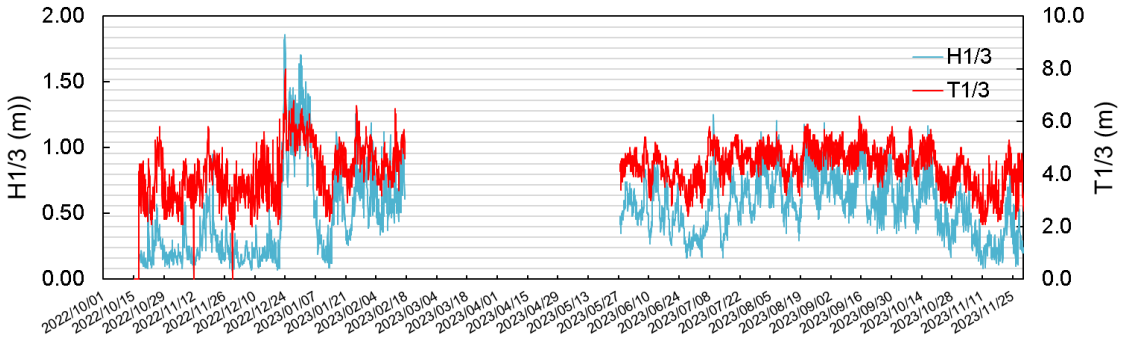
*max : maximum value of the data, mean: average value of the data

Source: JICA Study Team

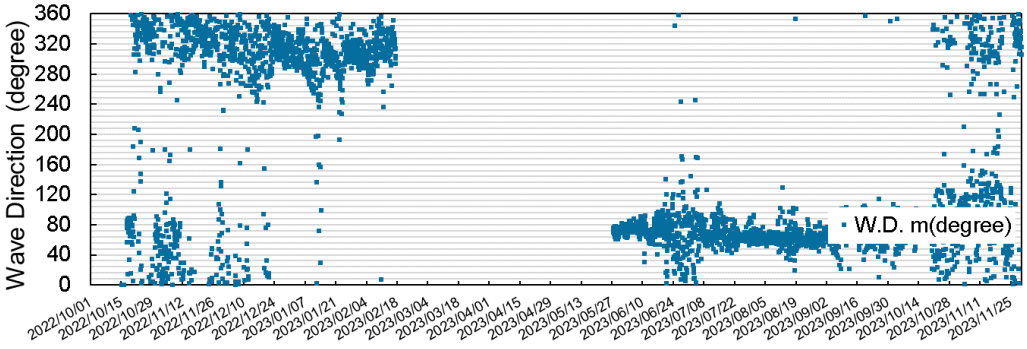
■ Time Series Graph of Maximum Wave Height and Significant Wave Height



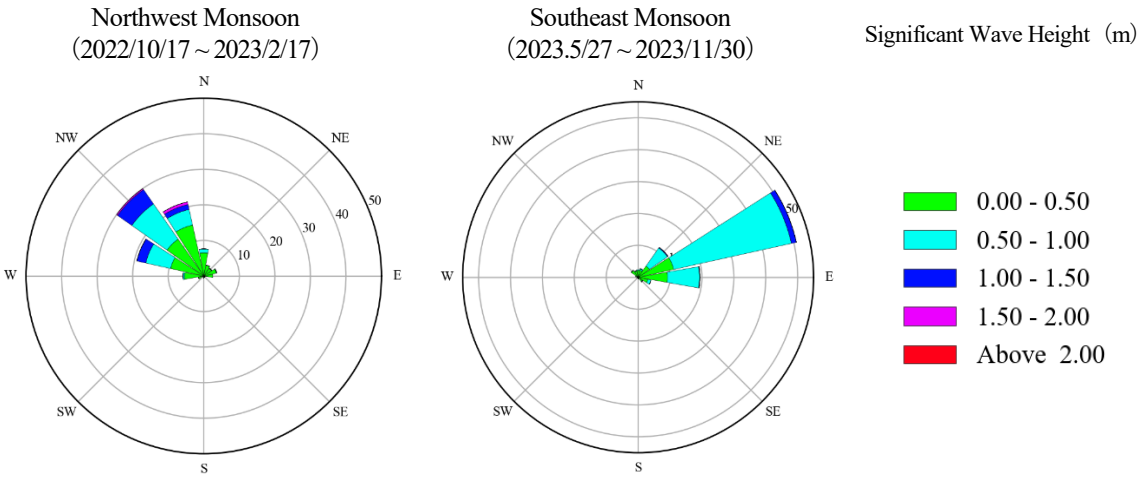
■ Time Series Graph of Significant Wave Height and Significant Wave Period



■ Time Series Graph of Mean Wave Direction (0 degrees at North, clockwise as positive)



■ Significant Wave Height and Mean Wave Direction

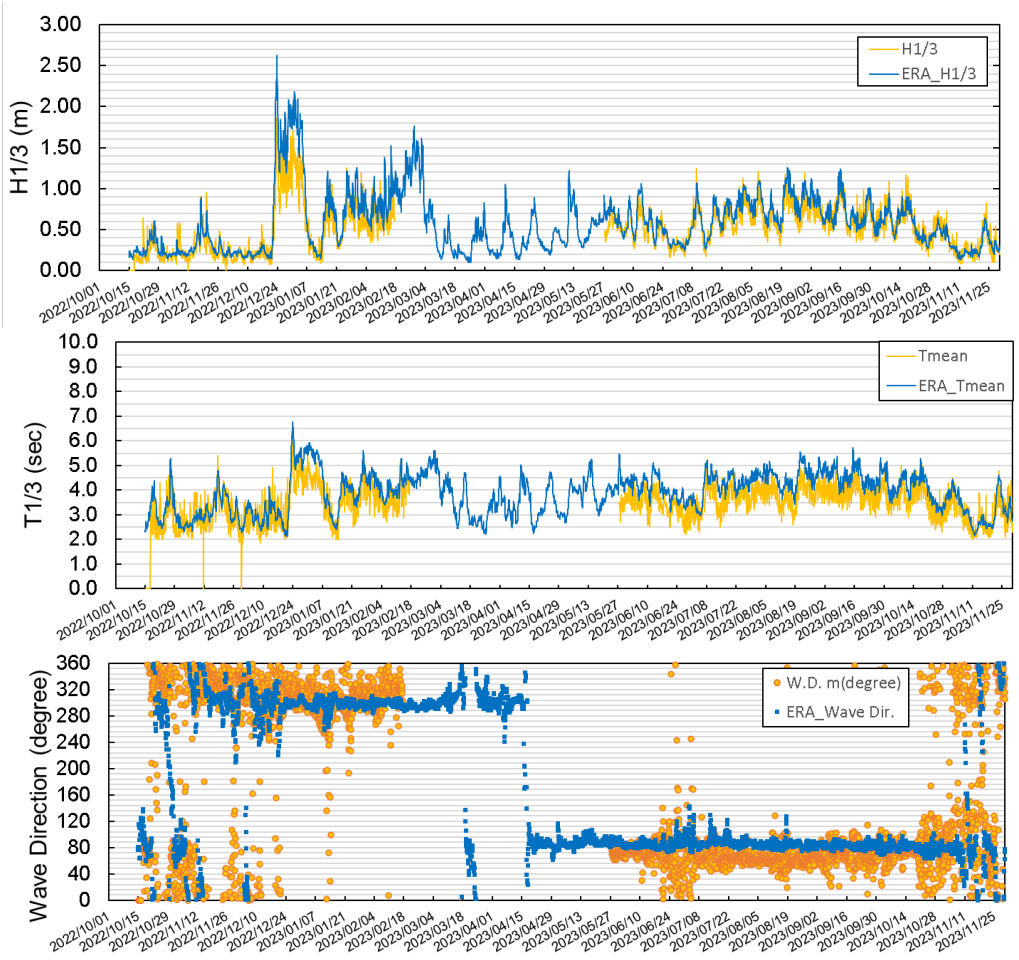


Source: JICA Study Team

Figure 3.2.3 Results of Wave Observation in Rembang-Tuban

(2) Comparison of Wave Observation and Reanalysis Data (ERA5)

Figure 3.2.4 shows the comparison of the wave observation data (illustrated by yellow lines in the graph) and reanalysis data, ERA5 (illustrated by blue lines in the graph) in terms of significant wave height, mean wave period, and wave direction. Overall, those two data have a similar trend in wave height, wave period, and wave direction.



Source: JICA Study Team

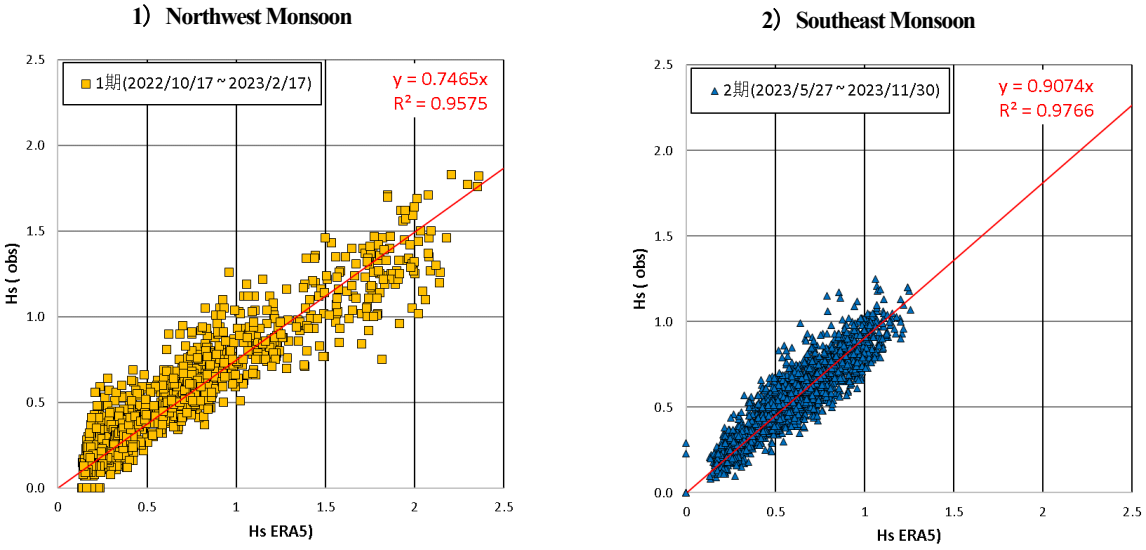
Figure 3.2.4 Comparison of Time-Series Graph Between Wave Observation and Reanalysis Data, ERA5, in Rembang-Tuban

For the validation of the applicability of the reanalysis data (ERA5) to the target coasts on the north coast of Java Island, Figure 3.2.5 shows the correlation between the wave observation data and the reanalysis data (ERA5) for each season. Both data have a good relationship. During the Northwest Monsoon, and about 75 % of the wave heights from the reanalysis data (ERA5) were observed. In contrast, during the Southeast Monsoon, about 90 % of the wave heights from the reanalysis data (ERA5) were observed.

Since the locations of the wave observation is close to the shore comparing with the extraction point of the reanalysis data (ERA5), it is necessary to consider the wave deformation due to topography. Therefore, wave transformation was considered by wave calculations. Figure 3.2.6 shows the wave height ratios at the wave observation points relative to the reanalysis data (ERA5) for each wave direction, based on both the wave observation data and the results of the wave calculations. According to the wave calculations, waves incoming from the west during the Northwest Monsoon are significantly refracted, at the result wave ratio attenuated. On the other hand, waves incoming from the northeast during the Southeast Monsoon reach the coastal area with relatively less

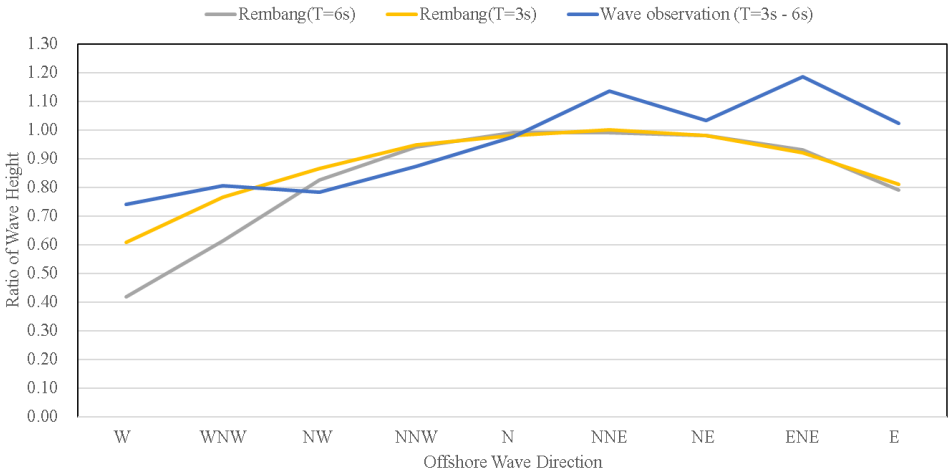
attenuation. This trend is generally consistent with the wave observation data, illustrated in the blue line in Figure 3.2.4.

Therefore, it can be concluded that the reanalysis data (ERA5) generally capture the trends observed in the wave observations in Rembang-Tuban. Moreover, the reanalysis data (ERA5) is concluded as useful for the design waves in the selected Areas.



Source: JICA Study Team

Figure 3.2.5 Comparison of Wave Observation and Reanalysis Data, ERA5 in Rembang-Tuban



Source: JICA Study Team

Figure 3.2.6 Ratio of Wave Height for Observation and Reanalysis Data, ERA5 in Rembang-Tuban

CHAPTER 4 Outline of the Draft of Basic Coastal Management Plan

4.1 Outline

In this chapter, the principle and study for preparation of the draft of Basic Coastal Management Plan will be described. Before this as pre-information, the following descriptions are shown in each section.

Section 4.2: Expected goal for coastal management in Indonesia

Section 4.3: Relation of "Basic Policy for Coastal Management", "Basic Coastal Management Plan" and "Coastal Facility Plan".

Section 4.4: Outline for the procedure of coastal management in Japan (as reference)

Section 4.5 Procedure for the preparation of the draft of "Basic Coastal Management Plan"

Section 4.6 Required Study for Preparation of "Basic Coastal Management Plan" as input information

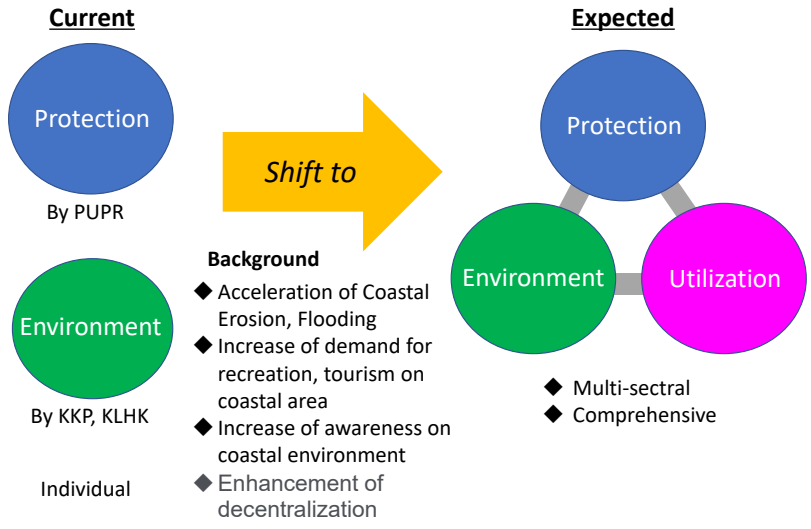
Section 4.7: Principle of "Protection", "Environment" and "Utilization" on the draft of "Basic Coastal Management Plan"

The results of concrete study for each procedure (step) are shown in Chapter 5 to 10.

4.2 Expected Goal for Coastal Management in Indonesia

Figure 4.2.1 shows the image of expected goal for coastal management in Indonesia.

In Indonesia, the implementation for coastal protection and management has been conducted basically individually by each agency based on each individual mandate for example, coastal protection measures have been executed by PUPR and coastal conservation activities using "Green Infrastructures such as mangrove plantation, etc." have been executed by KKP and KLHK. On the other hand, it has not been executed on coastal management activities based on the unified principle and planning on coastal management. This project is aimed to achieve the realization of coastal management under the unified principle and planning on coastal management with harmonization of "Protection", "Environment" and "Utilization" by cooperating of related agencies.

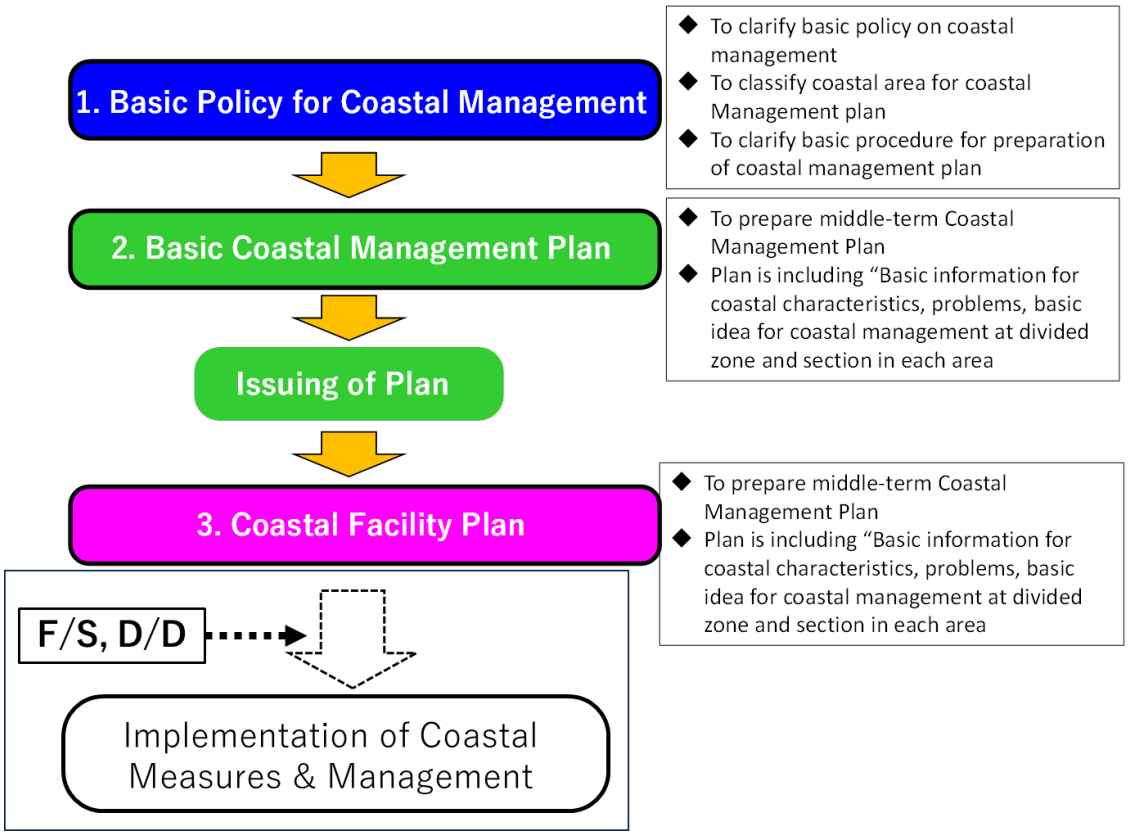


Source: JICA Study Team

Figure 4.2.1 Image of Expected Goal for Coastal Management in Indonesia

4.3 Relation of "Basic Policy for Coastal Management", "Basic Coastal Management Plan" and "Coastal Facility Plan"

Figure 4.3.1 shows the relation of the draft of "Basic Policy for Coastal Management", draft of "Basic Coastal Management Plan" and "Coastal Facility Plan", which are required as the final output in the Project. In this figure, the items required to be included in each output are also described.



Source: JICA Study Team

Figure 4.3.1 Image of Relation for the Draft of "Basic Policy for Coastal Management", Draft of "Basic Coastal Management Plan" and "Coastal Facility Plan"

These three outputs to be studied and the procedure for coastal management based on them is basically following that in Japan shown in Section 4.4. However, it will be modified appropriately based on discussions with relevant organizations and the current coastal condition in Indonesia as final outputs in the Project.

Table 4.3.1 shows each stage and study levels on planning and design for the implementation of coastal protection based on the unified plan. The "Basic Coastal Management Plan" is positioned as a master plan that provides a view of the medium-term coastal facility plan in some wide area. The final output of the "Basic Coastal Management Plan" is to show the rough layout image of coastal facility plan as a basic direction of coastal management, which does not include detailed dimensions of the coastal facilities. Next stage is the "Coastal Facility Plan", which is a pre-F/S level study for the planned section for implementation, showing the basic layout and cross-section image, dimensions of each coastal facility and the estimated project cost. Then, basic design (B/D, F/S) and detailed design (D/D) will be conducted and leads to the implementation of coastal protection projects and its management.

Table 4.3.1 Planning and Design Stage, Level and Overview

Planning & Design Stage	Overview
Basic Coastal Management Plan (Master Plan (M/P))	Develop a medium-term coastal development plan for the target area. Layout plan (without dimensions) will be prepared as final output.
Coastal Facility Plan (Pre-F/S)	Select the section to implement coastal protection from the target area. Study is the basic image of the layout plan, representative cross section of facility (with basic dimension) and estimation of rough project cost.
Basic Design (B/D, F/S)	Based on above Pre-F/S result, basic design is conducted. Quantity and cost for each item is calculated to estimate the project budget
Detailed Design (D/D)	Further quantity and cost calculation is conducted accurately. And prepare the implementation plan and contract document

This Project

Source: JICA Study Team

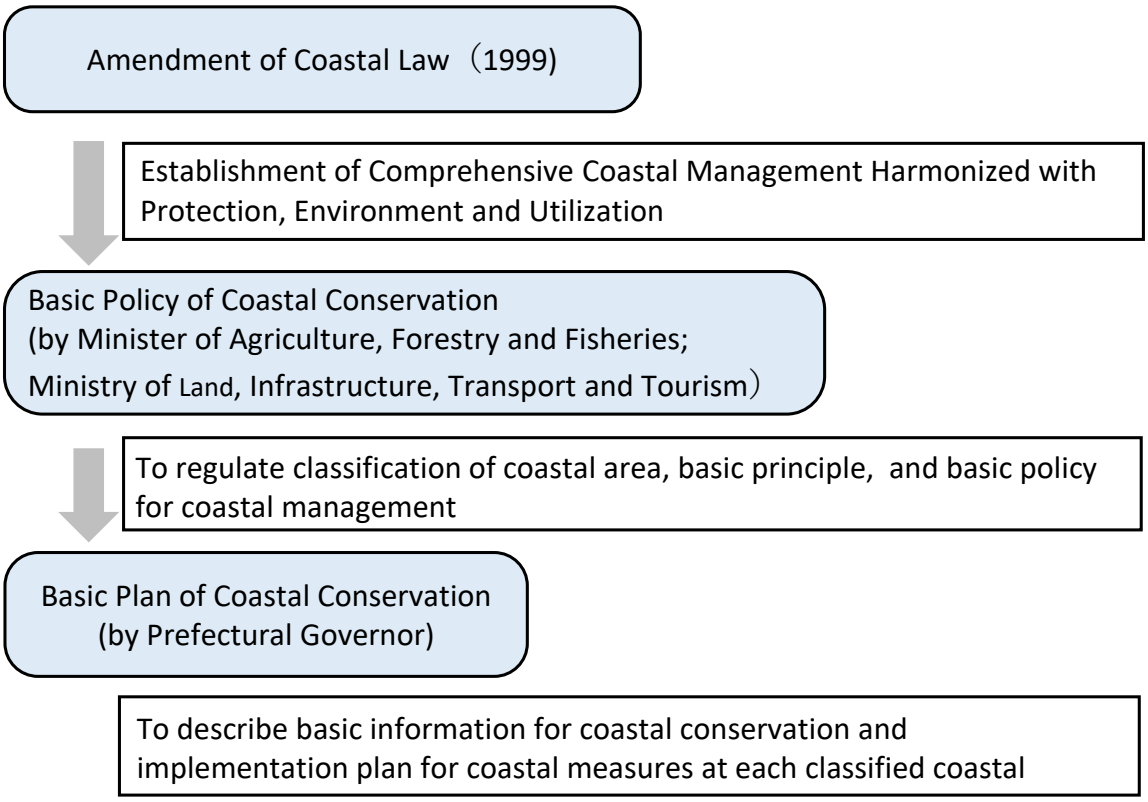
4.4 Outline for the Procedure of Coastal Management in Japan (as Reference)

4.4.1 Outline

Figure 4.4.1 shows the flow of the establishment of the basic plan of coastal conservation in Japan. Here in the case of Japan, the word of "management" is replaced to the word of "conservation" (e.g., "Coastal Management Plan" to Coastal Conservation Plan (in Japan case)).

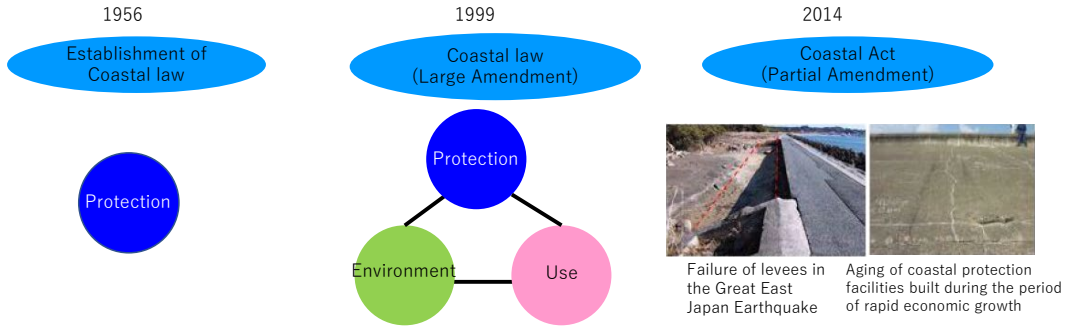
By the amendment of the Coastal Law in 1999, the Minister of Agriculture, Forestry and Fisheries and the Minister of Land, Infrastructure and Transport are obliged to define a "basic policy of coastal conservation" (Article 2.2 in the Coastal Law). It clarifies the basic policy of coastal conservation so that comprehensive coastal management in harmony with protection, environment, and utilization can be carried out properly. In addition, Article 2.3 in the Coastal Law requires that each prefectural governor defines the "basic plan of coastal conservation " based on the "basic policy of coastal conservation". The "basic policy of coastal conservation" has been changed based on the amendments and revisions of the Coastal Law, and then, the "basic plan of coastal conservation" has been reviewed every few or every ten and several years as necessary.

Figure 4.4.2 shows the changing history of the Coastal Law. The Coastal Law was established in 1956 and revised in 1999 from the traditional "protection" purpose to comprehensive coastal management with harmony of "protection", "environment", and "utilization". Based on serious tsunami damage caused by the Great East Japan Earthquake in March 2011, the Coastal Law was partially revised in 2014 and the promotion of disaster prevention such as proper maintenance and management of coastal conservation facilities has been added.



Source: JICA Study Team

Figure 4.4.1 Flow of Establishment of Basic Plan of Coastal Conservation in Japan



Content	・Implementation of protect against coastal hazards such as and waves	・Establishment of a comprehensive coastal management system that harmonizes protection, environment, and utilization ・ that reflects the opinions of the local community ・The prefectural governor formulates the "Basic Plan for Coastal Conservation" in accordance with the "Basic Coastal Preservation Policy" established by the national government ・Expansion of coasts covered by the Coastal Act (creation of general public coastal areas) ・Introduction of a national direct control system etc.	・Promotion of disaster prevention and mitigation measures in coastal management ・Establish a safe and reliable operation system for sluices and land gates ・Appropriate maintenance and management of coastal protection facilities ・Enhancement of coastal maintenance and management in accordance with local conditions

Source: Extracted from the Coastal Conservation Plan in Ibaraki Prefecture

Figure 4.4.2 Changing History of Coastal Law

4.4.2 Basic Policy of Coastal Conservation (Same as "Basic Policy for Coastal Management" in the Project)

The following items are shown as basic guidelines for coastal conservation in the basic policy of coastal conservation defined by the government:

a) Basic philosophy on coastal management

b) Principle on coastal management

c) Principle in coastal measures (facilities)

d) Other considerations on coastal management

In addition, it is stipulated that the coasts of the whole country should be classified into 71 divisions in consideration of the similarity of topography and marine characteristics, continuity of littoral drift, and prefectural boundaries.

In this basic policy, the following three items are stipulated as basic item to be included in the basic plan of coastal conservation:

a) Basic item on coastal management

b) Basic item on coastal measures (facilities)

c) Other items which shall be considered in the item for basic coastal management plan

Furthermore, the following four items are stipulated as matters to keep in mind when preparing a coastal conservation plan:

a) Ensuring consistency with related plans

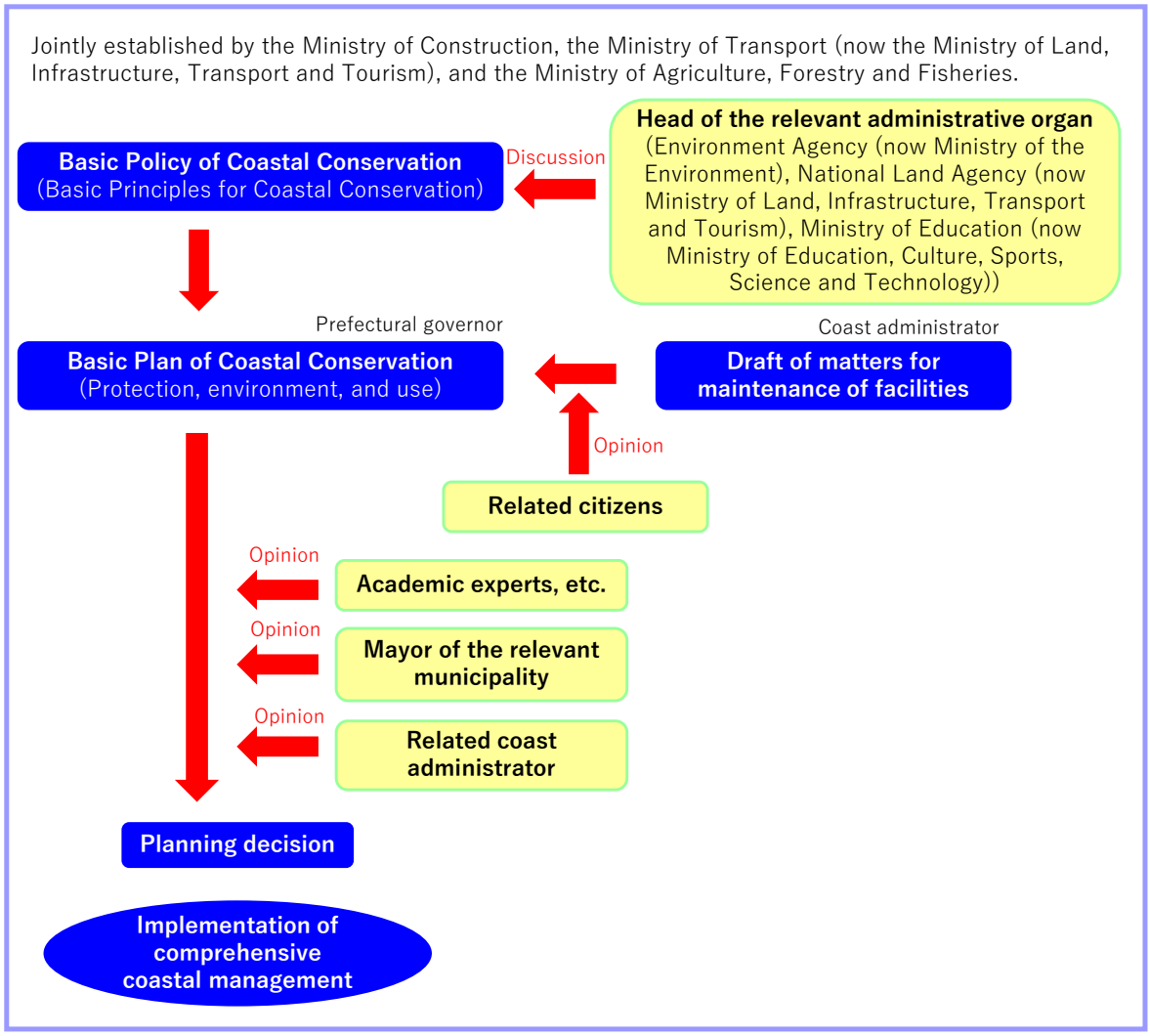
b) Coordination with related government agencies

c) Participation of local residents and information disclosure

d) Review of the plan

4.4.3 Basic Plan of Coastal Conservation (Same as "Basic Coastal Management Plan" in the Project)

The basic plan of coastal conservation is prepared so as to meet the basic matters shown in the aforementioned basic policy of coastal conservation. Figure 4.4.3 shows the process for the basic plan of coastal conservation. The basic plan of coastal conservation is examined by a specialized consultant procured by the prefecture, which is the responsible organization for planning, and in the process of preparation, opinions from related administrative agencies and academic experts, and from local residents are obtained. After information publication, the plan will be decided and implemented. The items to be considered in the basic plan of coastal conservation are organized in Table 4.4.1.



Source: Extracted from the Coastal Conservation Plan in Kanagawa Prefecture

Figure 4.4.3 Preparation Process of Coastal Conservation (Management) Plan in Japan

Table 4.4.1 Consideration Items in the Basic Plan of Coastal Conservation in Japan

Classification	Study Item	Concrete Study Item
1. Basic information for coastal conservation	(1) Basic study on current condition	Outline of nearshore condition, coastal conditions (natural characteristics, socio-economic conditions, coastal disasters and current conditions, classification of zoning and its characteristics, long-term issues, etc.)
	(2) Basic study on principle of coastal conservation	Basic policy, basic principle, targeted objective for long term at each classified area
	(3) Basic study on protection	Targeted achievement, measures to achievement
	(4) Basic study on coastal environment	Conservation of landscape, vegetation, ecology
	(5) Basic study on coastal utilization	Conservation of heritage, enhancement of cooperation with community and beach cleaning, enhancement of utility, opportunity of experimental education program, rule for pressure boat, usage adjustment of coastal area, etc.
2. Implementation plan for coastal measures at each classified coastal area	(1) Basic study on new and improved facilities	Determination of implementation area, kind of measures, scale and layout, ideas for conservation measures, area for beneficiary, etc.
	(2) Basic study on repair and maintenance of existing facilities	Identification of existing facility area, kind of measures, scale and layout, ideas for repair and maintenance, area for beneficiary, etc.
	(3) Study on implementation of coastal facilities for each classified area	Protection method, expected concern, etc.
3. Other important consideration	(1) Cooperation and consistency	Cooperation and arrangement with related agencies, consistency with other plans, projects
	(2) Public involvement and information sharing	
	(3) Enhancement of investigation and research	Adaptive management with monitoring, integrated sediment budget control, adaptation against climate change
	(4) Amendment of plan	

Source: Prepared by JICA Study Team referring to the Coastal Conservation Plan in Kanagawa Prefecture

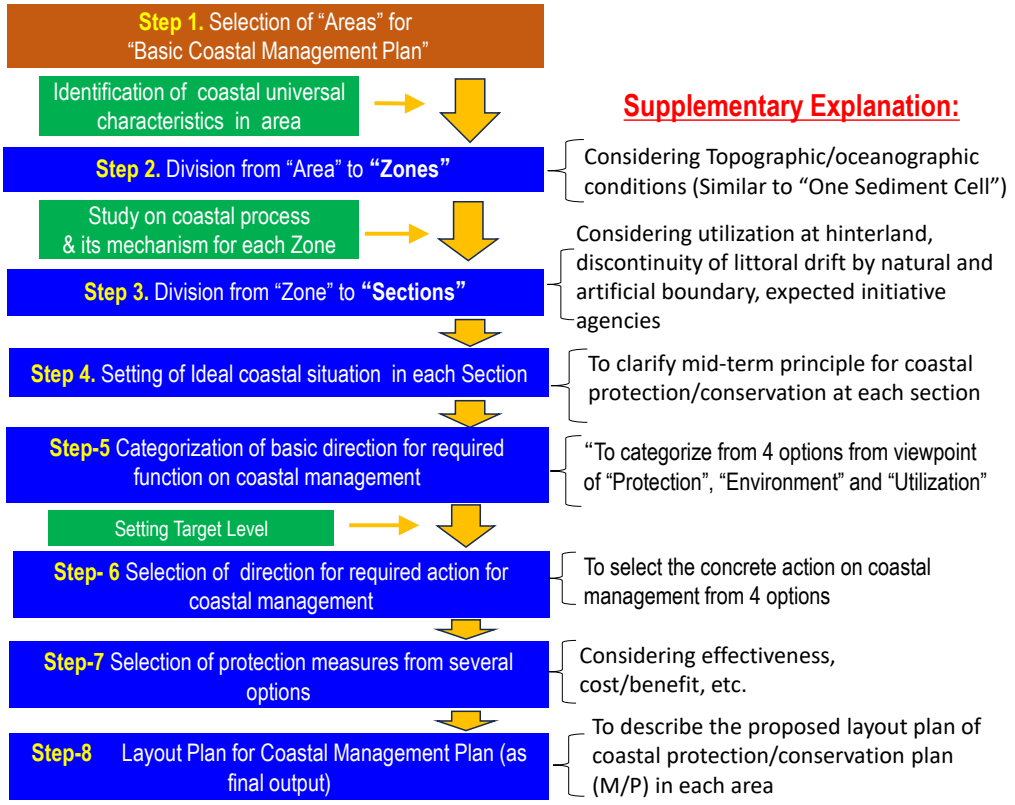
4.5 Procedure for the Preparation of the Draft of Basic Coastal Management Plan

Figure 4.5.1 shows the flow of preparation of the draft of Basic Coastal Management Plan. First of all, coastal divisions from an entire study area are required for the preparation of the draft of Basic Coastal Management Plan (from Step 1 to Step 3 in Figure 4.5.1).

Step 1: The priority "Area" (objective area for pilot study in the Project) for the preparation of the draft of Basic Coastal Management Plan shall be selected about several ten kilometers to one hundred kilometers order coastal length.

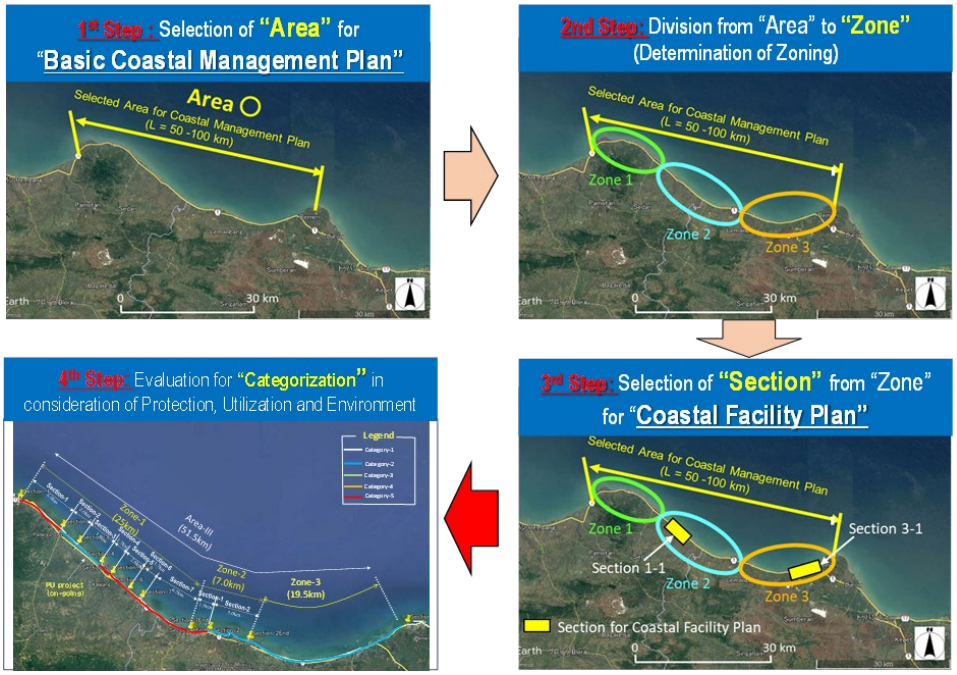
Step 2: The selected priority "Area" will be divided into "Zone" considering coastal characteristics, offshore wave characteristics, direction of coastline, etc. as universal coastal characteristics about several ten kilometer order coastal length.

Step 3: The "Zone" will be further divided into the "Section" considering the difference of utilization condition at the hinterland and/or coastal area taking appropriate boundary where the continuity of littoral drift is passed through by the natural coastal geography (e.g., river mouth, peninsula) or artificial facilities such as port, long jetty, etc. The draft of Basic Coastal Management Plan will be examined in the "Sections". Figure 4.5.2 shows the image for the relation of "Area", "Zone" and "Section".



Source: JICA Study Team

Figure 4.5.1 Flow of the Procedure for Preparation of the Draft of Basic Coastal Management Plan



Source: JICA Study Team

Figure 4.5.2 Relation of "Area", "Zone" and "Section"

Step 4: The "Ideal Situation of Coast" for each section will be defined based on the understanding of current coastal situation and issues at each coastal area.

Step 5: Each sectioning coast will be categorized into several categories of required coastal functions to achieve the ideal situation of coast. As this categorization will be conducted based on the difference of utilization condition of hinterland and coastal area, the section will be further divided into sub-section as required.

Step 6: After setting the target level to fulfill each required function considering current coastal condition, coastal hazard, utilization condition at the hinterland and coastal area etc., the concrete actions for coastal protection measures will be determined. As concrete actions for coastal protection measures, the following four measures (actions) are to be selected, which are (1) no action, (2) observation & monitoring, (3) improvement and upgrading of existing facilities, and (4) new protection development.

Step 6: For (3) and (4) above, which are conducting physical measures on site, the concrete method for coastal measures is selected. The most appropriate measure shall be selected from several options based on a comparative study of effectiveness and economic efficiency.

Step 7: Finally, the draft of Basic Coastal Management Plan will be prepared and described as the layout plan. This is final output of Basic Coastal Management Plan as a mid-term master plan (M/P).

4.6 Technical Study for Preparation of the Draft of Basic Coastal Management Plan as Input Condition

In order to develop the Basic Coastal Management Plan, various technical studies and analyses related to coastal processes and mechanisms are required as input conditions at each study stage as shown in the flow described in Section 4.5 above.

Figure 4.6.1 shows the basic information required for technical studies and analyses, and the items and methods of studies and analyses related to coastal mechanisms and causes of problems using this information. As shown in Table 4.3.1, since the Basic Coastal Management Plan is to show the future management policies for a wide range of coastal areas macroscopically, the detailed specifications and accurate evaluation of quantities, costs, etc. based on them are left to the next study step. Thereafter, as the Project progresses from Pre-F/S to Basic Design to Detailed Design, more quantitative and technical studies are required to achieve higher accuracy.

Item	Concrete items	Purpose	Method	Required action and study for the next step
Collection of basic information for the analysis	Coastal conditions and changes	Grasping the current condition of the coast	Implementation of site reconnaissance survey (observation of coast and hinterland condition, beach utilization condition, observation of bottom sediment characteristics and beach topography, resident interviews, drone photography, etc.)	Confirmation of coastal conditions and changes through repeated site reconnaissance survey
		Grasping the change of coastal line and estuarine in the long-term.	Collection of historical maps, aerial photographs, and satellite images	Obtaining high-resolution satellite images
	Status of coastal development and improvement	Changes in the state of construction of infrastructure facilities such as ports, training wall, etc., and artificial facilities such as coastal facilities	Collection of data and information from relevant organizations and above methods	Check for update information
	Condition and change of supply sources	Grasp of conditions and changes in inflowing rivers, coral reefs, sea cliff, etc., which are assumed sand and silt material sources	Information gathering from site reconnaissance survey, satellite images, relevant organizations, etc.	Above
	Status of coastal disaster	Grasp of coastal issues and disasters that have occurred in the past	Internet, press materials, interviews, etc.	Above
	Characteristics of external force	Grasp of seasonal and long-term changes in waves and abnormal events	Collection of open data (ERA5, etc.) and Implementation of wave observation	Implementation of wave observations on the subject beach (if necessary)
		Change in water level	Collection of existing tidal data and implementation of tide observation	Above
	Other	Status of land subsidence	Data collection from the survey and monitoring reports and literature, and information gathering through interviews, etc.	Grasp of the actual situation by collection of further detailed information and similar examples on the subject coast
		Implementation situation of green infrastructure such as mangrove planting		
Study and analysis for coastal characteristics and causes	A:Quantitative evaluation and analysis of external force conditions (waves, water levels, currents, etc.)	Analysis of wave characteristics	Analysis of appearance characteristics such as wave height, period and wave direction, appearance characteristics of high waves, and long-term change characteristics	Improvement of accuracy (wave analysis by numerical examination, verification with wave observation results)
		Analysis of water level	Calculation of meteorological tide level such as astronomical tide level and storm surge level, setup by waves and long-term water level rise.	Above
		Analysis of current condition	Confirmation and analysis of currents caused by beach topography, such as tidal currents, beach currents, and currents caused by water level differences between inside and outside the reef, which affect beach changes	Above
	B:Each event evaluation (Qualitative/ quantitative evaluation)	Situation of coastal erosion	Long-term shoreline changes calculated by image analysis	Improvement of accuracy (by high imaging, tide level correction, etc.)
		Situation of tidal wave, high tide and flooding	Calculation of the flooding area and depth for each water level from the ground height of the land area.	Improvement of accuracy (Comparative verification with examples, etc.)
		Land subsidence	Calculation of land subsidence (annual settlement)	To grasp the actual situation by gathering further detailed information and cases on the subject coast, and to conduct beach geological surveys as necessary
	C:Evaluation and analysis of correlation among shoreline change, external force and external factors.	Relationship between external impacts (changes in external forces, changes in the development of artificial facilities, changes in conditions of inflowing rivers and coral reefs, land subsidence, etc.) and shoreline changes	Analysis of the interrelationships between the above-mentioned information	Further detailed examination on the subject coast based on the above evaluation, and implementation of reproduction examination using numerical simulation if necessary
	D:Analysis of littoral drift characteristics	Based on the above analysis, the characteristics of littoral drift are as follows: 1) grasp of seasonal change and net for direction and scale of littoral drift, 2) identification of continuity of littoral drift, and 3) necessity of considering drifting sand off the shore, etc.	Numerical analysis (if necessary) and the above	Above
	E:Analysis for cause of casotal issues		Overall evaluation from the above	Above

Utilized as input to the Basic Coastal Management Plan (M/P) and Coastal Facility Plan

Source: JICA Study Team

Figure 4.6.1 List of Technical Studies Required to Prepare the Basic Coastal Management Plan

4.7 Principle of "Protection", "Environment" and "Utilization" on the Draft of Basic Coastal Management Plan

In formulating the Basic Coastal Management Plan, basic policies are presented below from the viewpoint of coastal protection, environment, and utilization.

4.7.1 Protection

The nearshore areas selected as the priority Areas are all experiencing significant coastal erosion. Tidal flood occurs due to coastal erosion, causing significant inundation damage. Additionally, there are residential areas, agricultural areas such as rice paddies, and fisheries such as fishponds in the hinterlands, and their lives and property must be protected from coastal erosion and flood damage. In some cases, the beaches themselves are used as tourist resorts, such as recreational beaches and beach parks. The conveniences of these coastal utilization are being lost due to coastal erosion and inundation. As such, the basic goal is to meet the following standards.

- Prevent erosion and inundation damage to residential areas in the hinterlands.
- Prevent or reduce damage to agricultural lands in the hinterlands and fisheries such as fishpond.
- In sandy beaches which are used for swimming, etc., protection by beaches itself should be the basic policy.

As for the level of coastal protection, it is basic that wave overtopping or flood damage will not occur even if a wave equivalent to a 50-year probability strikes at the maximum tide level of the year. For coastal erosion in the target coast, an appropriate shoreline position will be set considering the past erosion history, the importance and utilization of the hinterland, and the coastal utilization. In addition, for external forces greater than design condition of wave and tide, damage will be minimized by taking tenacious measures (structures), such as preventing them from collapsing easily due to wave overtopping. With regard to climate change represented by sea level rise, conditions such as external forces will be determined according to the importance of the hinterland and the cost of facilities, bearing in mind the scenarios predicted by the IPCC and others. In other words, if it costs a lot of money to renew the facility to respond to climate change, it is desirable to construct it at this time in anticipation of changes in external forces due to climate change, but if this is not the case, that is, if it is cost-appropriate to renew the facility under climate change conditions at the stage of maintenance and renewal, it will be done so. In general, it is assumed that coastal conservation facilities are often the latter. In addition, since land subsidence and subsidence of the facility itself are expected in the coastal area, it is considered appropriate to respond at the maintenance stage, such as responding to climate change in accordance with these measures.

4.7.2 Environment

Regarding the environmental aspects, coastal areas used for natural environments, tourism resources, and fishery activities, such as natural conservation areas, should be treated as coastal protection based on diverse regional characteristics. On the one hand, the main cause of the decline of mangrove forests in Java Island is excessive logging due to land reclamation associated with coastal development and conversion to shrimp and fish aquaculture ponds, agriculture, salt pans, etc. In order to prevent and preserve the deterioration and damage of this mangrove forest, it is necessary to take concrete actions, one of which is the restoration of mangroves in damaged areas. It has been reported that ecosystem services in mangrove forests have a wide variety of service functions. In the field of coastal conservation measures, among these service functions, service functions such as (1) climate change countermeasures, (2) mitigation of local disasters, (3) water volume adjustment, (4) water purification, and (5) suppression of soil erosion are highly expected. In recent years, the green infrastructure has begun to be used to solve social problems with the functions of the natural environment.

Based on the situation of mangroves in Java Island and the importance of the ecological service function of mangroves, as a basic environmental policy in this project, this project will actively utilize the green infrastructure using mangroves with the purpose of achieving various functions of mangroves and various effects such as coastal protection (disaster prevention and mitigation) and improvement of the local environment can be obtained. Specifically, the following is the target.

- For nature preserves, preservation of the environment and landscape should be kept in mind.
- Environmental preservation as a fishing area (protective measures that do not interfere with fishing activities).
- Implement green infrastructure along with protective measures with concrete structures (gray infrastructure).

4.7.3 Utilization

In terms of utilization, the goals are as follows.

- Protection shall be provided for the convenience of recreational users such as sea bathers, beach park users, and fishermen, as well as for the improvement of the living environment of local residents.
- Protection shall consider fishing activities.
- Protection shall contribute to the promotion of safety and comfortable use of the beach by meeting the needs of beach users.

CHAPTER 5 Selection of Priority Area for Basic Coastal Management Plan as Step-1

5.1 Overview for Selection

5.1.1 Background

The drafts of the Basic Coastal Management Plan and Coastal Facility Plan in the selected pilot area in the Project are required to be prepared as the output of the Project.

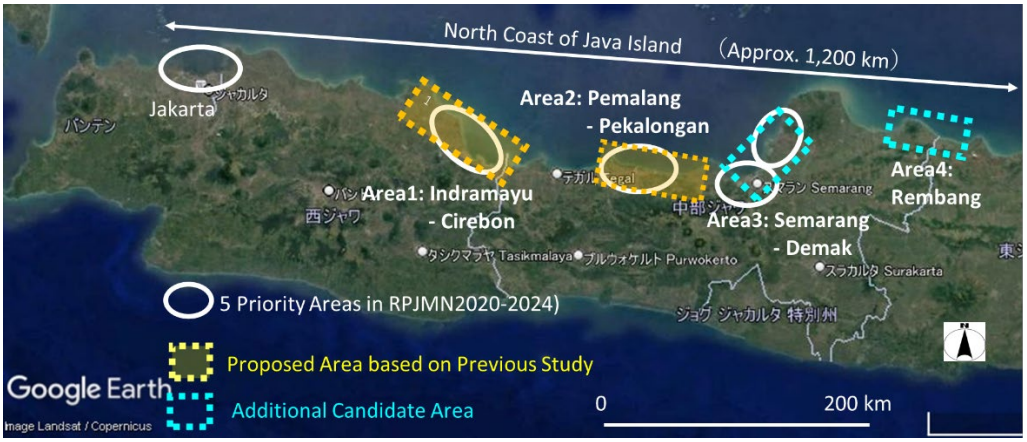
According to the R/D which was agreed on March 2022 between PUPR and JICA, two areas with approximately 50 to 100 km of shore length will be selected as the pilot areas for the preparation of the draft of the Basic Coastal Management Plan. However, such two pilot areas have not been decided yet until now. The priority area shall be selected by applying appropriate criteria which were basically agreed in the R/D and will be decided after the discussion with the C/P (PUPR). Based on the agreed result between PUPR and JICA, the current R/D will be revised and issued.

5.1.2 Chronology of Discussion

- Referring to the result of the Previous Study, four areas have been tentatively selected as candidate priority areas as shown in Figure 5.1.1. These selected candidate areas were presented in the 1st kick-off meeting which was held on July 7, 2022. In the meeting PUPR requested that the number of selected area be increased from the original two to three areas and this was basically accepted by JICA Study Team.
- In the 1st coordination meeting, which was held on September 27, 2022, the following two comments were pointed out from the Directorate of River & Coastal in PUPR:

  1) It is required to show the reason for the selection of the candidate areas

  2) It is also required to show the quantitative evidence for the selection of the three priority areas from the above mentioned candidate areas.
- The 2nd coordination meeting was held with the Directorate of River & Coastal in PUPR on October 7, 2022 to discuss again the selection of the priority area. As a result of the discussion, mutual acceptance was obtained for the study result by JICA Study Team.
- After that, the coordination meeting with BAPPENAS was held on October 26, 2022 for sharing the study results and exchanging opinion for the selection of the priority area. There was no objection for the selected three priority areas; however, BAPPENAS requested to do the study at Sayung in Demak as preliminary level only.
- The 3rd coordination meeting was held with the Directorate of River & Coastal in PUPR on November 1, 2022 to confirm again the selected three priority areas. Also, both sides agreed to add the study at Sayung in Demak as preliminary level only.
- On February 14, 2023, Joint Coordination Conference (JCC) was held with major related ministries and agencies including PUPR, on the agreement on the selected three priority areas. The description regarding the agreed priority areas is stated in the R/D, which is under confirmation by C/P as of March 2023.



Source: JICA Study Team

Figure 5.1.1 Four Candidate Areas for Priority Area of Basic Coastal Management Plan which were Presented in the Kickoff Meeting in the 1st Site Survey

Table 5.1.1 Outline of Four Candidate Areas

Name	Area Name	Coastal Length
Area-1	Indramayu – Cirebon	100 km
Area-2	Pemalang – Pekalongan	50 km
Area-3	Semarang – Demak	100 km
Area-4	Rembang	50 km

Source: JICA Study Team

5.2 Selection Method and Selection Criteria

5.2.1 Selection Method

The selection of priority area for the Basic Coastal Management Plan was conducted by using the following method:

- 2-step selections were employed for the selection of priority area, which were "to identify several candidate areas as 1st selection" and "selection of priority areas from 1st selected several candidate areas as 2nd selection".
- Five areas were selected as the candidate areas in the 1st selection and three areas were finally selected as proposed priority areas for the Basic Coastal Management Plan as agreed in the kick-off meeting.
- In the 1st selection for selection of candidate areas, three selection criteria were applied, which were picked up from the four selection criteria as was agreed and stated in the R/D. The evaluation for each criteria was carried out in every regency which belongs to the north coast of Java Island with approximately 1,200 km coastal line, and the final evaluation was obtained by summarizing each evaluation result for each regency.
- In the 2nd selection for selection of priority areas, six criteria in total were applied, which included four criteria stated in the R/D and two further additional criteria.

- The "Ranking Method", which was relative evaluation among five candidate areas for each criteria and is different from the "Scoring Method", was applied in the 2nd the selection for selection of priority areas. And the rankings for each criteria were finally summarized for the evaluation of the total ranking.

5.2.2 Selection Criteria

Table 5.2.1 and Table 5.2.2 shows the selection criteria which were applied in the 1st and 2nd selections, respectively.

1st selection to select five candidate areas

Table 5.2.1 Selection Criteria in the 1st Selection

No.	Evaluation Criteria	Evaluation Item
1	Representativeness	Length of coastal erosion, risk for tidal flooding, degree of land subsidence, type of coastal issue
2	Importance	Five priority areas on RPJMN or not
3	Utilization of Hinterland	Existence of heritage, tourism area, existence of important infrastructure

Source: JICA Study Team

2nd selection to select three priority areas

Table 5.2.2 Selection Criteria in the 2nd Selection

Category	No.	Evaluation Criteria	Evaluation Item
Criteria agreed by R/D	C-1	Representativeness (typical coastal issues, variation of coastal measures)	Kind of coastal issues, degree of coastal erosion (length and area for coastal erosion), variation of coastal measures)
	C-2	Priority from C/P and local community	Five priority areas on RPJMN or not, request and opinion from BBWS/BWS and local government.
	C-3	Priority for use of coastal area and hinterland	Heritage, tourism, residential, agriculture and fisheries
	C-4	Adverse effect to surrounding area	Validity of existing coastal measures, impact on surrounding coastal area
Additional Criteria	C-5	Economic impact (importance for protection of hinterland)	Population density, GDP per region
	C-6	Possibility to conduct technical viewpoint	Possibility of quantitative study based on future prediction

Source: JICA Study Team

5.3 Current Coastal Condition for Candidate Areas

5.3.1 Overview

Site surveys were conducted at several candidate coasts in the 1st field work (July 2022) and 2nd field work (October 2022) in order to grasp the current coastal condition for the candidate coasts. The following survey works were carried out during the site surveys.

- Site check visually (visual check, taking photos, simple survey such as visual check of sand contents and groin size, beach profile, etc.)
- Taking oblique photos and videos by drone to cover almost whole area of candidate area
- Data and information collection from each BBWS/BWS and local government, and interview survey to residents

Table 5.3.1 shows the list of coasts for conducting the site investigation and the main objectives for each investigation. Also, Table 5.3.2 shows the outline of coastal use and representative coastal issue for each site.

Table 5.3.1 List of Visited Coasts and Objectives of Visit

Site Survey	Visited Site	Category	Date	Main Objectives
1st Site Survey	Indramayu (East) - Cirebon	Area-1	2022/6/25-27	To know current condition
	Semarang - Demak	Area-3	2022/6/29-30	Same as above
	Rembang	Area-4	2022/6/30	Same as above
	Pekalongan - Pemalang	Area-2	2022/7/1-2	Same as above
Site Survey with JICA Adviser	Demak	Area-3	2022/8/8	To know current condition
	Rembang	Area-4	2022/8/9	For checking additional area
	Pekalongan	Area-2	2022/8/10	For further checking
2nd Site Survey	Indramayu (West)	Area-1'	2022/10/8-10	To know current condition for new additional area
	Pekalongan	Area-2	2022/10/11-12	For further checking
	Rembang -Tuban	Area-4	2022/10/14-15	For further checking including Tuban area

Source: JICA Study Team

Table 5.3.2 Condition for Use of Coastal Area and Main Coastal Issues at Each Candidate Area

Area	Regency	Coastal Use	Main Coastal Issue
Area-1	Indramayu (East) - Cirebon	Tourism, residential, agriculture/fishery, urban city	Coastal erosion, sedimentation
Area-1'	Indramayu (West) - (East)	Same as above	Coastal erosion
Area-2	Pekalongan - Pemalang	Tourism, residential, agriculture/fishery, urban city	Tidal flood due to land subsidence and coastal erosion
Area-3	Semarang - Demak	Tourism, residential, fishpond, urban city	Tidal flood due to land subsidence
Area-4	Rembang - Tuban	Tourism, residential, fishery	Coastal erosion

Source: JICA Study Team

5.3.2 Current Coastal Condition at Each Candidate Coast

Current coastal condition at each candidate coast is presented in Figure 5.3.1 to Figure 5.3.5.

Source: Final Report, the Previous Study (2021, JICA) (top) and JICA Study Team (bottom)

Figure 5.3.1 Indramayu East (Area-1)

Location of Indramayu (West)

Protection Measure using Rock Fill (P1)

Land Erosion (P1)

Collapse of Seawall due to further erosion (P1)

Beach Condition at Domestic Tourism Area (P1)

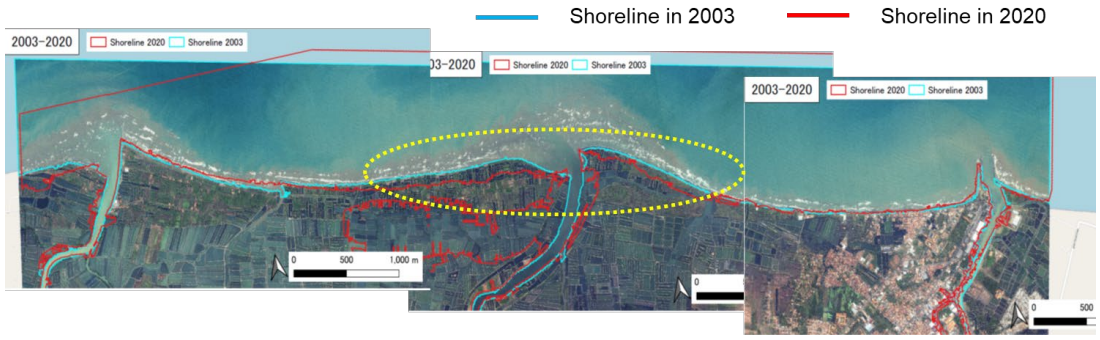
Silt Diffusion due to Land Erosion (P2)

Protection Measure (by line) at Residential Area (P3)

Protection Measure (Mangrove Plantation) at Fishpond (P4)

Source: Edited by JICA Study Team based on Google Earth (1st row) and JICA Study Team (2nd to 4th row)

Figure 5.3.2 Indramayu West (Area-1')



Significant Coastal Erosion at Sengkarang river mouth about 100-150 m for 17 years

Change in Water Area from 2003 to 2020

Coastal Protection at Urban Area (Line Protection)

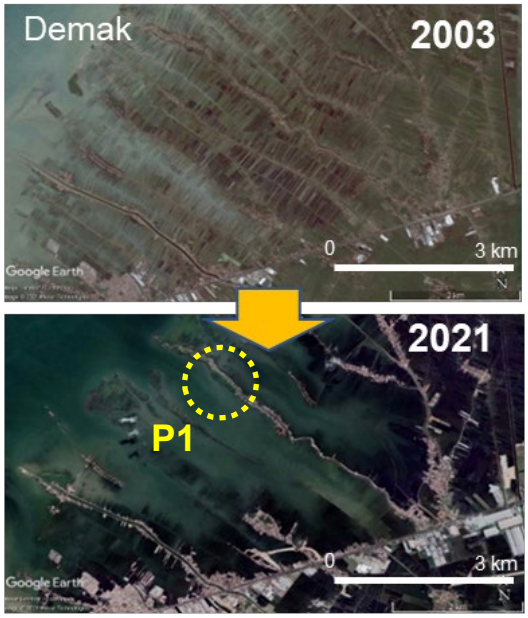
(Point P1 in the above figure)

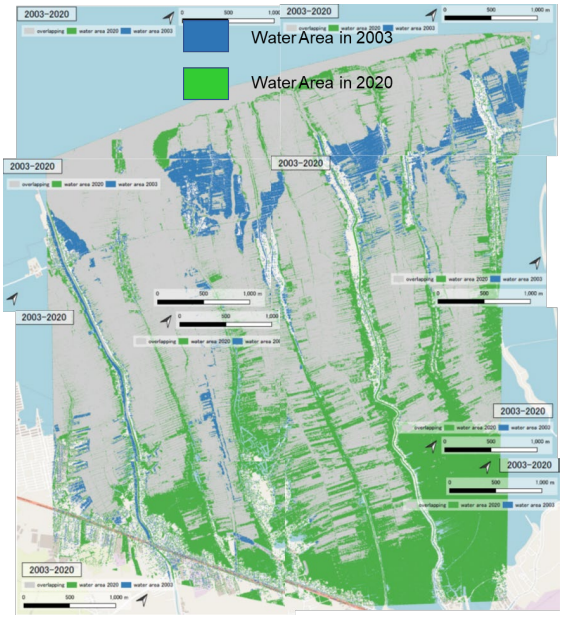
Protection Dike against Tidal Flood

(Point P2 in the above figure)

Source: Final Report, the Previous Study (2021, JICA) (top), JICA Study Team (bottom)

Figure 5.3.3 Pekalongan (Area-2)





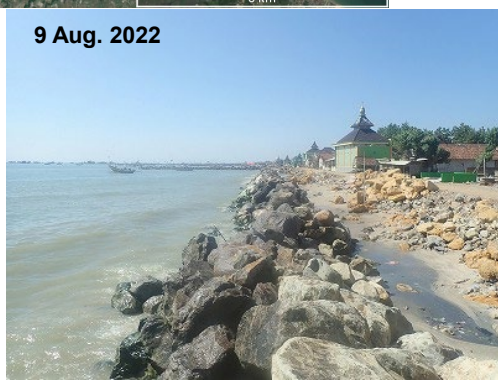
Change in Water Area from 2003 to 2020

Mangrove Transplantation at Tip Part and House (P1)

Source: Final Report, the Previous Study (2021, JICA) (top), JICA Study Team (bottom)

Figure 5.3.4 Demak (Area-3)

Revetment Construction by BBWS (P1)



Revetment Construction by BBWS (P1)

Groins and Seawall（P2）

Coastal Condition around Groin(P3)

Offshore Breakwaters（P4）

Groins（P4）

Source: Edited by JICA Study Team based on Google Earth (1st row) and JICA Study Team (2nd to 4th row)

Figure 5.3.5 Rembang（Area-4）

5.4 1st Step Selection (Narrowing Down of Candidate Areas)

5.4.1 Selection Criteria in the 1st Step

Regarding the selection in the 1st step, the aim is to narrow down the candidate sites to be selected throughout the north coast of Java Island to five places. Here, the whole area of the north coast of Java Island was divided into 24 areas for each regency/city and the evaluation was carried out for each area. The selection criteria are shown in Table 5.2.1 and the details of each evaluation item are shown in Table 5.4.1.

Table 5.4.1 Selection Criteria and Detailed Evaluation Items in the 1st Step Selection

Main Selection Criteria	Evaluation Items
Representativeness	● Coastal erosion (length of abrasion) ● Risk level of tidal flood (2015-2019) ● Land subsidence (cm/year) ● Types of coastal issues
Five key areas selected by RPJMN	Five areas (North Jakarta, Cirebon Regency, Pekalongan City, Semarang City and Demak Regency)
Priority on coastal utilization / land use	● Typical coastal/land utilization in coastal areas ● Heritage in coastal areas (within 100 m of the shoreline) ● Major tourist areas in coastal areas ● Critical infrastructures in coastal areas (national road/railway) (within 200 m of the shoreline)

Source: JICA Study Team

The typical coastal issues in the north coast of Java Island are coastal erosion, tidal flood, and sedimentation in river mouth. Coastal erosion has presumably occurred due to decrease of sand supply, imbalance of sand budget, and land subsidence in coastal areas. The tidal flood has presumably occurred due to inundation caused by both land subsidence and high tide, river flood by heavy rain, high wave, and storm surge in coastal area. Therefore, the representativeness criterion in the 1st step selection is whether or not the typical coastal problems are included, and evaluated by using the length of coastal erosion, risk level of tidal flood, and land subsidence (cm/year).

5.4.2 Evaluation Results for Each Criteria

■ **Representativeness**

Based on the selection criteria and four evaluation items, the representativeness of 24 areas was evaluated. Priority was set in consideration of the following three evaluations.

- Higher priority when the length of coastal erosion is greater than or equal to 5 km.
- Areas with a high risk of flooding not caused by land subsidence will be given higher priority.
- Areas with a high risk of flooding due mainly to land subsidence will have a lower priority.

Ten areas with higher priorities were selected as a result of the evaluation of representativeness as shown in Table 5.4.2.

Table 5.4.2 Evaluation Result of Representativeness

Adoministrative		Name of City/regency	(1) Representativeness				
province	regency/ city		Coastal erosion: Length of abrasion (km)	Tidal flood: Risk level of tidal flood (2015-2019)	Land Subsidence (㎝/year)	Type of coastal issues	(1) Evaluation Results
BANTEN	3	Tangerang regency	19.9	Low	0	Coastal Erosion, Inundation Inland	●
DKI JAKARTA	4	North Jakarta	62	High	0-15	Tidal flood, Inundation	△
WEST JAVA	5	Bekasi regency	5.2	High	1-2, 3-5	Tidal flood, Inundation	△
	6	Karawang regency+A:A:O	7.9	Mid	1-2	Coastal Erosion, Inundation Inland	●
	8	Indramayu regency	57	Low	0	Coastal Erosion	●
	9	Cirebon regncy	1.2	Mid.	6-10	Tidal flood, Inundation	△
CENTRAL JAVA	11	Brebes regency	14.44	Low	0	Coastal erosion	●
	12	Tegal city	10.3	Mid.	3-5	Tidal flood, Inundation	△
	14	Pemalang regency	6.84	Low	1-2	Coastal erosion	●
	15	Pekalongan regency	3.43	Mid	6-10	Tidal flood, Inundation	△
	16	Pekalongan City	3.43	High	3-5	Coastal Erosion, Inundation Inland	△
	17	Batang regency	8	Low	0	Coastal erosion	●
	18	Kendal regency	15	Mid.	0	Small Coastal Erosion, Inundation Inland	△
	19	Semarang city	20.86	High	11-15	Tidal flood, Inundation	△
	20	Demak regency	7.98	High	5-20	Tidal flood, Inundation	△
	21	Jepara regency	16.32	Low	0	Coastal erosion	●
	22	Pati regency	10.09	Low	0	Coastal erosion	●
	23	Rembang regency	9.8	Low	0	Coastal erosion	●
EAST JAVA	24	Tuban regency	8	Low	0	Coastal erosion	●
	26	Gresik regency	0.6	Low	1-2	Small Coastal Erosion, Inundation Inland	×
	27	Surabaya city	19.8	Low	3-5	Coastal Erosion, Inundation Inland	△
	28	Sidoarjo regency	5.5	Low	3-5	Coastal Erosion, Inundation Inland	△
	31	Probolinggo regency	1.7	Low	0	Small coastal Erosion, Inundation land	×
	33	Situbondo regency	7.2	Low	0	Small coastal erosion	△

Note: The evaluation results in the rightmost column were assessed as follows:

○ (Circle): Coasts where the impact of land subsidence on coastal disasters (coastal erosion and flooding) is considered to be small (coasts where the effects of general coastal conservation measures are expected to be sufficient). In addition, these are coasts with a significant extent of erosion (more than 5 km) and a high risk of coastal erosion or flooding.

△ (Triangle): Coasts where the impact of land subsidence on coastal disasters is considered to be significant (coasts where the effects of general coastal conservation measures are expected to be limited). Additionally, these are coasts that do not fall under the category marked by ×.

× (Cross): Coasts with limited erosion extent (less than 5 km) and a low risk of flooding

Source: JICA Study Team

■ Candidate Five Areas Selected by RPJMN

As mentioned above, the five areas of North Jakarta, Cirebon Regency, Pekalongan City, Semarang City, and Demak Regency were selected.

■ Priority on Coastal Utilization and Land Use

Based on the above-mentioned selection criteria and four evaluation items, the evaluation was carried out on beach the utilization and hinterland use of the coastal area of 24 areas. For the typical coastal/land utilization as the first evaluation item, priority was set high for areas occupied by many residential areas. For heritage in coastal areas, which is the second evaluation item, priorities were set higher when there are important shrines such as mosque with 100 m from the shoreline. As the third evaluation item, the priority should be set for major tourist areas which include beaches, water parks, aquariums, etc. As the last evaluation item, i.e., critical infrastructures in the coastal area, higher priorities will be set when national road and/or railway exists less than 200 m from the shoreline. In the north coast of Java Island, there is no railway in the coastal area, and only national roads were evaluated.

The above four items were comprehensively evaluated, and when there were three or more high priorities among the four items, they were selected as the priority coast in this selection. As a result, ten areas were selected.

Table 5.4.3 Evaluation Result on Coastal Utilization and Land Use

Adoministrative		Name of City / regency	(3) Priority on coastal utilization/land use				
province	regency/ city		Type of coastal utilization/land use along coastal zone (High priority is residencial)	Heritage along coastal zone (Within 100 m from shoreline)	Mejor Tourism area along coastal zone	Important infrastructure along coastal zone (National road / railway): within 200 m from shoreline	(3)Evaluation Results (More than 3 priorities as shown on the left were selected as high priority area)
BANTEN	3	Tangerang regency	Fish pond, Agricultural		4 beaches		△
DKI JAKARTA	4	North Jakarta	Development area, residential agricultural		- 1 beach - 1 recreation park		△
WEST JAVA	5	Bekasi regency	Fish pond, Agricultural land		-		×
	6	Karawang regency+A:A:O	Residential		6 beaches		△
	8	**Indramayu regency**	Residential and agricultural		6 beaches	○	●
	9	Cirebon regncy	Agricultural and Residential		-		△
CENTRAL JAVA	11	Brebes regency	Agricultural		1 beach		△
	12	**Tegal city**	Agricultural and Residential		1 beach	○	●
	14	**Pemalang regency**	Resindential and agricultural	○	3 beaches 1 waterpark		●
	15	Pekalongan regency	Agricultural		1 beach		△
	16	Pekalongan City	Residential and agricultural		2 beaches		△
	17	Batang regency	Agricultural		- 6 beaches - Dolphin center/Safari Batang		△
	18	Kendal regency	Agricultural and Residential		- 2 beaches - 1 mini zoo & aquarium		△
	19	**Semarang city**	Development area, residential agricultural	○	- 1 beach - 1 recreation park	○	●
	20	**Demak regency**	Residential, Fish pond	○	1 beach		●
	21	Jepara regency	Agricultural	○	- 7 beaches - 1 recreation park		△
	22	Pati regency	Agricultural		1 beach		△
	23	**Rembang regency**	Residential	○	- 5 beaches - 1 waterpark	○	●
EAST JAVA	24	**Tuban regency**	Agricultural	○	- 6 beaches - 1 recreation park	○	●
	26	Gresik regency	Development area, residential agricultural		1 beach		△
	27	**Surabaya city**	Development area, residential agricultural	○	1 beach		●
	28	Sidoarjo regency	Agricultural		-		×
	31	**Probolinggo regency**	Development area, residential agricultural		3 beaches	○	●
	33	**Situbondo regency**	Residential and agricultural		5 beaches	○	●

Source: JICA Study Team

5.4.3 Comprehensive Evaluation in the 1st Step Selection

As described above, the evaluation was carried out for 24 areas in each regency/city with respect to the three main selection criteria. These results are summarized in Table 5.4.4. In the first step, areas with two or more higher priorities among the three main criteria were selected. Consequently, eight areas of Indramayu Regency, Cirebon Regency Pemalang Regency, Pekalongan City, Semarang City, Demak Regency, Rembang Regency, and Tuban Regency were selected as candidate areas.

Table 5.4.4 Overall Evaluation Results Based on Three Criteria

Adominstrative province	regency/ city	Name of City / regency	Selection Criteria (1) Representativeness	(2) 5 important areas selected by RPJMN	(3) Priority on coastal utilization/land use	Overall Evaluation
BANTEN	3	Tangerang regency	●		△	
DKI JAKARTA	4	North Jakarta	△	●	△	Rejected due to executing other projects, although it is important area (RPJMN)
WEST JAVA	5	Bekasi regency	△		×	
	6	Karawang regency+A:A:O	●		△	
	8	**Indramayu regency**	●		●	**Selected because of more than two priority points**
	9	**Cirebon regncy**	△	●	△	Selected because of impoertant area (RPJMN)
CENTRAL JAVA	11	Brebes regency	●		△	
	12	Tegal city	△		●	
	14	**Pemalang regency**	●		●	**Selected because of more than two priority points**
	15	Pekalongan regency	△		△	
	16	**Pekalongan City**	△	●	△	Selected because of impoertant area (RPJMN)
	17	Batang regency	●		△	
	18	Kendal regency	△		△	
	19	**Semarang city**	△	●	●	**Selected because of more than two priority points**
	20	**Demak regency**	△	●	●	**Selected because of more than two priority points**
	21	Jepara regency	●		△	
	22	Pati regency	●		△	
	23	**Rembang regency**	●		●	**Selected because of more than two priority points**
EAST JAVA	24	**Tuban regency**	●		●	**Selected because of more than two priority points**
	26	Gresik regency	×		△	
	27	Surabaya city	△		●	
	28	Sidoarjo regency	△		×	
	31	Probolinggo regency	×		●	
	33	Situbondo regency	△		●	

Note: The evaluation results in the rightmost column were assessed as follows:

○ (Circle): Cases where 3 or more out of the 4 evaluation criteria are applicable.

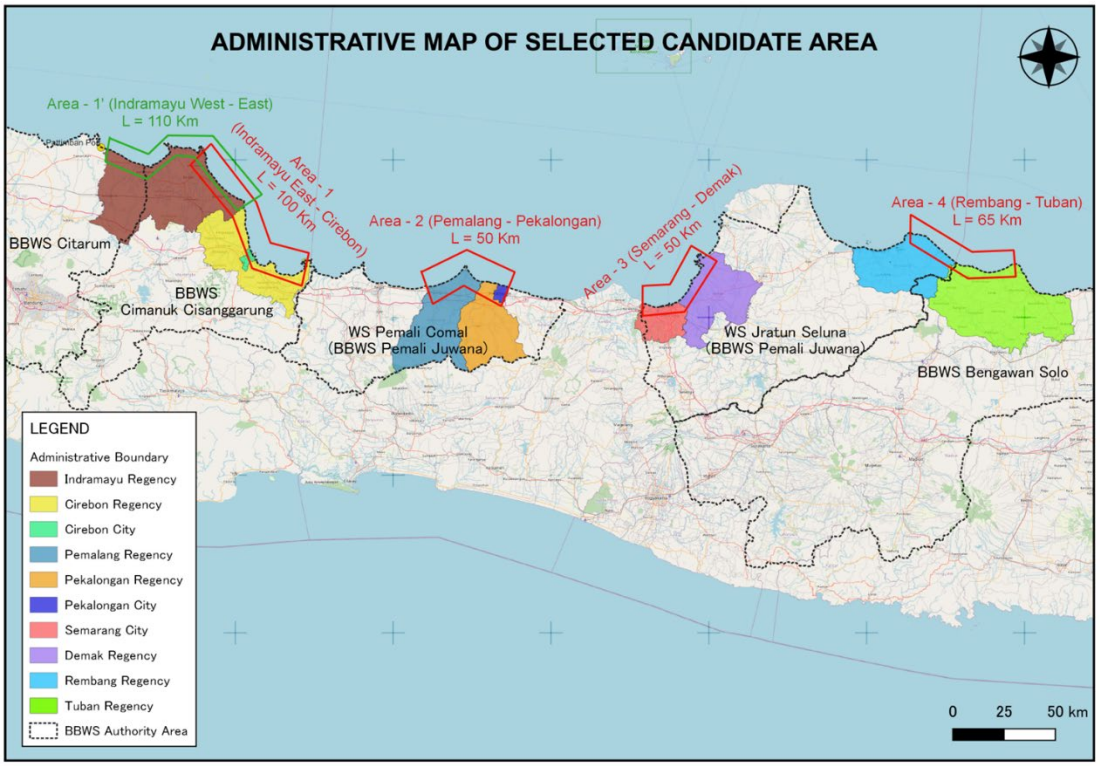
△ (Triangle): Cases where 1 to 2 out of the 4 evaluation criteria are applicable.

× (Cross): Cases where none of the 4 evaluation criteria are applicable.

Source: JICA Study Team

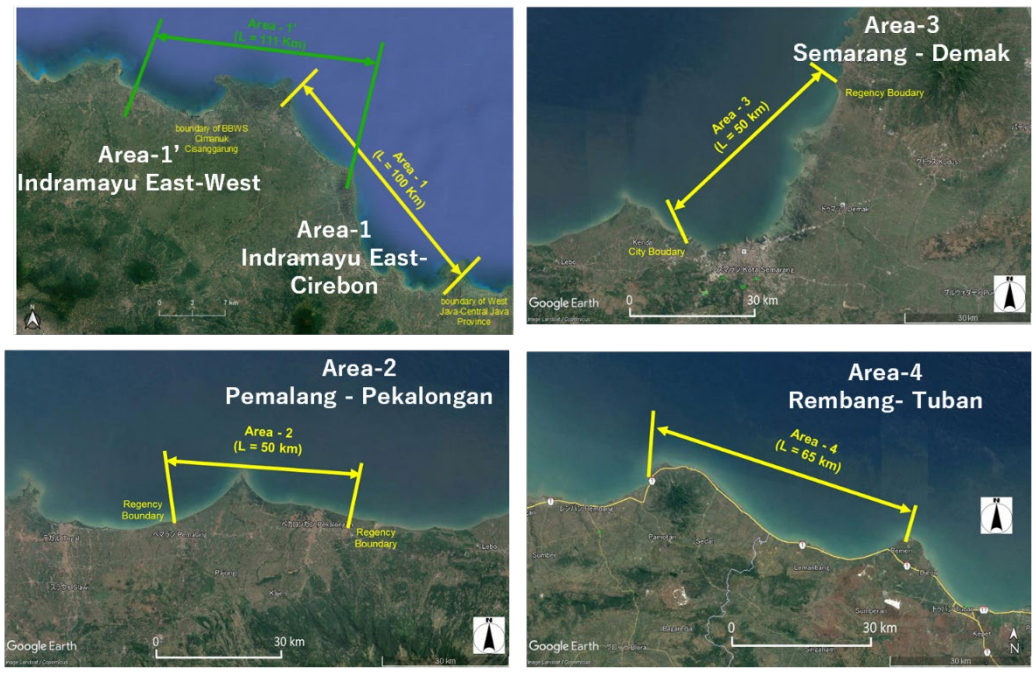
The priority area to be finally selected in the Project will have a coastal range between of 50 and 100 km set as one zone. Based on this, for the eight candidate areas selected, regional divisions will be established considering study scale, regional continuity (regency/city), administrative zone, etc. From this, it was summarized in the following five regions. Five of these candidate areas are shown in Figure 5.4.1, and the satellite images are shown in Figure 5.4.2.

1. Area-1 Indramayu East – Cirebon (100 km)
2. Area-1' Indramayu West - East (111 km)
3. Area-2 Pemalang – Pekalongan (50 km)
4. Area-3 Semarang – Demak (50 km)
5. Area-4 Rembang – Tuban (59 km)



Source: JICA Study Team

Figure 5.4.1 Selected Five Candidate Areas from the 1st Step Selection

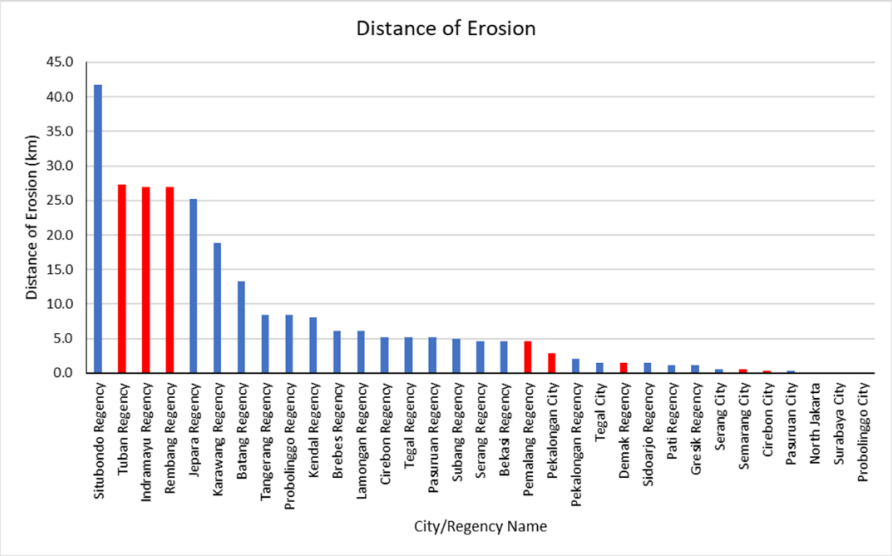


Source: JICA Study Team

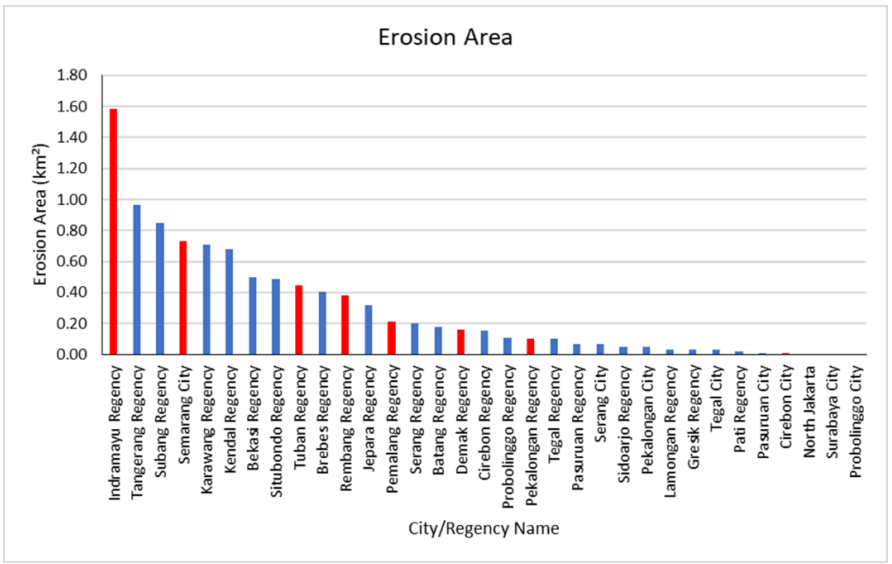
Figure 5.4.2 Satellite Image for Selected Five Candidate Areas

5.5 2nd Step Selection (Selection of Priority Areas)

In order to select the three priority areas, further quantitative evaluation was conducted using the evaluation criteria shown in Table 5.2.2 from the five candidate areas selected above. For example, Figure 5.5.1 shows the extent of erosion and areas of erosion as the degree of coastal erosion in the C-1 representativeness evaluation criteria, and Figure 5.5.2 shows the severity of flood damage for each city/regency. Figure 5.5.3 shows the population density and GDP for each prefecture in the C-5 economic impact assessment criteria. In the bar graphs of Figure 5.5.1 and Figure 5.5.3, the regencies or cities in the eight candidate areas selected in the 1st step selection are shown in red, and the others are shown in blue.



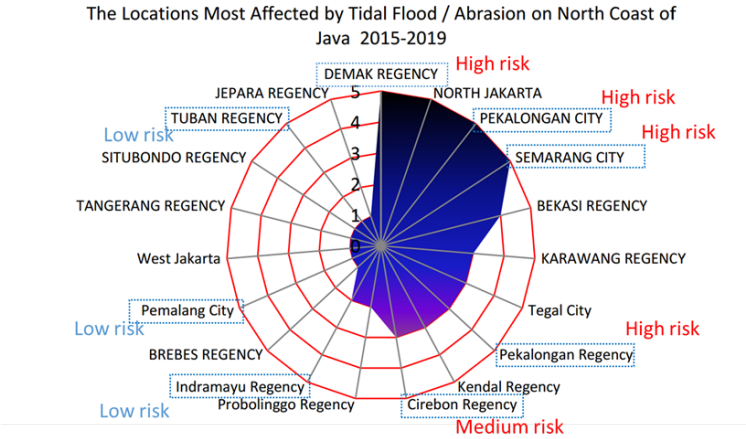
(1) Coastal Erosion Extent (Longshore Distance) for Each City/Regency



(2) Coastal Erosion Area for Each City/Regency (Erosion Distance x Amount of Coastal Recession)

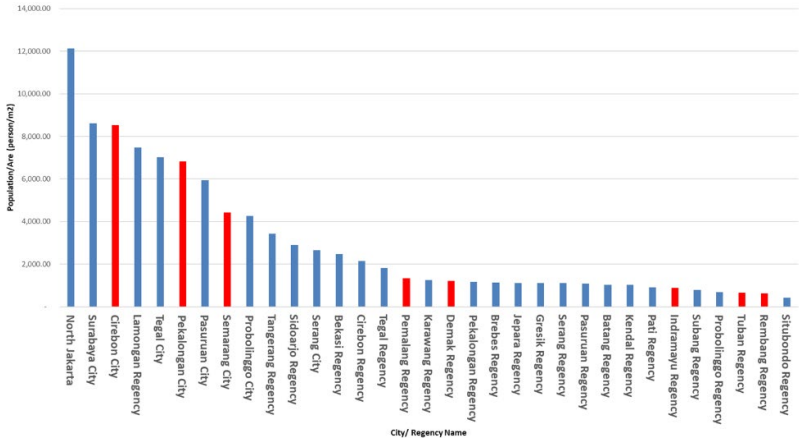
Source: JICA Study Team

Figure 5.5.1 Example of Evaluation of Extent of Coastal Erosion in the Evaluation Criteria C-1: Representativeness

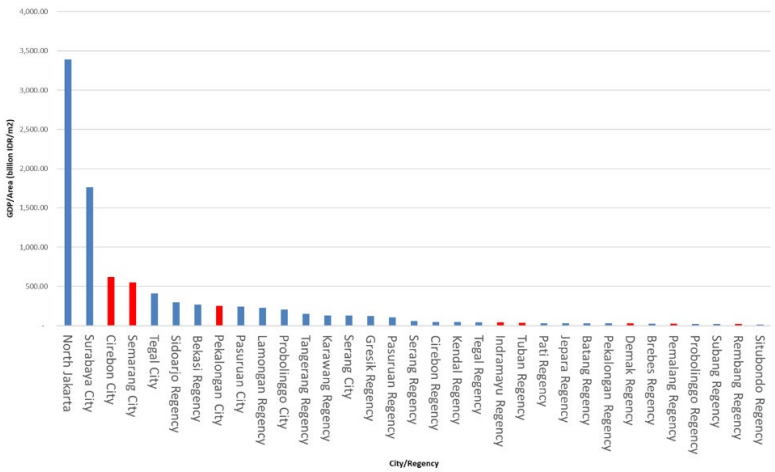


Source: Preliminary Data Collection Survey on the Project for Master Plan Study on the North Coast of Java Island (JICA, 2020)

Figure 5.5.2 Assessment of Flood Severity in the Evaluation Criteria C-1: Representativeness



(1) Population Density in Each City/Regency



(2) GDP in Each City/Regency

Source: Regency/City in Number, Statistic Center Agency, 2021, partially revised by JICA Study Team

Figure 5.5.3 Example of the Criteria C-4: Economic Impact

Table 5.5.1 lists the results of each evaluation, using criteria C-1 through C-4 agreed upon in the R/D. The following three areas received the top ratings.

No. 1: Area-2 (Pemalang-Pekalongan) and Area-1' (Indramayu West and East)

No. 3: Area-4 (Rembang-Tuban)

In addition, the following three areas received the top ratings in the overall C-1 to C-6 evaluation, adding the two evaluation criteria of C-5 Economic Impact and C-6 Feasibility of Technical Consideration.

No. 1: Area-2 (Pemalang-Pekalongan)

No. 2: Area-1'(Indramayu West and East) and Area-4 (Rembang-Tuban)

Thus, the top three sites were the same three coasts in both evaluations.

Table 5.5.1 Evaluation of Each Candidate Site Against Selection Criteria

Division	Candidate Priority Area		Area-1 (100 km)		Area-1' (60 km)		Area-2 (50 km)		Area-3 (50 km)		Area-4 (50 km)	
	Province		West Java		West Java		Central Java					East Java
	Location		Indramayu-East	Cirebon	Indramayu-West	Indramayu-East	Pemalang	Pekalongan	Semarang	Demak	Rembang	Tuban
	Administrative Division		Regency	City	Regency	Regency	Regency	Regency & City	City	Regency	Regency	Regency
Criteria based on R/D	C-1 Representativeness	Typical coastal problems	Coastal Erosion	Tidal flood due to mainly land subsidence (but medium level)	Coastal Erosion	Coastal Erosion	Coastal Erosion	- Coastal Erosion - Tidal Flood due to land subsidence and others	Tidal flood due to mainly land subsidence	- Coastal Erosion(Land loss) - Tidal flood due to mainly land subsidence	Coastal Erosion	Coastal Erosion
		Variation of coastal protection measures by PU	- Offshore Breakwaters - Revetment - Groins	Seawall	(Necessary to check on site)	- Offshore Breakwaters - Revetment - Groins	- Groins - Revetment	-Dyke - Geo tube breakwater	Offshore Sea dyke with Toll Road	Offshore Sea dyke with Toll Road	- Groins - Revetment - Offshore breakwater	- Groins - Revetment
		Other coastal protection measures	–	Mangrove Planting	(Necessary to check on site)	–	–	–	Mangrove Planting	–	–	–
		Evaluation	☆☆	☆	–	☆☆	☆☆	☆☆	☆	☆	☆☆	☆☆
		Comments	High representativeness is identified by executing various coastal protection measures against coastal erosion caused by waves or decrease of sand supply as typical coastal problem in Indonesia	Even though tidal flood is coastal problem in this area, it is not so serious level comparing to other areas, also quantitative study based on future prediction is difficult in this time	Based on satellite image, typical coastal erosion (maybe due to decrease of sand supply) was identified. This is common coastal problem in Indonesia.	High representativeness is identified by executing various coastal protection measures against coastal erosion caused by waves or decrease of sand supply as typical coastal problem in Indonesia	High representativeness is identified by executing various coastal protection measures against coastal erosion as typical coastal problem in Indonesia	Coastal problem might be combined coastal erosion and flooding due to waves and tide. Also, coastal protection measures have been on-going. From this, high representativeness is identified.	Even though tidal flood due to land subsidence is serious in this area, there is difficulty to solve this problem without control and regulation for land subsidence. So, quantitative study based on future prediction is also difficult in this time.	same as left	High representativeness is identified by executing various coastal protection measures against coastal erosion caused by interruption of littoral drift as typical coastal problem in Indonesia	same as left
		Ranking for C-1	**4th**		**1st**		**1st**		**5th**		**1st**	
	C-2 Priority by the PUPR and local governments	Priority area in RPJMN	–	○	–	–	–	○	○	○	–	–
		Intension (Request) from PU	High	–	High	High	–	High	High	High	High	–
		Intension (Request) from BBWS based on 1st site survey	High	–	High	High	High	High	High	High	High	–
		Intension (Request) from local government	–	–	–	–	–	–	–	–	–	–
		Evaluation	☆☆	☆☆	☆☆	☆☆	☆	☆☆☆	☆☆☆	☆☆☆	☆☆	–
		Ranking for C-2	**2nd**		**2nd**		**2nd**		**1st**		**5th**	
	C-3 Priority on coastal utilization/land use	Coastal use		Urban area	Industrial area (2 ports)				Urban area			
		Heritage near coast					Tomb of Syekh Maulana Samsudin		Tomb of Waliyyulloh Syekh Maulana Jumadil Kubro	Tomb of Syekh Mudzakir	Tomb of Putri Cempo Pasujudan Sunan Bonang	Kwan Sing Bio Temple
		Tourism Area	Domestic			Domestic	Domestic	Domestic		Domestic	Domestic	Domestic
		Infrastructure near coast	National Road			National Road			National Road		National Road	National Road
		Residential Area	○		○	○	○	○		○	○	○
		Fishery / Agriculture	○		○	○	○	○		○	○	○
		Evaluation	☆☆☆	☆	☆☆	☆☆☆	☆☆☆	☆☆	☆☆☆	☆☆☆	☆☆☆☆	☆☆☆☆
		Comments	Highly utilized as tourism and residential area. Also national road exist near coastal area. So, priority is high.	Urban area is important on economical point of view, on the other hand, possibility for harmonization of protection, environment and utilization is low. So, priority is not so high.	Two offshore big ports exist in this area and residential area also exists. So, priority is high.	National road exists near coastal area. Also coastal area is utilized as tourism and residential area. So, priority is high.	Heritage exists near coastal area. Also coastal area is utilized as tourism and residential area. So, priority is high.	Coastal area is utilized as tourism and residential area. So, priority is high.	Urban area is important on economical point of view. Even though possibility for harmonization of protection, environment and utilization are low, heritage and national road exist near coastal area. So, priority is	Heritage exists near coastal area. Also coastal area is utilized as tourism and residential area. So, priority is very high.	Heritage and national road exist near coastal area. Also coastal area is utilized as tourism and residential area. So, priority is very high.	Heritage and national road exist near coastal area. Also coastal area is utilized as tourism and residential area. So, priority is very high.
		Ranking for C-3	**5th**		**3rd**		**3rd**		**2nd**		**1st**	
	C-4 Potential adverse impacts on the environment and society (Possibility to cause adverse effect due to implementation of protection measures)	Adequacy of existing or on-going coastal protection measures					inadequate partially (retreat at down drift side of groins)				inadequate (loss of sandy beach, retreat at down drift side of groins / revetment)	inadequate (retreat at down drift side of groins / revetment)
		Ranking for C-4	**3rd**		**3rd**		**2nd**		**3rd**		**1st**	
	Sum Num. of Ranking from C-1 to C4		**14**		**9**		**8**		**11**		**8**	
	Total Ranking from C-1 to C-4 based on R/D Criteria		**5th**		**3rd**		**1st**		**4th**		**1st**	
Other criteria	C-5 Economic impact	Priority of population per area	6	1	7	6	4	2	3	5	8	8
		Priority of GDP per area	4	1	7	4	6	3	2	5	8	8
		Priority (in average)	3		6		3.75		3.75		8	
		Ranking for C-5	**1st**		**4th**		**2nd**		**2nd**		**5th**	
	C-6 Quantitative study based on future prediction	Possible or difficult?	Possible	Difficult	Possible	Possible	Possible	Possible for coastal erosion issue	Difficult	Difficult	Possible	Possible
		Evaluation	☆☆	–	☆☆	☆☆	☆☆	☆	–	–	☆☆	☆☆
		Ranking for C-6	**4th**		**1st**		**3rd**		**5th**		**1st**	
Sum Num. of Ranking from C-1 to C6			**19**		**14**		**13**		**18**		**14**	
Total Ranking from C-1 to C-6			**5th**		**2nd**		**1st**		**4th**		**2nd**	

Source: JICA Study Team

5.6 Conclusion

The selection of priority areas for the Basic Coastal Management Plan study was conducted in two steps: the selection of candidate sites as 1st Step, and the selection of priority areas from candidate areas as 2nd Steps.

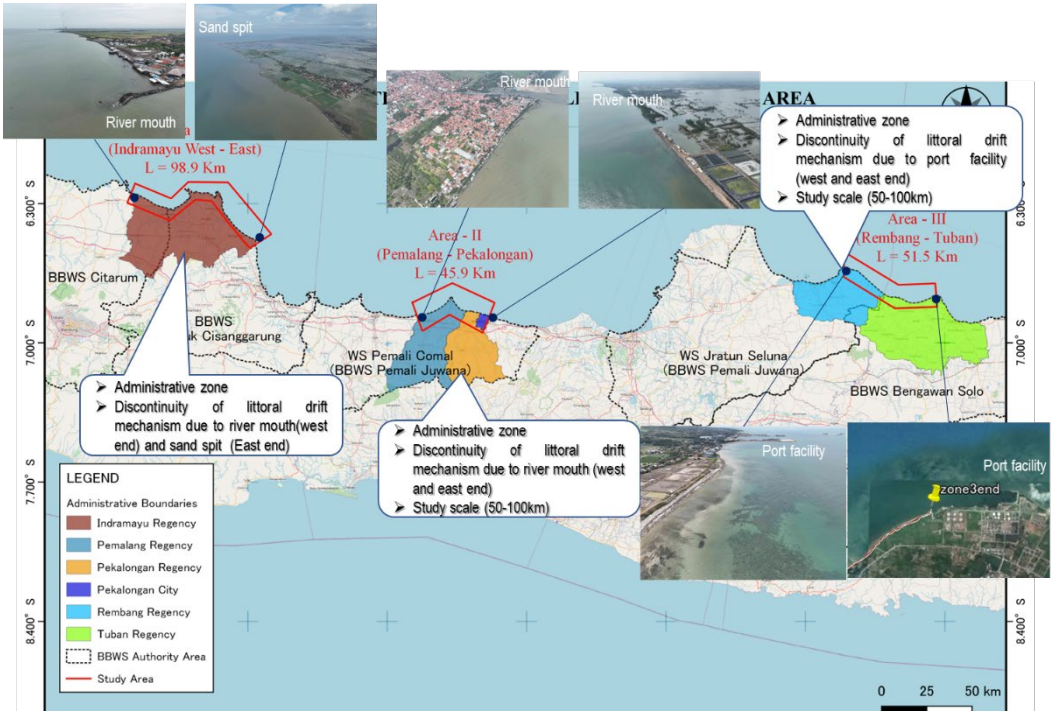
As a result of 1st Step, the five candidate areas were selected: Area-1 (Indramayu East - Cirebon), Area-1' (Indramayu West - East), Area-2 (Pemalang - Pekalongan), Area-3 (Semarang - Demak), and Area-4 (Rembang - Tuban).

From the above five selected candidate areas, the results of 2nd Step of selection were Area-1' (Indramayu West - East), Area-2 (Pemalang - Pekalongan) and Area-4 (Rembang - Tuban). Pekalongan) and Area-4 (Rembang - Tuban) were selected as the priority pilot areas for the Basic Coastal Management Plan (Figure 5.6.1).

Area-3 (Semarang - Demak) was excluded from the priority areas, but during the subsequent discussions, GOI requested a review of the existing survey and study in the Sayung area in the eastern part of Demak, and a study on the future draft action plan based on results. According to this the request, the above action plan will be studied as an additional study area, although it was excluded in the priority area.

Hereinafter, the selected three priority areas such as Indramayu, Pemalang-Pekalongan, and Rembang-Tuban are referred as Area-I, Area-II, and Area-III, respectively. For these selected three priority areas, the boundaries in each area were set as follows (Figure 4.6.1), by considering: 1) Boundary between administrative (Province, Regency, City, etc.), 2) Continuity of littoral drift, 3) Appropriate scale (50-100 km for one area) in developing the Basic Coastal Conservation Plan. It should be noted that the area boundaries will be finalized based on the discussion with the related organizations such as BBWS at the area.

- Area-I: Indramayu (Total coastal length: 98.9 km)
  - Inside Indramayu Regency
  - West end: river mouth (leading dike), East end: considering the continuity of littoral drift due to existence of the tip of the sand spit
- Area-II: Pemalang-Pekalongan (Total coastal length: 45.9 km)
  - Area among Pemalang Regency, Pekalongan Regency, and Pekalongan City
  - West end: river mouth (training wall), East end: considering the continuity of littoral drift due to existence of the river mouth
- Area-III: Rembang Regency – Tuban Regency (Object extension: 51.5 km)
  - Area between part of Rembang Regency and part of Tuban Regency
  - West end: Port facilities, East end: Considering continuity of littoral drift due to existence of port facilities.



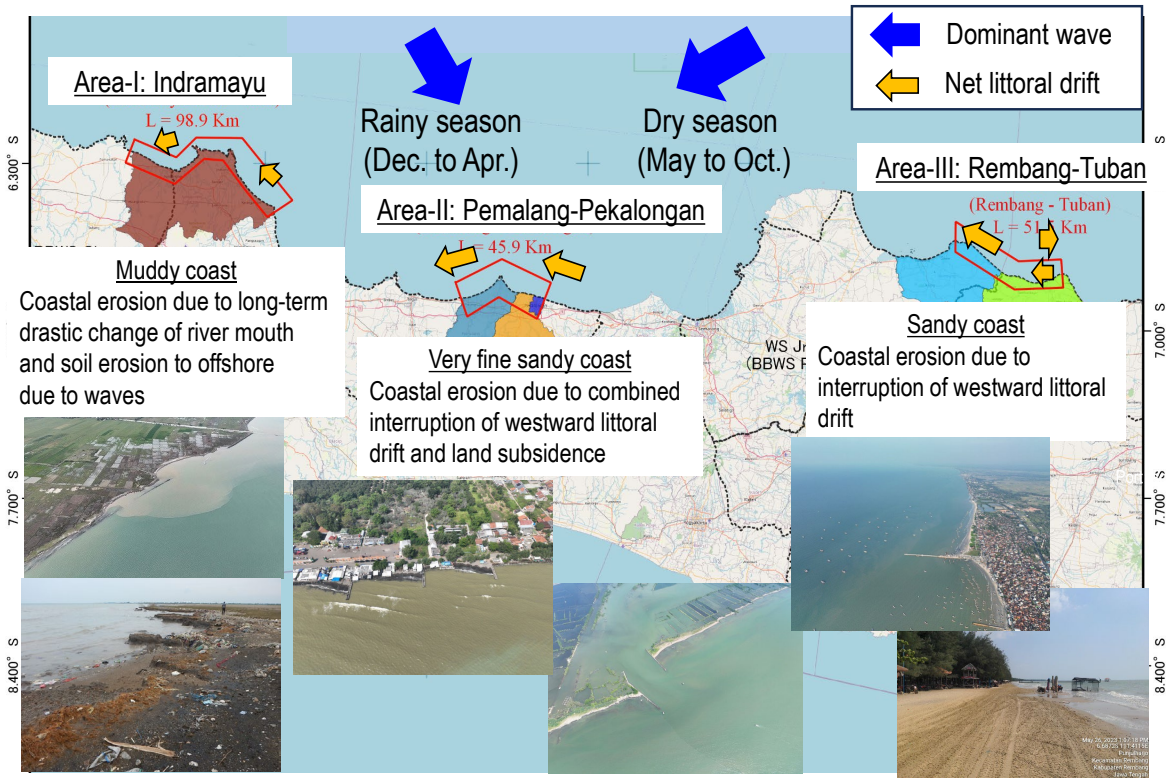
Source: JICA Study Team

Figure 5.6.1 Selected Three Priority Areas

CHAPTER 6 Characteristics of the Three Selected Areas

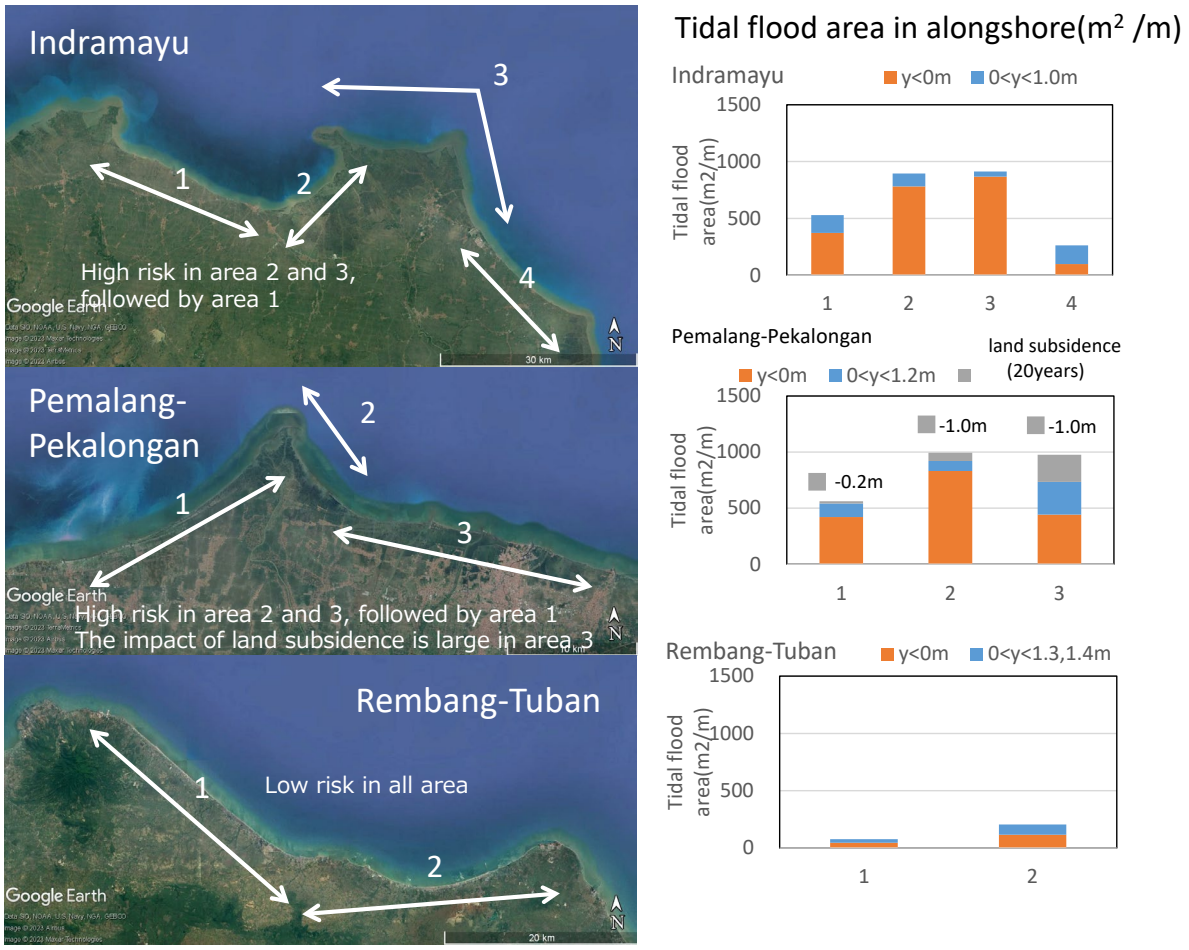
6.1 Current Status of the Coast

The characteristics of the three selected coastal areas in terms of sediment transport and tidal flood are compared and summarized (Figure 6.1.1, Figure 6.1.2 and Table 6.1.1).



Source: JICA Study Team

Figure 6.1.1 Overview of Coastal Characteristics at Three Areas



Source: JICA Study Team

Figure 6.1.2 Vulnerability for Tidal Flood

Table 6.1.1 Comparison of Coastal Characteristics in the Three Areas

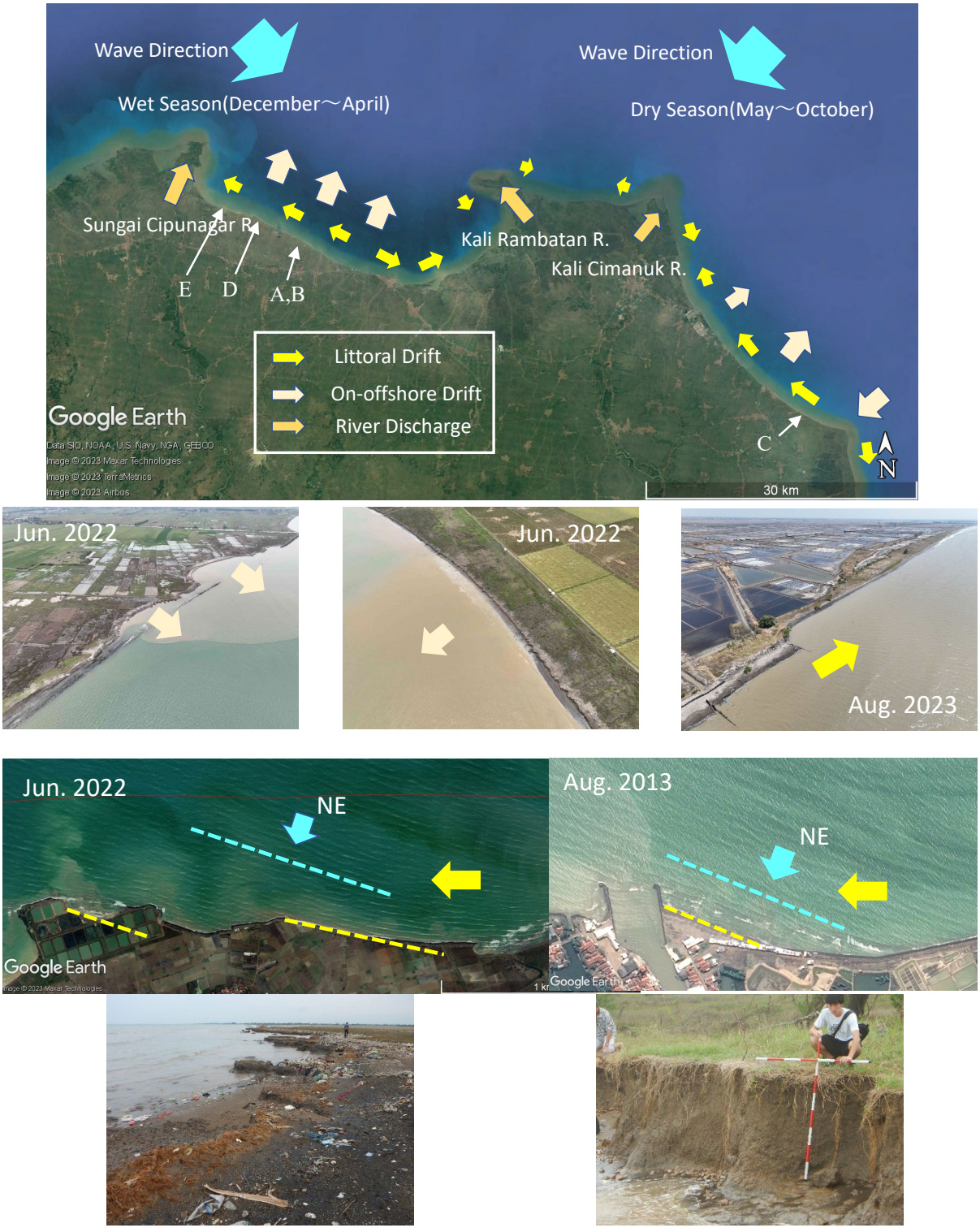
Item	Indramayu	Pemalang-Pekalongan	Rembang-Tuban
Wave (Return period :50years)※1	H=2.5m,T=5.8s	H=2.9m,T=6.6s	H=3.1m,T=6.7s
High tide level※2	+1.0m	+1.1～+1.2m	+1.3～+1.4m
Sediment	Silt, clay and very fine sand	Fine sand	Fine sand and Medium sand
Ground height in the hinterland	Low	Low	High
Littoral drift	Westward mainly	Westward mainly	Rembang:Westward mainly Tuban:Balanced in west and east direction
On-offshore drift	Offshore for silt & clay Onshore on the sand spit at the east end	-	-
Topography change	Retreat the shore in 10m/year in the west part and the east side of the east part continually in 80 years	Change around the river mouth Deposit in the east side and erode in the west side of jetty	Stable relatively Deposit in the east side and erode in the west side of the breakwater of port, the offshore breakwaters and groins
Land subsidence	-	Heavy in east(Pekalongan) (over -5cm/year)	-
Mechanism of erosion	Silt and cray comprise land move offshore due to waves	Littoral drift westward is prevented by the structures such as jetties or groins Land subsidence	Littoral drift westward is prevented by the structures such as piers, breakwaters of port, groins and offshore breakwaters
Risk of erosion	High risk in the coast attacked by waves directly	High risk in the coast located downstream of littoral drift of the structure and in land subsidence heavily	High risk in the coast located downstream of littoral drift of the structure
Risk of tidal flood	High risk due to low ground	High risk in the coast with severe erosion and land subsidence In particular, east area(Pekalongan) has high risk owing to heavy land subsidence	Low risk due to high ground compare with high tide, however high risk in the coast with heavy erosion

※1 Extreme statistics analysis result using the estimating wave data ERA5(1881-2001)
※2 The value of the annual maximum tide level plus the water level rising due to waves(Return period 50 years)

Source: JICA Study Team

6.1.1 Area-I: Indramayu

Figure 6.1.3 shows the mechanism of sediment transport in the coastal area, and the findings on the mechanism are summarized below.

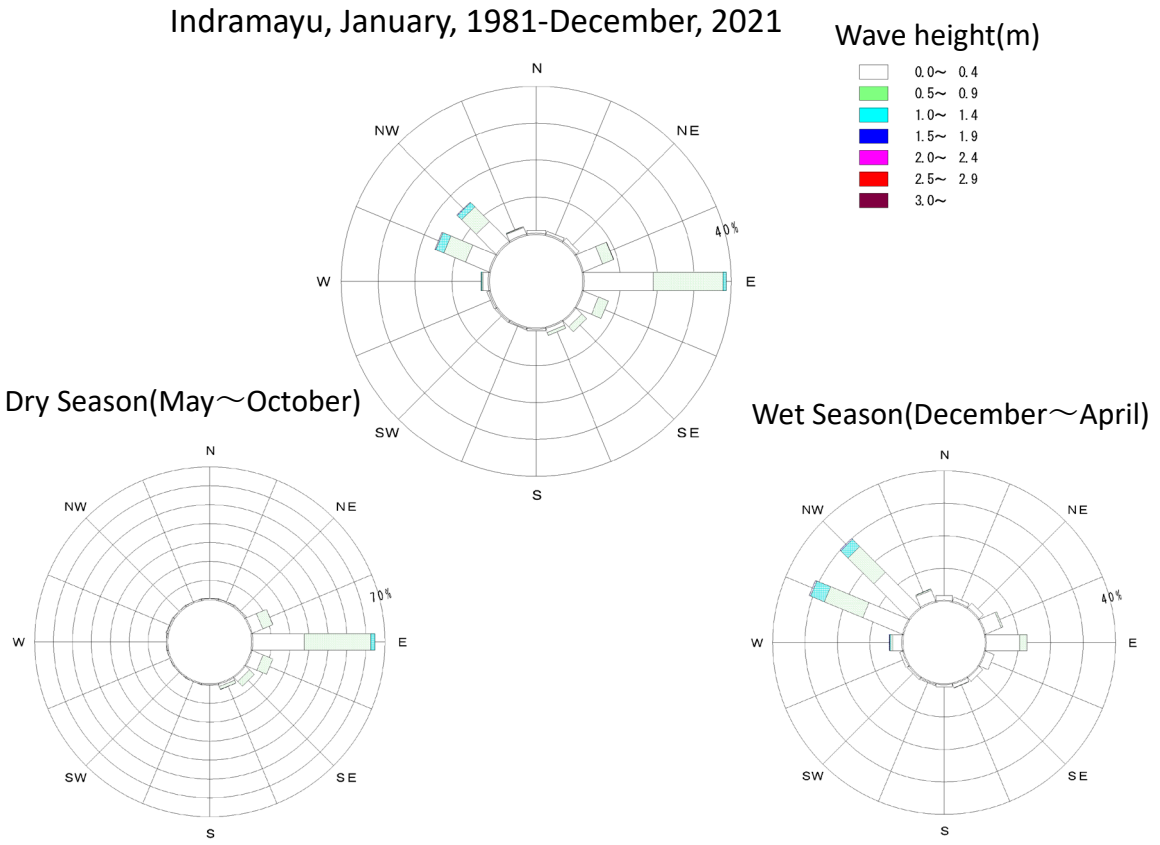


Source: 1st and 3rd figures Edited by JICA Study Team based on Google Earth; Others - JICA Study Team

Figure 6.1.3 Mechanism of Sediment Movement in Indramayu Coast

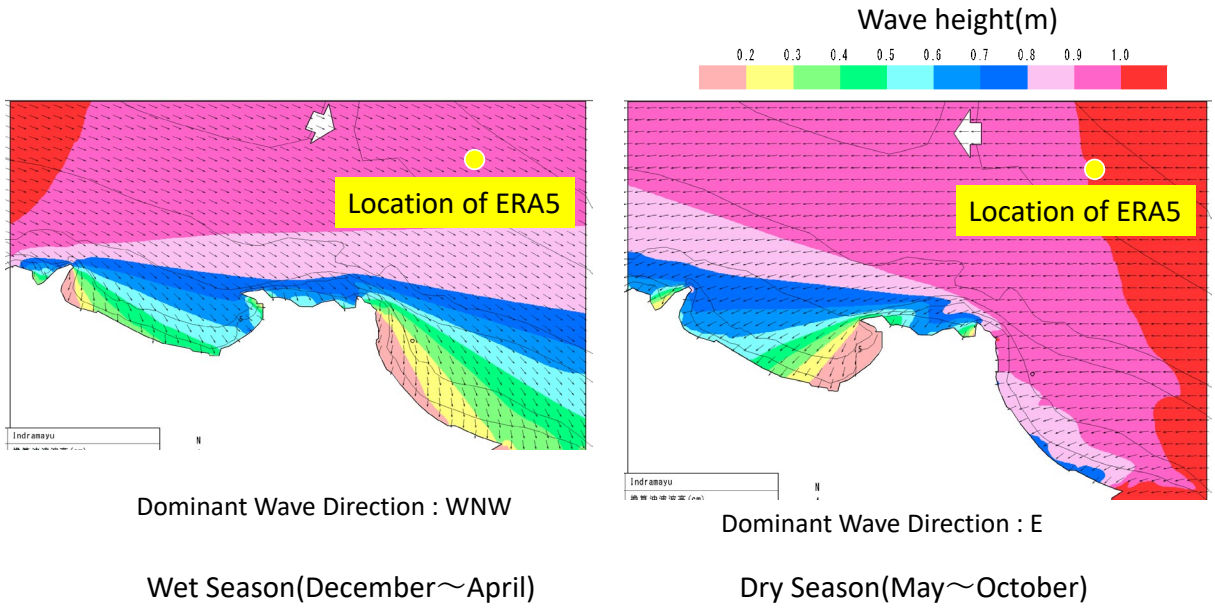
(1) Wave Characteristics

Figure 6.1.4 shows the frequency distribution by wave direction and height class analyzed from the wave data estimated off the coast from 1981 to 2021. In the dry season (May-October), waves are predominantly from the east, and in the wet season (October-April), waves are predominantly from the west. Under these conditions, wave deformation calculations based on the energy equilibrium equation were used to analyze the wave conditions reaching the coastal area (Figure 6.1.5). Based on the results, the predominant direction of sediment transport in the longshore direction was estimated to be almost westward (Figure 6.1.6).



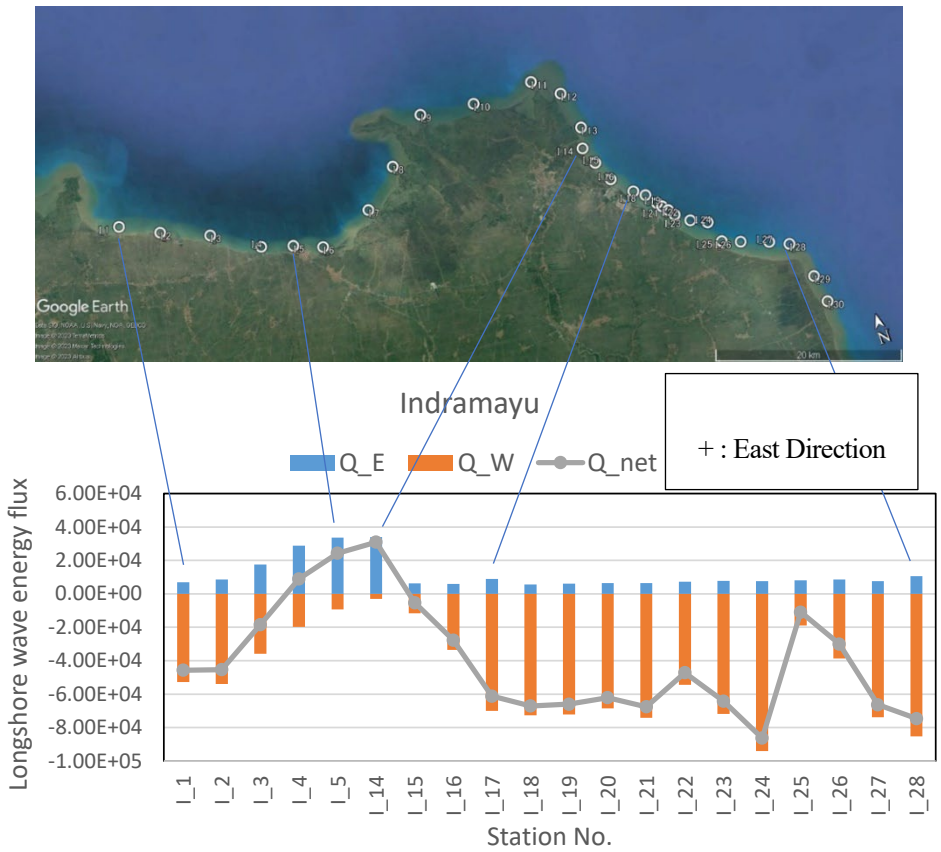
Source: JICA Study Team

Figure 6.1.4 Wave Characteristics in Indramayu According to ERA5(1981-2021)



Source: JICA Study Team

Figure 6.1.5 Distribution of Wave Height and Direction in Indramayu by the Numerical Model



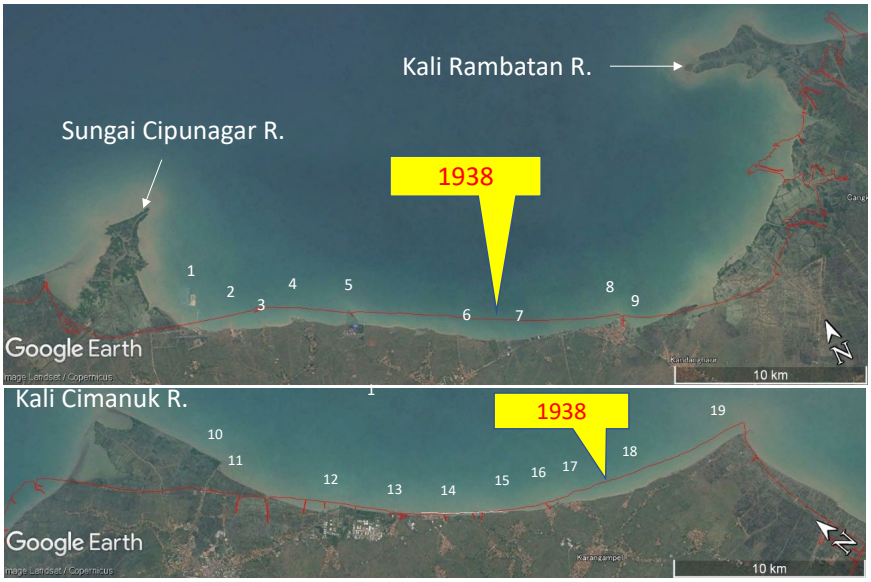
Source: Top figure - Edited by JICA Study Team based on Google Earth; Bottom figure - JICA Study Team

Figure 6.1.6 Dominant Direction of Littoral Drift in Indramayu Estimated by Wave Analysis

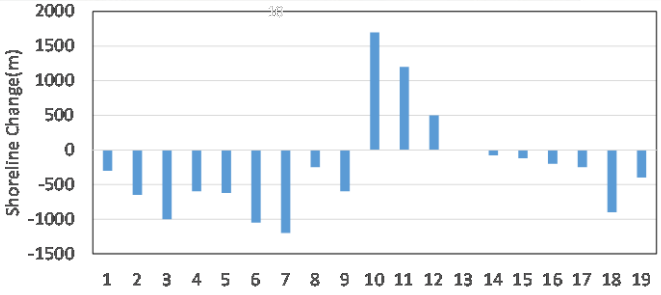
(2) Morphological Change Characteristics

The Cipunagar River flows out of the western end, and the Rambatan and Cimanuk Rivers flow out of the center. The topography of the area has changed significantly over the past 80 years due to changes in the location of the mouths of these rivers and the sediment discharged from these rivers (Figure 6.1.7). The western part of Indramayu and the eastern edge of Indramayu have experienced shoreline retreat at a rate of about 10 m/year over the past 80 years, and this rate has not changed to this day. These topographic changes are presumed to be caused by the silt-clay soils that make up the land area (see Figure 6.1.19), which are washed offshore by wave action, and the small amount of sand is moved by the westward longshore drift that predominates along this coast. The above-mentioned shoreline recession is currently prevented by stone masonry-type breakwater and upright breakwater placed near the shoreline. However, the shoreline is receding in some areas where the masonry-type breakwater has opened due to subsidence, etc. (Figure 6.1.8 to Figure 6.1.12). However, there are also areas where the erosion rate seems to have decreased due to the formation of curved topography caused by the retention of sand near the shoreline due to wave action (Figure 6.1.13 to Figure 6.1.19). The area around the breakwater of the thermal power plant harbor, a large-scale structure constructed along this coast, was compared from east to west. The results show that the western shoreline is slightly receding, and further west, the shoreline on the east side of the training wall at the river mouth tends to advance slightly. These are the types of shoreline changes observed when westward longshore drift is predominant.

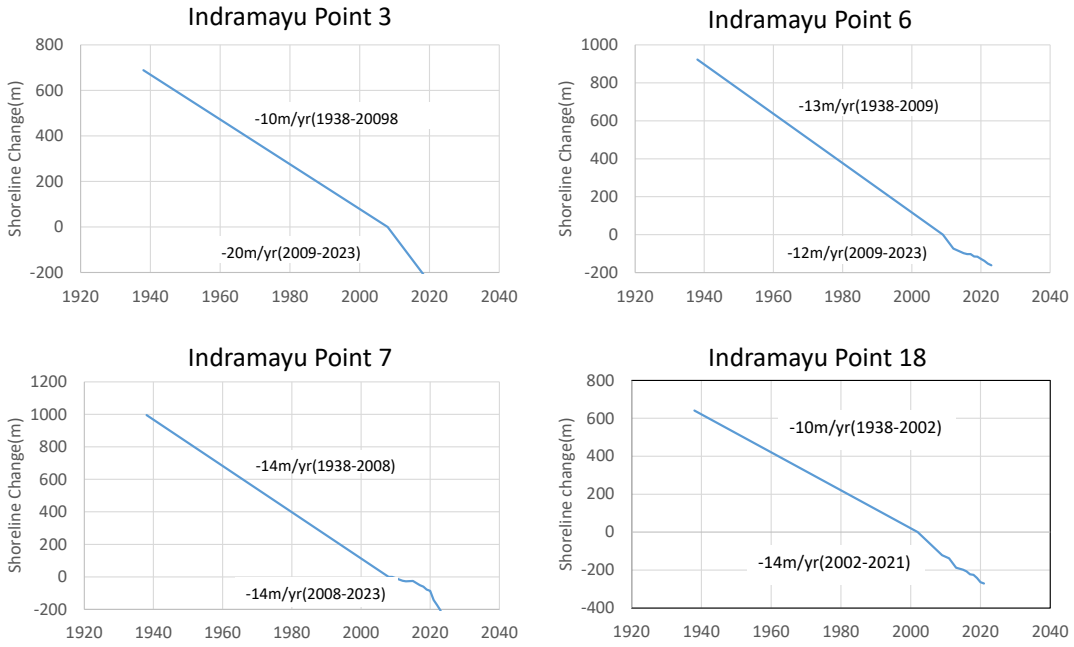
(a) Indramayu coastline in 1938 indicated by red solid line



(b) Shoreline change between 1938 and 2023 in No.1-19 shown above

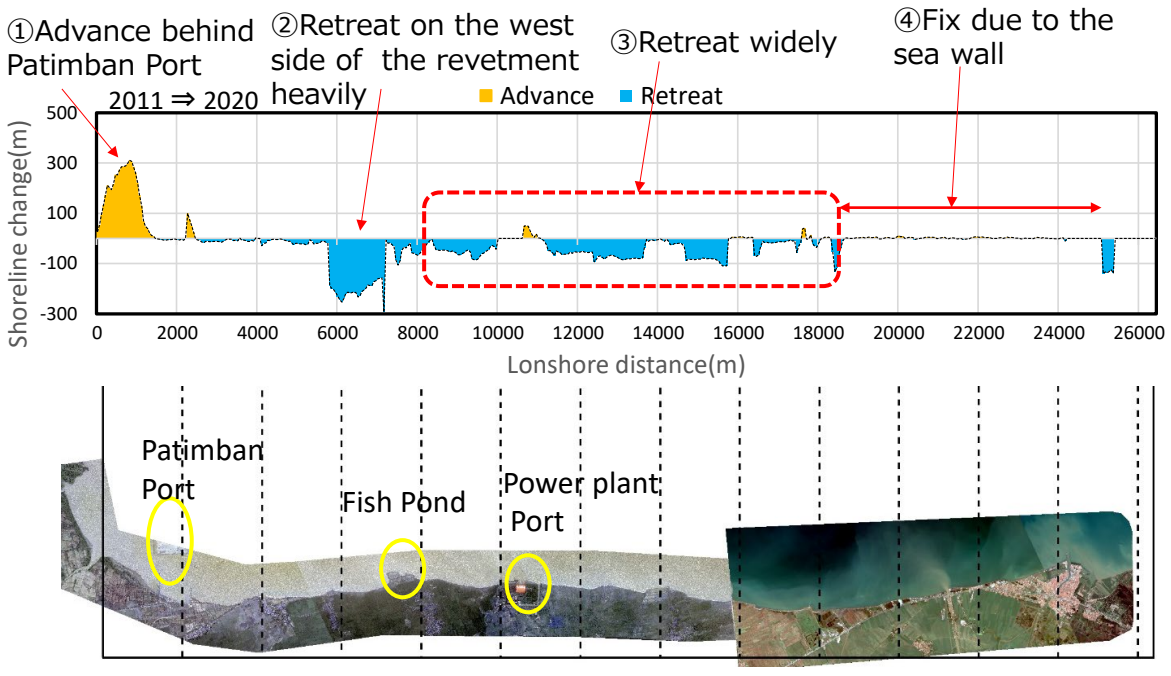


(c) History of shoreline change



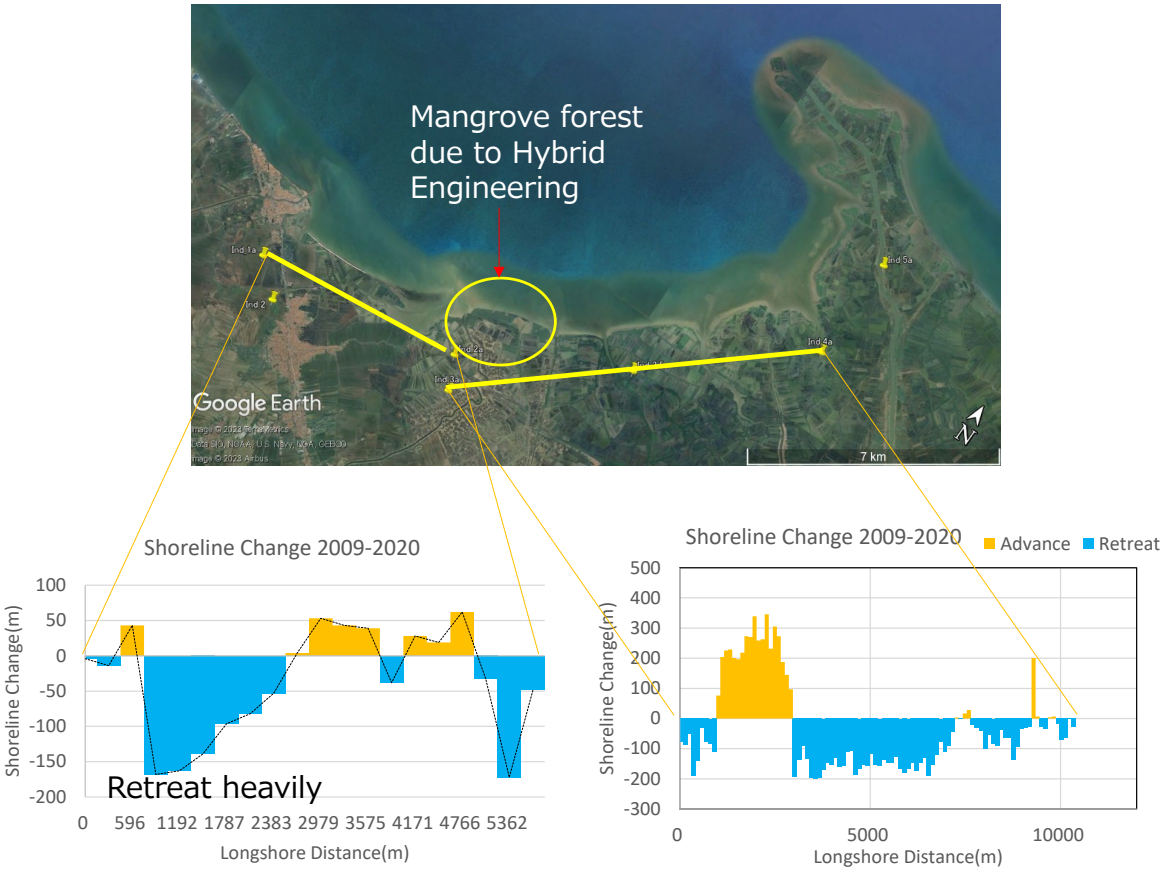
Source: Fig. (a) - Edited by JICA Study Team based on Google Earth; Fig. (b) and Fig(c) - JICA Study Team

Figure 6.1.7 Long-term Shoreline Change in Indramayu



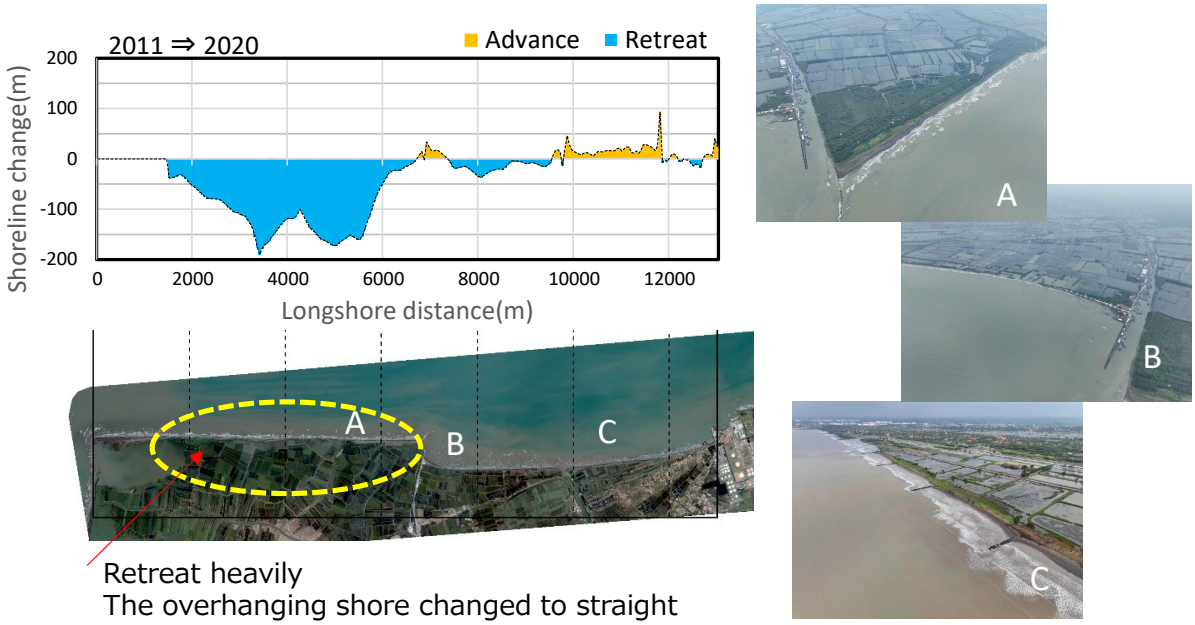
Source: JICA Study Team

Figure 6.1.8 Shoreline Change in the West Part of Indramayu West Between 2011 and 2020



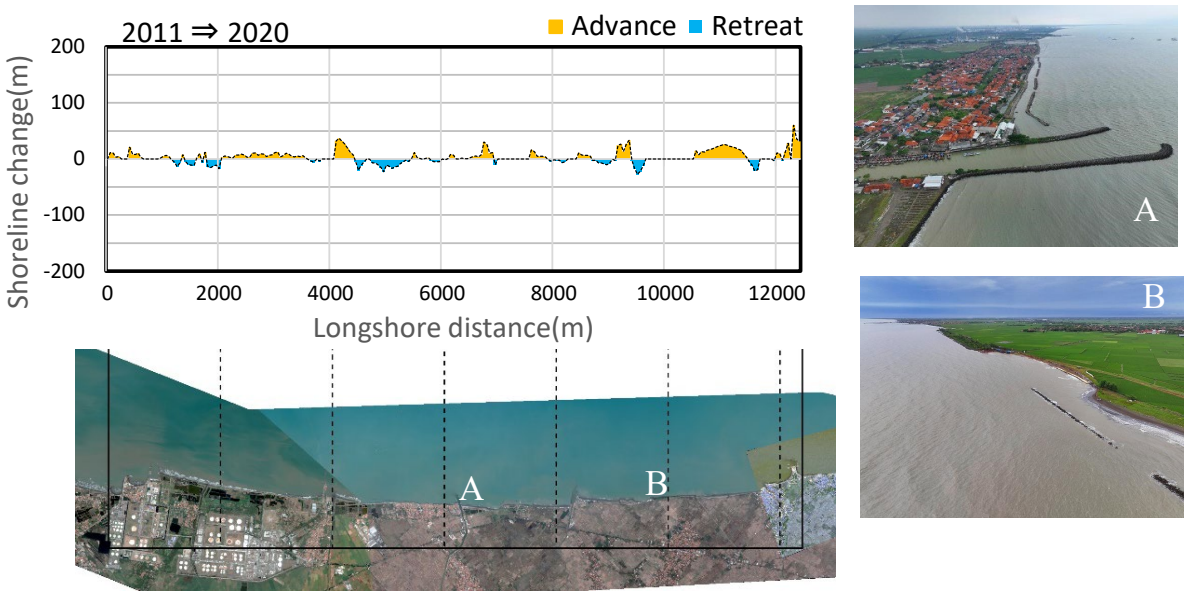
Source: Top figure - Edited by JICA Study Team based on Google Earth; Bottom figures - JICA Study Team

Figure 6.1.9 Shoreline Change in the East Part of Indramayu West Between 2011 and 2020



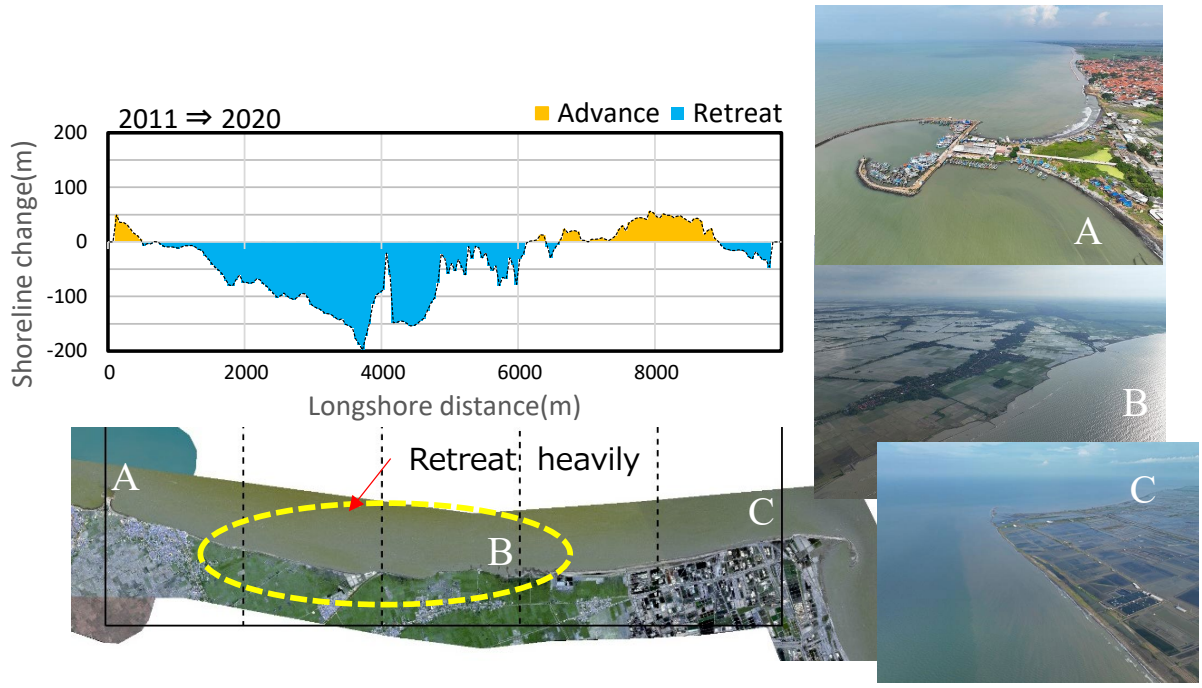
Source: JICA Study Team

Figure 6.1.10 Shoreline Change in the West Part of Indramayu East Between 2011 and 2020



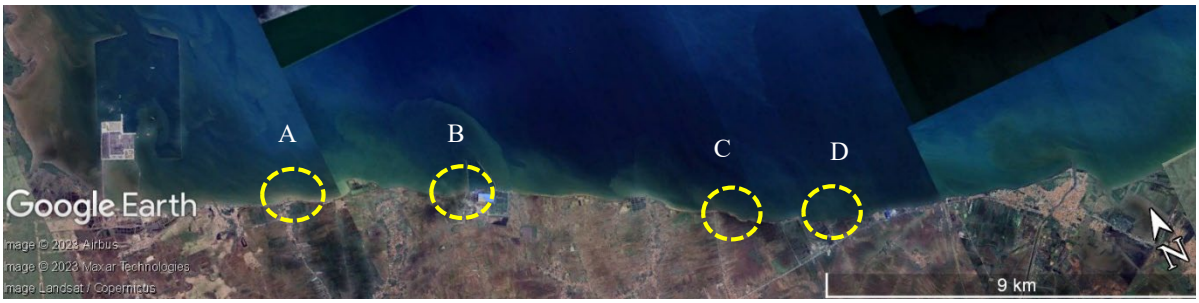
Source: JICA Study Team

Figure 6.1.11 Shoreline Change in the Central Part of Indramayu East Between 2011 and 2020



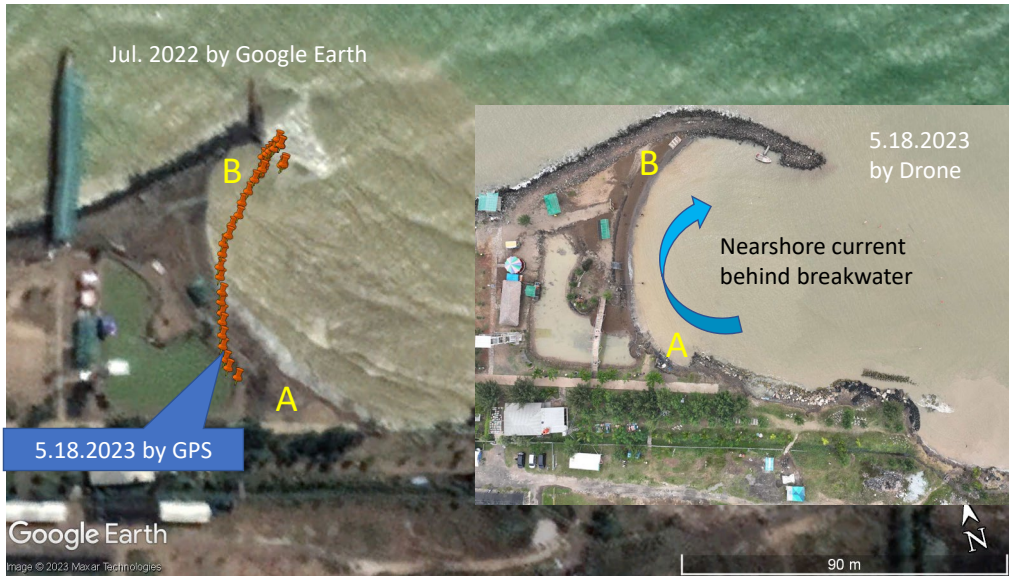
Source: JICA Study Team

Figure 6.1.12 Shoreline Change in the East Part of Indramayu East Between 2011 and 2020



Source: Edited by JICA Study Team based on Google Earth

Figure 6.1.13 Location Map of the Curved Coast in Indramayu West



Source: Edited by JICA Study Team based on Google Earth

Figure 6.1.14 Curved Coast A in Indramayu West

The shore behind the breakwater reached to the breakwater

Offshore slope : 1/80
Foreshore slope : 1/10
Berm height : 0.8m

Beach sediment : Fine sand

The crown height of stone breakwater : 1.2m above sea surface

The erosion behind the breakwater

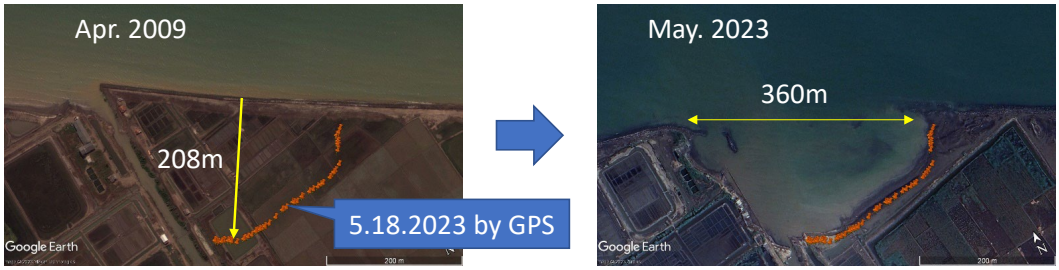
The height of scarp : 1m

Source: JICA Study Team

Figure 6.1.15 Survey Result in the Curved Coast A (June 2022)

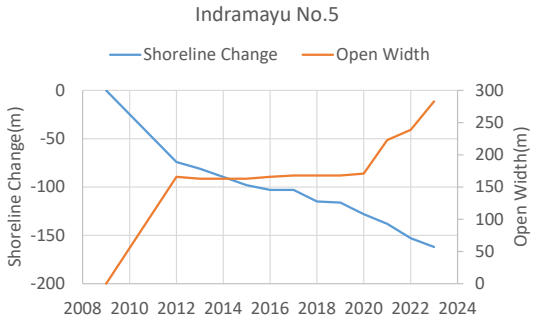
Source: Edited by JICA Study Team based on Google Earth

Figure 6.1.16 Curved Coast B in Indramayu West



Source: Edited by JICA Study Team based on Google Earth

Figure 6.1.17 Curved Coast D in Indramayu West



The part of stone revetment has been sunk.
The shore retreated to 80 m in the open width 150m.
The shoreline retreat rate has been slow, when the opening width has not changed significantly.
However, when the opening width has been greater again, the shore begun to retreat.

Source: Top and middle figures - Edited by JICA Study Team based on Google Earth; Bottom figure - JICA Study Team

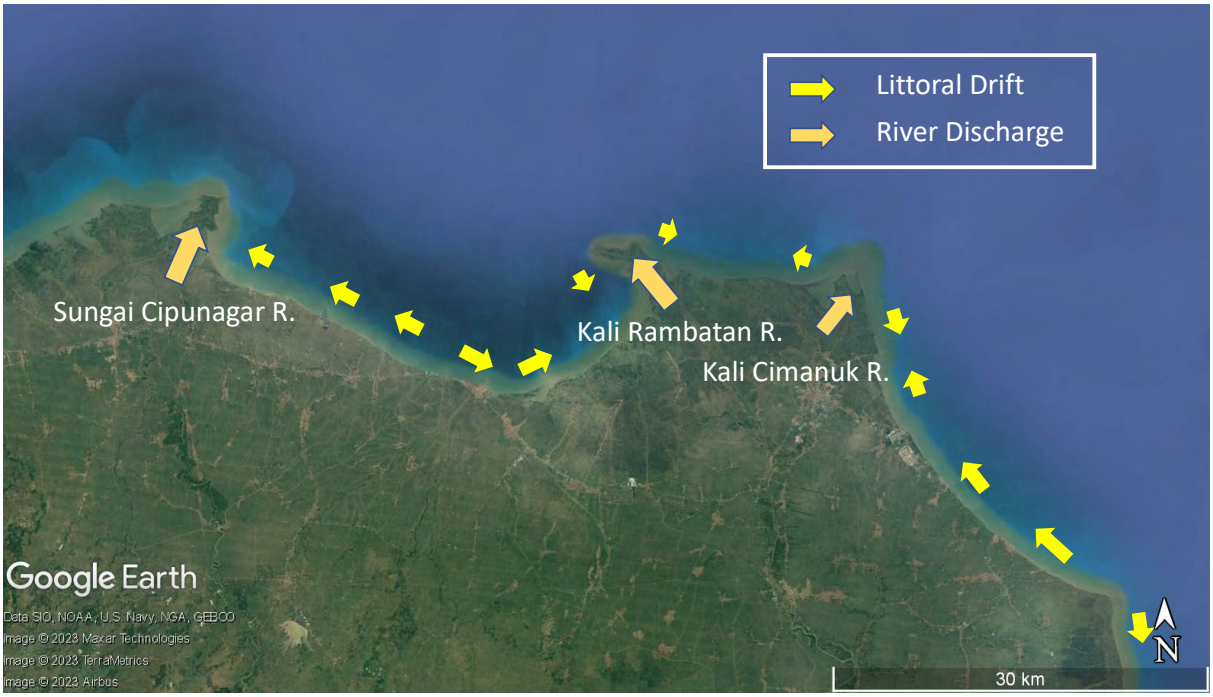
Figure 6.1.18 Curved Coast C in Indramayu West

Source: JICA Study Team

Figure 6.1.19 Survey Result in the Curved Coast C (June 2022)

(3) Longshore Sediment Transport

Figure 6.1.20 shows the dominant direction of longshore drift estimated based on the results of the wave and topographic change analysis. The figure shows that the dominant direction of longshore drift in the coastal area is estimated to be westward. Since the land area including the shoreline is composed of silt and clay soils, it is considered that silt and clay sediments are discharged offshore by waves in a suspended state and deposited over a wide area, and only a small amount of sandy sediments moves as westward longshore drift sand. However, the curved nearshore area west of the central convexity is also a wave shield area, and it is presumed that some eastward longshore drifted sand toward the shield area is generated. At the eastern end of the spit, the direction of the coastline bends to the south, and it is assumed that eastward longshore drift is dominant on the Indramayu side of the coast, while southward longshore drift is dominant on the southward bending coast, indicating a reversal in the direction of drift. From the viewpoint of sediment budget, erosion would naturally progress in such areas, but no significant erosion has been observed. One possible reason for this is that sediment may be supplied from the offshore area where the spit has developed.



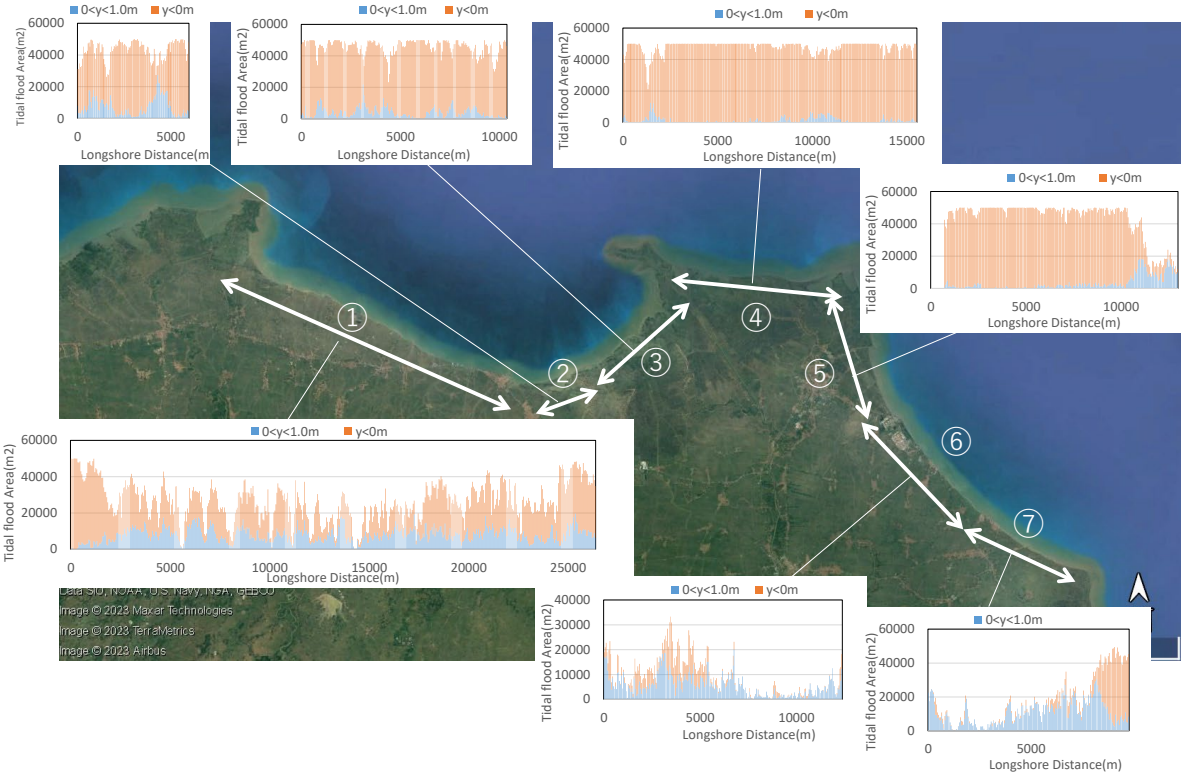
Source: Edited by JICA Study Team based on Google Earth

Figure 6.1.20 Dominant Direction of Littoral Drift in Indramayu

(3) Tidal Flood

The evaluation of vulnerability for tidal flood along the coast of Indramayu is shown in Figure 6.1.21, which indicates the area under the high sea-water level at the storm surge. The flooding area was estimated at intervals of 50 m alongshore within a range of 1 km behind the coastline. The ground height in the hinterland is based on the DEMNAS data from Badan Informasi Geospasial. The sea-water level was set at +1.0 m, which is the annual maximum tide level of+0.65 m plus a water level rise due to waves with a 50-year probability occurrence.

In the middle area of Indramayu (②-⑤ of Figure 6.1.21), the target range (Area: 50,000 m^2) is almost under the high seawater level. Also, in the east area (⑥ and ⑦ of Figure 6.1.21), the flood risk is low due to relatively high ground level.

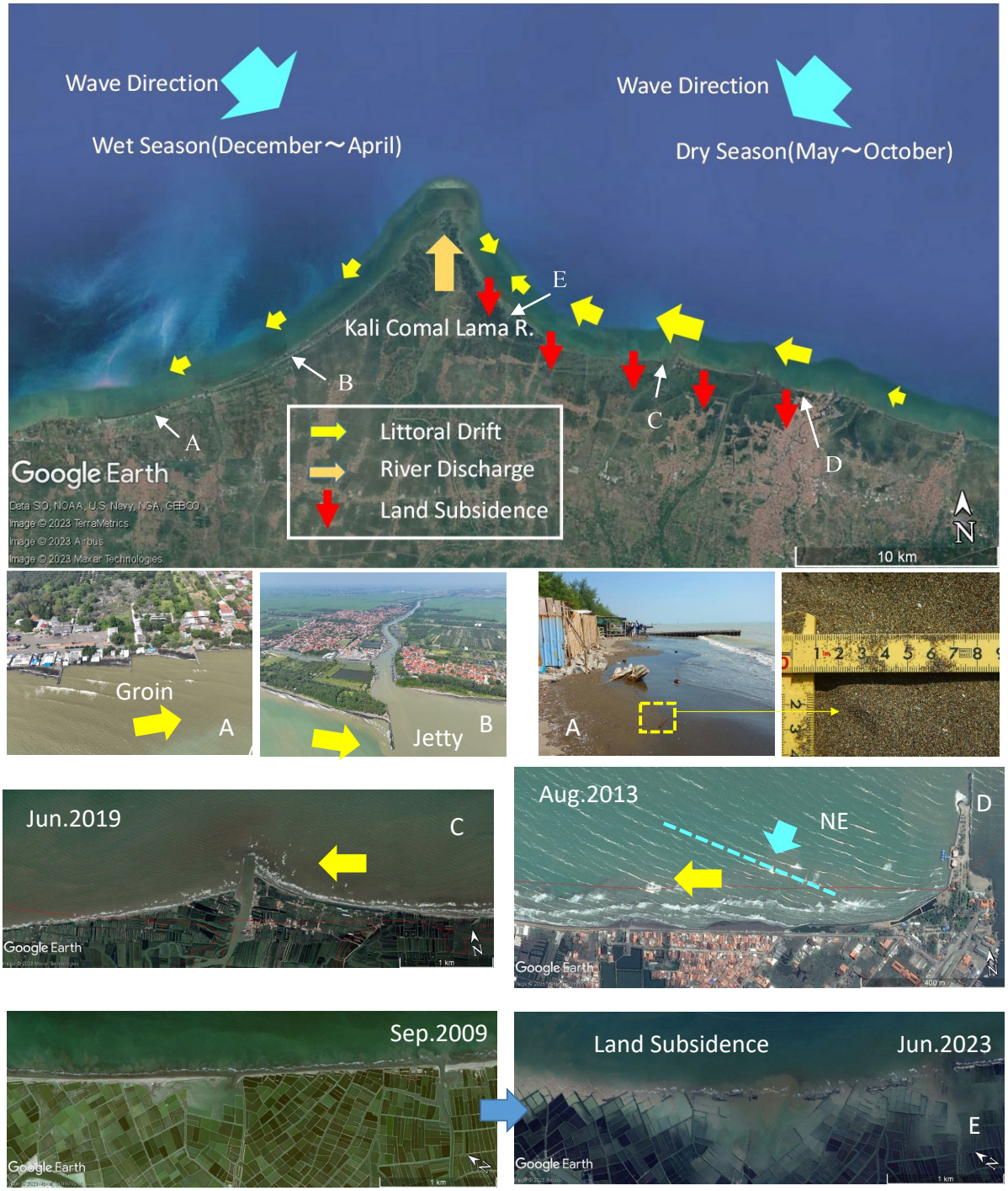


Source: JICA Study Team

Figure 6.1.21 Evaluation of Vulnerability for Tidal Flood in Indramayu

6.1.2 Area-II: Pemalang-Pekalongan

Figure 6.1.22 shows the mechanism of sediment transport in the coastal area, and the findings on the mechanism are summarized below.

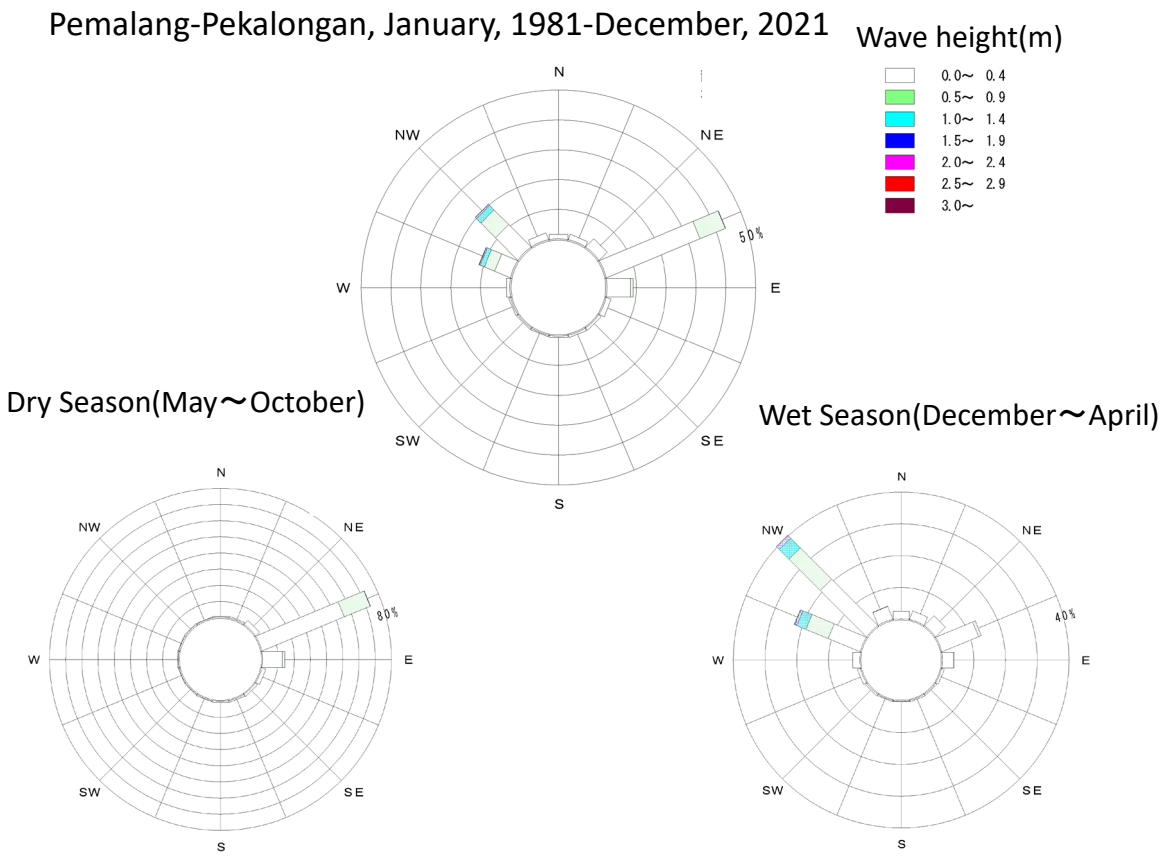


Source: 1st, 3rd and 4th figures - Edited by JICA Study Team based on Google Earth; 2nd figure - JICA Study Team

Figure 6.1.22 Mechanism of Sediment Movement in Pemalang-Pekalongan Coast

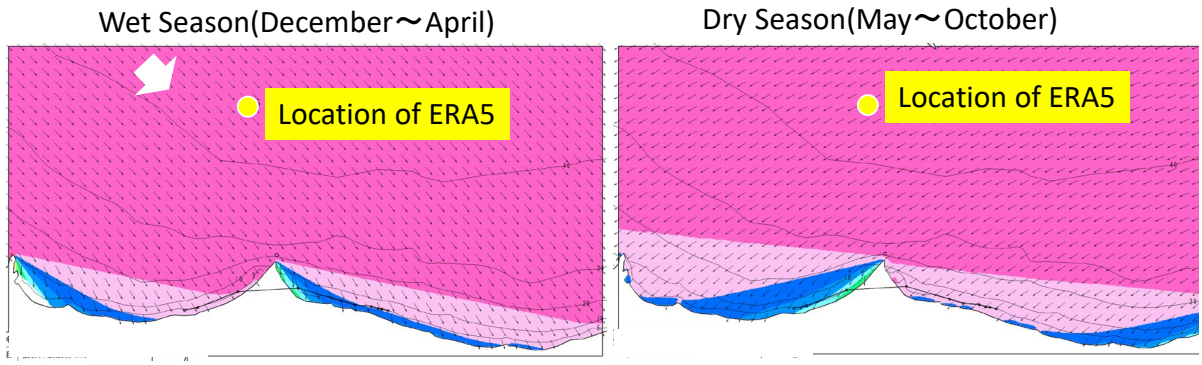
(1) Wave Characteristics

Wave data for the 1981-2021 period estimated off the coast of the area indicate that waves are predominantly from the east during the dry season (May-October) and from the west during the rainy season (October-April). Under these conditions, wave deformation calculations using the energy equilibrium equation were performed to analyze the wave conditions reaching the coastal area. Based on the results, the dominant direction of sediment transport in the longshore direction was estimated, and found that it was mostly in the east direction except for both sides of the large northward protrusion in the center. This result, which will be shown later, does not match the direction of longshore sediment drift estimated from the actual topographic change in some areas.



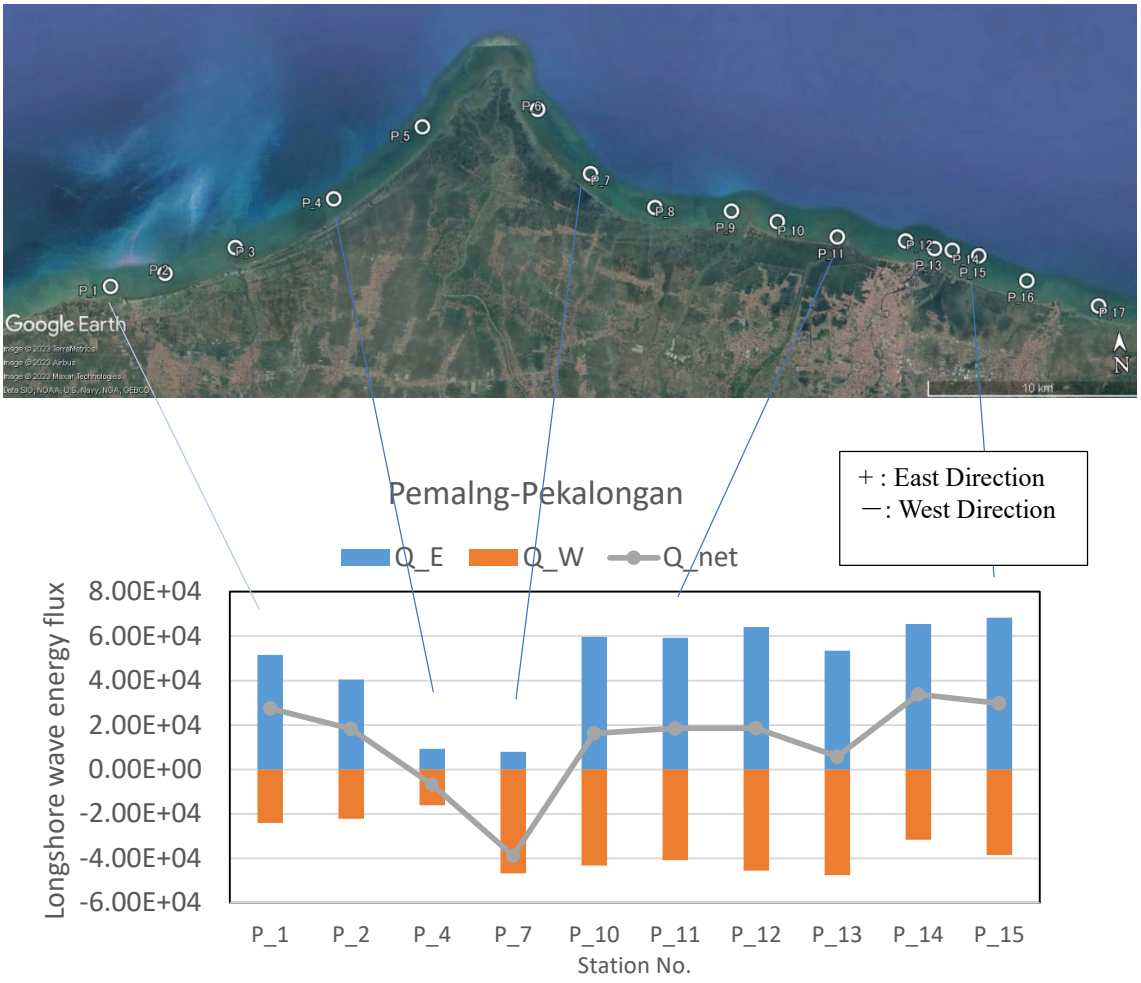
Source: JICA Study Team

Figure 6.1.23 Wave Characteristics in Pemalang-Pekalongan According to ERA5 (1981-2021)



Source: JICA Study Team

Figure 6.1.24 Distribution of Wave Height and Direction in Pemalang-Pekalongan by the Numerical Model

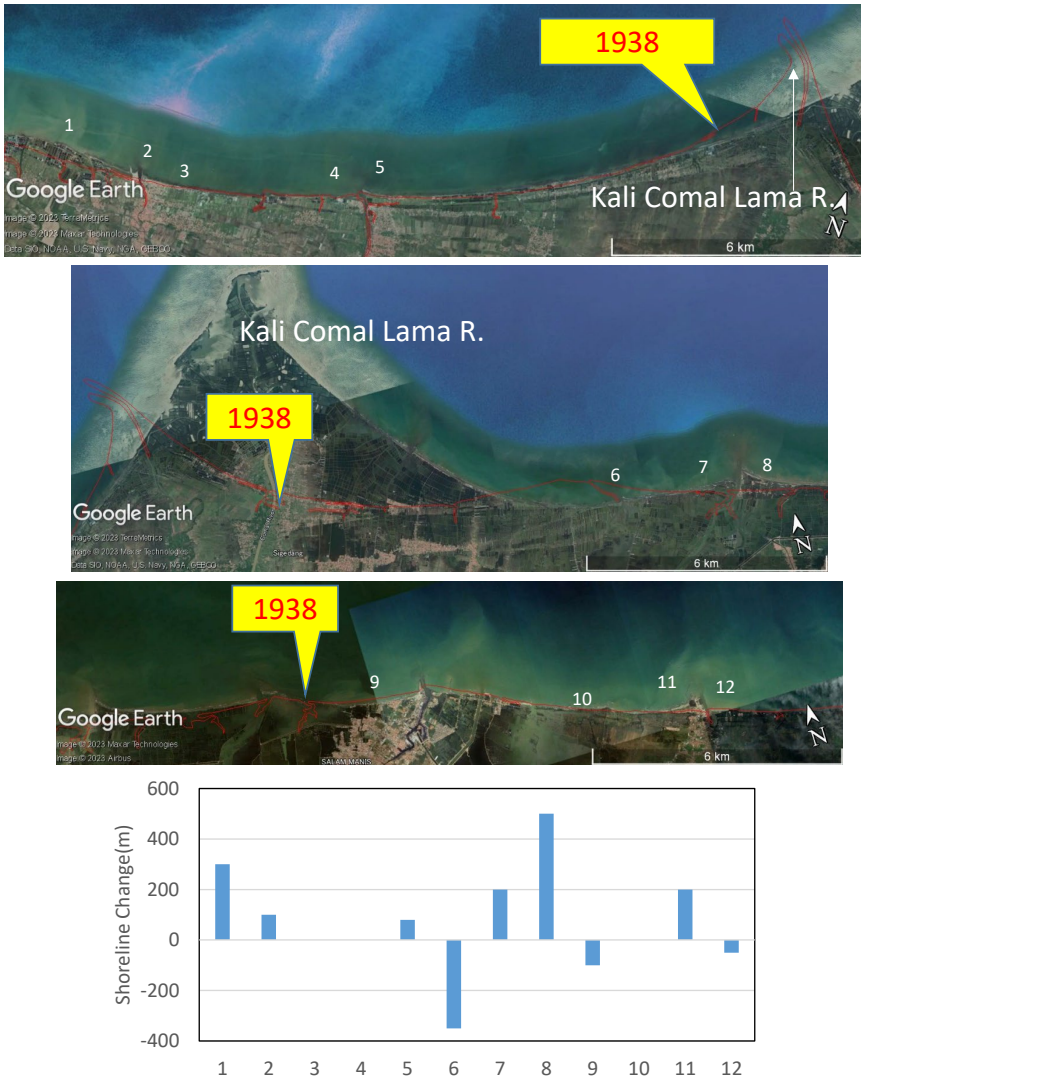


Source: Top figure - Edited by JICA Study Team based on Google Earth; Bottom figure - JICA Study Team

Figure 6.1.25 Dominant Direction of Littoral Drift in Pemalang-Pekalongan Estimated by Wave Analysis

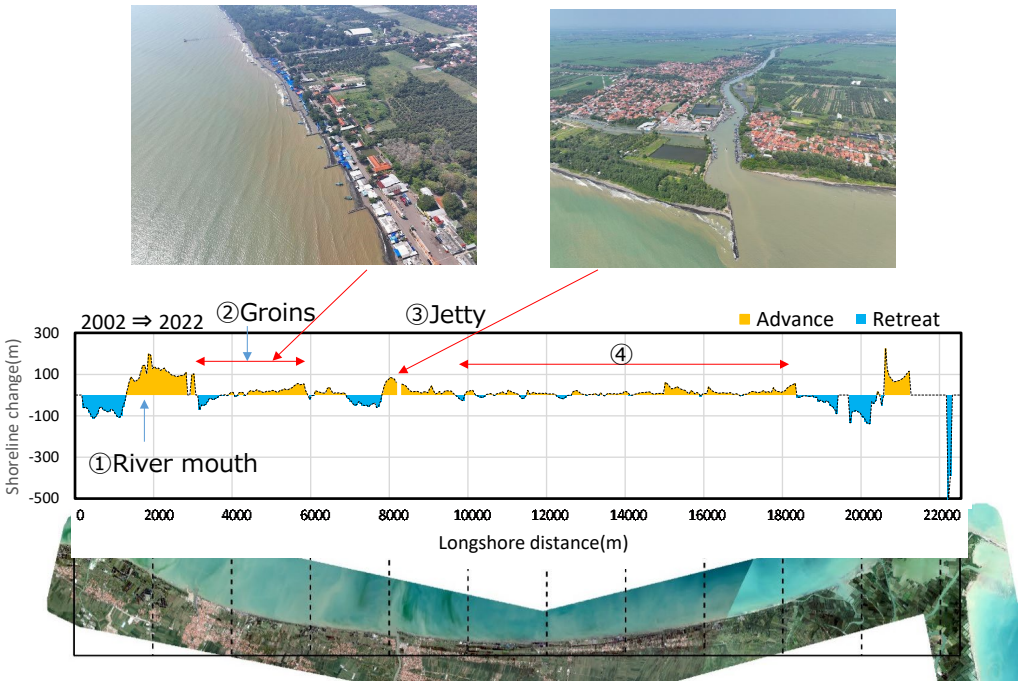
(2) Morphological Change Characteristics

The Comal Lama River flows out of the center, and the surrounding coastline has undergone significant topographic changes over the past 80 years due to changes in the location of the river mouth and sediment discharge (Figure 6.1.26). However, no significant shoreline change has occurred in western Pemalang which is located west of the mouth of the river, and in Pekalongan. During the most recent 20 years or so, Pemalang West shows shoreline advance on the east side of the jetties and training wall at the river mouth and shoreline recession on the west side (Figure 6.1.27). In other words, westward longshore drift is presumed to be dominant in this coastal area. To the east of Pemalang, the shoreline has partially collapsed, allowing seawater to enter behind it and inundate the area (Figure 6.1.28). Further east, at Pekalongan, the western shoreline of the estuary levee has receded more significantly than the eastern shoreline (Figure 6.1.29). This suggests that westward longshore drift is dominant in this coastal area as well. The lack of shoreline advance on the east side suggests that land subsidence in this coastal area is one of the reasons for the shoreline retreat.



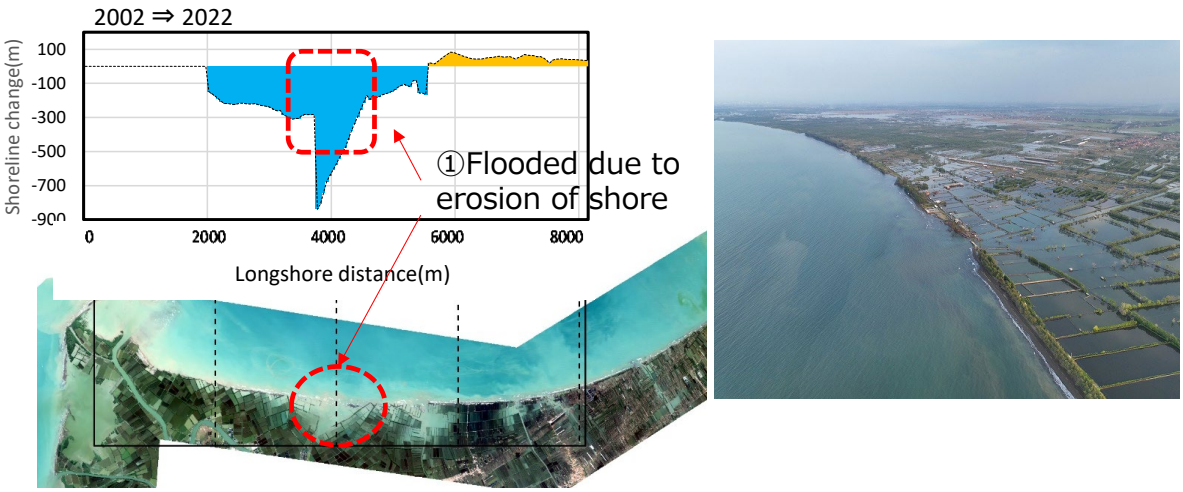
Source: 1st, 2nd and 3rd figures - Edited by JICA Study Team based on Google Earth; 4th figures - JICA Study Team

Figure 6.1.26 Long-term Shoreline Change in Pemalang-Pekalongan



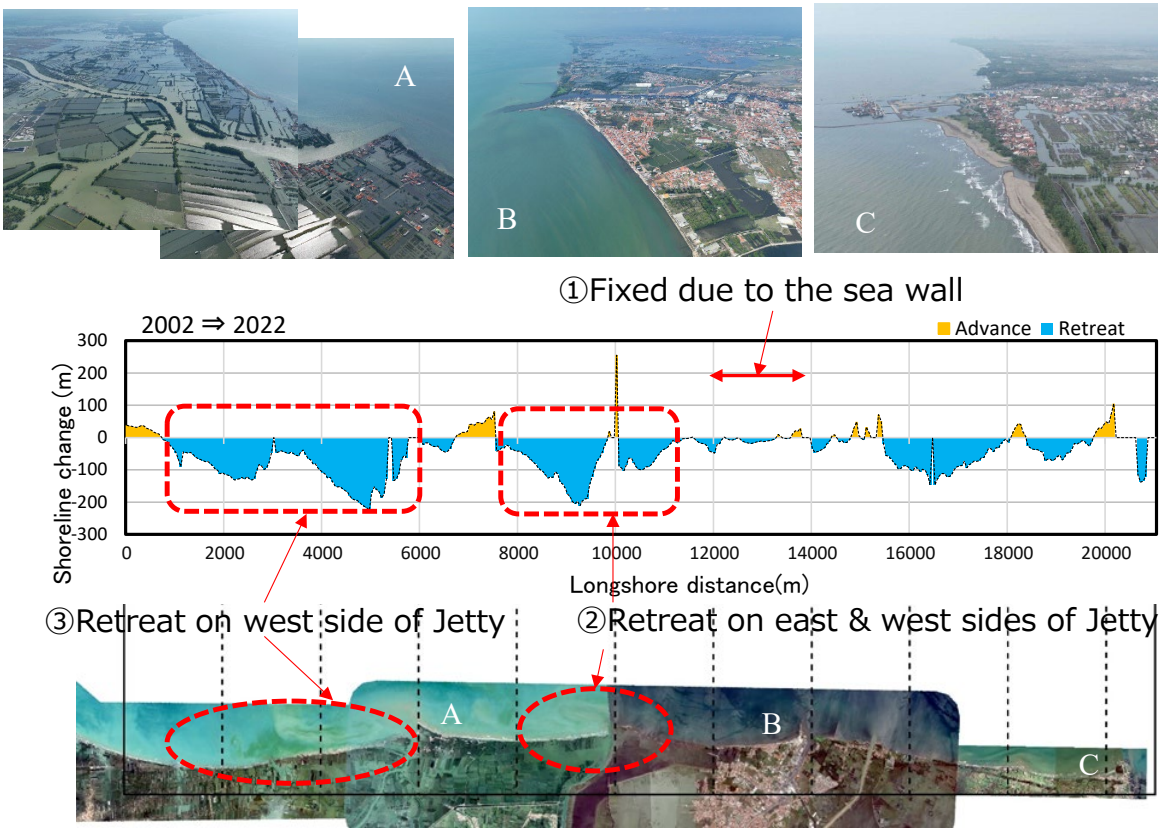
Source: JICA Study Team

Figure 6.1.27 Shoreline Change in the West Part of Pemalang West Between 2002 and 2022



Source: JICA Study Team

Figure 6.1.28 Shoreline Change in the West Part of Pemalang East Between 2002 and 2022

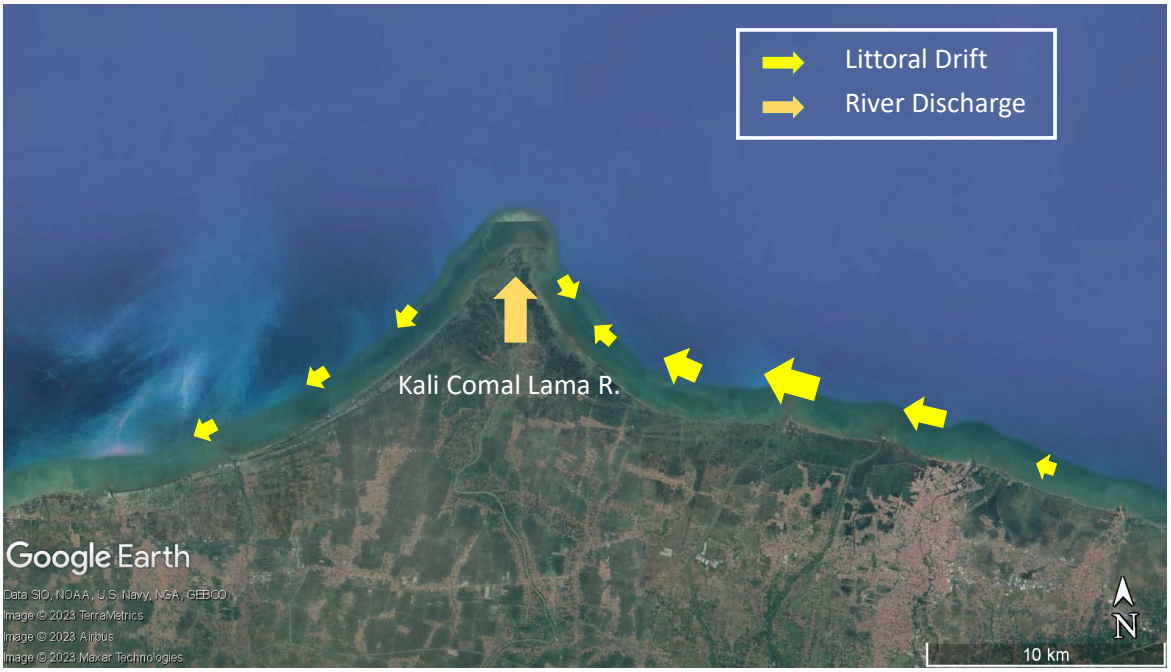


Source: JICA Study Team

Figure 6.1.29 Shoreline Change in the West Part of Pekalongan Between 2002 and 2022

(3) Longshore Sediment Transport

Figure 6.1.30 shows the predominant direction of longshore sand drift estimated based on the results of the wave and topographic change analysis. In this coast, there is no significant long-term topographic change along the coast away from the mouth of the Comal Lama River, although significant topographic change is observed near the mouth of the river. However, erosion due to land subsidence is thought to have become apparent in recent years. Although the overall longshore drift is westward, the wave characteristics indicate a predominance of eastward longshore drift, suggesting that longshore drift in both directions may be in equilibrium. In addition, compared to Indramayu, the sand content in the bottom sediment suggests that erosion by offshore silt and clay runoff, as seen at Indramayu, is less (although to a certain extent).



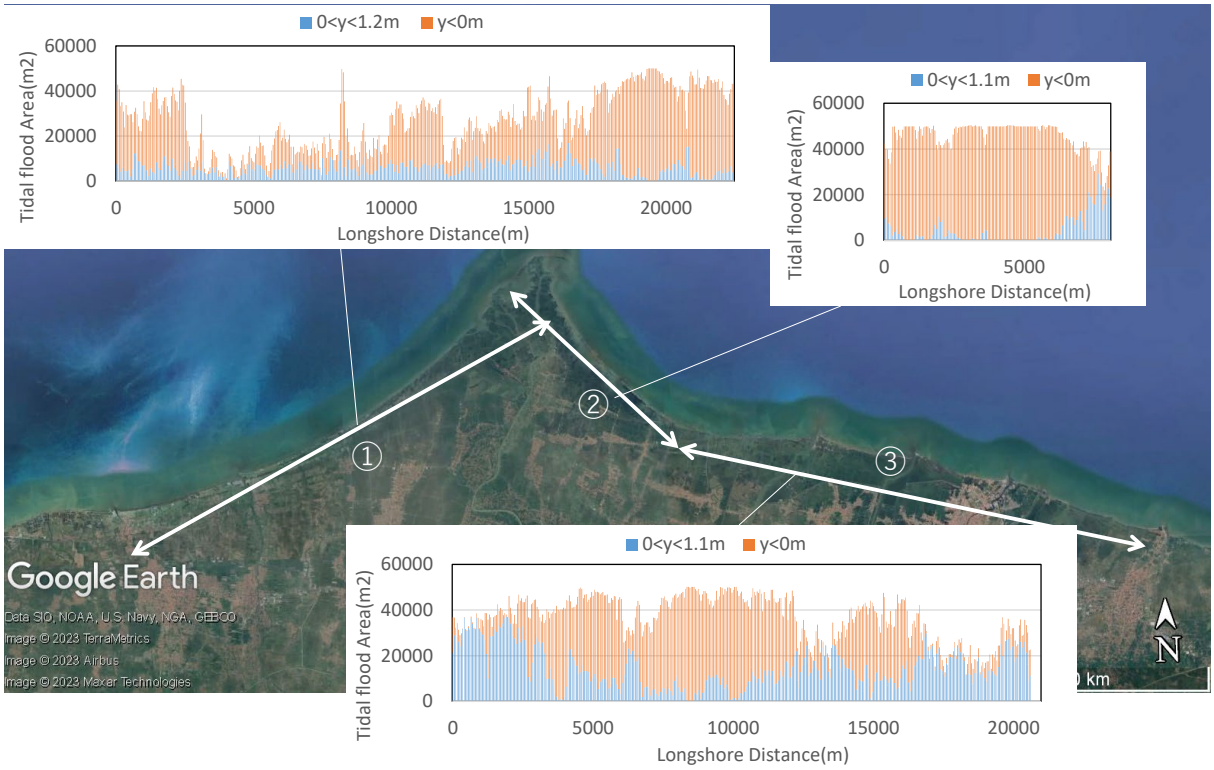
Source: Edited by JICA Study Team based on Google Earth

Figure 6.1.30 Dominant Direction of Littoral Drift in Pemalang-Pekalongan

(4) Tidal Flood

The evaluation of vulnerability for tidal flood along the coast of Pemalang-Pekalongan is shown in Figure 6.1.31, which indicates the area under the high sea-water level at the storm surge. The flooding area was estimated at intervals of 50 m alongshore within a range of 1 km behind the coastline. The ground height in the hinterland is based on the DEMNAS data from Badan Informasi Geospasial. The sea-water level was set at between +1.1 and +1.2 m, which is the annual maximum tide level of +0.70 m plus a water level rise due to waves with a 50-year probability occurrence.

In the middle area of Pemalang (the east in ① and ② of Figure 6.1.31) where the river mouth of Kali Comal Lama River is located, the target range (Area: 50,000 m^2) is almost under the high sea-water level. Also, on the west part of ③ in Figure 6.1.31 (x=0~12,000 m), the flooding area is relatively large.

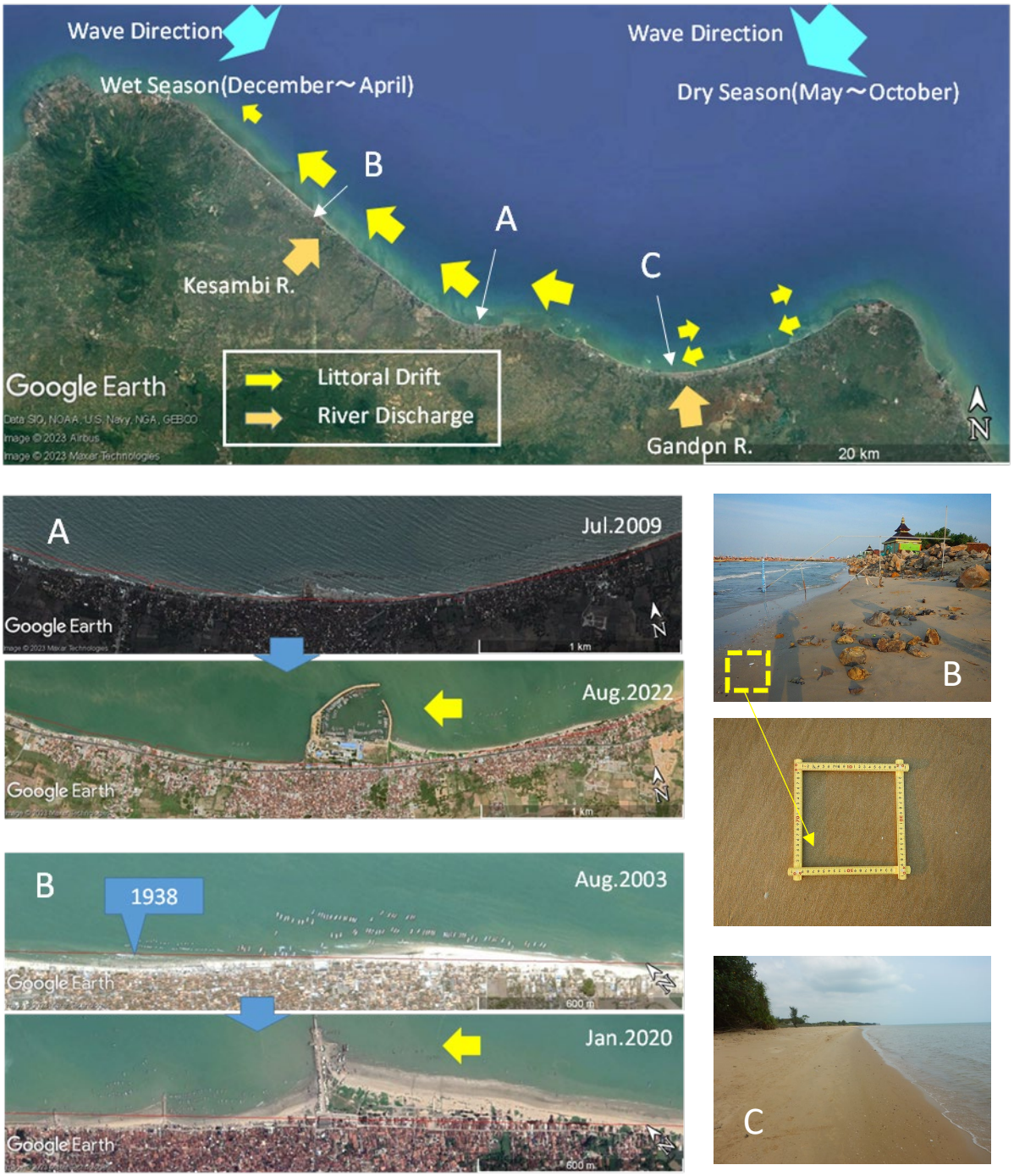


Source: JICA Study Team

Figure 6.1.31 Evaluation of Vulnerability for Tidal Flood in Pemalang-Pekalongan

6.1.3 Area-III: Rembang-Tuban

Figure 6.1.32 shows the mechanism of sediment transport in the coastal area, and the findings on the mechanism are summarized below.

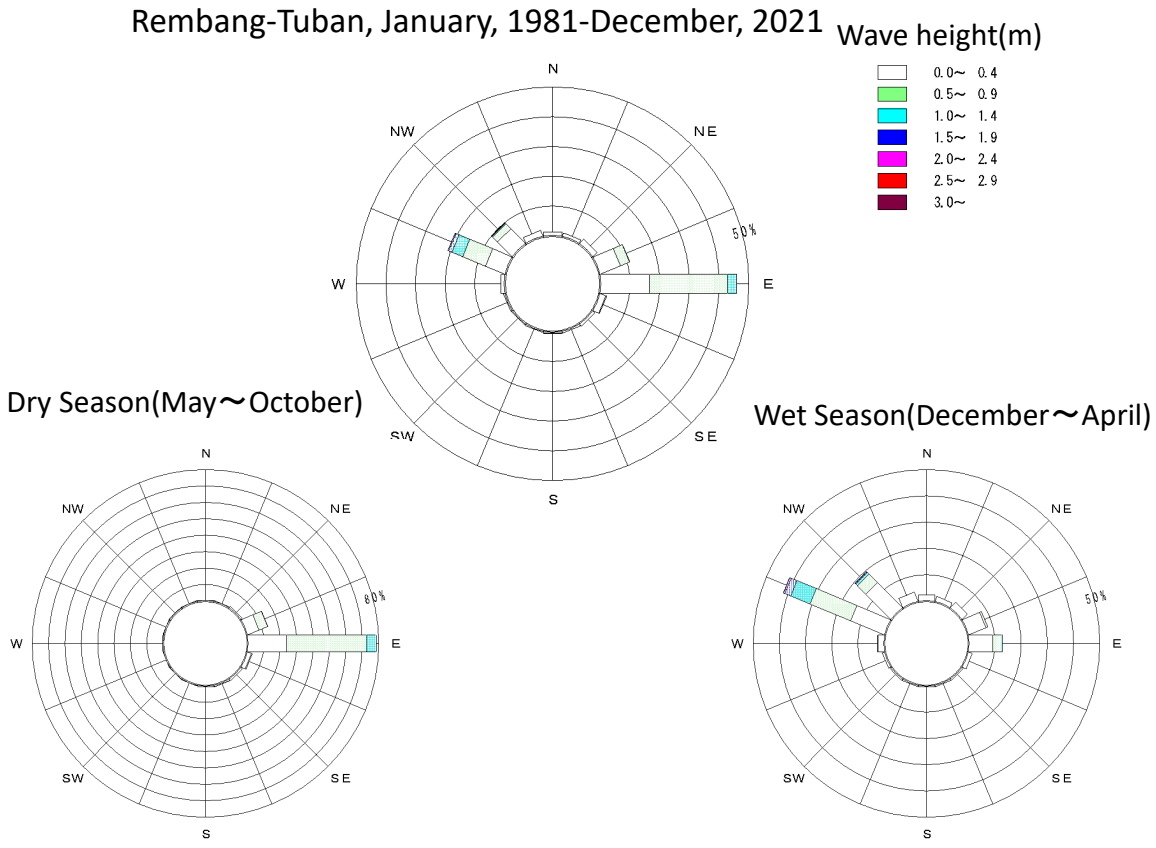


Source: Right 3 figures - JICA Study Team; Others - Edited by JICA Study Team using Google Earth

Figure 6.1.32 Mechanism of Sediment Movement in Rembang-Tuban Coast

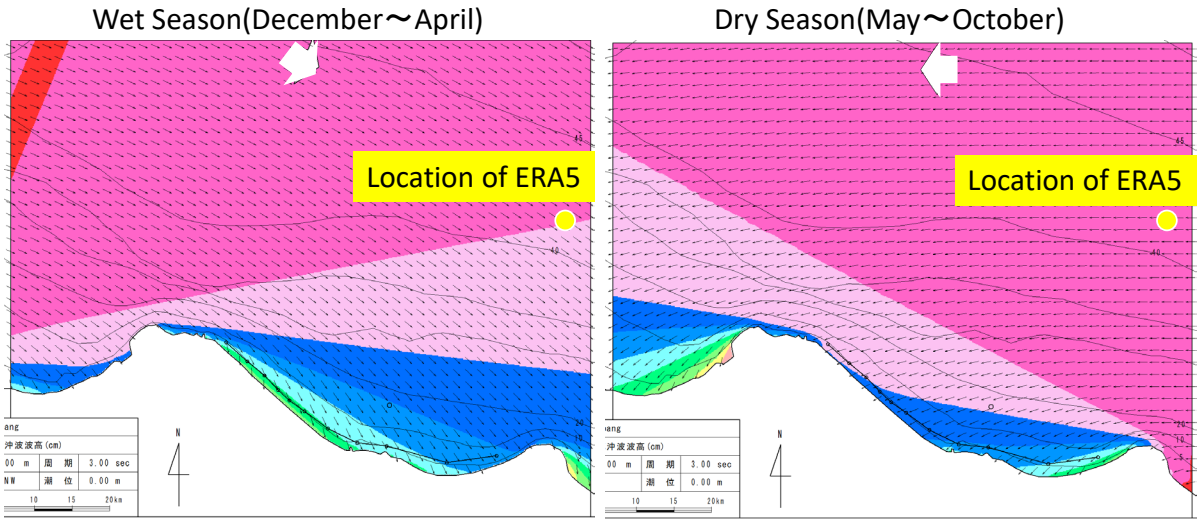
(1) Wave Characteristics

Wave data for the 1981-2021 period estimated off the coast of the area indicate that waves are predominantly from the east during the dry season (May-October) and from the west during the rainy season (October-April). Under these conditions, wave deformation calculations using the energy equilibrium equation were performed to analyze the wave conditions reaching the coastal area. Based on the results, the dominant direction of longshore sediment transport was estimated, and it was found that the sediment transport along the Rembang Coast is almost westward. On the other hand, on the west side of the Tuban Coast, sediment is moving in a westward direction, but as it moves eastward, it is estimated that the longshore drift of both east and west directions is in a state of equilibrium.



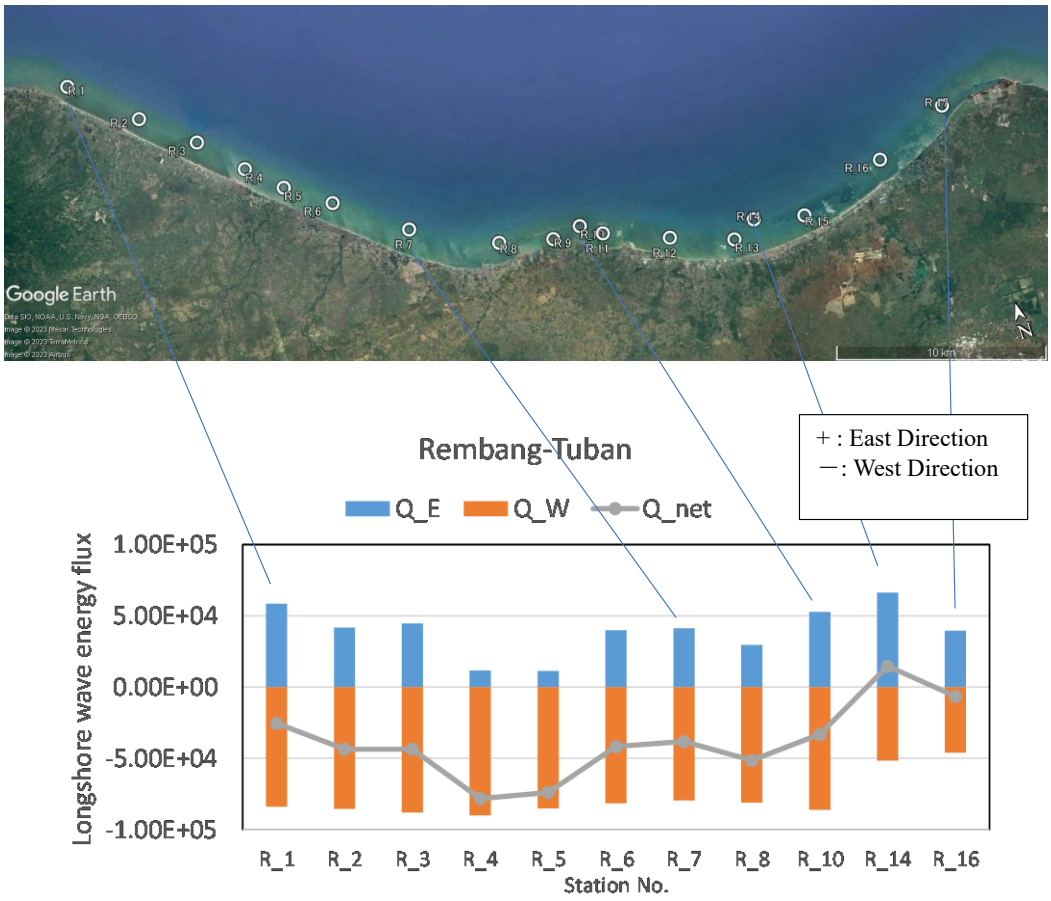
Source: JICA Study Team

Figure 6.1.33 Wave Characteristics in Rembang-Tuban According to ERA5 (1981-2021)



Source: JICA Study Team

Figure 6.1.34 Distribution of Wave Height and Direction in Rembang-Tuban by the Numerical Model



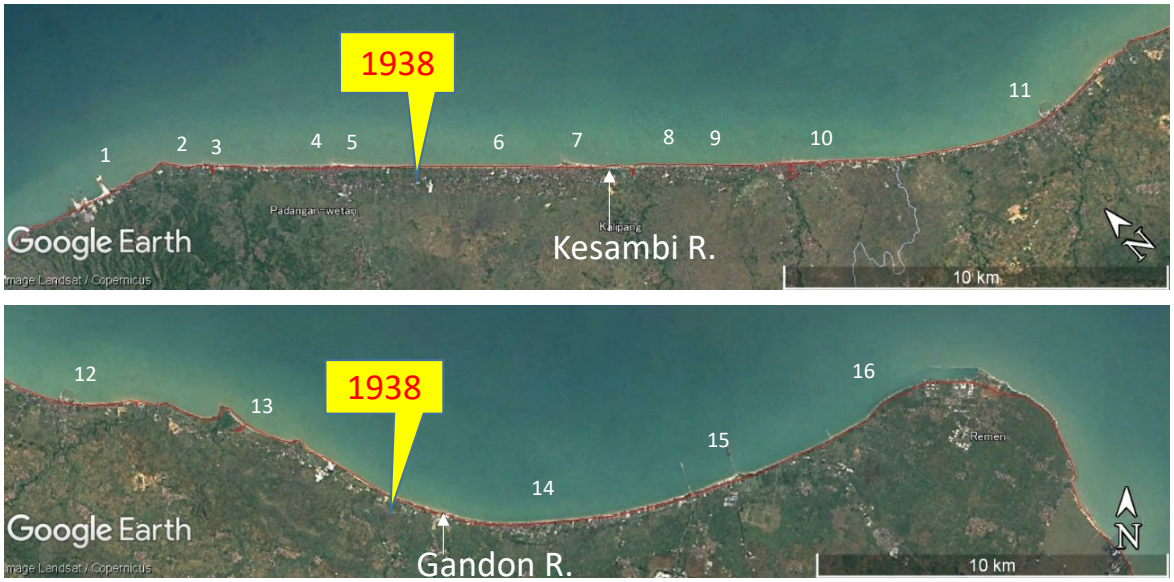
Source: Top figure - Edited by JICA Study Team; Bottom figure - JICA Study Team

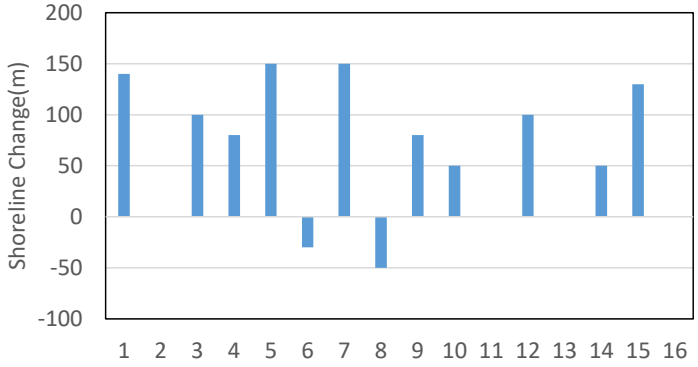
Figure 6.1.35 Dominant Direction of Littoral Drift in Rembang-Tuban Estimated by Wave Analysis

(2) Morphological Change Characteristics

In this coastal area, there is no discharge from large rivers such as the Indramayu and Pemalang-Pekalongan. Therefore, there are no protruding landforms caused by river sediment discharge, and Rembang has an almost straight shoreline, while Tuban has a gently curved shoreline. Overall, the shoreline has advanced over the past approximately 80 years (Figure 6.1.36).

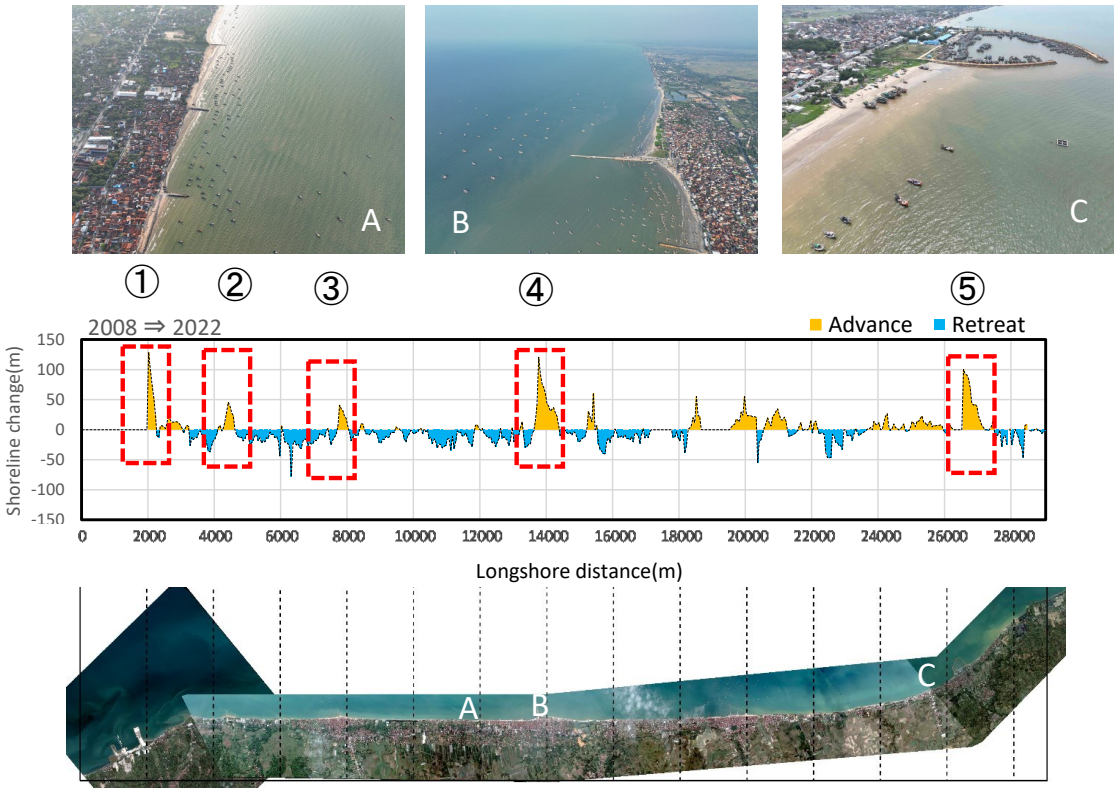
In Rembang, the construction of groin-like structures for mooring vessels, jetties, and harbor breakwaters in the last 20 years has caused the shoreline on the east side to advance and the shoreline on the west side to retreat (Figure 6.1.37). From this, it can be inferred that westward longshore drift is dominant in this coastal area. In Tuban, the shoreline retreats on the west side of the heavily curved coast while the shoreline advances on the east side (Figure 6.1.38). This situation suggests that the topographic change during the period compared is due to eastward longshore drift sand. However, the shoreline advance on the east side can be assumed to be caused by wave shielding by the recently constructed pier and the quay facilities built at the tip of the pier. In addition, a medium-sized river (Gandon River) discharges from the boundary between the erosion area on the west side and the deposition area on the east side, and the change in sediment discharge from the river may have influenced the change.





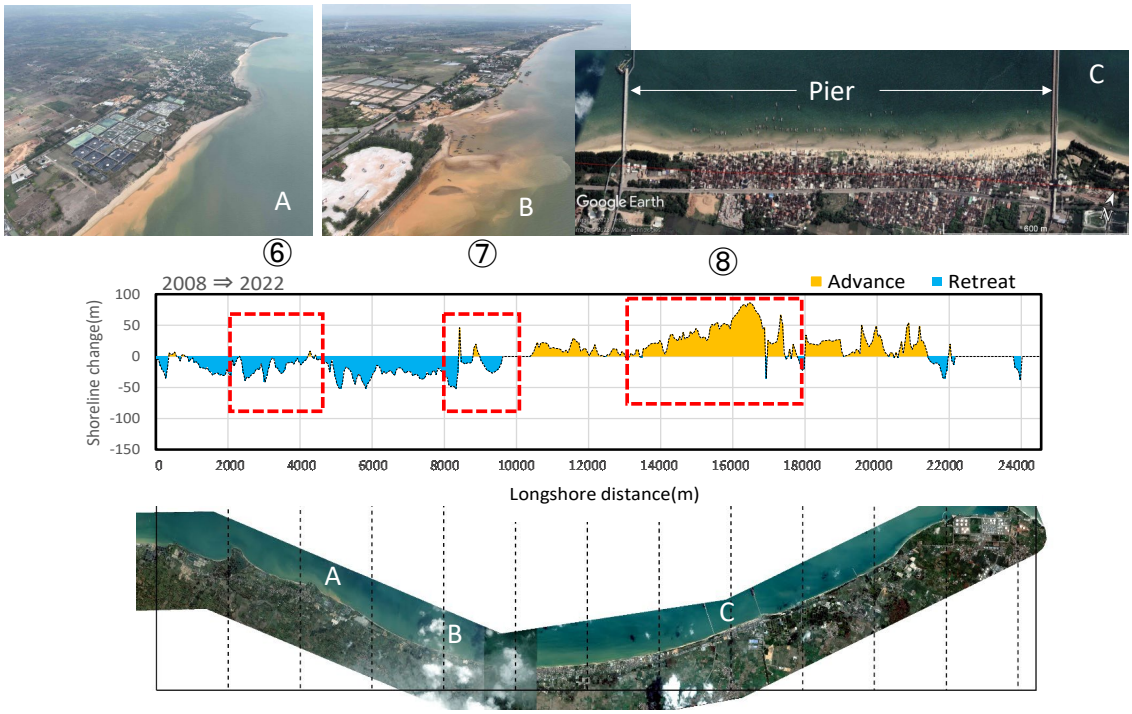
Source: Top and middle figure - Edited by JICA Study Team based on Google Earth; Bottom figure - JICA Study Team

Figure 6.1.36 Long-term Shoreline Change in Rembang-Tuban



Source: JICA Study Team

Figure 6.1.37 Shoreline Change in the West Part of Rembang Between 2008 and 2022



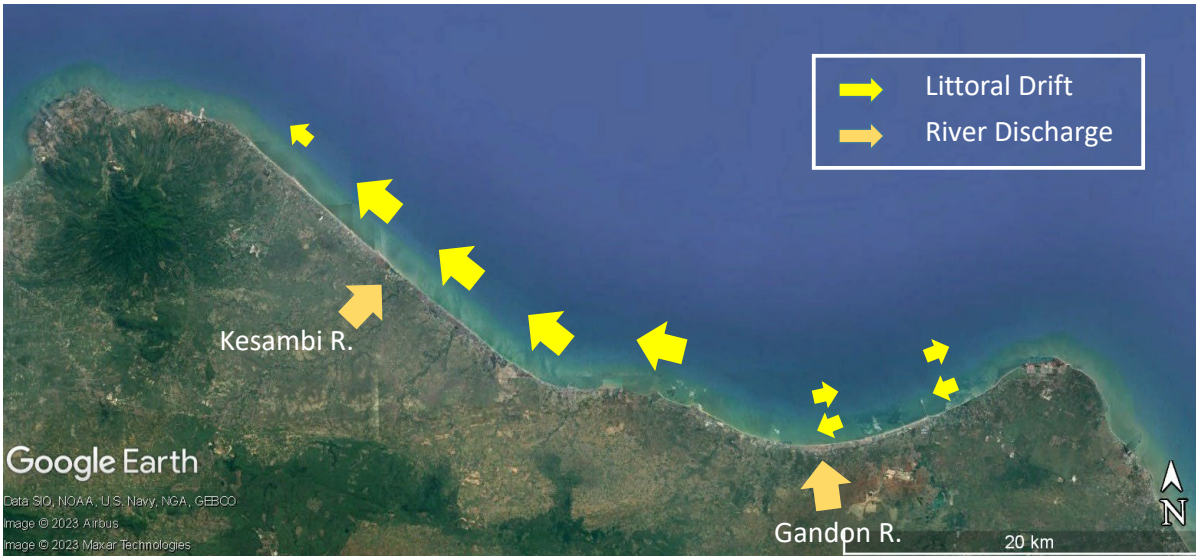
Source: 1st right figure - Edited by JICA Study Team based on Google Earth; Others JICA Study Team

Figure 6.1.38 Shoreline Change in the West Part of Tuban Between 2008 and 2022

(3) Longshore Sediment Transport

The ottom sediment of this coast is composed of fine sand, which is transported as longshore drift sand. Therefore, along the Rembang Coast, which is dominated by westward longshore drift sand, the construction of jetties and breakwaters has blocked the longshore drift sand, resulting in topographic changes. In other words, sedimentation occurs on the upper side of the longshore drift, while erosion occurs on the lower side.

Tuban Coast has a gently curving coastline with many sandy beaches. According to the results of wave analysis, it is presumed that the beach is stable because the longshore sand drift in both directions is balanced along this coast. However, the topography is expected to change if structures are constructed in the coastal area that affect the longshore sand drift.



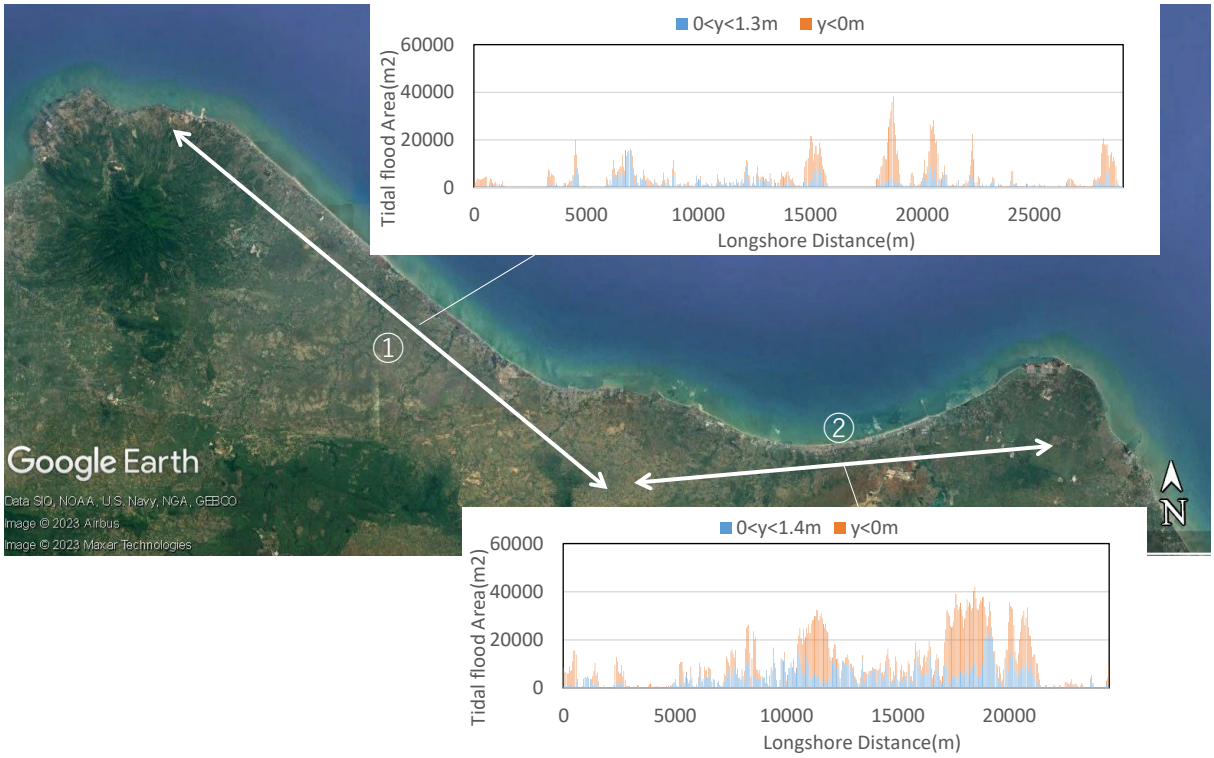
Source: Edited by JICA Study Ream based on Google Earth

Figure 6.1.39 Dominant Direction of Littoral Drift in Rembang-Tuban

(4) Tidal Flood

The evaluation of vulnerability for tidal flood along the coast of Rembang-Tuban is shown in Figure 6.1.40, which indicates the area under the high sea-water level at the storm surge. The flooding area was estimated at intervals of 50m alongshore within a range of 1 km behind the coastline. The ground height in the hinterland is based on the DEMNAS data from Badan Informasi Geospasial. The sea-water level was set at between +1.3 and +1.4 m, which is the annual maximum tide level of+0.90 m plus a water level rise due to waves with a 50-year probability occurrence.

Although the flood area in the part of the east region of Tuban (② of Figure 6.1.40) is wider than others, Rembang-Tuban area has overall low risk for tidal flood compared to Indramayu and Pemalang-Pekalongan.



Source: JICA Study Team

Figure 6.1.40 Evaluation of Vulnerability for Tidal Flood in Rembang-Tuban

6.2 Current Status of Social Environment, Residential Opinions, and Organizations

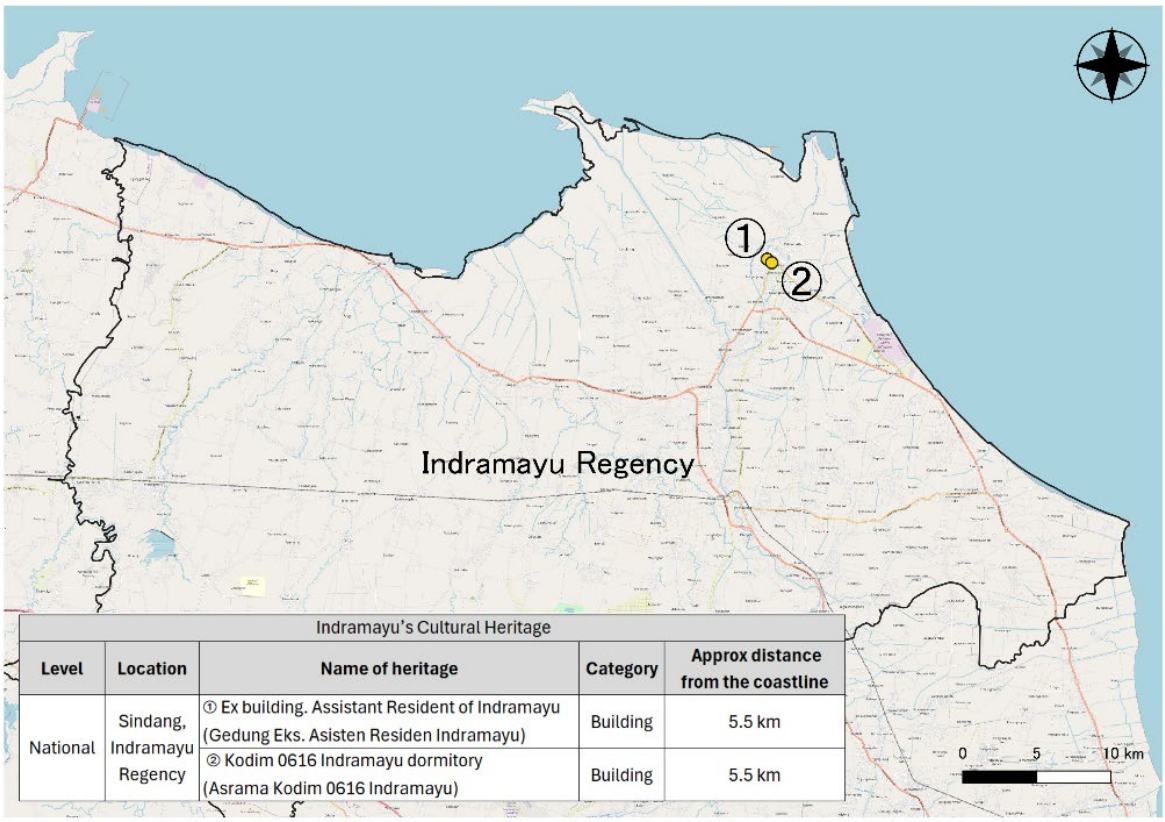
6.2.1 Area-I: Indramayu

(1) Culture and Social Customs

This section describes the cultural and social customs. Population and administrative divisions, indigenous peoples and ethnic minorities, and industries are described in Section 14.2 in Chapter 14.

1) Registered Cultural Heritage

There are no World Heritage Sites in Indramayu Region. Other cultural heritage sites include the building shown below, which is located approximately 5.5 km from the coast.



Indramayu's Cultural Heritage

Level	Location	Name of heritage	Category	Approx distance from the coastline
National	Sindang, Indramayu Regency	① Ex building. Assistant Resident of Indramayu (Gedung Eks. Asisten Residen Indramayu)	Building	5.5 km
		② Kodim 0616 Indramayu dormitory (Asrama Kodim 0616 Indramayu)	Building	5.5 km

Source: JICA Study Team

Figure 6.2.1 Location of Cultural Heritage in Indramayu

2) Local Culture

Like other coastal cities in Northern Java, Indramayu's Eretan Kulon, Eretan Wetan, Dadap, Limbangan, and Karangsong beaches holds a fishing festival called "Nadran" once a year. [1)]

3) Utilization of Coastal Areas

There are salt farms at four districts in Indramayu. (923 ha in Losarang, 190 ha in Kandanghaur, 600 ha in Krangkeng)[2)]. Salt production in Indramayu takes place only during the summer and dry season, and during the rainy season, the salt producers change jobs to fishermen and fish traders.[3)]

Indramayu has mangrove forests in four districts (Cantigi, Kandanghaur, Losarang, Sindang). However, from 1989 to 2010, the area of mangroves decreased by 29.9 % due to the conversion of land to brackish water fishponds. [4)] The restoration of mangrove forests is being carried out by various communities in Inderamayu (e.g., 1500 mangroves were planted in Dadap Baru Village by Sanggar Lingkungan Hidup on the World Environmental Day.[5)] However, these activities were carried out only once and not continuously.

Beach cleanup activities also seem to be carried out by the community, but continuous activities have not been confirmed.

4) Tourism Resources

Beaches and mangrove forests along the coast of Indramayu are used as tourism resources, and ecotourism is being carried out in the mangrove forests of Karangsong.

Source: JICA Study Team

Figure 6.2.2 Tourism Resource Locations Along the Coast of Indramayu

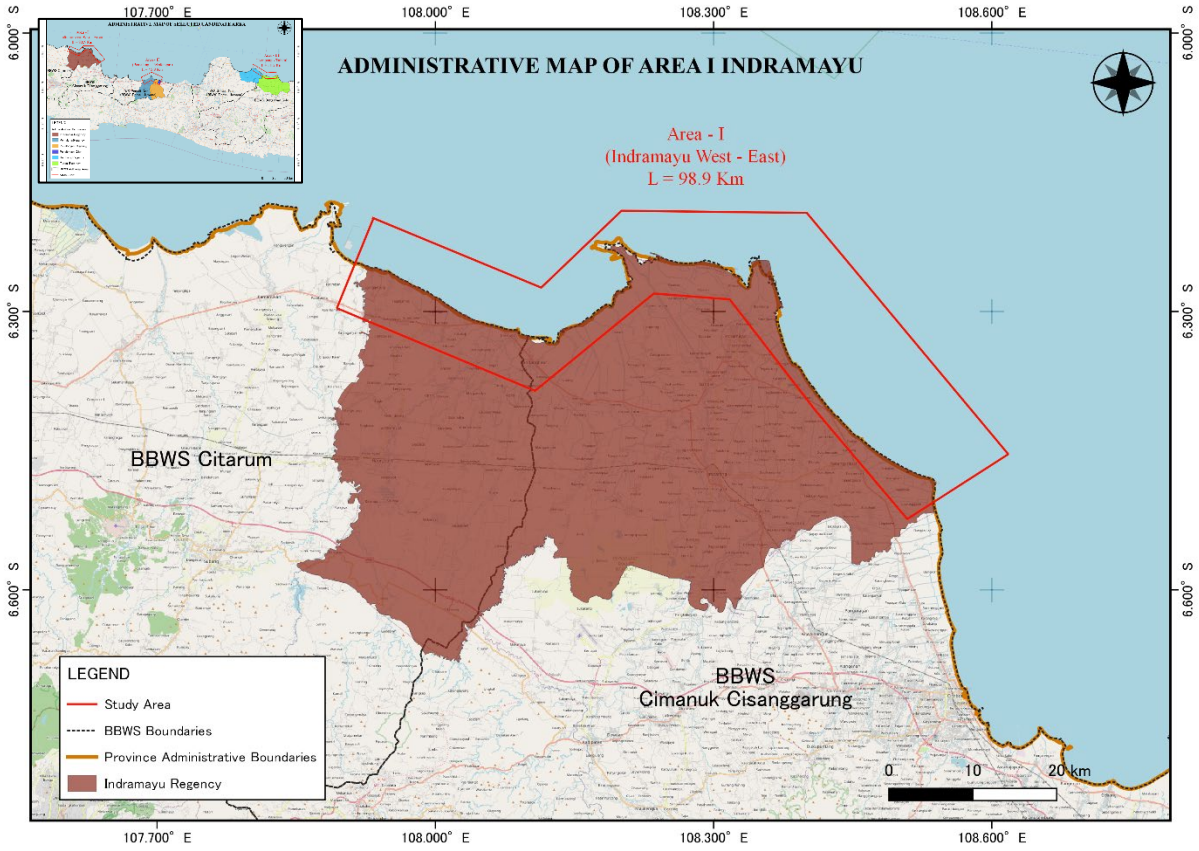
(2) Opinions of Residents

Focus group discussions (FGD) were held in the coastal areas of the priority areas to gather information on the views of residents. Details are given in Chapter 17.

(3) System

1) Organizational Structure for Coastal Management

Area-I belongs to Indramayu Province, West Java. As for water resources management, it belongs to the Citarum basin and the Cimanuk Cissangarung basin, and the jurisdiction of both basins is stipulated by the PUPR Ministerial Regulation 04/PRT/M/2015 to be managed by the central government. It spans across two BBWS (PURR branch office) jurisdictions: BBWS Citarum for Citarum basin and BBWS Cimanuk-Cisanggarung for Cimanuk-Cisanggarung basin.



Source: JICA Study Team

Figure 6.2.3 Administrative Map of Indramayu Area

Coastal protection, utilization, and environmental jurisdiction of Indramayu area can be summarized as shown in Table 6.2.1 . As for protection, BBWS implements the hard infrastructure and KKP implements the green infrastructure called hybrid engineering, but there is no legal division of roles and it is not clear.

Table 6.2.1 Coastal Management System in Indramayu

Category	Responsible Organization	Function
Water resource management (including coastal protection)	BBWS Citarum	Development and maintenance of coastal protection facilities (mainly breakwater, seawall, revetment and other tangible infrastructures)
	BBWS Cimanuk-Cisanggarung	Development and maintenance of coastal protection facilities (mainly breakwater, seawall, revetment and other tangible infrastructures)
Coastal disaster prevention	KKP	Development, maintenance and management of coastal protection facilities (mainly green infrastructure)
Coastal utilization	DKP, West Java Province	Development of coastal space plans and examination of coastal utilization
	Indramayu Regency	Management of coastal utilization (tourism resources, cleaning activities, etc.)

Source: JICA Study Team

According to the results of interviews conducted on the coastal projects of BBWS, which is a local office of PUPR, both offices have not continuously implemented projects on the coast, and in the ten years since 2012, coastal projects have been implemented for four years in both offices. The average project cost in the year when projects were implemented is IDR 7.8 billionin BBWS Citarum and IDR 29.2 billion in BBWS Cimanuk-Cisanggarung.

Table 6.2.2 Actual Coastal Project Expenses (IDR) in BBWS Citarum

Type of Coastal Project (such as detail design, break water, sea wall, environmental measure, maitenance, and etc.)	Budget Allocation (Actual) (Unit: 1,000 IDR)									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
rehabilitation/repair work	965,900		391,450							
supervision on coastal protection work	272,662		344,862	318,426				347,777		
seawall constrcution	8,611,395		4,553,876	11,548,268				3,764,848		
Total budget for coastal project	9,849,957	0	5,290,188	11,866,694	0	0	0	4,112,625	0	0
Total Budget of Rivers & Coasts Project of BBWS	481,822,188	746,383,458	114,930,428	257,885,750	107,615,162	440,617,110	592,981,944	759,608,289	535,851,570	432,871,593

Source: JICA Study Team

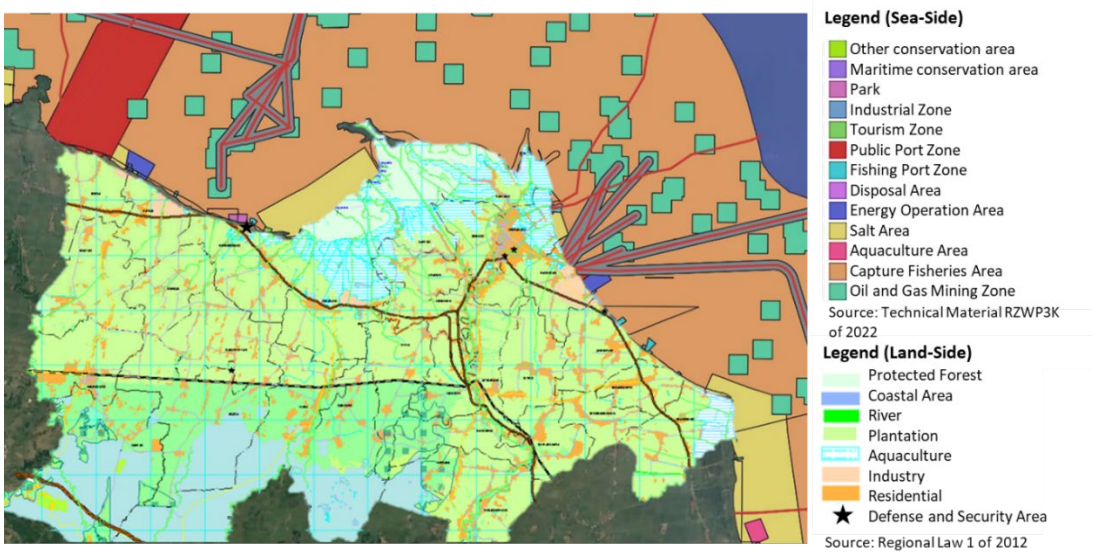
Table 6.2.3 Actual Coastal Project Expenses (IDR) in BBWS Cimanuk Cisanggarung

Type of Coastal Project (such as detail design, break water, sea wall, environmental measure, maitenance, and etc.)	Budget Allocation (Actual) (Unit: 1,000 IDR)									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
supervision on a construction work		474,010					1,314,045	1,207,465		2,437,294
jetty construction work		7,867,123								
construction around estuary							13,048,440			
coastal protection work								6,999,390		83,316,400
Total budget for coastal project	0	8,341,133	0	0	0	0	14,362,485	8,206,855	0	85,753,694
Total Budget of Water Resources Project of BBWS		141,374,206	99,571,041	324,462,899	145,151,456	172,065,797	94,627,906	43,976,883	21,759,009	111,137,587

Source: JICA Study Team

2)Spatial Planning

The marine spatial plan of Indramayu area has been published as Regional Regulation No.9 of 2022, West Java Spatial Plan (Perda 9 Tahun 2022-RTRWP 2022 2042). The land spatial plan of Indramayu area has been published as Regional Regulation No.1 of 2012, West Java Spatial Plan. Figure 6.2.4 shows the marine and land spatial plans.



Source: JICA Study Team based on Regional Regulation No.9/2022 and Regional Regulation No.1/2012, West Java Spatial Plan

Figure 6.2.4 Marine and Land Spatial Plan of Indramayu Area

Table 6.2.6 shows the spatial plan of each priority zone to be classified in this project. Allowed activities, prohibited activities, and activities allowed with conditions in zones included in Area-I and in their respective areas are listed in the attachment. "Development of breakwater, revetment, groin" related to this project is an activity permitted by obtaining approval in all areas. The approval referred to here is obtained through the KKPRL/KKRL procedures.

Table 6.2.4 Spatial Plan of Area-I

Zone	Marine Spatial Plan	Land Spatial Plan
1	Ports, salt fields, energy zones, etc.	Plantation, industrial zones, etc.
2	Energy, fisheries, conservation zones (see Chapter 17), etc.	Plantation, industrial zones, etc.
3	Salt farm, fisheries zone, etc.	Aquaculture, protected forest zones (see Chapter 17), etc.
4	Salt farm, tourism, pipeline zone, etc.	Aquaculture, housing zones, etc.
5	Pipeline, energy zone, etc.	Industrial zones, etc.
6	Fisheries, fishing ports, tourism zones, etc.	Plantation zone, etc.
7	Fisheries, fishing ports, salt farm zones, etc.	Plantation, aquaculture zones, etc.

Source: JICA Study Team

6.2.2 Area-II: Pemalang-Pekalongan

(1) Culture and Social Customs

This section describes the cultural and social customs. Population and administrative divisions, indigenous peoples and ethnic minorities, and industries are described in Section 9.2 in Chapter 17.

1) Registered Cultural Heritage

There are no World Heritage Sites or national cultural heritage sites in Pemalang-Pekalongan.

2) Local Culture

In Pemalang's Asemdoyong Village, a fishing festival called "Baritan" is held annually on the first Monday or Friday of the month of Surah (Islamic calendar). [6)]

Pekalongan is one of the cities with a strong Islamic culture. Once a year, a fishing festival called "Nyadran" or "Sedekah Laut" is held in Wonokerto Village in the month of Shawwal (Islamic calendar). [7)] Apart from this, there is a similar festival held during the Lunar New Year by the Chinese communities in Pekalongan. This festival is called "Pek Cun" and is held at Pasir Kencana Beach. [8)]

3) Utilization of Coastal Areas

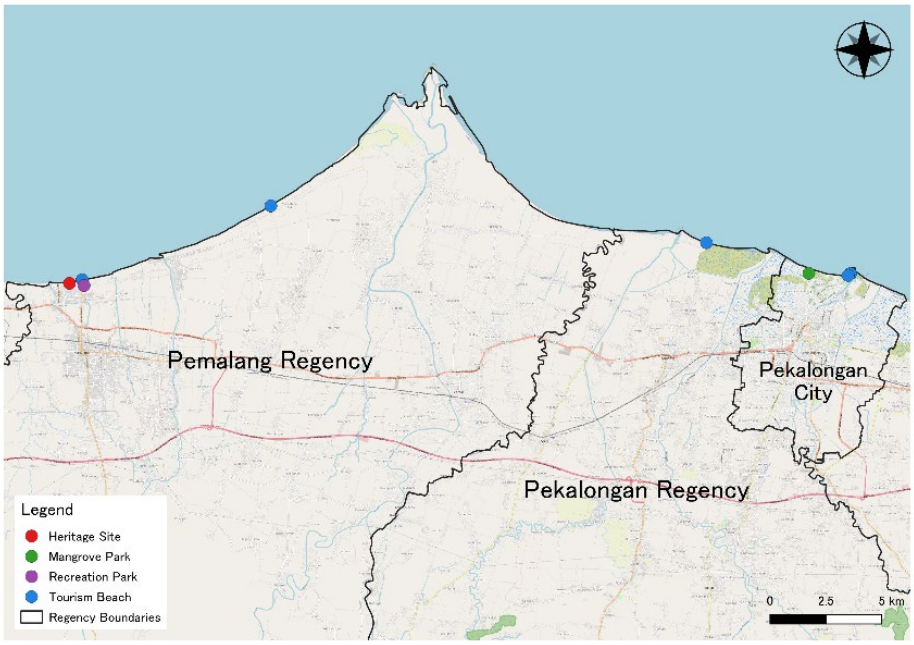
In the Pemalang-Pekalongan area, paddy fields used to spread along the coastal areas, but flooding caused by storm surges has made agriculture impossible, and they are being converted to aquaculture ponds. From 2003 to 2016, agricultural land in Pekalongan decreased by 370.26 ha and wetland area-increased by 292.68 ha due to sea-level rise or the effect of land subsidence. [9)]

Mangrove reforestation is carried out in various communities in the region by governmental organizations, NGO, etc., but these activities are for a limited period, and continuous activities have not been confirmed.

Similarly, it seems that beach cleanup activities are being carried out by communities, but continuous activities have not been confirmed.

4) Tourism Resources

In Pemalang-Pekalongan, beaches and mangrove forests are being utilized as tourist attractions. Near Widuri Beach in Pemalang, there is a mausoleum of Islamic leader "Makam Syeikh Maulana Syamsudin" which is a tourist attraction. According to interviews with people involved in the facilities, 30 to 50 tourist buses visit on weekends.



Source: JICA Study Team

Figure 6.2.5 Map of Tourism Resource Locations Along the Coast of Pemalang-Pekalongan

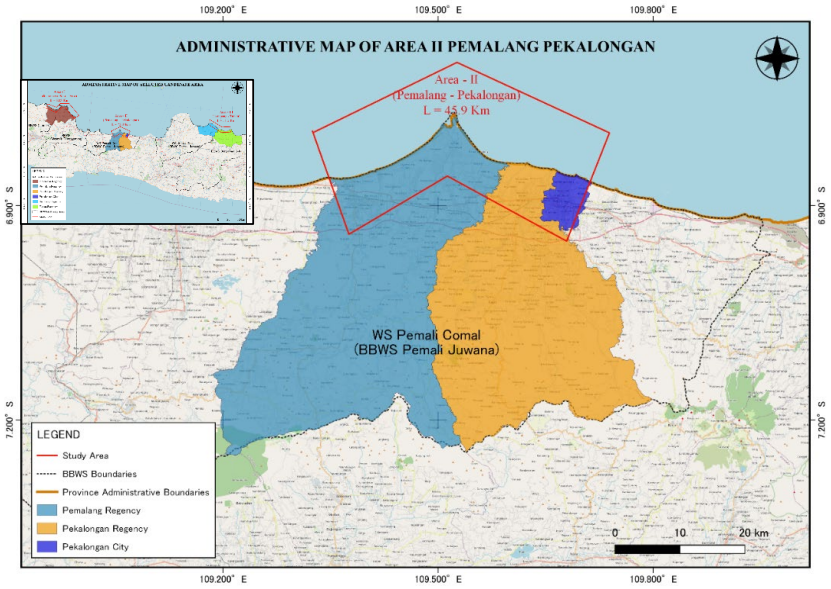
(2) Opinions of Residents

Focus group discussions (FGD) were held in the coastal areas of each priority areas to gather information on the views of residents. Details are given in Chapter 17.

(3) System

1) Organizational Structure for Coastal Management

Area-II belongs to Pemalang Regency, Pekalongan Regency, and Pekalongan City in Central Java Province as shown in Figure 6.2.7. As for water resources management, it belongs to the Pemali Comal basin, and the jurisdiction of the basin is defined as Central Java Province according to the PUPR Ministerial Regulation 04/PRT/M/2015, but with the support of BBWS Pemali-Juana.



Source: JICA Study Team

Figure 6.2.6 Administrative Map of the Pemalang-Pekalongan Area

The coastal protection, utilization, and environmental jurisdiction of the Pemalang-Pekalongan area can be summarized as shown in Table 6.2.5. As mentioned above, water resources management including coastal protection is under the jurisdiction of Central Java Province. However, BBWS Pemali-Juana is often implementing the measures due to the lack of resources and other factors. Even then, the central Java province is supposed to carry out the management. Regarding protection, while the Central Java Province (or BBWS) implements tangible infrastructure and KKP implements a green infrastructure called hybrid engineering, the legal division of roles is not clear.

Table 6.2.5 Coastal Management System in the Pemalang-Pekalongan Area

Category	Responsible Organization	Function
Water resource management (including coastal protection)	Dinas PU, Central Java Province, (BBWS Pemali-Juana)	Development and maintenance of coastal protection facilities (mainly breakwater, sea wall, revetment and other tangible infrastructures) ※Many cases in which BBWS Pemali-Juana implements the management due to factors such as the shortage of state resources.
Coastal disaster prevention	KKP	Development, maintenance, and management of coastal protection facilities (mainly green infrastructure)
Coastal utilization	DKP, Central Java Province	Development of coastal space plans and examination of coastal utilization
	Pemalang Regency	Management of coastal utilization (tourism resources, cleaning activities, etc.)
	Pekalongan Regency	Management of coastal utilization (tourism resources, cleaning activities, etc.)
	Pekalongan City	Management of coastal utilization (tourism resources, cleaning activities, etc.)

Source: JICA Study Team

According to the results of interview with BBWS Pemali-Juana on the coastal project records, the annual average coastal project cost is IDR. 480 billion.

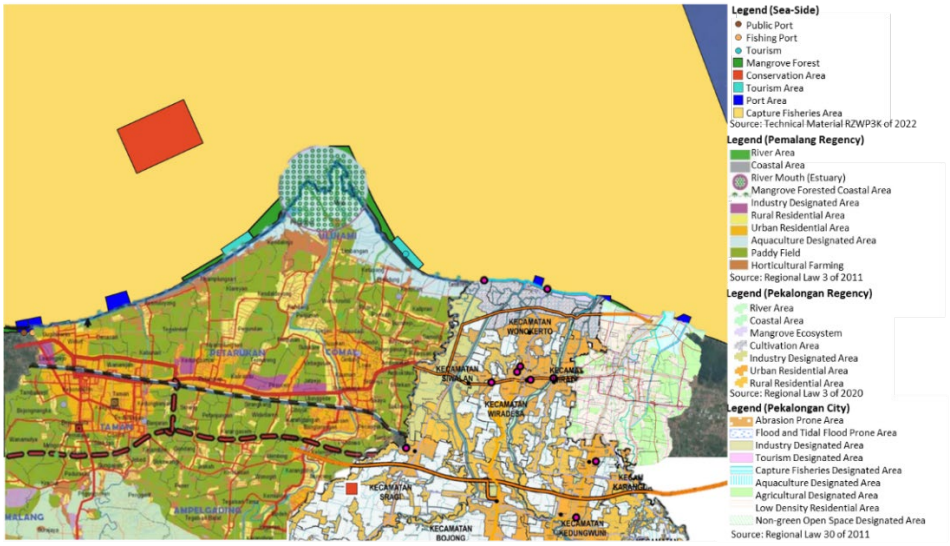
Table 6.2.6 Actual Coastal Project Expenses in BBWS Pemali-Juana (IDR)

Type of Coastal Project (such as detail design, break water, sea wall, environmental measure, maitenance, and etc.)	Budget Allocation (Actual) (Unit: 1,000 IDR)									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Coastal protection in Depok Beach, Pekalongan Regency			111,981,779							
no remarks				260,895,917	147,407,685	525,842,689	881,394,896	877,091,117	233,990,039	869,226,432
Total budget for coastal project										
Total Buget for Water Resources Project of BBWS			111,981,779	260,895,917	147,407,685	525,842,689	881,394,896	877,091,117	233,990,039	869,226,432

Source: JICA Study Team

2) Spatial Planning

The marine spatial plan of the Pemalang-Pekalongan area is under the process of revision by the Central Java Province. The land spatial plan of the Pemalang-Pekalongan area has been published as a regional regulation for each of the target regencies and cities. The marine and land spatial plan of the Pemalang-Pekalongan area is shown in Figure 6.2.7.



Source: Created by the JICA Study Team based on the Central Java Spatial Plan (Draft) and based on regional regulations

Figure 6.2.7 Marine and Land Spatial Plan of the Pemalang-Pekalongan Area

Table 6.2.10 shows the spatial plan of each priority zone to be classified in this project. Allowed activities, prohibited activities, and activities allowed with conditions in zones included in Area-II and in their respective areas are listed in the attachment. "Development of breakwater, revetment, groin" related to this project is an activity permitted by obtaining approval in all areas. The approval referred to here is obtained through the KKPRL/KKRL procedures.

Table 6.2.7 Spatial Plan of Area-II

Zone	Marine Spatial Plan	Land Spatial Plan
1	Fisheries, fishing ports, tourism zones, etc.	Urban areas, paddy zones, etc.
2	Fisheries, mangroves, tourism zones, etc.	Paddy fields, mangroves, aquaculture zones, etc.
3	Fisheries, fishing ports, tourism zones, etc.	Aquaculture, tourism zones, etc.

Source: JICA Study Team

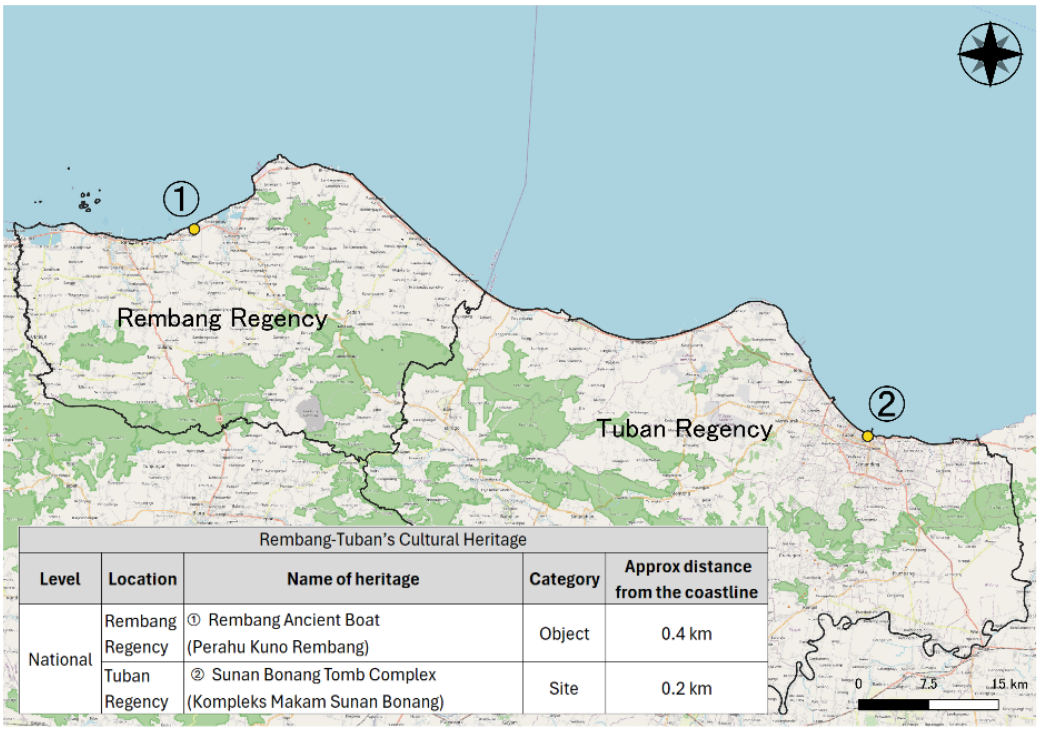
6.2.3 Area-III: Rembang-Tuban

(1) Culture and Social Customs

This section describes the cultural and social customs. Population and administrative divisions, indigenous peoples and ethnic minorities, and industries are described in Section 9.2.

1) Registered Cultural Heritage

There are no World Heritage Sites in the Rembang-Tuban Region. In Rembang, an ancient boat is registered as "other cultural heritage" and is preserved at a location about 400 m from the shore. In Tuban, a mausoleum is located about 200 m from the shore.



Rembang-Tuban's Cultural Heritage

Level	Location	Name of heritage	Category	Approx distance from the coastline
National	Rembang Regency	① Rembang Ancient Boat (Perahu Kuno Rembang)	Object	0.4 km
	Tuban Regency	② Sunan Bonang Tomb Complex (Kompleks Makam Sunan Bonang)	Site	0.2 km

Source: JICA Study Team

Figure 6.2.8 Location of Rembang-Tuban's Cultural Heritage

2) Local Culture

Rembang region is a Region with a strong Islamic culture. Once a year, a fishing festival called Sedekah Laut is held in Tasikagung Village. [10)]

In Rembang region, there is a custom of providing mutual assistance called "Sambatan" where people cooperate and assist each other. [11)] (such as pulling up a ship anchored at a beach, pulling up fish on the ship, repairing or cleaning up a ship)

3) Utilization of Coastal Areas

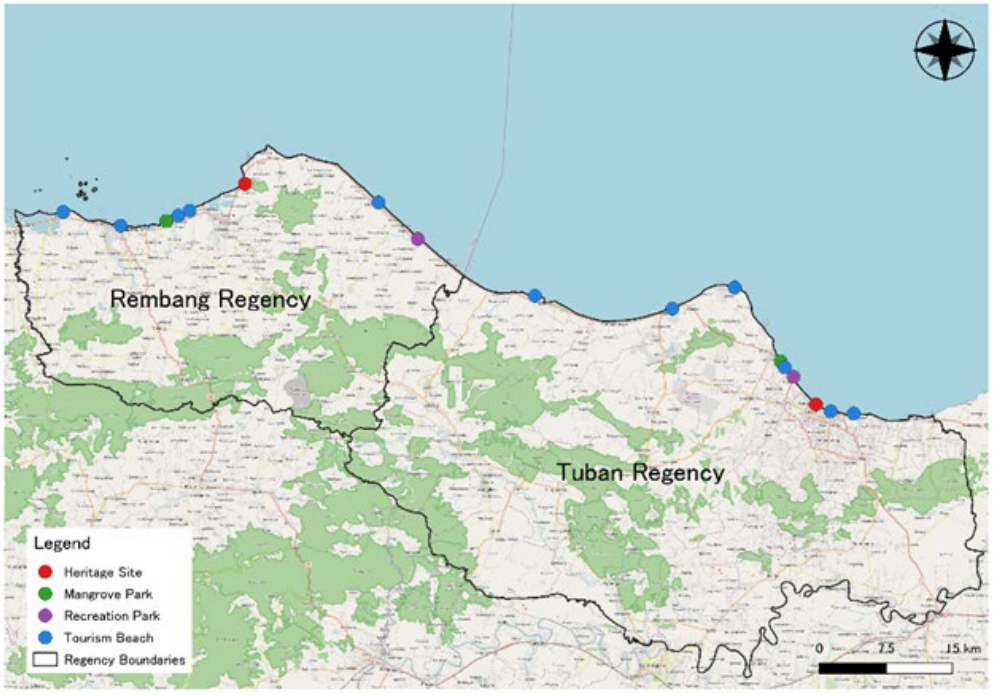
There are industrial areas in the Rembang Region, and industries such as mining, shipbuilding, salt processing, and seafood processing are thriving. Other areas include fisheries, aquaculture, and salt production.

Mangrove reforestation is carried out in various communities in the region by governmental organizations, NGO, etc., but these activities are for a limited period of time, and continuous activities have not been confirmed.

Similarly, it seems that beach cleanup activities are being carried out by the community, but continuous activities have not been confirmed.

4) Tourism Resources

Beach and mangrove forests along the coast of Rembang-Tuban are being utilized as tourism resources.



Source: JICA Study Team

Figure 6.2.9 Map of Tourism Resource Locations Along the Coast of Rembang-Tuban

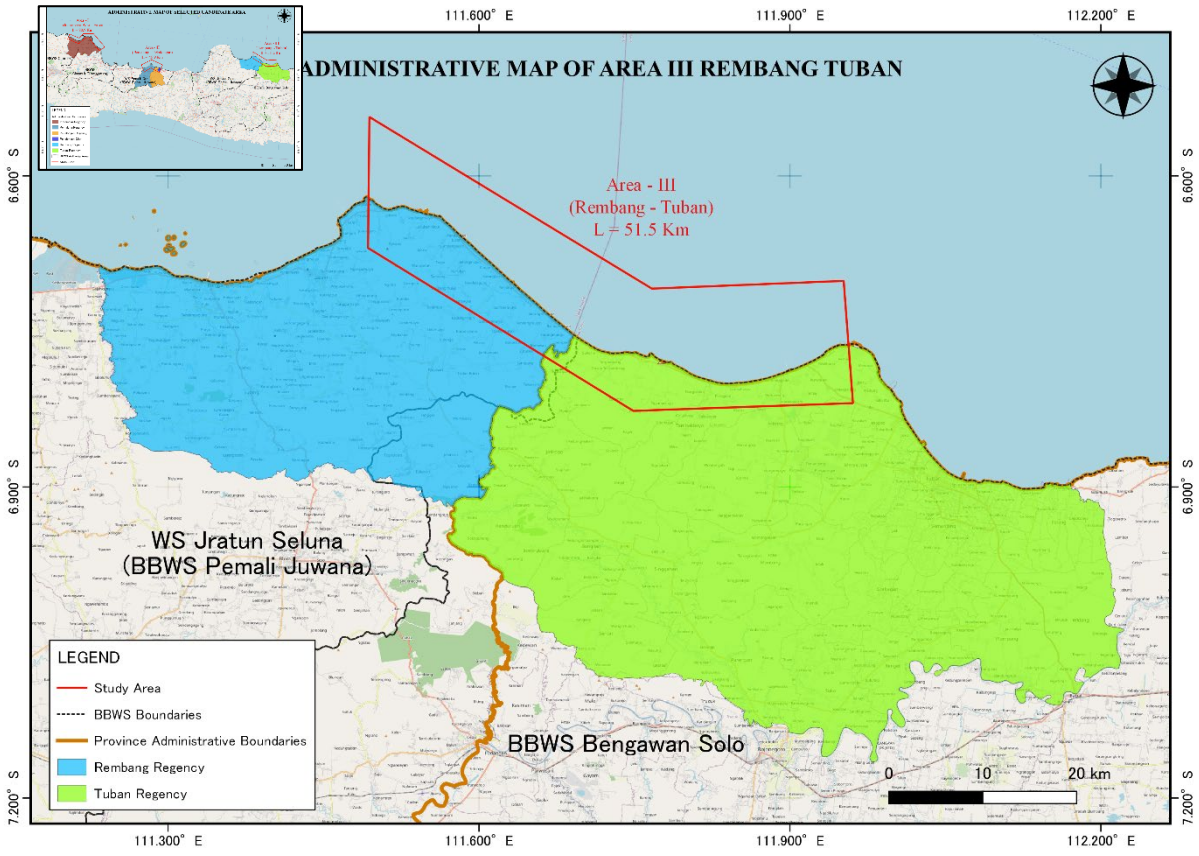
(2) Opinions of Residents

Focus group discussions (FGD) were held in the coastal areas of each priority area to collect information on residents' opinions. Details are given in Chapter 17.

(3) System

1) Organizational Structure for Coastal Management

Area-III spans across the Rembang Regency in Central Java and the Tuban Regency in East Java. As for the water resource management area, the west belongs to Jratunseluna area and the east belongs to Bengawan Solo area, and both areas are under the jurisdiction of the central government according to the PUPR Ministerial Regulation 04/PRT/M/2015. The Jratunseluna area is managed by BBWS Pemali Juana, a branch office of PUPR, and the eastern Bengawan Solo area is managed by BBWS Bengawan Solo.



Source: JICA Study Team

Figure 6.2.10 Administrative Map of the Rembang-Tuban Area

The coastal protection, utilization, and environmental jurisdiction of the Rembang-Tuban area can be summarized as shown in Table 6.2.8. As for protection, BBWS implements the tangible infrastructure and KKP implements the green infrastructure called hybrid engineering, but the legal division of roles is not clear.

Table 6.2.8 Coastal Management System in Rembang-Tuban

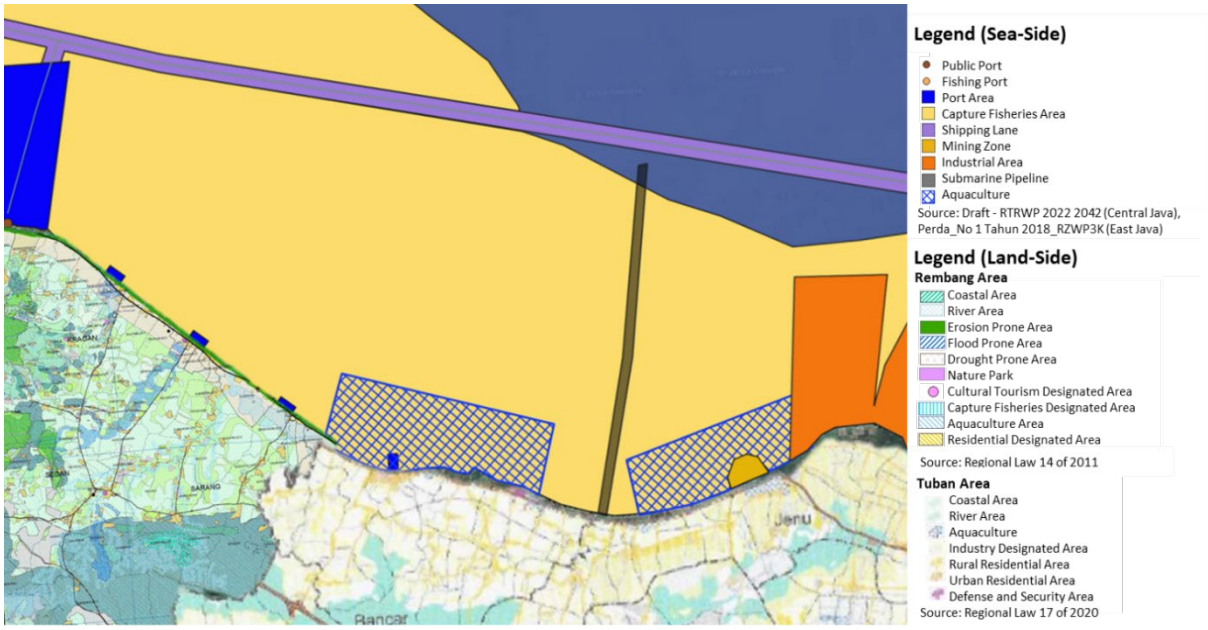
Category	Responsible Organization	Function
Water resource management (including coastal protection)	BBWS Pemali-Juana	Development and maintenance of coastal protection facilities (mainly breakwater, seawall, revetment and other tangible infrastructures)
	BBWS Bengawan Solo	Development and maintenance of coastal protection facilities (mainly breakwater, seawall, revetment and other tangible infrastructures)
Coastal disaster prevention	KKP	Development, maintenance and management of coastal protection facilities (mainly green infrastructure)
Coastal utilization	DKP, West Java Province	Development of coastal space plans and examination of coastal utilization
	DKP, East Java Province	Development of coastal space plans and examination of coastal utilization
	Rembang Regency	Management of coastal utilization (tourism resources, cleaning activities, etc.)
	Tuban Regency	Management of coastal utilization (tourism resources, cleaning activities, etc.)

Source: JICA Study Team

According to the results of interview with BBWS Pemali-Juana on the coastal project records, the average annual coastal project cost is IDR. 480 billion.

2) Spatial Planning

The marine spatial plans are under the process of revision in both Central Java. The land spatial plan of the Rembang-Tuban area has been published as a regional regulation for each regency and city concerned. The latest marine and land spatial plan of the Rembang-Tuban area-is shown in Figure 6.2.11.



Source: JICA Study Team based on the Central Java Spatial Plan (Draft), Regional Regulations No.1 of 2018 East Java Spatial Plan and the regional regulations.

Figure 6.2.11 Marine and Land Spatial Plan for Rembang-Tuban Area

Table 6.2.9 shows the spatial plan of each priority zone to be classified in this project. Details of the defense zone included in Zone 3 will be confirmed as needed. Allowed activities, prohibited activities, and activities allowed with conditions in zones included in Area-III and in their respective areas are listed in the attachment. "Development of breakwater, revetment, groin" related to this project is prohibited in the Mining Zone, Industrial Zone, Submarine Pipeline and Shipping Lane, but it is permitted by obtaining approval in the rest of the area. The approval referred to here is obtained through the KKPRL/KKRL procedures.

Table 6.2.9 Spatial Plan of Area-III

Zone	Marine Spatial Plan	Land Spatial Plan
1	Fisheries, fishing ports, aquaculture zones, etc.	Aquaculture, housing zones, etc.
2	Aquaculture zones, etc.	Housing zones, etc.
3	Aquaculture, fisheries, mining, industrial zones, etc.	Defense, housing, aquaculture, industrial zones, etc.

Source: JICA Study Team

＜Chapter 6 References＞

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CHAPTER 7 Setting of Coastal Division (Step-2 and Step-3)

7.1 Overview of Coastal Division

In the previous chapter, the extent for developing a single Basic Coastal Management Plan was determined by considering administrative boundaries and the locations of major river mouth, defining an "Area" ranging from several tens of kilometers to about 100 kilometers. The draft of the Basic Coastal Management Plan is formulated for this "the Area" unit. However, even within a single "the Area", the coastal characteristics, natural conditions such as incident waves, and social environmental characteristics, including the use of hinterland and coastal areas, vary. Therefore, when developing the draft of the Basic Coastal Management Plan for each of this "the Area," it is necessary to consider the differences and similarities. In order to incorporate them, coastal division within a single "the Area" will be examined based on the differences and similarities in natural conditions and the utilization of hinterland and coastal area for further detailed study.

This chapter describes the procedure of examining coastal division. Coastal division follows two steps, namely, Step-2 and Step-3, in the procedure of preparing the draft of the Basic Coastal Management Plan. In Step-2: Based on the coastal characteristics, incident wave characteristics, and the angle of the shoreline, as the universal coastal characteristics, zoning of "the Area" will be conducted. The divided coast is referred to as "the Zone." The coastal length of "the Zone" is approximately several tens of kilometers. Next, in Step-3: Given the presence of artificial coastal structures, such as ports and jetties, that affect the littoral drift system, further coastal division is conducted by considering both the continuity of littoral drift and the utilization of hinterland and coastal area. This divided coast is defined as "the Section", which is a coastal extent for concrete planning.

7.2 Zone Setting (Step-2)

7.2.1 Zone Classification Policy

(1) Implications of Zone Classification

By zoning the target coastal area according to its topographic and oceanographic characteristics, the direction of coastal conservation (management) corresponding to those characteristics can be indicated. Therefore, the Area to be considered for the Draft Basic Coastal Management Plan is divided into zones of several kilometers to several dozen kilometers of coastal area based on similarities in topographic and oceanographic characteristics, and the direction of coastal facility plan and maintenance is indicated for each zoning.

(2) Concept of Zone Classification

The following steps will be used to classify them.

1) Shoreline Direction

Wave characteristics (wave height and direction), which are external forces for sediment transport, are greatly affected by the orientation of the shoreline. Since sediment transport is an important factor in coastal protection, the orientation of the shoreline is used as a guide for zoning.

2) Beach Topography Characteristics

Even if the beaches are classified as above, the beaches are classified if the bed material comprising the beach area differs significantly, such as sand and gravel or rocky reef.

(3) Bounding Zone Classification Method

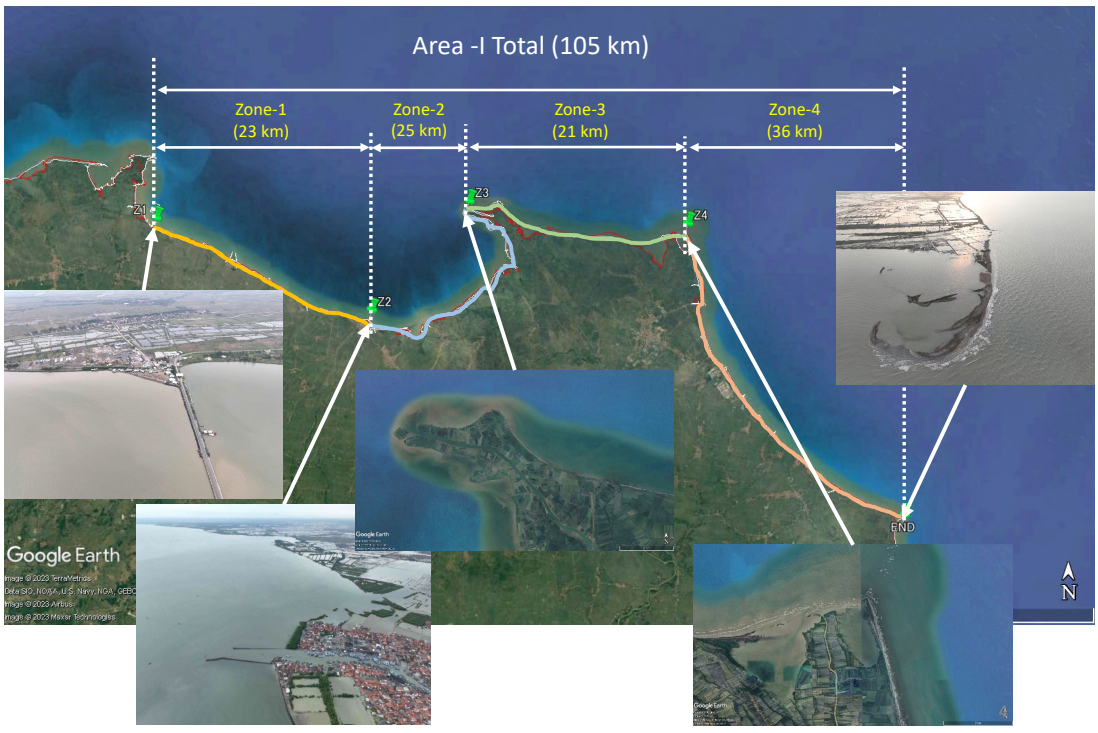
The conditions listed above may vary continuously in some cases, and in such cases, as a rule of thumb, the locations should be those that provide boundary conditions for sediment transport, such as headland topography, breakwaters and other port facilities, and river mouths (training wall, etc.).

7.2.2 Zone Classification

The three selected coastal zones were zoned as shown below, in accordance with the policy outlined above.

(1) Area-I: Indramayu

Indramayu has a northward protruding convex topography, probably formed by sediment discharged from the Cimanuk River in the center, and thus the shoreline shape varies greatly from coast to coast. As shown in Figure 7.2.1, the coastline is divided into four zones: Zone-1 consists of an almost straight coastline, while Zone-2 is a coastline with a curved coastline on the west side of the convex topography. Zone-3 is the top of the convexity, but has a straight coastline with a northerly orientation. The boundary between Zone-1 and Zone-2 is at the mouth of the estuary, and the boundaries between Zone-2 and Zone-3, and between Zone-3 and Zone-4 are at the top of the protruding landform.

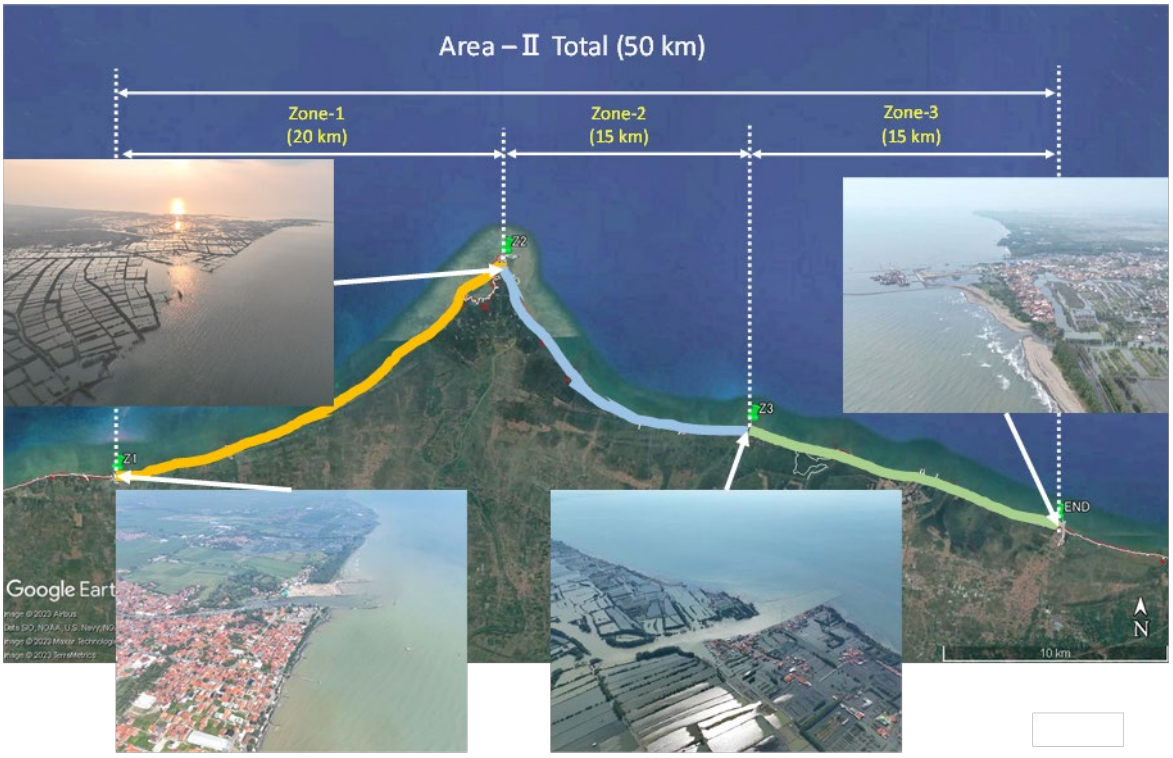


Source: Edited by JICA Study Team based on Google Earth

Figure 7.2.1 Zoning in Indramayu Coast

(2) Area-II: Pemalang-Pekalongan

Pemalang-Pekalongan has a northward protruding convex topography that appears to have been formed by sediment discharge from the center of the region, which causes the shoreline shape to vary greatly from coast to coast. Based on this feature, Pekalongan is divided into three zones as shown in Figure 7.2.2. Zone-2 is located on the east side of the landform, and has a curved coastline, although the curvature is slightly stronger than that of Zone-1. The boundary between Zone-1 and Zone-2 is located at the tip of the landform, while the boundary between Zone-2 and Zone-3 is located at the mouth of the river.

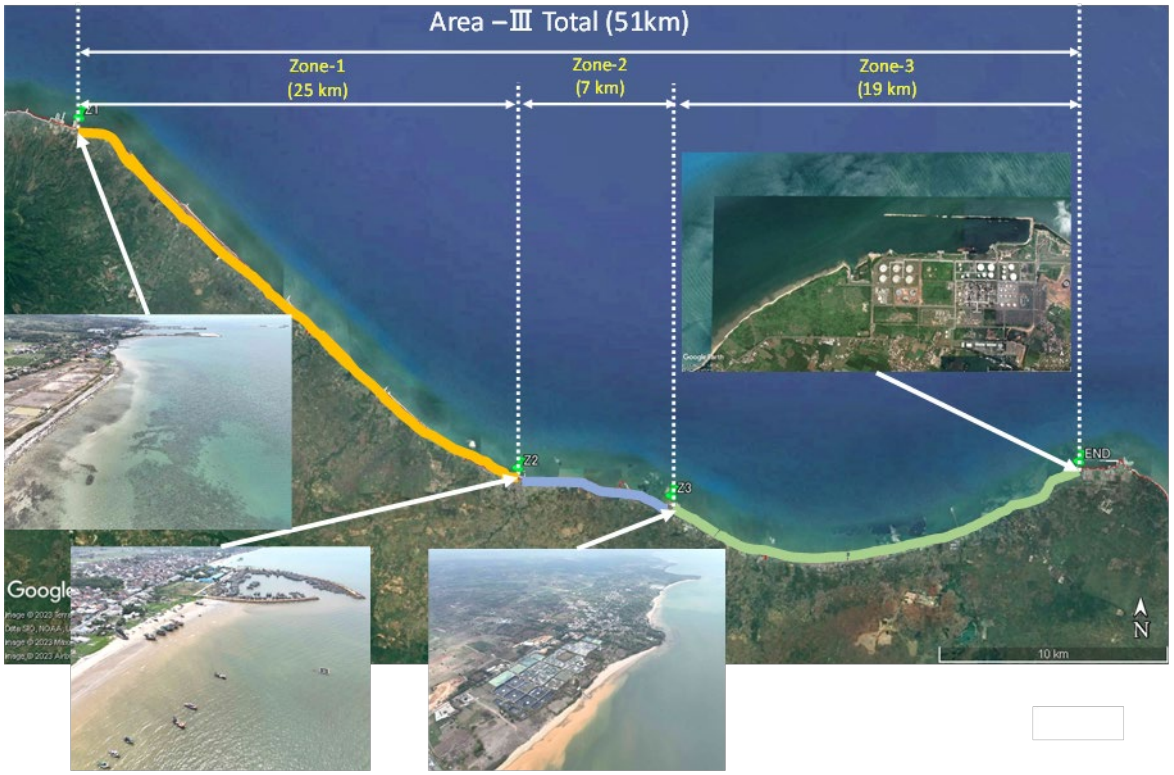


Source: Edited by JICA Study Team based on Google Earth

Figure 7.2.2 Zoning in Pemalang-Pekalongan Coast

(3) Area-III: Rembang-Tuban

Rembang-Tuban has an overhanging topography at its east-west end and a cape topography at its center. Based on these characteristics, we classified them into three zones, as shown in Figure 7.2.3. Zone-1 is a straight coastline oriented almost northeast. Zone-2, which is adjacent to the east of Zone-1, differs from Zone-1 in that the coastline is oriented in a northerly direction, and there are several cape landforms. Zone-3, which is adjacent to the east of Zone-1, has a gently curving coastline that faces east, with port facilities located at the boundary between Zone-1 and Zone-2, and capes at the boundary between Zone-2 and Zone-3.



Source: Edited by JICA Study Team based on Google Earth

Figure 7.2.3 Zoning in Rembang-Tuban Coast

7.3 Classification of the Sections (Step-3)

7.3.1 Objectives and Policies for Classification of the Sections

The final output of the draft of the Basic Coastal Management Plan is to show the coastal management measures at each zone including the layout plan. To achieve this, it is necessary to select the most appropriate measure from several candidate measures, evaluating the current and future conditions of each coastal area as well as the possible impact on the surrounding coast by implementation of the measures. Since this is the first attempt in Indonesia, further discussions will be needed to determine the organization who will take the lead in preparing the draft of the Basic Coastal Management Plan, considering future duplication in Indonesia. In this Project, it is required to prepare the Coastal Facility Plans for PUPR to implement at the coastal section, which are selected from the coastal zones in the three priority areas. Thus, it is important to identify and allocate the main management agencies of the coastal management plan for these sections.

In this chapter, as previously stated in Chapter 4, coastal sections are selected from the coastal zones considering situation of hinterland and coastal utilization of each area. Then, the main management body at each section is proposed considering the Basic Coastal Management Plan prepared for the target section. Boundaries between each section shall be set where sediment transport is discontinued; therefore, they are determined by river mouth and artificial structures such as groin and jetties.

7.3.2 Methods of the Classification for the Sections

(1) Condition of Hinterland and Beach Use

1) Hinterland Use

Most part of the coastline of the north coast of Java Island has already been developed in the coastal hinterland, with a mix of urban and residential areas, and critical infrastructure uses such as national roads, power plants, oil refineries, and other energy-related facilities. There are also primary industrial uses such as agricultural land, aquaculture facilities, and salt pans. Energy-related facilities are located especially in Indramayu in Area-I, a heritage site (Tomb of Syeikh Maulana Samsudin) is in Pemalang in Area-II, and a large tourist complex is behind the city center of Pekalongan. In addition, national roads are located behind the coast in Indramayu in Area-I and Rembang in Area-III.

Source: JICA Study Team

Figure 7.3.1 Examples of Hinterland Use Conditions

2) Beach Use

Most of the coastal areas in the three target areas are used for recreation by tourists from within Java, for local tourism such as swimming and other marine sports, and for fishing activities such as mooring and unloading of fishing boats. However, the primary industrial areas such as farmlands and salt farms, which account for the majority of the area, hardly use the coastal area at all. Local tourism areas are scattered throughout the region, especially in Area-I and Area-II, each extending about 1 km. In Area-III, Rembang and Tuban, small fishing boats are moored on the beaches and shallows, and the coast is actively used for landing, unloading, repairing fishing boats, and shipbuilding. In some areas where the backshore areas are agricultural lands or fish farms, mangroves are planted or naturally growing in the coastal areas and are used for various purposes such as land erosion control, protection of fishery resources, tourism areas, and protected areas.

Source: JICA Study Team

Figure 7.3.2 Examples of Beach Use

(2) Boundaries for the Sections

1) Artificial Facilities as Boundaries

In the three target areas, artificial facilities that prevent the continuity of sediment transport can be classified into (1) port facilities, (2) breakwaters, and (3) coastal protection facilities. Port facilities include large-scale breakwaters installed at power plants, oil refineries, etc., as well as breakwaters and access roads at fishing ports. Jetties are constructed to prevent the sedimentation of navigation routes for fishing vessels and to increase the flow capacity of rivers to prevent flooding. These artificial facilities, which are considered to have already interrupted the continuity of sand drift, are set as boundaries of the coastal sections.

Source: JICA Study Team

Figure 7.3.3 Examples of Artificial Facilities as Boundaries for the Sections

2) Natural Boundaries

Natural boundaries in three priority areas can be classified into: (1) river mouths, (2) sand spits, and (3) mangroves. Estuaries, where fishing ports are located in the river basin, often have the aforementioned jetties to secure navigation route against sedimentation. On the other hand, there are also natural river mouths without dikes, and the shape of the estuary can be seen to affect the continuity of sediment transport. In addition, spits exist at the eastern end of Indramayu and are thought to influence the continuity of longshore sediment transport. There are also mangrove plantations in the target area that protrude offshore from the current shoreline, which may affect the continuity of sediment transport.

Source: JICA Study Team

Figure 7.3.4 Examples of Natural Boundaries for the Sections

(3) Main Management Agencies of the Coastal Management Plans

Table 7.3.1 shows the assumed related organizations that will take the lead in preparing the coastal management plan in the future for duplication of the plans in other coastal areas in Indonesia.

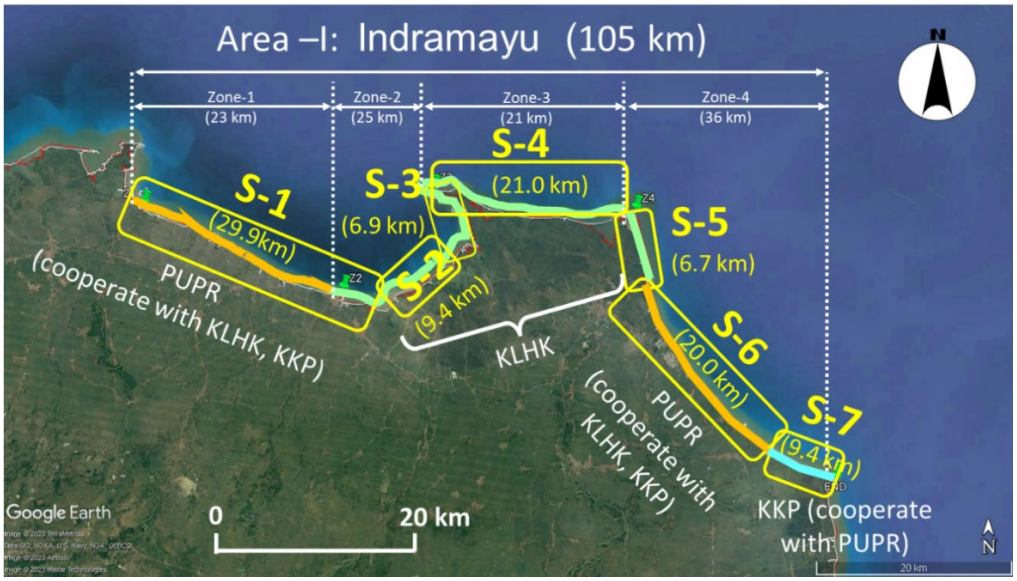
Table 7.3.1 Main Management Agencies of the Basic Coastal Management Plans

Type of land utilization at hinterland	Agencies who have to mainly consider management plan
Tourism Area (except mangrove eco-tourism)	PUPR, (DINAS PU)
Residential Area	
Agricultural Area (Farm)	
Fishery Port Area	KKP
Agricultural Area (Salt Farm, Fishpond)	
Natural Forest (Mangrove) Protection Area (include mangrove eco-tourism/ Mangrove restoration area in Mangrove Rehabilitation Program)	KLHK
Industrial and/or Commercial Port Area	Private, Pelindo, etc.

Source: JICA Study Team

7.3.3 Classifications of the Sections in Each Area

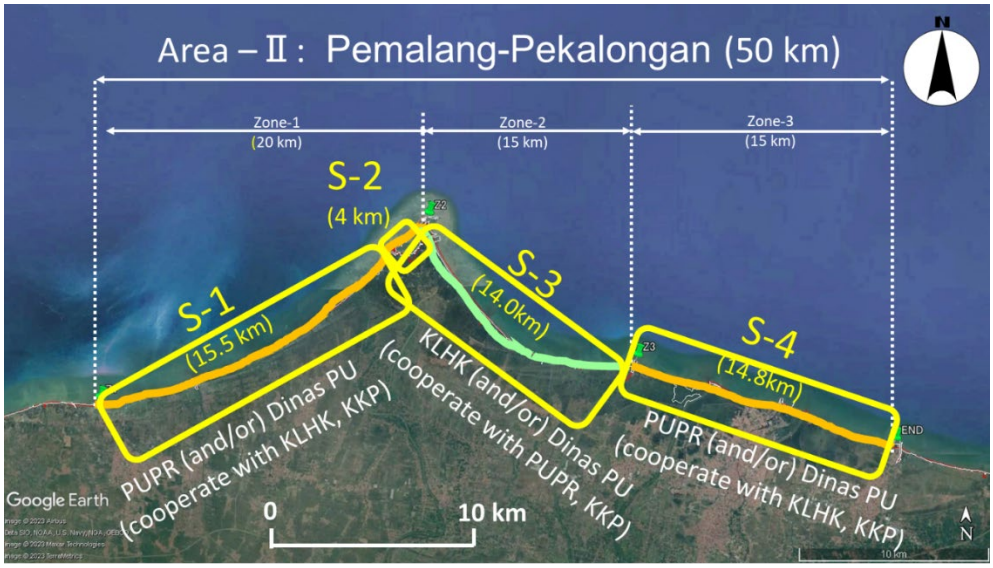
Figure 7.3.5 shows the classifications of the sections in Area-I (Indramayu). Based on the use of the hinterland and beach, the area is divided into seven sections as shown in Figure 7.3.5, and the lead agencies involved in each section are indicated.



Source: Edited by JICA Study Team based on Google Earth

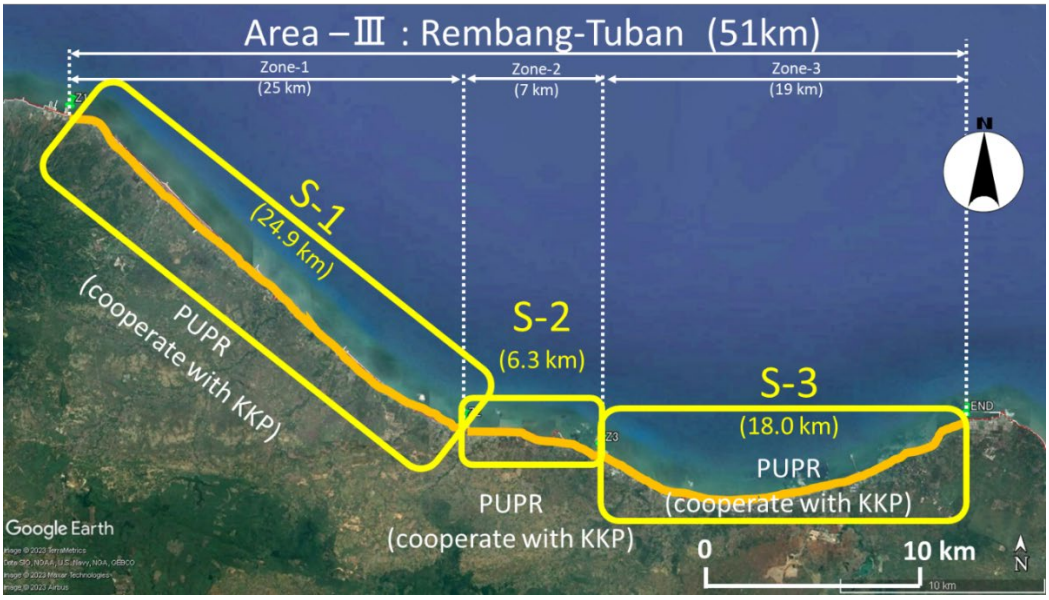
Figure 7.3.5 Classification of the Sections in Area-I

Similarly, the classifications of the sections for Area-II (Pemalang-Pekalongan) and Area-III (Rembang-Tuban) and their respective lead agencies are shown in Figure 7.3.6 and Figure 7.3.7, respectively Area-II has four sections and Area-III has three sections.



Source: Edited by JICA Study Team based on Google Earth

Figure 7.3.6 Classification of the Sections in Area-II



Source: Edited by JICA Study Team based on Google Earth

Figure 7.3.7 Classification of the Sections in Area-III

CHAPTER 8 Setting of Ideal Coastal Situation (Step-4)

8.1 Outline

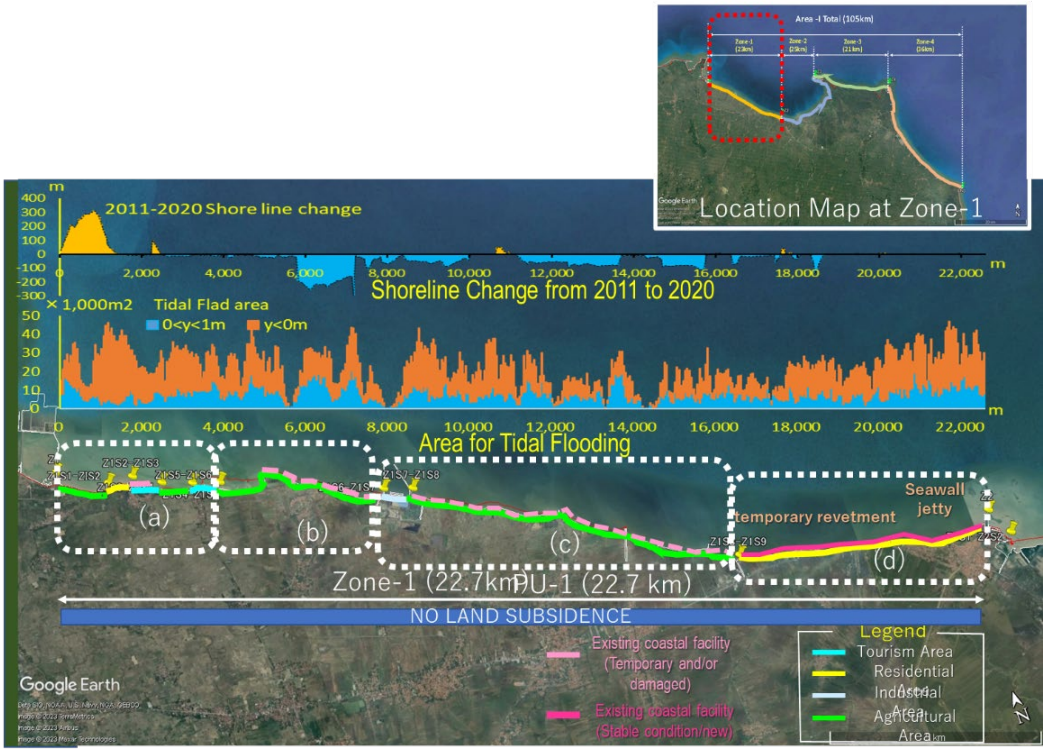
After evaluating the current status of the coast in each section and clarifying the problems and issues, how the management and conservation of each coast should be in the future (this is called "Ideal Coastal Situation") is set and then the draft of the Basic Coastal Management Plan is prepared in each coastal area. In this chapter, the "Ideal Coastal Situation" for each section of each area is discussed.

8.2 Assessment of the Current Status, Problems, and Issues and "Ideal Coastal Situation "in Each Section

8.2.1 Area-I: Indramayu

To assess the existing condition of the coast in the sections, three types of information are presented in each section: 1) coastal hazard risk, 2) utilization in hinterland and coastal area, and 3) presence of existing facilities and their functions.

Figure 8.2.1 shows the current situation in Section 1 of Area-I. The figure also shows the current status of coastal disaster risk in terms of (1) shoreline change over the 10-year period from 2011 to 2020, (2) inundation risk in the hinterland and (3) land subsidence. 3) The presence or absence of existing facilities and their functions are considered in determining whether any coastal facilities already exist and whether they were recently or previously constructed.



Source: Google Earth Image Edited by JICA Study Team

Figure 8.2.1 Current Condition of the Coast in Section-1 of Area-I

These issues based on the evaluation of the current status of each Section from these three perspectives, and the "Ideal Coastal Situation" for each section are summarized in Table 8.2.1.

Table 8.2.1 Assessment of Current Coastal Status and Issues and "Ideal Coastal Situation" in Area-I

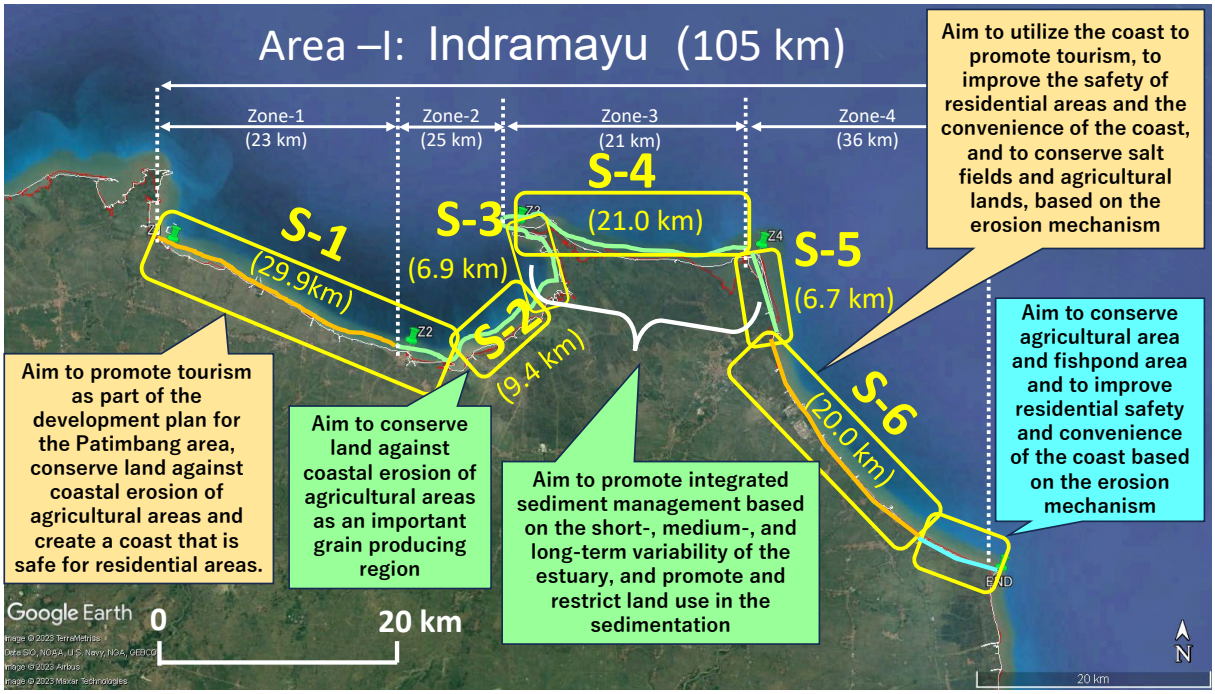
Section	Coastal Disaster Risk	Utilization	Existing Facilities	Evaluation/Issues	Ideal Coastal Situation
S-1	Although there is little evidence of widespread land subsidence due to groundwater pumping, etc., the shoreline has retreated by several meters to 20 meters in the last 10 years. Ground elevation in the back area is as low as +1.5 m and inundation risk is likely to increase due to coastal erosion.	The hinterland is dominated by agricultural areas but there are scattered residential and industrial facility areas as well as coastal areas that are used as local tourism areas.	Coastal facilities which are previously build such as rubble revetments and groins as well as new revetments, have been constructed in almost 60 % of the coastal area. About 70 % of that are offshore breakwaters that have been constructed in recent years.	The west side of this section is planned to be comprehensively developed as the Patimbang Port development area and there is also a tourism area. Therefore, it is necessary to create a coast that takes these factors into account. In addition, although this section has a national grain-growing area, the risk of land loss (especially in agricultural areas) and disasters to residential area is expected to increase due to coastal erosion caused by mud and fine sand lost from waves so it is necessary to consider adaptation measures against those factors.	Aim to promote tourism as part of the development plan for the Patimbang area, conserve land against coastal erosion of agricultural areas and create a coast that is safe for residential areas
S-2	Although there is little evidence of widespread land subsidence due to groundwater pumping, etc., severe coastal erosion is observed, especially in agricultural areas with some areas having lost more than 200 m in the last 10 years. The ground elevation in the hinterland is as low as +1.5 and the inundation area has already extended inland.	The west side of this section is residential area, while agricultural area and fishpond extend from the center to the east. Coastal use as tourism is rarely seen in the section.	Hard structures haves been built in about 20 % of the beaches but most of the beaches are natural beaches or mangrove forests (natural and planted).	Some areas are protected by buffer zones created by mangrove plantations but in other coastal areas, coastal erosion and inundation have occurred inland. It is assumed that the risk of land loss and disasters to residential area will increase in such areas.	Aim to conserve land against coastal erosion of agricultural areas as an important grain producing region.
S-3	This Section is located on the west side of the Cimanuk River estuary. Long-term changes in estuary position and sediment inflow conditions cause topographic change. Recently, sediments from the river mouth have been deposited on the west side of the estuary, resulting in a depositional trend as a whole.	The land newly formed by sedimentation is used as agricultural area and there is almost no residential area or other use.	Most of the coastal area is covered with mangrove forests either natural or planted. There are no hard facilities in this section.	This Section is an estuary of one of the representative rivers in the northern Java coast, which is basically a sedimentation area. In addition, there are mangrove forests in the coastal area. This means that the risk of coastal disasters is low compared to other sections. On the other hand, the sediment inflow from the estuary is sediment that originally contributed to the formation of the coast in other areas, so it is necessary to consider land use in the sedimentation area based on comprehensive sediment management.	Aim to promote integrated sediment management based on the short-, medium-, and long-term variability of the estuary, and promote and restrict land use in the sedimentation.

S-4	Because it is located in the Section between the present and former estuaries of the Cimanuk River, it is in the same area of variability around the estuary as S-3. Although there is a sedimentation trend as a whole, sediment from the present estuary is discharged to the west, so sedimentation is not as significant as in S-3.	As S-3, the hinterland is used as agricultural land, and there is almost no residential area or other use.	Most of the coastal area has natural beaches and some mangrove forests, and there are no hard facilities in this section.	same as above	Same as above
S-5	As the Section has a shoreline of about 6.7 km in a north-south direction from the former mouth of the Cimanuk River, the localized southward longshore drift has resulted in an erosional trend near the former mouth and a depositional trend near the southern jetty.	As S-3 and S-4, the hinterland is used as agricultural area and there is almost no residential area or other use.	Same as above	Same as above	Same as above
S-6	Northward longshore drift is dominant. Although the amount of erosion is not significant in the long term, erosion problems have become more apparent in recent years. There is little evidence of widespread land subsidence due to groundwater pumping, etc., but subsidence has occurred after the construction of coastal facilities.	The hinterland is highly utilized as salt farm, agricultural area, residential area and energy facilities. Some coastal areas are also used for local tourism.	The hinterland is highly utilized and coastal facilities are being developed in this section. 80% of the coasts have revetments, groins, etc., but most of these facilities was built more than 10 years ago.	Coastal erosion and the loss of land for salt fields and farmland due to coastal erosion, as well as high waves and flooding in residential areas, occur. Hard measures have been implemented in each location and there are extension plans for these structure in the future. Although the sections where coastal measures have been implemented in recent years are considered to be functioning in terms of short-term protection. But they might not be effective against the offshore discharge of sediment, which is considered to be the main cause of erosion in this area. In the tourism area, the coastal measures are causing problems in terms of coastal use and it is necessary to review the existing coastal measures in consideration of the hinterland and coastal use.	Aim to utilize the coast to promote tourism, to improve the safety of residential areas and the convenience of the coast, and to conserve salt fields and agricultural lands, based on the erosion mechanism.
S-7	The Section is approximately 10 km in length bounded by a fishing port at the western	Fishing villages are spread out around the fishing port at the western end but from	Although coastal measures against erosion have been	Hard countermeasures have been implemented to protect residential areas and prevent the loss of agricultural area but the	Aim to conserve agricultural area and fishpond area and to improve residential safety and convenience of the coast

	end and a spit-formed bend at the eastern end and it has experienced significant shoreline retreat of 100 to 200 m over the past 10 years. This is thought to be due to a combination of factors including the convex topography of the spit at the east end of this section, which was a former estuary and the discontinuity of westward littoral drift.	there to the east, most of the land is used for agricultural area, fishpond and salt farm. There are no tourism areas in the coastal area. The front of the fishing village is already protected by a sea wall, so there is no use of the coast for fishing or other purposes.	implemented with rubble breakwaters in residential areas in the west and a group of offshore breakwaters in front of agricultural area. But these measures account for only about 20 % of the total shoreline. In addition, shoreline retreat in the surrounding areas is serious.	effectiveness of these measures as a countermeasure against the combined erosion factors in this area is questionable because of the negative impact of these measures on the surrounding beaches. It is necessary to consider development in coastal area continuously for this 10 km based on the continuity of littoral drift.	based on the erosion mechanism.

Source: JICA Study Team

The "Ideal Coastal Situation" for each Section in Area-I is shown in Figure 8.2.2.

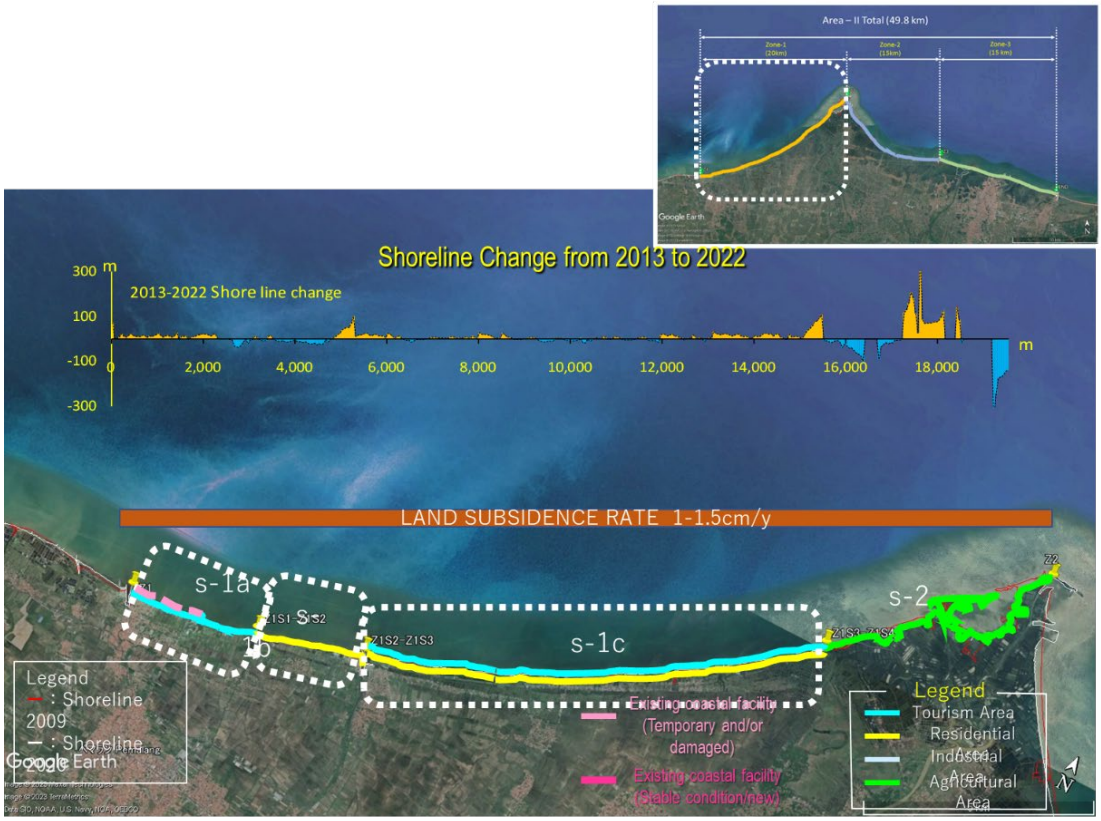


Source: Edited by JICA Study Team based on Google Earth

Figure 8.2.2 "Ideal Coastal Situation" for Each Section in Area-I.

8.2.2 Area-II: Pemalang-Pekalongan

To establish the "Ideal Coastal Situation" for each Section in Area- II, the information of the coastal erosion, flood risk, land subsidence, and the utilization and presence of existing facilities for Section 1, as an example, are shown on the map in Figure 8.2.3. The issues identified based on the current situation and the "Ideal Coastal Situation" are shown in Table 8.2.2.



Source: Edited by JICA Study Team based on Google Earth

Figure 8.2.3 Current Condition of the Coast in Section-1 of Area-II

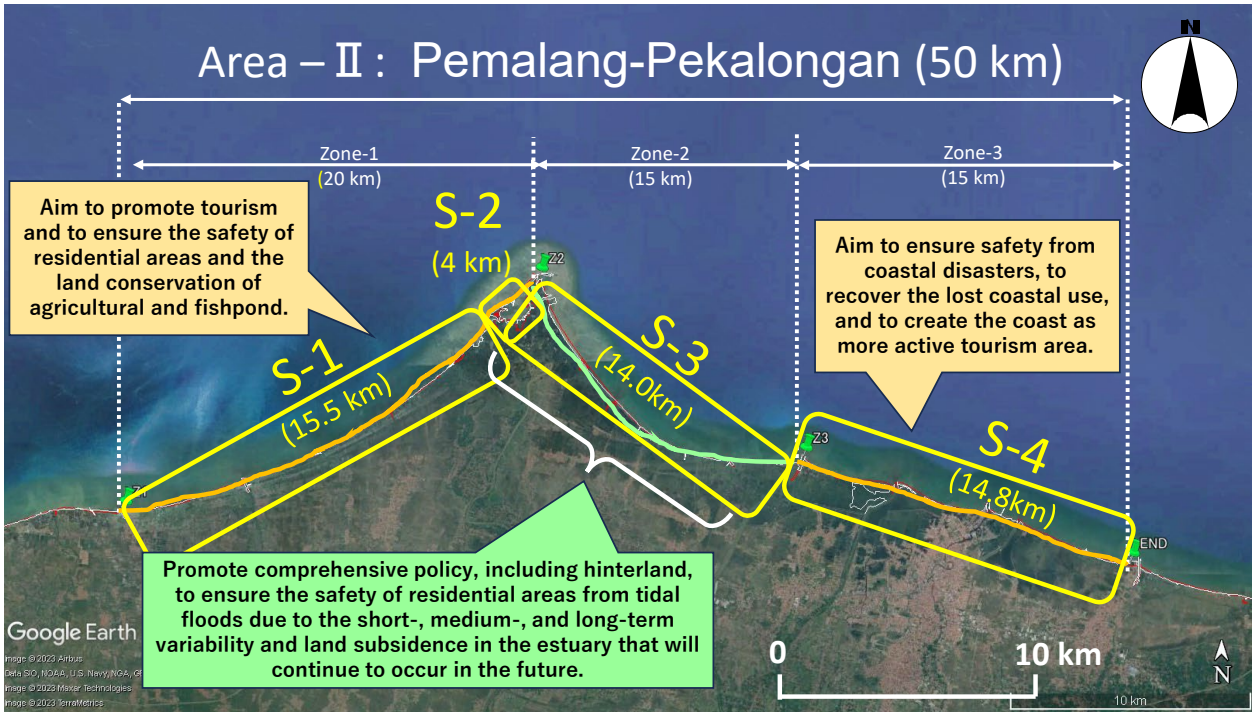
Table 8.2.2 Assessment of Current Coastal Status and Issues and "Ideal Coastal Situation" in Area-II

Section	Coastal Disaster Risk	Utilization	Existing Facilities	Evaluation/Issues	Ideal Coastal Situation
S-1	At about 90 % of shoreline in the Section, structure measures haves already been done, so the apparent amount of shoreline retreat is small, but the amount of shoreline retreat in the beach area where no measures have been taken is about 2 m/year to 5 m/year over the past 10 years, indicating an erosion trend. The presence of land subsidence compared to Area-I is reported, as well as a slight increase in wave and tide levels compared to Area-I. The average ground elevation is about +1.5 m similar to Area-I. Therefore, the risk of flooding due to future coastal erosion and land subsidence may increase.	Settlements are scattered in the hinterland, in agricultural area and in fishing areas. The coastal area also includes the coast, which is used by many tourists as a local tourism area.	In particular, in the western part of this section, coastal measures have been implemented in recent years using a group of groins. About 90 % of the coastline of this section has been already constructed. On the other hand, there are still non-constructed area on the east side.	The main tourism area of Area-II, including prominent temples, is located behind this Section. The coast is also a popular tourist area. On the other hand, there are some areas where there is not enough beach width for coastal use, and the use of some areas have been disturbed by the installation of hard structures. This Section has a higher risk of flooding than Area-I and flooding damage has been also reported. Therefore, it is necessary to take into consideration the use of the coast for tourism areas and residential areas, as well as protection measures for the hinterland.	Aim to promote tourism and to ensure the safety of residential areas and the land conservation of agricultural and fishpond.
S-2	This Section is located on the west side of the Komar River estuary. Long-term changes in estuary position and sediment inflow conditions cause topography change. There has been an overall sedimentation trend in recent years. Land subsidence has been reported but the details are unknown. At least partial inundation of the land area occurs during high tides and waves.	The hinterland is used for fishpond and agricultural area. The residential areas are located more than 1 km landward from the coastline and the coastal area is not used.	There are no existing hard facilities. The coastline is covered with sand spits formed by wave action or natural mangrove forests.	This Section is basically a sedimentation area and there are mangrove forests in the coastal area. The hinterland is used for fishpond and some agricultural area. From the perspective of people and assets, the coastal disaster risk of this section is low. On the other hand, the area around the estuary is undergoing significant topographic change and some land areas are inundated during storm surges and high waves. Although the residential area is located more than 1 km landward from the coast, the topographical changes around the estuary. In addition, the possibility of increase in land subsidence is expected to continue. Therefore, land use management including the function as a buffer zone for the land area and land subsidence countermeasures are necessary.	Promote comprehensive policy, including hinterland, to ensure the safety of residential areas from tidal floods due to the short-, medium-, and long-term variability and land subsidence in the estuary that will continue to occur in the future.

S-3	This is a Section of about 14 km east of the Komal River estuary. Shoreline retreat of up to 200 m has occurred in the past 10 years, which is significantly different from the trend in S-2. This Section has been reported to have experienced widespread land subsidence, the cause of which is unknown. Tidal flooding has occurred inland during high tides, causing the most severe flooding and inundation damage in Area-II.	The hinterland is used for fishpond and agricultural area. The residential areas are located more than 1 km landward from the coastline, as in S-2, and the coastal area is not used.	Old seawalls installed in the past are present in some coastal areas but are no longer functional due to land subsidence. Most of the other coastal areas remain in their natural state with little mangrove vegetation.	Shoreline has been retreated by two main factors of land subsidence and decrease of sediment inflow from the estuary. As S-2, land use management including land buffer zone function and land subsidence countermeasures are needed considering the geomorphological changes around the estuary and the possibility of increase in land subsidence, which are expected to occur in the future. Therefore, land use management including the function as a buffer zone for the land area and land subsidence countermeasures are necessary.	Same as above
S-4	It is an approximately 15 km Section with Pekalongan which is one of the major cities in Central Java. The shoreline has retreated by more than 100 m over the past 10 years due to two factors: the blocking of westward littoral drift due to the artificialization of various coastal facilities and severe land subsidence throughout the coastal area. High wave inundation, or tidal flood, occurs along the coast every year.	The hinterland is the urban area of Pekalongan and the entire coastal area to the west of this Section has already been inundated, making it difficult to use the seaward side of the seawall, which was newly constructed at about 1 km inland. On the east side, there are densely populated residential areas directly behind the coast. The beach in front of this area used to be used for local tourism previously, but due to the raising of the existing seawall, it is now almost impossible to use the beach.	On the west side, a new seawall was built about 1 km inland to prevent seawater intrusion during storm surges, but no measures have been taken on the ocean side. On the east side, construction work is continuing to raise the existing seawall to protect the residential areas directly behind the beach from high wave inundation.	This section is the only coastal area with an urban area in the hinterland among the three priority areas selected for this project. The coastal erosion and tidal inundation damage in this section is caused by a combination of blockage of westward littoral drift and widespread land subsidence in the coastal area. Therefore, coastal measures to mitigate these two factors must be considered comprehensively, including land subsidence issues and land use planning in the hinterland as well as the coastal area. In addition, the hinterland is an urban area and there are also tourist facilities. In the past, the coastal area was used as a tourist site for swimming and other activities, but it has become difficult due to the raised embankment. Therefore, it is necessary to consider the coastal measures from the aspects of safety as an urban area and the use of the coast.	Aim to ensure safety from coastal disasters, to recover the lost coastal use, and to create the coast as more active tourism area.

Source: JICA Study Team

The “Ideal Coastal Situation” for each section in Area-II is shown in Figure 8.2.4.

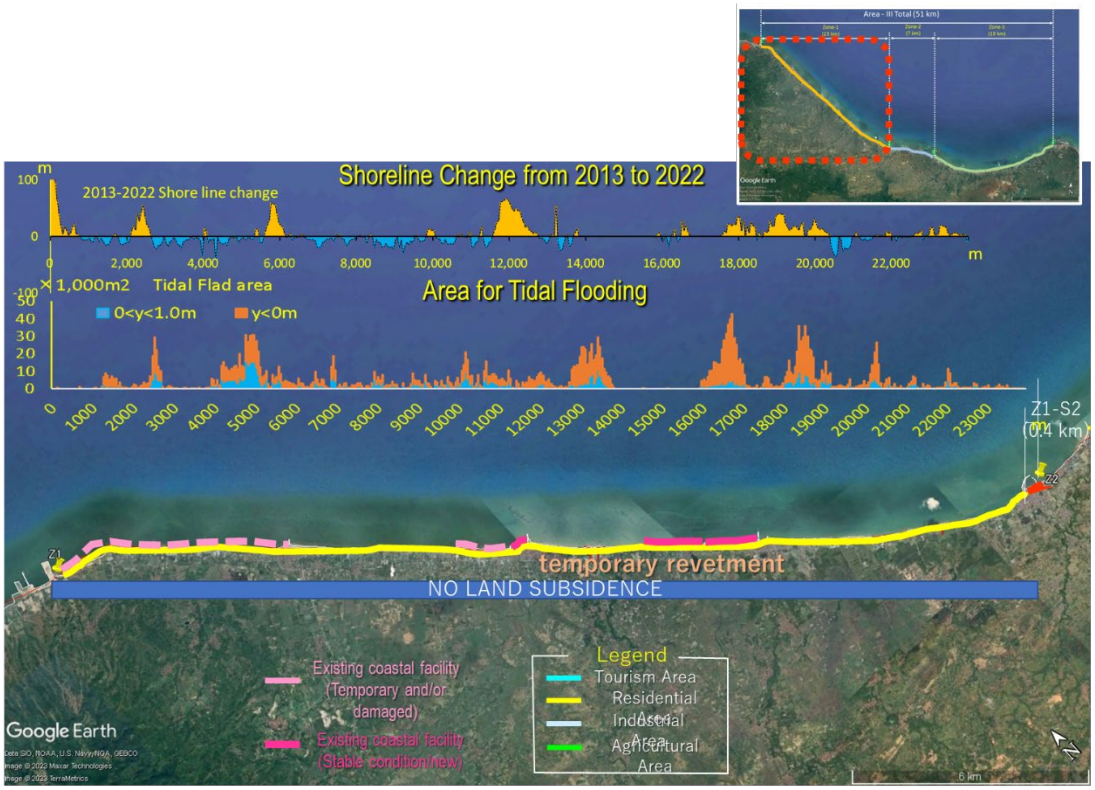


Source: Edited by JICA Study Team based on Google Earth

Figure 8.2.4 "Ideal Coastal Situation" for Each Section in Area-II

8.2.3 Area-III: Rembang-Tuban

To establish the "Ideal Coastal Situation" for each section in Area-III, the information of the coastal erosion, flood risk, land subsidence, and the utilization and presence of existing facilities for Section-1, as an example, are shown on the map in Figure 8.2.5. The issues identified based on the current situation and the "Ideal Coastal Situation" are shown in Table 8.2.3.



Source: Edited by JICA Study Team based on Google Earth

Figure 8.2.5 Current Condition of the Coast in Section-1 of Area-III

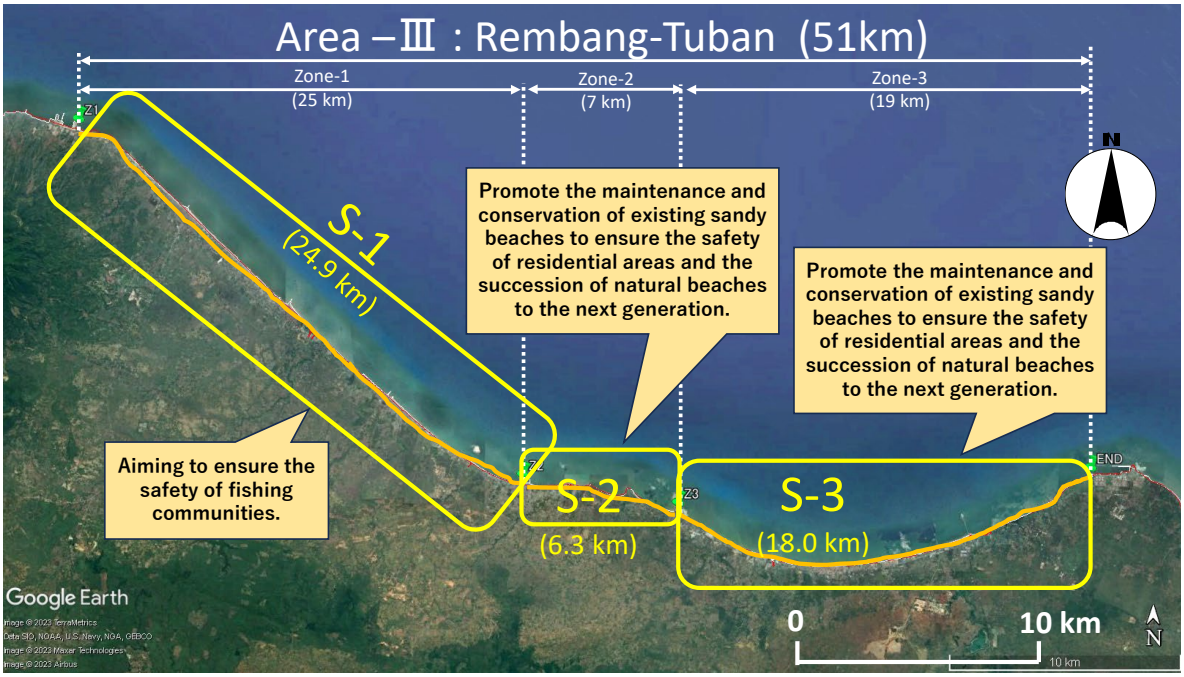
Table 8.2.3 Assessment of Current Coastal Status and Issues and "Ideal Coastal Situation" in Area-III

Section	Coastal Disaster Risk	Utilization	Existing Facilities	Evaluation/Issues	Ideal Coastal Situation
S-1	This Section (Rembang), approximately 25 km west of Area-III, is dominated by westward littoral drift. In the past 10 years, erosion of about 20 m has occurred, causing tidal wave inundation damage in some areas. For this reason, hard countermeasures such as groins and revetments have been implemented in the past, which have contributed to the erosion on the down drift side. Currently, hard countermeasures by rubble revetment are underway and while the effect against high wave inundation can be obtained, 75 % of the existing sandy beach is already disappearing. While the wave height and tide level are higher in Area-III than in Area-I and	Almost all of the hinterland are densely populated fishing villages. Some of the coastal area used as a recreational area for the local community previously, but with the progress of coastal improvement by harbor control measures, the area that cannot be used has been increasing.	As a protection measure for the residential area in the hinterland, coastal measure using groin has been implemented on approximately 30 % of the beaches in this Section. In recent years, rubble stone revetment has been continuously implemented. And the implemented area reaches approximately 40 %. The remaining natural sandy beaches are expected to be completely lost due	This Section has erosion tendency in recent years and almost 75 % of the coastline has already been man-made as a result of the hard measures implemented to protect fishing villages in the hinterland from high wave inundation damage. Due to continuous westward littoral drift beach, more than 70 % of the beaches have already been man-made, making it difficult to basically maintain the section as a whole based on the continuity of the littoral drift. As long as the function of these structures is maintained by hard countermeasures, the protection function is expected to be maintained, but the natural sandy beaches that originally existed are almost disappearing and it makes coastal use difficult.	Aim to ensure the safety of fishing communities.

Section	Coastal Disaster Risk	Utilization	Existing Facilities	Evaluation/Issues	Ideal Coastal Situation
	Area-II, the ground level behind the beach is higher (+4.0 m) and land subsidence has not occurred, resulting in almost no inland flood damage due to tidal flooding.		to the hard measures to be planned in the future.		
S-2	The Section has approximately 6.3 km of shoreline and there is a fishing port and two capes, which are surrounded by pocket beaches and treated as independent sections. The presence of fishing ports and capes, which are thought to influence the continuity of these drifting sands, makes the coast relatively stable.	Fishing villages are located behind the fishing port at the western end but the rest of the land is used for agricultural area and fishpond. There are forested areas behind the two capes. There is no particular use of the coastal area.	There are no specific coastal facilities in this section.	Most of area in this Section is located as a pocket beach surrounded by a fishing port and two capes and a relatively stable beach is maintained, especially in the absence of coastal facilities. Therefore, the priority is to maintain this beach condition over the long term and the conservation of the current beach condition. In addition, land use regulations in the coastal area should be considered.	Promote the maintenance and conservation of existing sandy beaches to ensure the safety of residential areas and the succession of natural beaches to the next generation.
S-3	The Section has approximately 18 km of coastline with the direction of the shoreline of north-south direction. This change in shoreline direction does not result in a constant direction of westerly littoral drift as in S-1, but rather a seasonal change. The shoreline changed over the past 10 years shows that erosion and sedimentation areas are present, but on average, shoreline changes are not so significant.	In the hinterland of this Section, fishing villages are located to the west for approximately 11 km. From there to the east of this area, there are agricultural area and fishpond. An energy port is located at the eastern end of this section.	Two port piers are present in this Section, but they are not constructed to intercept littoral drift. There are almost no coastal facilities in this section.	Based on the direction of the shoreline, the current beach and past shoreline changes, this Section is relatively sediment balanced. There are no coastal facilities that would affect the movement of sediment. Therefore, the priority is to maintain this beach condition over the long term and the conservation of the current beach condition. In addition, land use regulations in the coastal area should be considered.	Promote the maintenance and conservation of existing sandy beaches to ensure the safety of residential areas and the succession of natural beaches to the next generation.

Source: JICA Study Team

The "Ideal Coastal Situation" for each section in Area-III is shown in Figure 8.2.6.



Source: Edited by JICA Study Team based on Google Earth

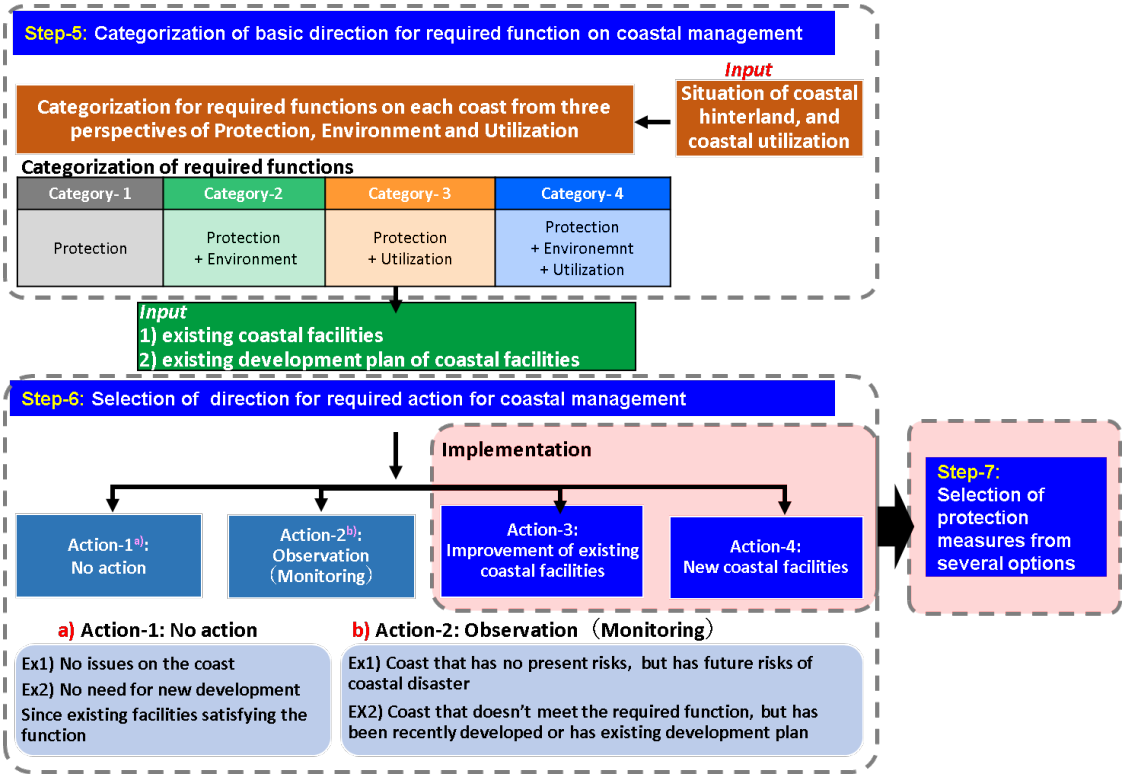
Figure 8.2.6 "Ideal Coastal Situation" for Each Section in Area-III

CHAPTER 9 Selection of Coastal Measures (Step-5 – Step-7)

9.1 Overview

In Chapter 8, coastal issues have been extracted from the assessment of coastal disaster risk and the characteristics of hinterland utilization. Additionally, the ideal situation of the coast has been determined in Step-4 in the procedure for preparation of the draft of Basic Coastal Management Plan. In this chapter, to achieve the ideal situation of the coast, the concrete coastal measures to be indicated in the Basic Coastal Management Plan as M/P are examined in Step-5 to Step-7. As described in Chapter 4, the final output of the draft of the Basic Coastal Management Plan is the macro-level layout image in which the specification of each coastal facility is not indicated.

In order to consider coastal measures in the macro-level, that is broad and comprehensive perspectives, three steps are set as follows: Step-5) Categorization of basic direction for required function on coastal management, Step-6) Selection of direction for required action for coastal management, and Step-7) Selection of concrete coastal measures. In Step-5, considering the characteristics of hinterland and coastal utilization, required coastal functions in each coast are clarified by combination of three functions: Protection, Utilization and Environment. After Step-5, the target levels for each function are set. In Step-6, the function of existing coastal facilities is assessed considering the set target level. If existing coastal facilities are insufficient for achieving the target levels, new development of coastal facilities is needed including both modification of existing coastal facilities and construction of new coastal facilities. Finally, in Step-7, when new development of coastal facilities is required, concrete coastal measures are examined with the consideration of required coastal functions, etc.



Source: JICA Study Team

Figure 9.1.1 Flow of Selecting Coastal Measures

9.2 Identification of Required Function (Category Setting) (Step-5)

The required coastal function in each coast is identified from the hinterland and coastal utilization. Each coast is classified into four categories, hereinafter described as "Category", based on a combination of "protection," "utilization," and "environment" functions (Table 9.2.1). Since the Basic Coastal Management Plan is mainly for coastal protection, the protection function should be included in each categorization. Additionally, the patterns of the hinterland and coastal utilization are described in the draft of the Basic Management Plan. The patterns of hinterland utilization are mainly classified into residential areas, agricultural areas (including regions used for primary industries such as salt fields and aquaculture), industrial areas, and environmental protection areas. The patterns of coastal utilization are mainly classified into the use of fishery activities such as ship mooring on sandy beaches and the use of local tourism areas in coastal areas.

Table 9.2.1 Categorization of Required Coastal Functions

Category-1	Category-2	Category-3	Category-4
Protection	Protection +Environment	Protection +Utilization	Protection +Environment +Utilization

Source: JICA Study Team

Table 9.2.2 shows examples of protection, environment, and utilization as required coastal functions. Firstly, the coast where the protection function is required includes coasts with risk of coastal disasters such as coastal erosion and storm surge. As input information, coastal disaster risk assessments for each coast are used. Next, the coast where the environmental function is required includes coasts where the hinterland and coastal areas are designated as environmental protection areas. As input information, land and marine spatial plans are used. Finally, the coast where the utilization function is required includes coasts either where the coastal areas are currently used for coastal activities or where coastal development contributes to creating demand for tourism and other uses. The latter means that the demand for future coastal utilization is anticipated. As input information, the utilization patterns of hinterland and coastal areas, or the land and marine spatial plans are used.

Table 9.2.2 Examples of Protection, Environment, and Utilization as Required Coastal Functions

	Coasts where each function required	Examples
Protection	Coast with high risks of coastal disaster	(ex.) high risk of coastal erosion and/or coastal flooding
Environment	Coast with environmental protection area	-
	Coast with good ecosystem and landscape	(ex.) Coast that requires conservation of sandy beach, mangrove forest, coral reefs
Utilization	Coast with current demand of coastal utilization	(ex.) Coast that is used as local tourism area
	Coast with potential demand of coastal utilization	(ex.) Coast where future coastal demand is anticipated due to the use of the hinterland such as coastal areas of urban area

Source: JICA Study Team

Figure 9.2.1 and Figure 9.2.2 show examples of the categorization of required costal functions. The categorization for all the project areas is shown in the draft of the Basic Coastal Management Plan.

Source: Edited by JICA Study Team based on Google Earth

Figure 9.2.1 Example of Categorization of Required Coastal Function (Category-1 and Category-3)

Source: Edited by JICA Study Team based on Google Earth

Figure 9.2.2 Example of Categorization of Required Coastal Function (Category-2)

9.3 Setting Target Level

In the previous section, the required coastal functions are identified with a combination of protection, environment, and utilization. In this section, according to the categorization, the target levels for each function are set as shown in Table 9.3.1.

For the target level of coastal protection, considering the main coastal disasters in the selected three Areas, which are coastal erosion and inundation induced by high waves and storm surges, the target level of protection function is set according to hinterland utilization. On coasts with residential areas or critical infrastructures in the hinterland, the target level of protection function is to prevent damage to human lives, human activities, and economic activities caused by high waves and/or storm surge inundation and coastal erosion. Moreover, for coastal erosion protection, the minimum target level is to prevent further shoreline recession, that is maintaining the present shoreline position. When coastal erosion progresses and hinterland protection cannot be achieved through maintaining the present shoreline position, the target level to restore the shoreline position is determined as necessary. On coasts with primary industry in the hinterland such as agricultural and aquacultural areas, the target level is to allow wave intrusion under extreme oceanographic conditions but prevent further shoreline recession (maintaining present shoreline). It should be noted that the target level described here is different from the protection level for the design of Coastal Facility Plan such as the probability of occurrence of design external force, allowable wave-overtopping rate, etc. The protection level should be determined in Coastal Facility Plan at each coast.

For the target level of environment function, on coasts with well-preserved natural coastal environment, the target level is to maintain and protect the current coastal environment. Conversely, the target level is to restore and rehabilitate the original coastal environments when natural coastal environments formed by mangrove forests or sandy beaches have deteriorated or disappeared due to coastal development or coastal erosion, etc., resulting in declines in protection, environmental quality, and usage.

For the target level of utilization function, the minimum goal is to maintain the current coastal utilization without degradation, according to the type of current coastal utilization (such as fishing activities or local tourism areas). Additionally, the target level is to enhance and promote further coastal utilization through coastal facility development, thereby contributing to improved economic benefits.

Table 9.3.1 Target Level for Each Functional

Categorization	Functions	The Target Level for Each Function
Category-1	Protection	Coasts with residential areas or critical infrastructures in the hinterland: the target level of protection function is to prevent damage to human lives, human activities, and economic activities caused by high waves and/or storm surge inundation and coastal erosion. Against coastal erosion, the minimum target level is to prevent further shoreline recession (maintaining the present shoreline position). When coastal erosion progresses and hinterland protection cannot be achieved through maintaining the present shoreline position, the target level to restore the shoreline position is determined as necessary.
		Coasts with primary industry in the hinterland such as agricultural and aquacultural areas: To allow wave intrusion under extreme oceanographic conditions but prevent further shoreline recession (maintaining the present shoreline).
Category-2	Protection	To allow wave intrusion under extreme oceanographic conditions but prevent further shoreline recession (maintaining the present shoreline).
	Environment	On coasts with well-preserved natural coastal environment, the target level is to maintain and protect it. Conversely, when natural coastal environments formed by mangrove forests or sandy beaches have deteriorated or disappeared due to coastal development or coastal erosion etc., resulting in declines in protection, environmental quality, and usage, the target level is to restore and rehabilitate the original coastal environments.
Category-3	Protection	Coasts with residential areas or critical infrastructures in the hinterland: the target level of protection function is to prevent damage to human lives, human activities, and economic activities caused by high waves and/or storm surge inundation and coastal erosion. Against coastal erosion, the minimum target level is to prevent further shoreline recession (maintaining the present shoreline position). When coastal erosion progresses and hinterland protection cannot be achieved through maintaining the present shoreline position, the target level to restore the shoreline position is determined as necessary.
	Utilization	For the target level of utilization function, according to the type of coastal utilization (such as fishing activities or local tourism areas), the minimum goal is to maintain the current coastal utilization without degradation. Additionally, the target level is to enhance and promote further coastal utilization through coastal facility development, thereby contributing to improved economic benefits.
Category-4	Protection	（Same as Category-3）
	Environment	（Same as Category-2）
	Utilization	（Same as Category-3）

Source: JICA Study Team

9.4 Direction for Required Action for Coastal Management (Step-6)

In the previous section, the required coastal functions are identified for each coast based on the hinterland and coastal utilization. Meanwhile, the current coastal areas include those with well-preserved natural beaches that require the most maintenance and preservation, as well as coasts where existing coastal facilities function sufficiently, making new development unnecessary. Thus, the draft of Basic Coastal Management Plan needs to differentiate between the coasts that do not require further new development of coastal facilities and, conversely, those that need future new development of coastal facilities. To make this distinction, the condition of existing facilities and existing development plans are reviewed. The suitable Action is selected from four Actions for each coast as illustrated in Figure 9.4.1

The cases that do not require new development of coastal facilities are classified as Action-1 (No action) and Action-2 (Observation and Monitoring). Action-1 applies when there are no coastal issues or existing facilities adequately meet the required functions. Action-2 applies when current conditions are no problem, but future coastal disaster risks are anticipated. Action-2 includes when coastal facilities function well short-term but may be insufficient long-term. Additionally, if coastal facilities are recently constructed, that is making the implementation of new projects impractical, these cases also are under Action-2.

The cases requiring new development of coastal facilities are classified as Action-3 (Improvement of Existing Coastal Facilities) and Action-4 (New Coastal Facilities). If existing conditions or coastal facilities do not meet the necessary functions designated by the Categories, the case falls under Action-3 or Action-4. Specifically, Action-4 applies when new coastal functions, which are protection, utilization, and/or environment, are required to be added. For example, if a seawall exists (as shown in Figure 9.4.1) and the utilization function needs to be enhanced, it is classified as Action-4. Conversely, if only improvements such as raising the seawall height are needed without adding new functions, it is classified as Action-3.

Source: Edited by JICA Study Team based on Google Earth

Figure 9.4.1 Selection of Direction for Required Actions for Coastal Management

9.5 Selection of Coastal Measures (Step-7)

9.5.1 Selection of Coastal Measures that Provide Required Coastal Functions

In the previous section, required coastal functions are identified based on the characteristics of hinterland and coastal utilization. Additionally, required actions, such as the necessity for the development of new coastal facilities, were determined considering the function of current coastal conditions and existing coastal facilities. This section describes the procedure for planning concrete coastal measures when the Action is designated as Action-3 (Improvement of Existing Coastal Facilities) or Action-4 (New Coastal Facilities).

In selecting coastal measures, it is essential to ensure that the chosen measures can provide the required coastal functions. Generally, coastal measures are classified into (1) gray (hard) measures (e.g., seawalls), (2) soft measures (e.g., beach nourishment), (3) green measures (e.g., mangrove plantation), and (4) combinations of gray, soft, and green measures (Figure 9.5.1). Table 9.5.1 shows representative applicable categories based on the functions provided by each coastal measure.

(1) Gray (hard) measures such as seawalls ensure sufficient protection if properly designed, but they generally perform poorly in terms of environmental and utilization functions. (2) Green measures such as mangrove plantations offer high environmental functions, but they have relatively high uncertainties in protection and challenges in coastal utilization. Considering these aspects, reasonable coastal measures should be selected based on the required coastal functions. It is important to note that the functions of each coastal measure described here are general and dependent on the specific coastal conditions and application conditions of the coastal measures.

Table 9.5.1 Representative Applicable Categories for Coastal Measures

coastal measure		Categories for required functions			
		Cat.1 Protection	Cat.2 Protection Environment	Cat.3 Protection Utilization	Cat.4 Protection Utilization Environment
1	**Hard (Structure) measure** (Revetment, groin)	■			
2	**Green measure** (Mangrove plantation, Coral transplantation)	■	■		
3	**Soft measure** (Beach nourishment)			■	■
4	**Combination** (hard, soft, green, gray measures)		■	■	■

Source: JICA Study Team

(1) Gray Measures（Seawall）

(2) Soft Measures

(3) Green Measures

(4) Combination Measures

Source: JICA Study Team

Figure 9.5.1 Examples of Coastal Measures

9.5.2 Types and Characteristics of Representative Coastal Measures

For selecting concrete coastal measures for the selected three Areas of the Project, several coastal measures are listed as candidate options with their functions, effectiveness, and characteristics. Four types of representative coastal measures are discussed: 1) Revetment, 2) Offshore Breakwater, 3) Mangrove Plantation, and 4) Beach nourishment. The effects of these coastal measures and the considerations for coastal facility selection are described as follows.

1) Revetment (Impermeable type, permeable type, water-friendly seawall (revetment with backfill)

- Characteristics in functionality: Coastal protection measures that are commonly applied in Indonesia have protection functions against inundation induced by high waves and high tides, and coastal erosion. Meanwhile, utilization and environmental function are relatively limited. Additionally, in recent times, the revetments with a designated width buffer zone behind them has been applied in Indonesia. These aim to enhance protective functions, improve public assess to the sea, and increase general usability.
- Consideration on selection of coastal facilities: While revetments protect the hinterland behind them, they cannot reduce or solve coastal erosion directly. Thus, when applying revetments as a coastal measure to combat coastal erosion, evaluating the the impacts on the surrounding coasts and the

scoring effect caused by reflected waves is crucial. After these considerations about the applicability, a structural type of the revetment should be determined. To reduce the effect of scouring, permeable type and gentle sloping revetments are more advantageous compared to impermeable revetments such as by concrete materials.

2) Offshore breakwater (made of rock materials or concrete blocks)

- Characteristics in functionality: Due to the sedimentation effects behind the offshore breakwaters (so-called tombolo topography), they provide protection functions localized for the hinterland behind them against high waves and high tide induced inundation, wave-overtopping, and coastal erosion. When applying offshore breakwaters, sedimentation behind them occurs, but an equivalent amount of erosion occurs at the opening part between them. Thus, offshore breakwaters itself do not increase the total sediment supply on the coast and are not the effective solution for the coastal erosion for the entire littoral drift system.

- Consideration on selection of coastal facilities: As noted above, offshore breakwaters provide localized protection for the hinterland and may exacerbate erosion at the surrounding coast, such as downdrift side, and openings between the structures. Thus, it is essential to consider these impacts when determining their applicability. To mitigate these negative effects, combining offshore breakwaters and beach nourishment is generally recommended.

3) Mangrove Plantation (mangrove plantation alone, mangrove plantation with wave blocking facilities)

- Characteristics in functionality: Mangrove with extensive and dense plantation protects the hinterland from inundation induced by high waves and high tides, and from coastal erosion through reduced wave intrusion and increased sedimentation. However, under extreme oceanographic conditions, the inundation and wave overtopping to the hinterland may occur to some extent. Therefore, the use of mangrove plantation depends on accepting these limitations.

- Consideration on selection of coastal facilities: If there are concerns about the impact of external forces such as waves on the growth of mangroves during growing up, the wave-blocking structure should be installed. The wave-blocking structure is made of stone or natural materials such as bamboo, which should be designed under the expected wave conditions.

4) Beach nourishment (for dynamically stable beach or statically stable beach)

- Characteristics in functionality: Beach nourishment is applied for coastal protection against coastal erosion due to the imbalance or reduction of sediment supply caused by artificial coastal modifications. A sandy beach restored by supplying sediment to such coast artificially can be reduce waves and create a buffer zone, which in turn protects the hinterland. Additionally, restoring and

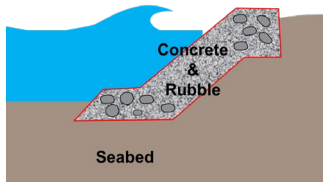
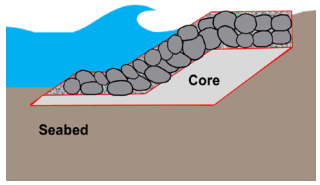
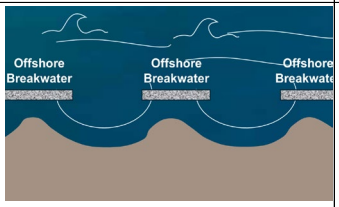
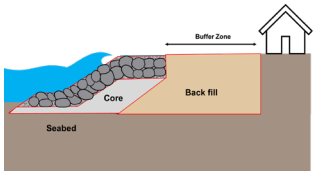
creating sandy beaches can enhance coastal utilization. Moreover, as an environmental function, the creation of sandy (gravel) beaches is expected to improve water quality and enhance marine biological habitats.

- Consideration on selection of coastal facilities: Beach nourishment is divided into two approaches. One method is for a dynamically stable beach, which involves sand fill alone without additional facilities such as groins, resembling a natural beach environment. The other method is for a statically stable beach, which integrates sand fill and facilities such as headlands and groins to control sand movement. The selection of the method is based on coastal dynamics and required service duration, and overall project cost, including both initial nourishment and maintenance, as well as the maintenance effort.

9.5.3 Rough Comparison Among Representative Coastal Measures

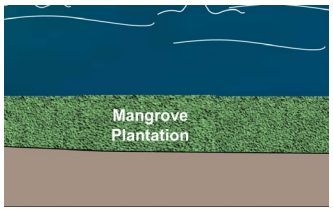
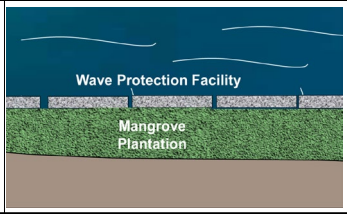
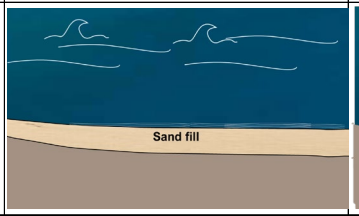
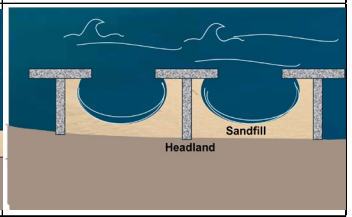
From the characteristics of coastal measures, a comparison table is shown in Table 9.5.2 and Table 9.5.3, summarizing the features and challenges of each coastal measure. The bottom of the table shows the coastal measure options for each category in the selected three Areas of the Project. These options are selected with consideration of the functions and costs of coastal measures. Additionally, the initial construction cost per meter was estimated assuming the application of coastal measures to the selected three Areas of this Project. It is important to note the cost varies depending on the assumption, and the range of cost variations for the selected coastal measures applied to the draft Basic Coastal Conservation Plan is illustrated in Figure 9.5.2, which will be discussed in the next section.

Table 9.5.2 Rough Comparison of Coastal Measure (Part-1)

Options of coastal measures	Impermibale revetment	Rubble-rock revetment	Offshore breakwater (rock material)	Revetment with backspace (with amenities)
image				
Initial construction cost per meter	12.5 - 17.5 milliom Rp. (Assume: 50%-70% of rubble-rock revetment)	25 million Rp. (Assume: project coast)	30 - 37.5 milliom Rp. (Assume; 120%-150% of rubble-rock revetment)	40 million Rp. (Assume: projecet coast)
Protection function	○ (Highly-expected)	○ (Highly-expected)	○ (Highly-expected)	○ (Highly-expected)
Utilizatin function	— (Less-expected)	— (Less-expected)	— (Less-expected)	○ (Highly-expected)
Environment function	— (Less-expected)	— (Less-expected)	— (Less-expected)	— (Less-expected)
Characteristics	To reduce costs, an impermeable revetment made by binding stones with concrete	Recently, permeable revetments have become commonly used in Indoensia. Compared to impermeable revetment, permiable revetment expected to mitigate front scouring by reducing reflected waves.	The sediment accumulation effect of tombolos formed behind offshore breakwaters provides localized protection for the hinterland. Offshore breakwaters can be used alone or in combination with beach nourishment.	- Instead of traditional revetments in Indoensia, creating revetments with appropriate buffer zones from the coastal area can reduce damage to residences and infrastructure during high waves and storm surges. - Additionally, establishing walkways, beaches, and slopes in these extensive areas can promote coastal utilization.
Issues	Being an impermeable revetment, it causes scouring in front, leading to significant beach loss and durability issues.	- The cost is greatly influenced by the source of the stones, as the quantity required increases. - For application on the northern coast of Java, subsidence measures, monitoring, and maintenance are necessary.	- When offshore breakwaters are used without beach nourishment, sediment accumulates behind the tombolos, but erosion is promoted at the openings and downdrift areas. - Marine construction generally results in higher costs compared to revetments. - In their application to the norht coast of Java Island, subsidence measures, monitoring, and maintenance are more necessary than for revetments.	When residences, restaurants, and other buildings in the hinterland are close to the coastal area, it becomes difficult to establish appropriate buffer zones. Consequently, buffer zones may need to be placed seaward of the existing coastline, requiring consideration of erosion impacts on the surrounding marine areas.
Options of coastal measures for project coasts by each category	Category-1（Protection）			Category-3 (Protection, Utilziation)

Source: JICA Study Team

Table 9.5.3 Rough Comparison of Coastal Measure (Part-2)

Options of coastal measures	Mangrove plantation (alone)	Mangrove plantation + wave-blocking structures	Beach nourishment (alone)	Beach nourishment + headlands/groins
image				
Initial construction cost per meter	0.5 million Rp. (Assume: Project coast)	15 million Rp (Assume: Project coast)	25 million Rp. (Assume: Project coast)	40 million Rp, (Assume: Project coast)
Protection function	△ (Moderately-expected)	△ (Moderately-expected)	○ (Highly-expected)	○ (Highly-expected)
Utilizatin function	△ (Moderately-expected)	△ (Moderately-expected)	○ (Highly-expected)	○ (Highly-expected)
Environment function	○ (Highly-expected)	○ (Highly-expected)	○ (Highly-expected)	○ (Highly-expected)
Characteristics	Applied in calm wave areas where wave impact does not hinder a problem for mangrove growth. Extensive mangrove plantation is expected to reduce wave intrusion and promote sediment retention (accumulation).	In cases where wave impact affects mangrove growth, wave-blocking structures are used as supplementary facilities until the mangroves are fully grown. Common materials for wave-blocking structure include natural materials (such as bamboo) and rocks.	This method most closely resembles natural beaches, offering benefits in protection, utilization, environment, and landscape compared to other hard coastal measures.	In beaches where sediment supply has decreased, creating a static beach by combining groins or headlands helps control sediment movement, thereby fulfilling protection, utilization, and environmental functions.
Issues	Determining whether the environmental conditions are suitable for mangrove growth (e.g., waves, substrate) is crucial. Regular monitoring and maintenance as needed are also required	Wave-blocking structures typically involve marine construction, which increases costs. Therefore, economic design is necessary considering the purpose of the wave-blocking structures, the required durability period, and the durability of materials.	Similar to natural beaches, dynamic littoral drift is maintained. However, in the area where sediment supply are decreasing, continuous sand fill is necessary to ensure supply. Therefore, applying this method on coasts with significant sediment transport volume requires consideration of increased maintenance frequency and costs. It is crucial to make application decisions based on a thorough understanding of the sediment transport mechanicms of the target coast.	The combination of headlands/groins increases construction costs. It is crucial to understand the sediment transport mechanisms of the target coast and to carefully design the layout to ensure the effectiveness of sand stabilization while considering utilization and landscape aspects.
Options of coastal measures for project coasts by each category	Category-1（Procteion）			
	Category-2（Protection, Environment）			
	Category-3（Protection, utilization）			
	Category-4（Prortection, Enironment, Utilization）			

Source: JICA Study Teram

9.5.4 Selection of Coastal Measures for the Selected Three Areas of the Project

Following are the basic principles for selecting coastal measures for the coasts designated as Action-3 or Action-4 in the selected three Areas of the Project. Since the coasts designated as Action-3 or Action-4 in the target Areas do not include Category-4, coastal measures in the coasts are not discussed in the follows.

- Coast where protection function is required（Category-1）

  - Revetments: Revetments are applied when there are residential areas or critical infrastructure facilities in the hinterland that need protection from seawater intrusion (caused by high waves/tides or wave overtopping) and land loss due to coastal erosion. However, developing revetments can block access to the sew and may cause environmental and utilization issues due to further loss of the foreshore because of non-control for the littoral drift. Therefore, these impacts need to be carefully considered when applying revetments.

  - Mangrove plantation: Mangrove plantation is applied where the hinterland is used for primary industries (e.g., agriculture, aquaculture), and where high waves/tides, wave overtopping, and coastal erosion do not cause direct threats to human lives, activities, or critical infrastructure. On such coasts, since the target protection level is to prevent further shoreline retreat and protect the hinterland from external forces, mangrove plantation is applied as the low-cost coastal measure compared with gray(hard) structures such as revetment. Additionally, it can also offer benefits such as land stability through sediment accumulation and potential economic benefits from ecotourism, and an increase in aquacultural resources. However, when applying mangrove plantation, it is essential to carefully consider the natural conditions such as waves and seabed sediment to select suitable locations and species, and the effectiveness and appropriateness of applying mangrove plantation as protection facilities. Additionally, to support the stable growth of planted mangroves, it may be necessary to install wave-blocking structures made of rock or bamboo, and soil to ensure the necessary planting depth, at the result potentially increasing costs. In the draft Basic Coastal Management Plan, wave-blocking structures made of rock or natural materials like bamboo are assumed to be applied. Before the application of this measure, the need for these supplementary measures, including additional soil filling requires further information collection, research, and consideration.

- Coast where protection and environmental function are required（Category-2）

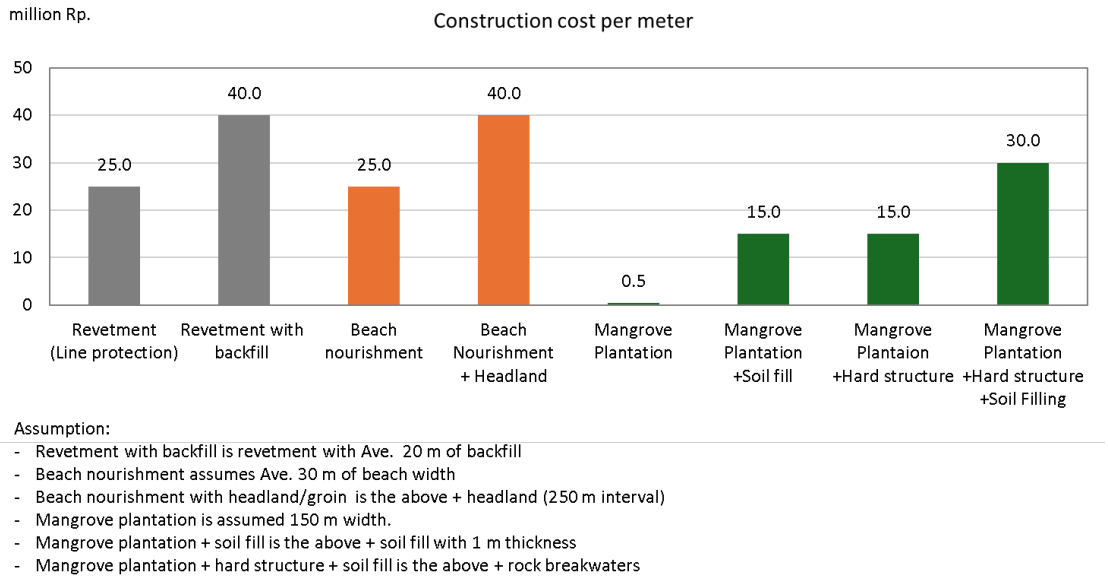
  - Mangrove plantation: This category is applied to the coast which is designated as an environmental protection area (Mangrove conservation area), etc. Since it is a natural measure with low environmental impact and these areas provide favorable conditions for natural mangrove growth, the mangrove plantation is applied. The necessity for wave-blocking structures for mangrove plantations is in the same condition as

above (Category 1).

➢ Coast where protection and utilization functions are required（Category-3）

○ Beach nourishment and headlands/groins: Beach nourishment and headlands/groins are applied for the coasts that require protection and utilization. Especially, the beach is needed for local tourism, such as swimming and recreational use in the target area of the Project. The beach nourishment for statically stable beach is employed by combining with headlands/groins, considering the coastal use as tourism resources, and characteristics of the coast such as waves, topography, and bottom sediment and nourishment materials, to reduce the additional nourished material and to maintain the recreated beach as much as possible. In Area-I and II, where the coast consists of silt and relatively fine sand, headlands is suitable for control the sediment movement to reduce offshore sediment loss. Conversely, in Area-III, where the coast consists of standard grain-sized sand, the risk of offshore sediment loss is expected low compared to Area-I and Area-II. Therefore, the supplemental structures such as groins or headlands are selected as appropriate considering both the control of littoral drift and the utilization aspect.

Figure 9.5.2 shows rough construction cost comparing among coastal measures applied in the target coast of the Project. It is worth noting that this rough cost of coastal measures is estimated for the target coast of this Project, which can be changed depending on the regions. Additionally, the cost can vary largely dependent on the assumption such as the presence/absence of supplemental structures for beach nourishment and soil filling for mangrove plantation. These assumptions for designing coastal facilities should be verified by investigation in the further studies (F/S, D/D).



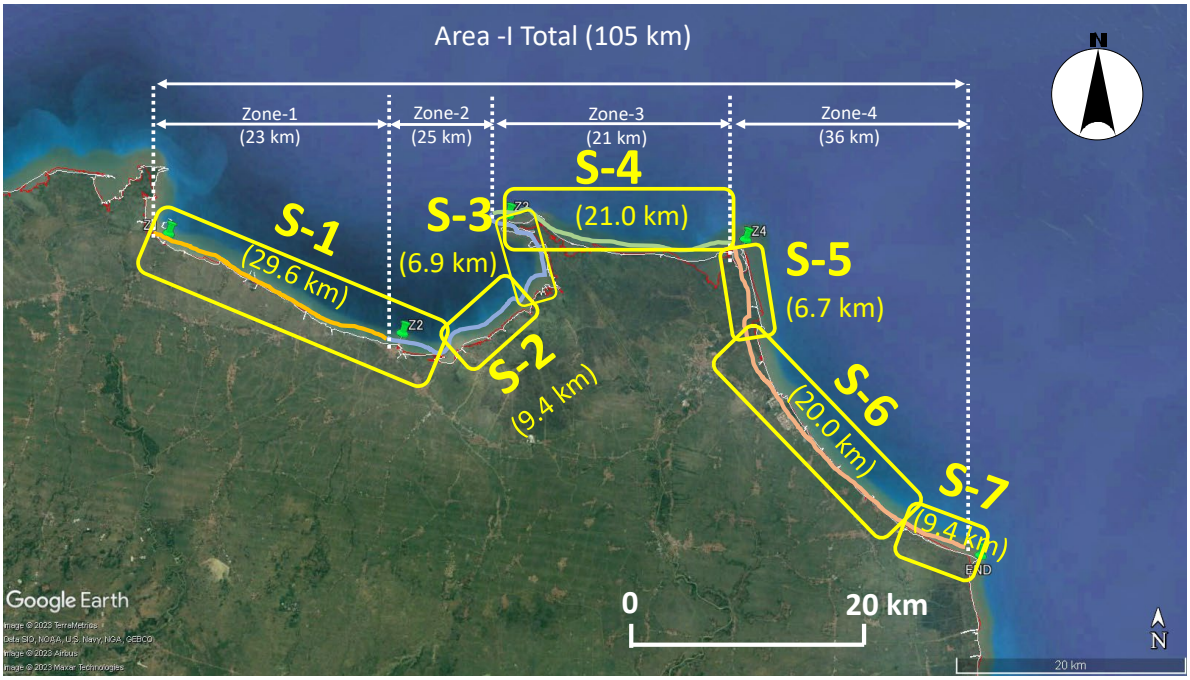
Source: JICA Study Team

Figure 9.5.2 Comparison of Construction Cost Per Meter

CHAPTER 10 Draft of Basic Coastal Management Plan for Three Priority Areas (Step-8)

10.1 Area-I: Indramayu

Figure 10.1.1 shows the locations of the Section in Area-I. Figure 10.1.2−Figure 10.1.9 shows the draft of Basic Coastal Management Plan in each Section.



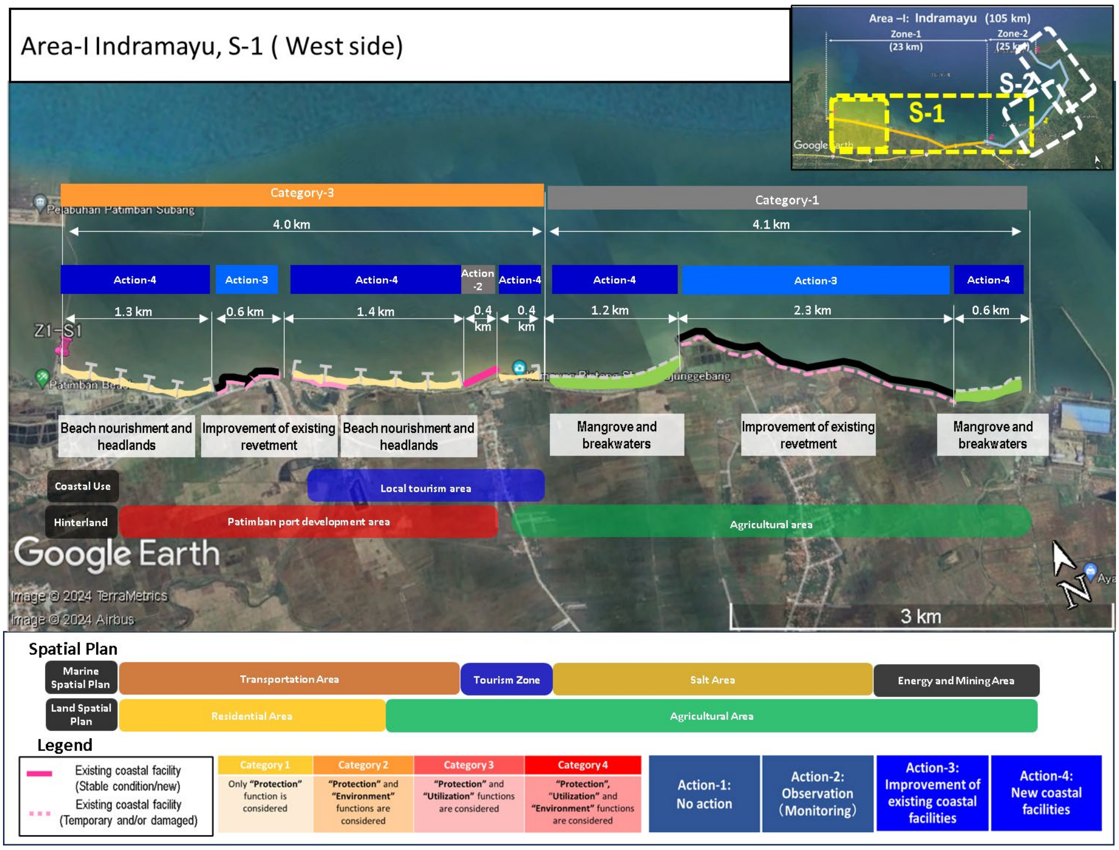
Source: Edited by JICA Study Team based on Google Earth

Figure 10.1.1 Locations of Sections in Area-I (Indramayu)

10.1.1 Area-I: Indramayu S-1

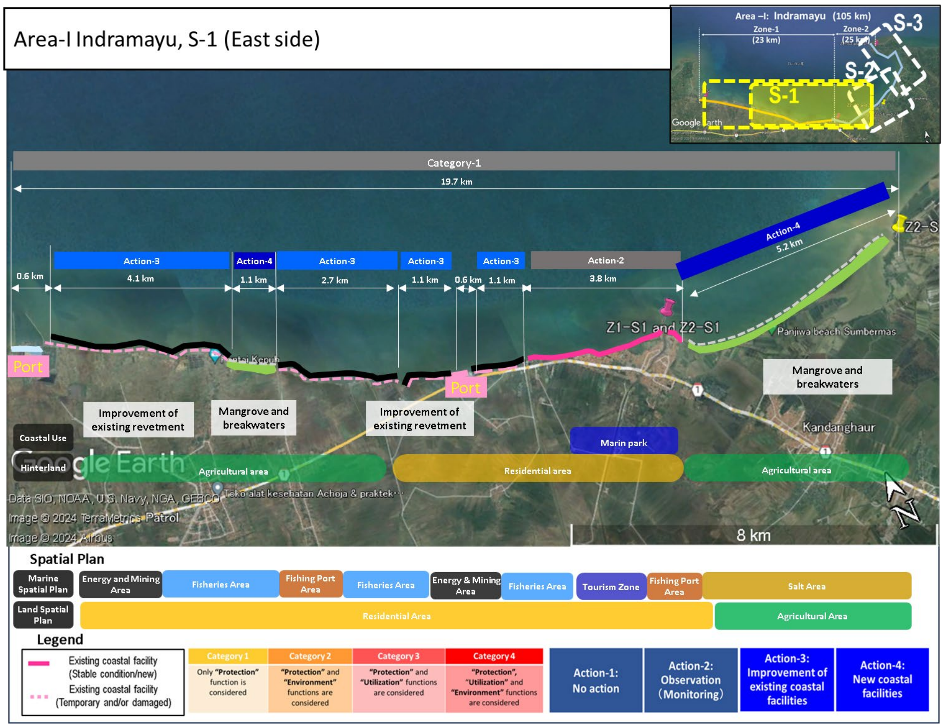
Figure 10.1.2 and Figure 10.1.3 shows the draft of Basic Coastal Management Plan in S-1 of Area-I: Indramayu.

■Evaluation/Issues: The west side of this Section is planned to be comprehensively developed as the Patimbang Port development area and there is also a tourism area. Therefore, it is necessary to create a coast that takes these factors into account. In addition, although this Section has a national grain-growing area, the risk of land loss (especially in agricultural areas) and disasters to residential area is expected to increase due to coastal erosion caused by mud and fine sand lost from waves so it is necessary to consider adaptation measures against those factors.
■Ideal coastal situation: Aim to promote tourism as part of the development plan for the Patimbang area, conserve land against coastal erosion of agricultural areas and create a coast that is safe for residential areas
■Required Coastal Functions: Hinterland, especially west area, is a Patimbang port development area, and others are utilized as residential area, agricultural/aquacultural area, including fishpond. For coastal utilization, the west Patimbang port development area is utilized as local tourism area. Based on this information, the required coastal function is determined as Category-3 (Protection and Utilization) at the west region, and Category-1 (Protection) at other areas, whose hinterland is utilized as agricultural/aquacultural area, considering its expected less demand on coastal utilization.
■Direction of Required Action and Selection of Coastal Measures: Western coast designated as Category-3 is mainly classed into Action-4 (new coastal facilities) when there is no existing facilities, and beach nourishment and headland is proposed in the coast. Meanwhile, in eastern cost designated as Category-1, when existing coastal facilities is absent, and its hinterland is utilized as agricultural purposes, mangrove plantation with breakwaters is proposed as Action-4 (new coastal facilities). The other area, evaluating functionality of existing coastal facilities, is classified into Action-2 (Observation and monitoring), and Action-3 (Improvement of existing coastal facilities).



Source: Edited by JICA Study Team based on Google Earth

Figure 10.1.2 Draft of Basic Coastal Management Plan in Indramayu Section-1 (West)



Source: Edited by JICA Study Team based on: Google Earth

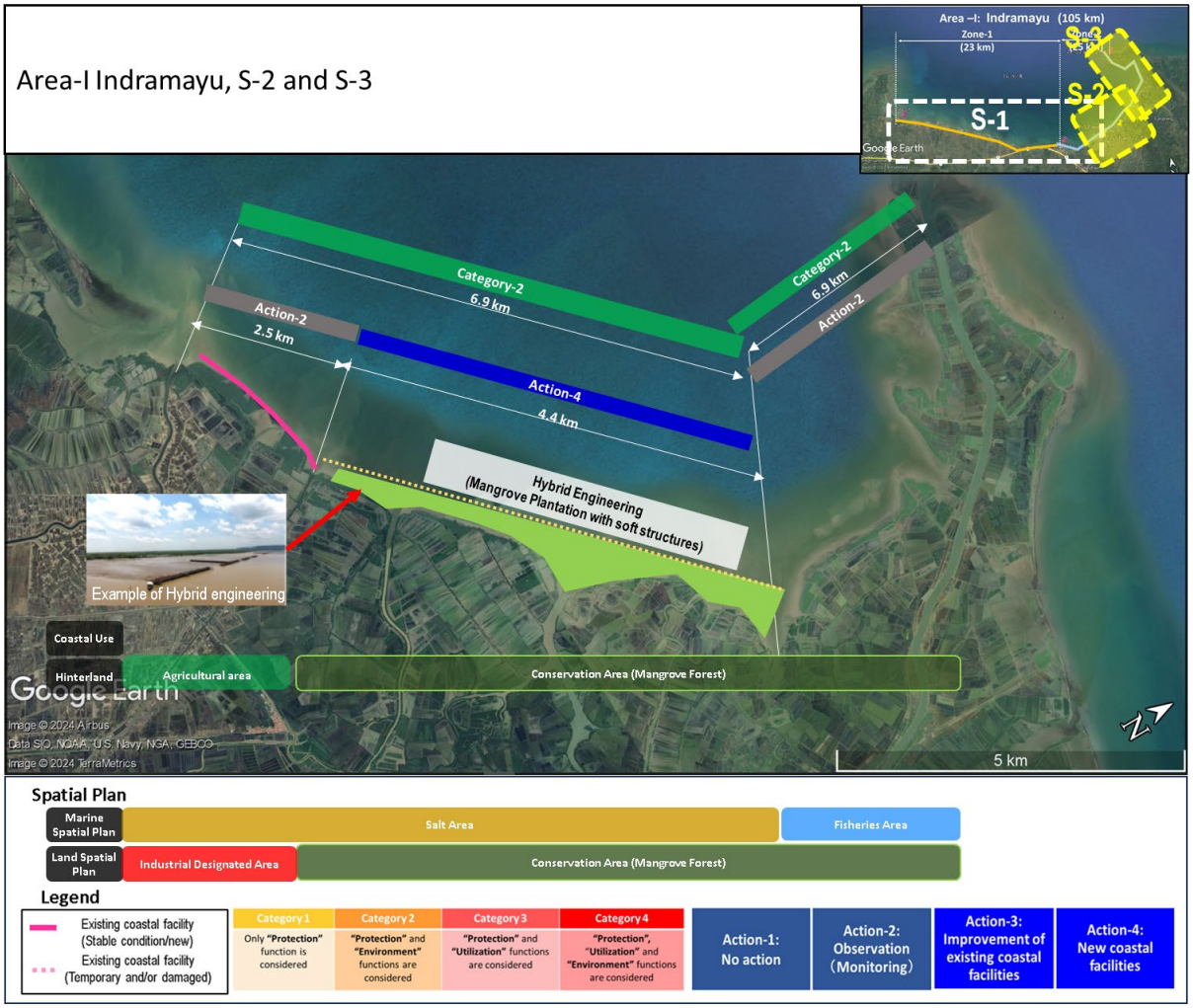
Figure 10.1.3 Draft of Basic Coastal Management Plan in Indramayu Section-1 (East)

10.1.2 Area-I: Indramayu S-2 and S-3

Figure 10.1.4 shows the draft of Basic Coastal Management Plan in Area-I: Indramayu S-2 and S-3.

Area-I: Indramayu S-2
■Evaluation/Issues: Some areas are protected by buffer zones created by mangrove plantations but in other coastal areas, coastal erosion and inundation have occurred inland. It is assumed that the risk of land loss and disasters to residential area will increase in such areas.
■Ideal coastal situation: Aim to conserve land against coastal erosion of agricultural areas as an important grain producing region.
■Required Coastal Functions: In the spatial plan, hinterland is designated as environmental protection area, that is mangrove conservation area. Thus. the required coastal function is set as Category-2 (Protection and Environment).
■ Direction of Required Action and Selection of Coastal Measures: Western area of the Section is erosion area, but existing facilities are functioning. Thus, the western area is designated as Action-2 (Observation (Monitoring)). Eastern area, to protect and restore national land from drastic coastal erosion, Action-4 (new coastal facilities) is proposed with coastal measure of mangrove plantation considering both environmental applicability of planting mangroves due to its naturally growing mangroves and a low environmental negative impact for this environmental protected area. Wave-blocking facility is proposed by hybrid measures using bamboo materials, considering the local natural condition that dominant east-directional waves come with being diffracted, and strong structural measures is not required.

Area-I: Indramayu S-3
■Evaluation/Issues: This Section is an estuary of one of the representative rivers in the north coast of Java Island, which is basically a sedimentation area. In addition, there are mangrove forests in the coastal area. This means that the risk of coastal disasters is low compared to other sections. On the other hand, the sediment inflow from the estuary is sediment that originally contributed to the formation of the coast in other areas, so it is necessary to consider land use in the sedimentation area based on comprehensive sediment management.
■Ideal coastal situation: Aim to promote integrated sediment management based on the short-, medium-, and long-term variability of the estuary, and promote and restrict land use in the sedimentation.
■Required Coastal Functions: In the spatial plan, hinterland is designated as environmental protection area, that is mangrove conservation area. Thus. the required coastal function is set as Category-2 (Protection and Environment).
■ Direction of Required Action and Selection of Coastal Measures: This Section basically has low risk of coastal disasters, which located in the fluctuated area of topographic changes due to river discharge. Thus, the Section is designated as Action-2 (Observation (Monitoring)).



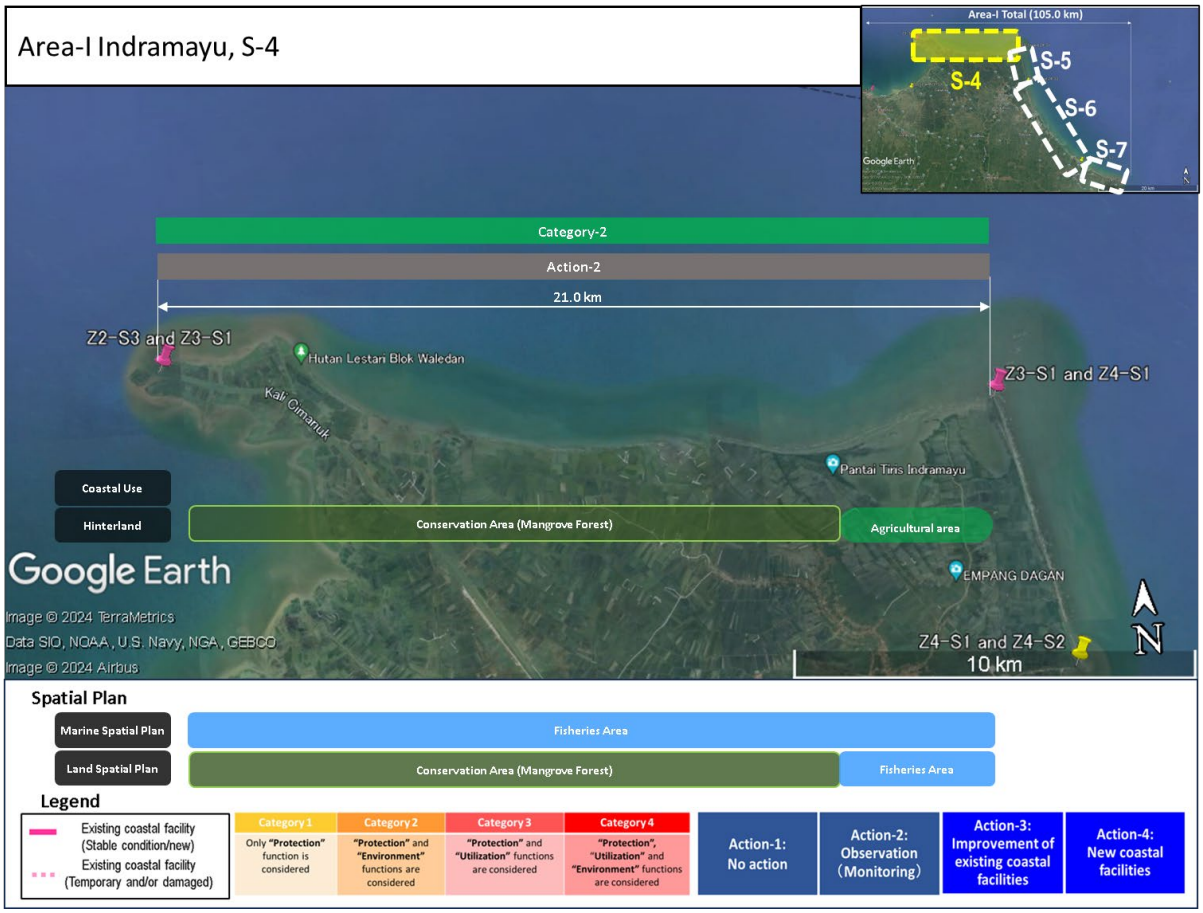
Source: Edited by JICA Study Team based on Google Earth

Figure 10.1.4 Draft of Basic Coastal Management Plan in Indramayu Section-2 and Section-3

10.1.3 Area-I: Indramayu S-4

Figure 10.1.5 shows the draft of Basic Coastal Management Plan in Area-I: Indramayu S-4

■Evaluation/Issues: This Section is an estuary of one of the representative rivers in the north coast of Java Island, which is basically a sedimentation area. In addition, there are mangrove forests in the coastal area. This means that the risk of coastal disasters is low compared to other sections. On the other hand, the sediment inflow from the estuary is sediment that originally contributed to the formation of the coast in other areas, so it is necessary to consider land use in the sedimentation area based on comprehensive sediment management.
■Ideal coastal situation: Aim to promote integrated sediment management based on the short-, medium-, and long-term variability of the estuary, and promote and restrict land use in the sedimentation.
■Required Coastal Functions: In the spatial plan, hinterland is designated as environmental protection area, that is mangrove conservation area. Thus, the required coastal function is set as Category-2 (Protection and Environment).
■ Direction of Required Action and Selection of Coastal Measures: The Section is principally required to preserve natural great environment, while the Section is located in the topographical fluctuation area due to river discharge. Thus, the Section is designated as Action-2 (Observation (Monitoring)).



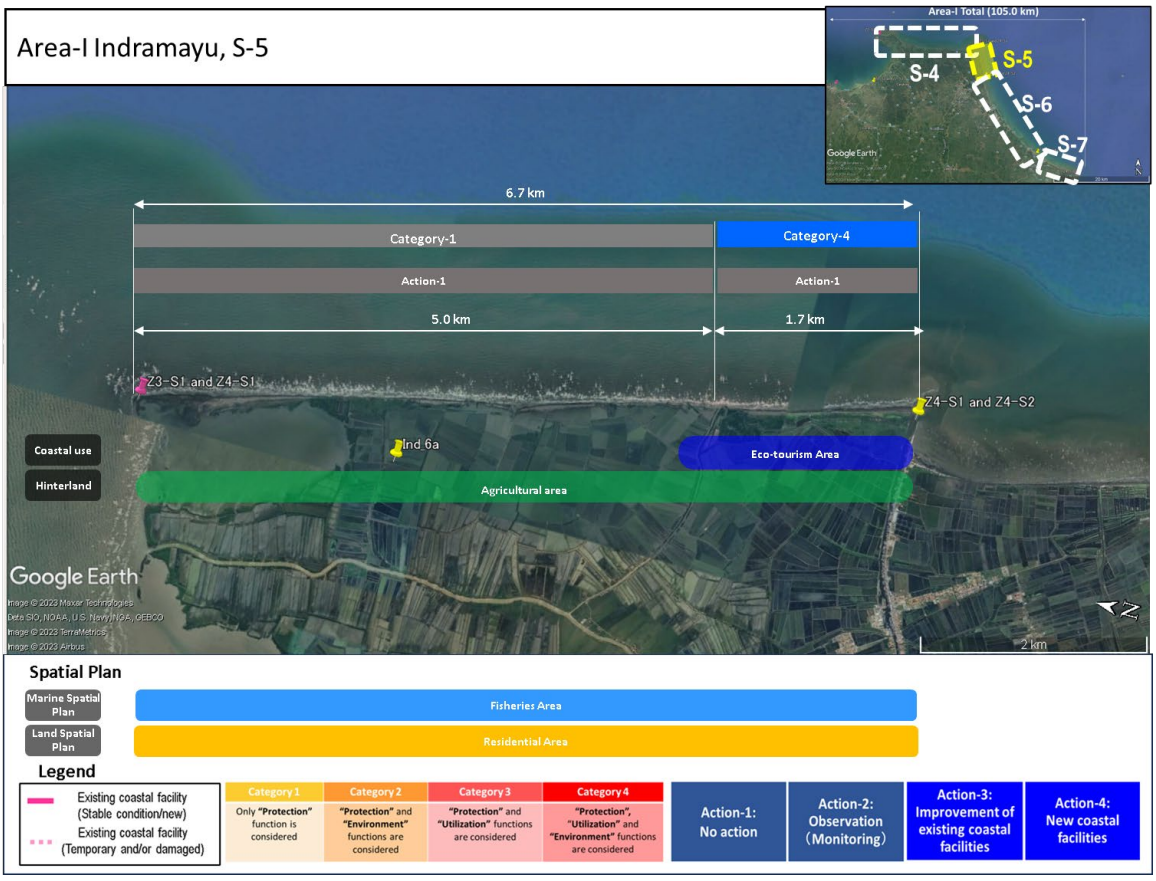
Source: Edited by JICA Study Team based on Google Earth

Figure 10.1.5 Draft of Basic Coastal Management Plan in Indramayu Section-4

10.1.4 Area-I: Indramayu S-5

Figure 10.1.6 shows the draft of Basic Coastal Management Plan in Area-I: Indramayu S-5

■Evaluation/Issues: This Section is an estuary of one of the representative rivers in the north coast of Java Island, which is basically a sedimentation area. In addition, there are mangrove forests in the coastal area. This means that the risk of coastal disasters is low compared to other sections. On the other hand, the sediment inflow from the estuary is sediment that originally contributed to the formation of the coast in other areas, so it is necessary to consider land use in the sedimentation area based on comprehensive sediment management.
■Ideal coastal situation: Aim to promote integrated sediment management based on the short-, medium-, and long-term variability of the estuary, and promote and restrict land use in the sedimentation.
■Required Coastal Functions: The hinterland is utilized as agricultural area. The coastal area has great/healthy mangrove forest exist, and a part of the area is utilized as eco-tourism area. In the area, preservation of great environment is important, so the required function is set as Category-4 (Protection, Environment, Utilization). Other area that is not utilized as eco-tourism area is categorized as Category-1 (Protection).
■ Direction of Required Action and Selection of Coastal Measures: The Section is basically sedimentation area of discharged sand by river, of which hinterland is utilized as residential area. Thus, the Section is considered as low risk of coastal disaster, and preservation of current natural condition is primally important. Therefore, it designated as Action-1(No action).



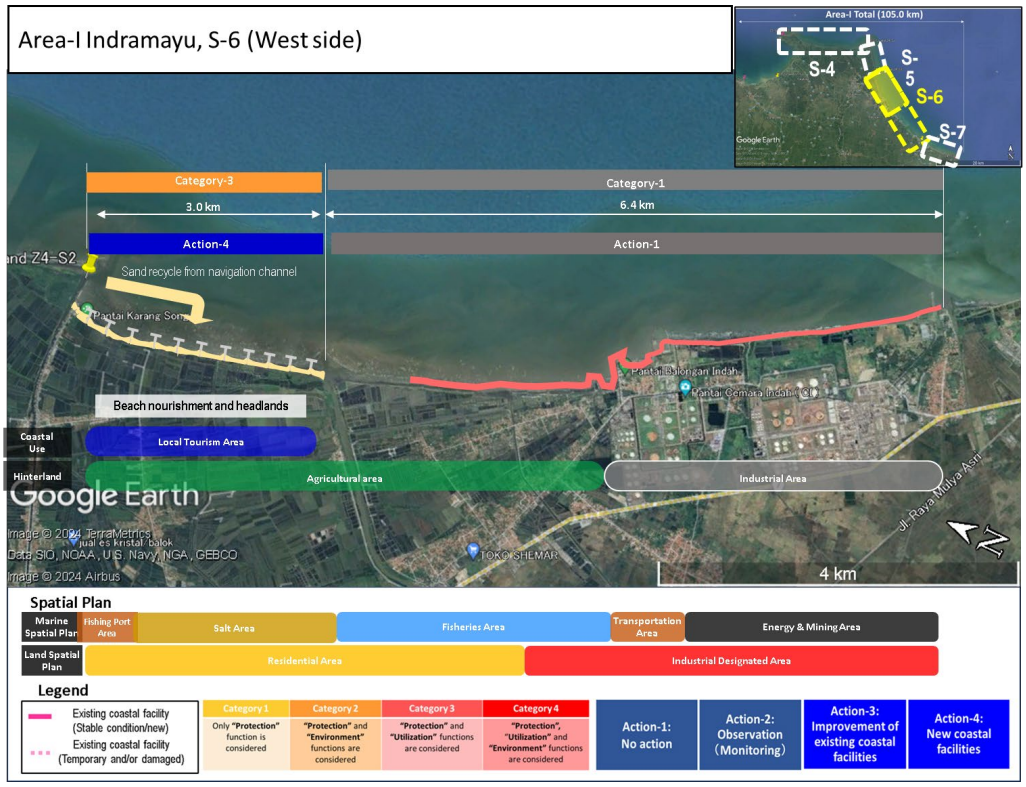
Source: Edited by JICA Study Team based on Google Earth

Figure 10.1.6 Draft of Basic Coastal Management Plan in Indramayu Section-5

10.1.5 Area-I: Indramayu S-6

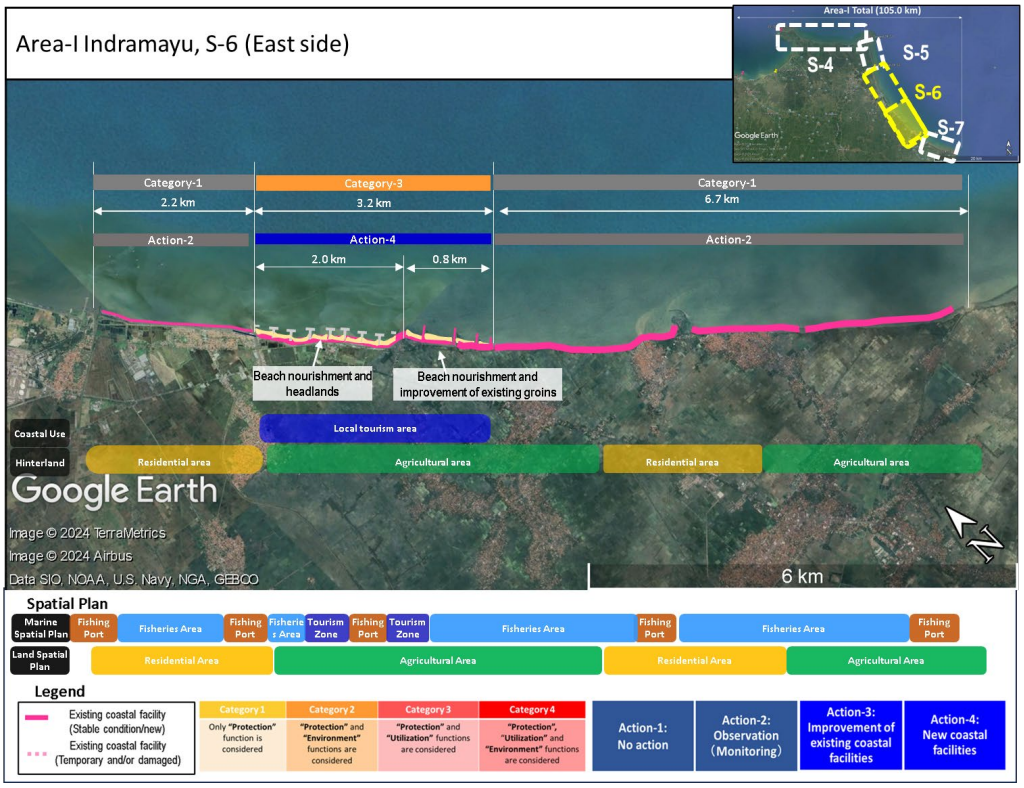
Figure 10.1.7 and Figure 10.1.8 shows the draft of Basic Coastal Management Plan Area-I: Indramayu S-6.

■Evaluation/Issues: Coastal erosion and the loss of land for salt fields and farmland due to coastal erosion, as well as high waves and flooding in residential areas, occur. Hard measures have been implemented in each location and there is extension plan of these structure in the future. Although the sections where coastal measures have been implemented in recent years are considered to be functioning in terms of short-term protection. But they might not be effective against the offshore discharge of sediment, which is considered to be the main cause of erosion in this area. In the tourism area, the coastal measures are causing problems in terms of coastal use and it is necessary to review the existing coastal measures in consideration of the hinterland and coastal use.
■Ideal coastal situation: Aim to utilize the coast to promote tourism, to improve the safety of residential areas and the convenience of the coast, and to conserve salt fields and agricultural lands, based on the erosion mechanism.
■Required Coastal Functions: The hinterland is utilized diversely as residential area, agricultural area, and industrial area. The coastal utilization includes tourism at the existing natural beaches at both west side, and east side near the boundary of the area, which areas are designated as Category-3 (Protection and Utilization). Additionally, other areas utilized as industrial area and the area in front of residential area are designated as Category-1 (Protection).
■ Direction of Required Action and Selection of Coastal Measures: In order not to hinder the existing coastal utilization, while protecting the hinterland from coastal erosion and inundation induced by high-waves and high-tides, beach nourishment and headland is proposed as Action-4 (new coastal facilities). Additionally, the most area of the Section has recently implemented coastal facilities, considered as functioning in short-term. Thus, the area is designated as Action-2 (Observation (Monitoring)). Meanwhile, in east area of the Section which requires coastal utilization, and in which the recently implemented coastal facilities does not satisfy the utilization function, Action-4 (new coastal facilities) is designated, and beach nourishment and headlands is proposed as coastal measure.



Source: Edited by JICA Study Team based on Google Earth

Figure 10.1.7 Draft of Basic Coastal Management Plan in Indramayu Section-6 (West)



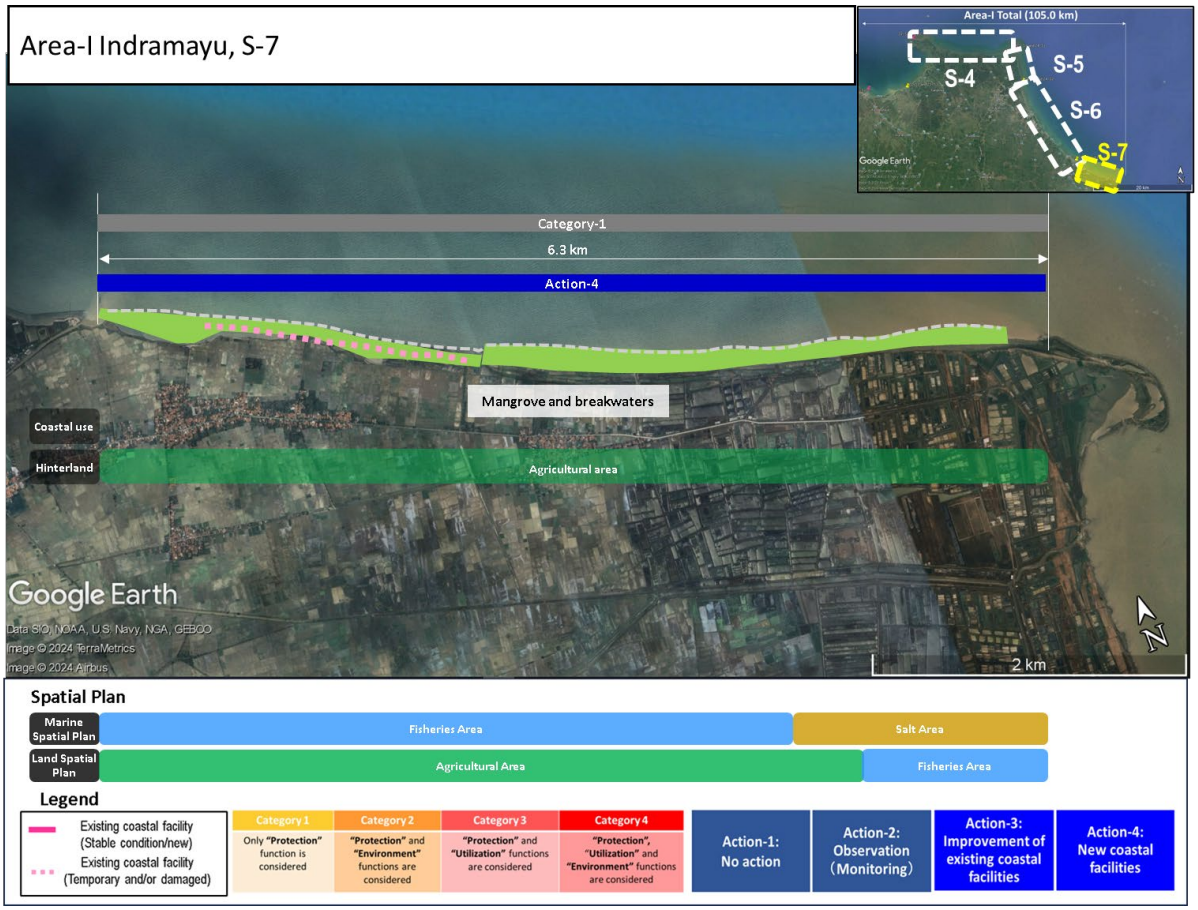
Source: Edited by JICA Study Team based on Google Earth

Figure 10.1.8 Draft of Basic Coastal Management Plan in Indramayu Section-6 (East)

10.1.6 Area-I: Indramayu S-7

Figure 10.1.9 shows the draft of Basic Coastal Management Plan in Area-I: Indramayu S-7b.

■Evaluation/Issues: Hard countermeasures have been implemented to protect residential areas and prevent the loss of agricultural area but the effectiveness of these measures as a countermeasure against the combined erosion factors in this area is questionable because of the negative impact of these measures on the surrounding beaches. It is necessary to consider development in coastal area continuously for this 10 km based on the continuity of littoral drift..
■Ideal coastal situation: Aim to conserve agricultural area and fishpond area and to improve residential safety and convenience of the coast based on the erosion mechanism.
■Required Coastal Functions: The hinterland is mainly utilized as agricultural area, although the residential utilization is seen in the western area. Current coastal utilization is insignificant and future coastal utilization is not much anticipated. Based on them, the required coastal function in the area is set as Category-1 (Protection).
■ Direction of Required Action and Selection of Coastal Measures: The Section has existing coastal facilities in west of the Section, functioning insufficiently. Thus, considering the hinterland utilization, mangrove plantation with breakwaters is proposed as Action-4 (new coastal facilities).

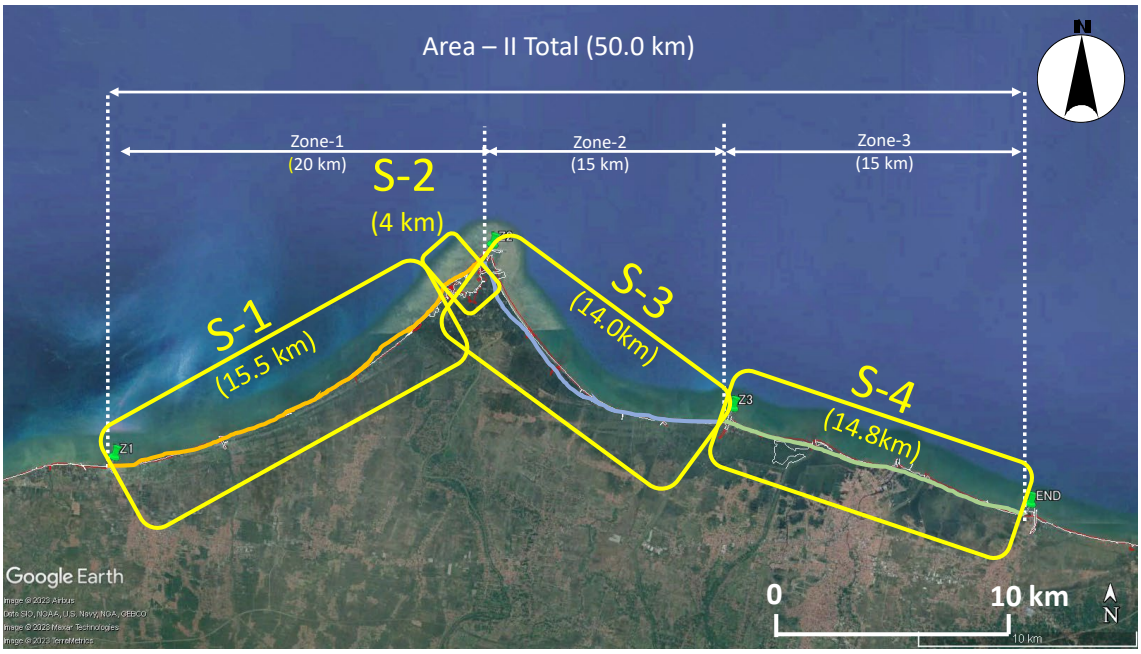


Source: Edited by JICA Study Team based on Google Earth

Figure 10.1.9 Draft of Basic Coastal Management Plan in Indramayu Section-7

10.2 Area-II: Pemalang-Pekalongan

Figure 10.2.1 shows the location of Sections. Figure 10.2.2−Figure 10.2.5 shows the draft of Basic Coastal Management Plan in Area-II: Pemalang-Pekalongan.



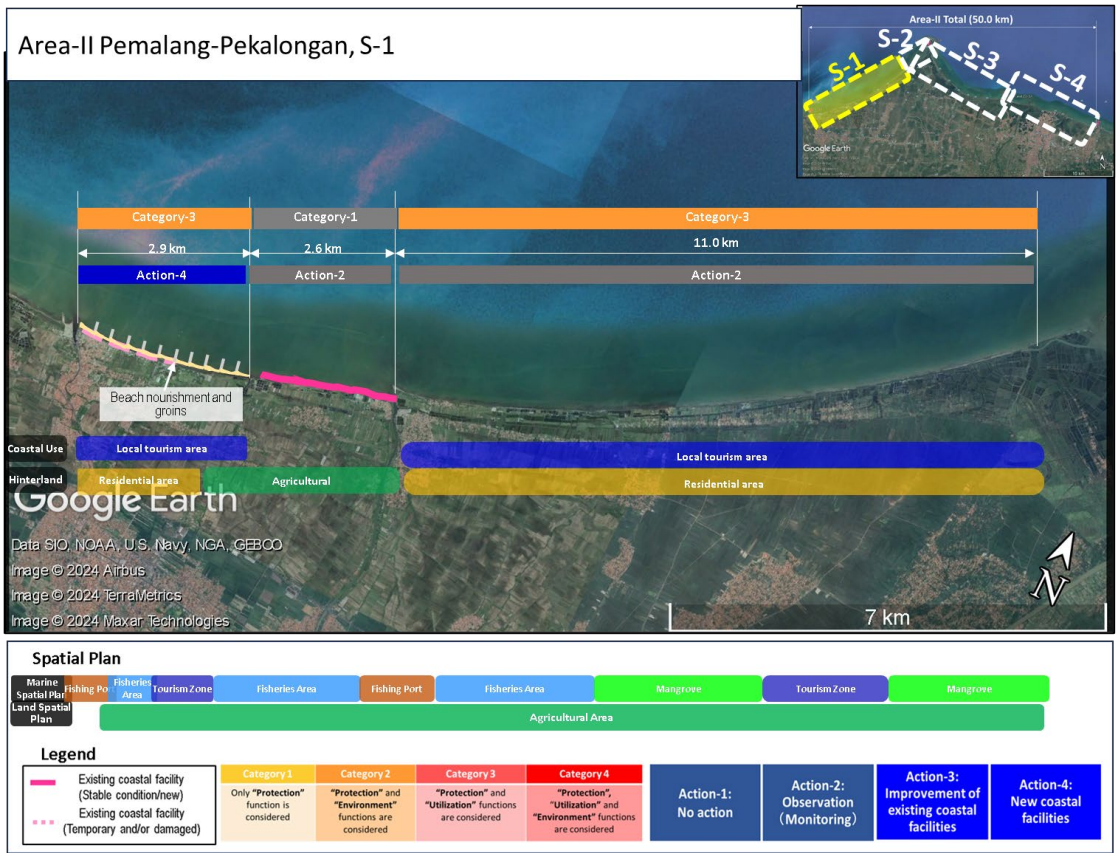
Source: Edited by JICA Study Team based on Google Earth

Figure 10.2.1 Location of Sections in Area-II (Pemalang-Pekalongan)

10.2.1 Area-II: Pemalang-Pekalongan S-1

Figure 10.2.2 shows the draft of Basic Coastal Management Plan in Area-II: Pemalang-Pekalongan S-1

■Evaluation/Issues: The main tourism area of Area-II, including prominent temples, is located behind this Section. The coast is also a popular tourist area. On the other hand, there are some areas where there is not enough beach width for coastal use, and the use of some areas have been disturbed by the installation of hard structures. This Section has a higher risk of flooding than Area-I and flooding damage has been also reported. Therefore, it is necessary to take into consideration the use of the coast for tourism areas and residential areas, as well as protection measures for the hinterland.
■Ideal coastal situation: Aim to promote tourism and to ensure the safety of residential areas and the land conservation of agricultural and fishpond.
■Required Coastal Functions: The hinterland is utilized as residential, agricultural and aquacultural area. The coastal area is utilized as local tourism area and one of the populated tourism areas in the north coast of Java Island. Thus, the required coastal function is set as Category-3 (Protection and Utilization). Meanwhile, the area, in which hinterland is utilized as agricultural area and the coastal utilization is less expected, is designated as Category-1 (Protection).
■ Direction of Required Action and Selection of Coastal Measures: For the eastern local tourism area of The Section, beach nourishment and headlands are proposed as Action-4 (new coastal facilities). In other areas, given the existence of recent development projects and land subsidence, though there is no significant immediate risk of coastal disasters, there is a potential for future risks, which necessitates Action-2 (Observation (Monitoring)).



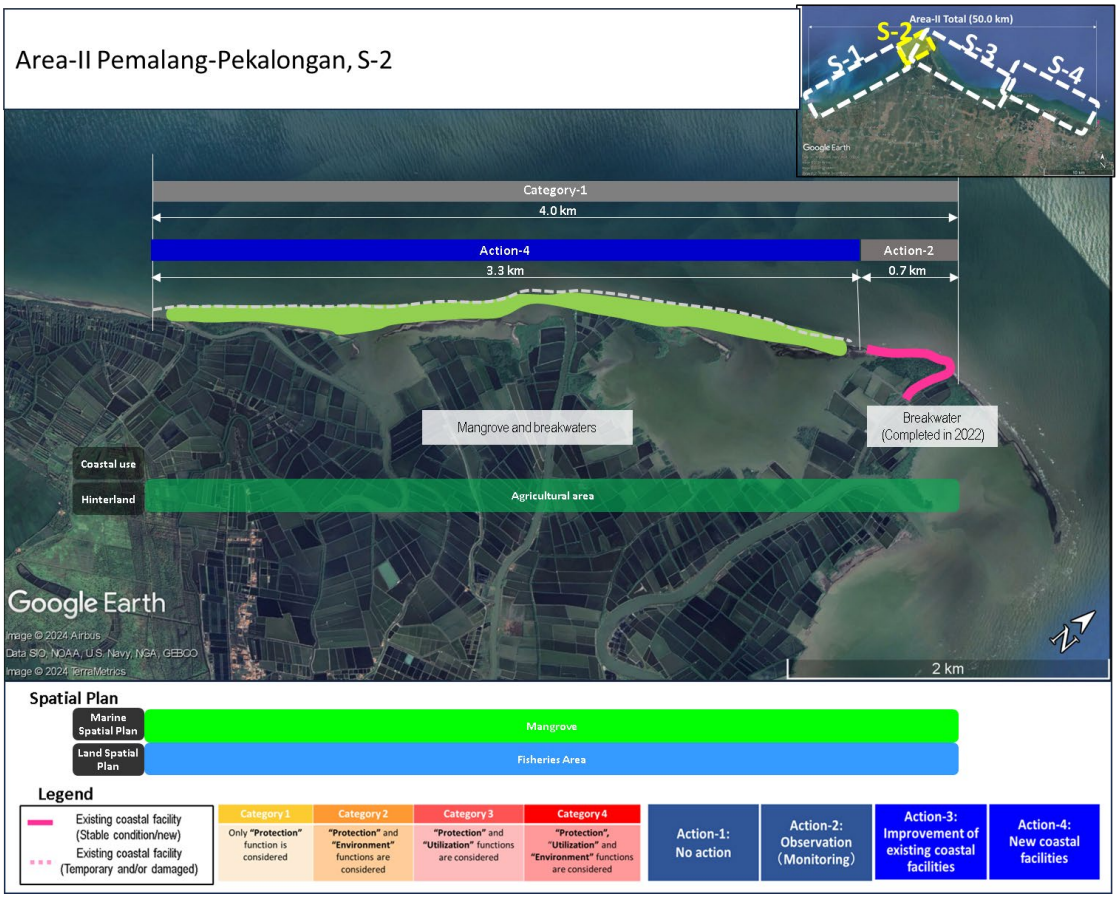
Source: Edited by JICA Study Team based on Google Earth

Figure 10.2.2 Draft of Basic Coastal Management Plan in Pemalang-Pekalongan Section-1

10.2.2 Area-II: Pemalang-Pekalongan S-2

Figure 10.2.3. shows the draft of Basic Coastal Management Plan in Area-II: Pemalang-Pekalongan S-2.

■Evaluation/Issues: This Section is basically a sedimentation area and there are mangrove forests in the coastal area. The hinterland is used for fishpond and some agricultural area. From the perspective of people and assets, the coastal disaster risk of this Section is low. On the other hand, the area around the estuary is undergoing significant topographic change and some land areas are inundated during storm surges and high waves. Although the residential area is located more than 1 km landward from the coast, the topographical changes around the estuary. In addition, the possibility of increase in land subsidence is expected to continue. Therefore, land use management including the function as a buffer zone for the land area and land subsidence countermeasures are necessary.
■Ideal coastal situation: Promote comprehensive policy, including hinterland, to ensure the safety of residential areas from tidal floods due to the short-, medium-, and long-term variability and land subsidence in the estuary that will continue to occur in the future.
■Required Coastal Functions: The hinterland is utilized as agricultural and aquacultural purposes such as fishpond use. Coastal utilization by developing coastal facility is less expected. Thus, the required coastal function is set as Cateogry-1(Protection).
■ Direction of Required Action and Selection of Coastal Measures: Part of this Section has already been protected with breakwaters by the BBWS. For other areas, considering the usage behind them, mangrove plantations with breakwaters are proposed as Action-4 (new coastal facilities).



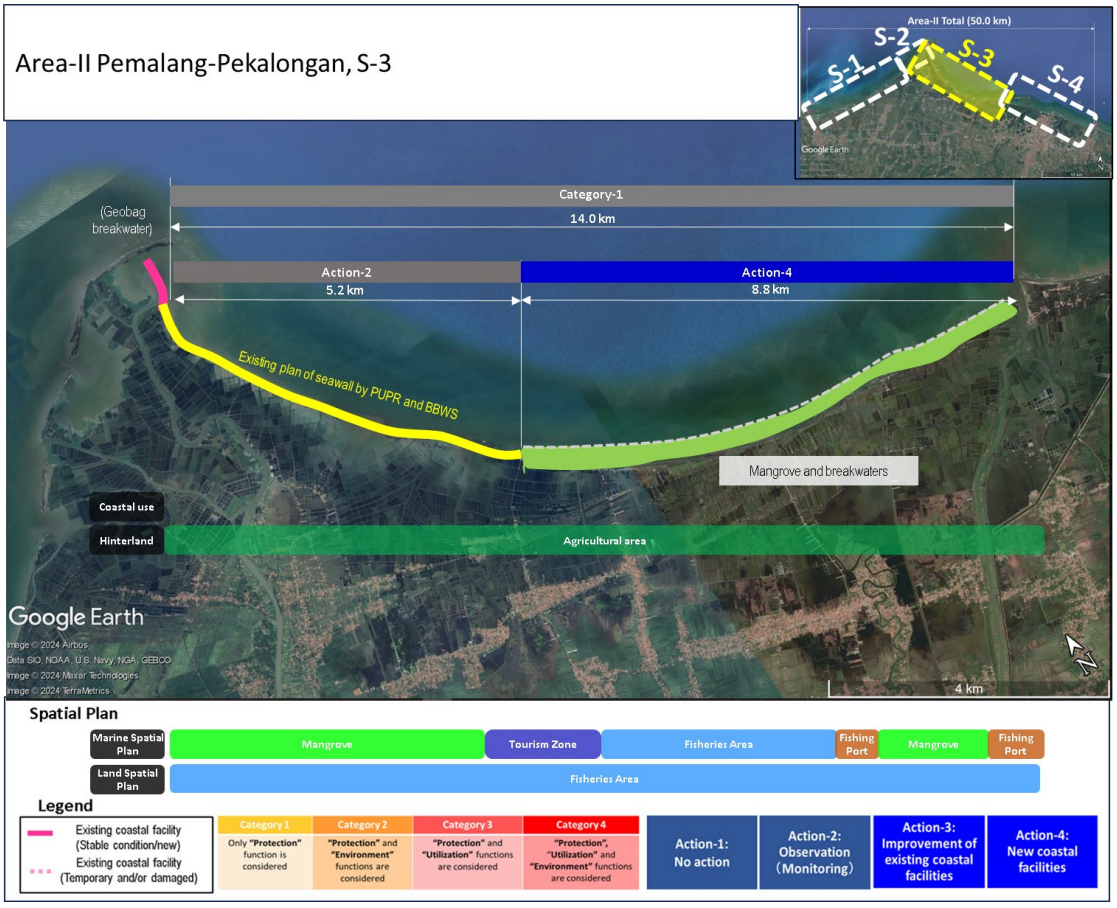
Source: Edited by JICA Study Team based on Google Earth

Figure 10.2.3 Draft of Basic Coastal Management Plan in Pemalang-Pekalongan Section-2

10.2.3 Area-II: Pemalang-Pekalongan S-3

Figure 10.2.4. shows the draft of Basic Coastal Management Plan in Area-II: Pemalang-Pekalongan S-3.

■Evaluation/Issues: Shoreline has been retreated by two main factors of land subsidence and decrease of sediment inflow from the estuary. As S-2, land use management including land buffer zone function and land subsidence countermeasures are needed in light of the geomorphological changes around the estuary and the possibility of increase in land subsidence, which are expected to occur in the future. Therefore, land use management including the function as a buffer zone for the land area and land subsidence countermeasures are necessary.
■Ideal coastal situation: Promote comprehensive policy, including hinterland, to ensure the safety of residential areas from tidal floods due to the short-, medium-, and long-term variability and land subsidence in the estuary that will continue to occur in the future.
■Required Coastal Functions: The hinterland is utilized as agricultural and aquacultural purposes such as fishpond use. Coastal utilization by developing coastal facility is less expected. Thus, the required coastal function is set as Cateogry-1(Protection).
■ Direction of Required Action and Selection of Coastal Measures: The western part of this Section is planned for revetment development by PUPR and BBWS as existing plans of coastal facility development, which are considered to fulfill protection functions. Thus, Action-1(No action) is designated for this area. For the eastern part, where no existing plans of coastal facility development are in place, considering the hinterland utilization, mangrove plantation with breakwaters is proposed as Action-4 (new coastal facilities).



Source: Edited by JICA Study Team based on Google Earth

Figure 10.2.4 Draft of Basic Coastal Management Plan in Pemalang-Pekalongan Section-3

10.2.4 Area-II: Pemalang-Pekalongan S-4

Figure 10.2.5 shows the draft of Basic Coastal Management Plan in Area-II: Pemalang-Pekalongan S-4.

■Evaluation/Issues:

This Section is the only coastal area with an urban area in the hinterland among the three priority areas selected for this project. The coastal erosion and tidal inundation damage in this Section is considered to be caused by a combination of blockage of westward littoral drift and widespread land subsidence in the coastal area. Therefore, coastal measures to mitigate these two factors must be considered comprehensively, including land subsidence issues and land use planning in the hinterland as well as the coastal area. In addition, the hinterland is an urban area and there are also tourist facilities. In the past, the coastal area was used as a tourist site for swimming and other activities, but it has become difficult due to the raised embankment. Therefore, it is necessary to consider the coastal measures from the aspects of safety as an urban area and the use of the coast.

■Ideal coastal situation:

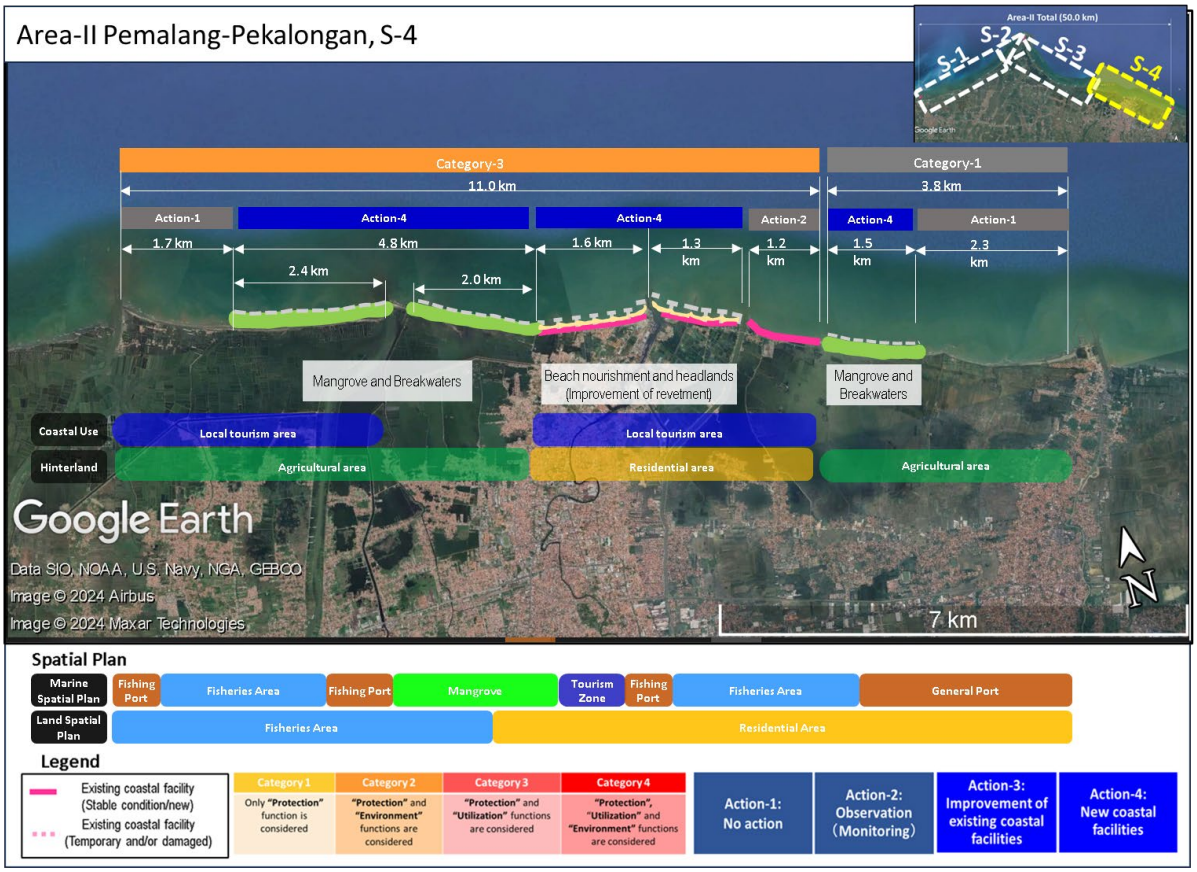
Aim to ensure safety from coastal disasters, to recover the lost coastal use, and to create the coast as more active tourism area.

■Required Coastal Functions:

The hinterland is utilized as residential area or agricultural area. The coastal area is high local tourism area, and future coastal utilization by developing coastal facilities is expected due to the existence of large urban area behind the coast. Thus, the required coastal function is designated as Category-3 (Protection and Utilization) in the tourism area, and Category-1 (Protection) in the other area.

■Direction of Required Action and Selection of Coastal Measures:

The Section includes some existing and planned coastal facilities, yet without considering utilization function. For urban frontages area utilized as tourist areas, considering future coastal utilization, beach nourishment and headlands are proposed as Action-4 (new coastal facilities). Meanwhile, for areas used for agriculture and aquacultural area such as fishponds, which are partially submerged due to land subsidence, mangrove plantation with breakwaters is proposed as Action-4 (new coastal facilities). In areas where coastal erosion is not significant or where coastal facilities have been recently built, the recommended actions are either Action-1 (No action) or Action-2 (Observation (Monitoring)).

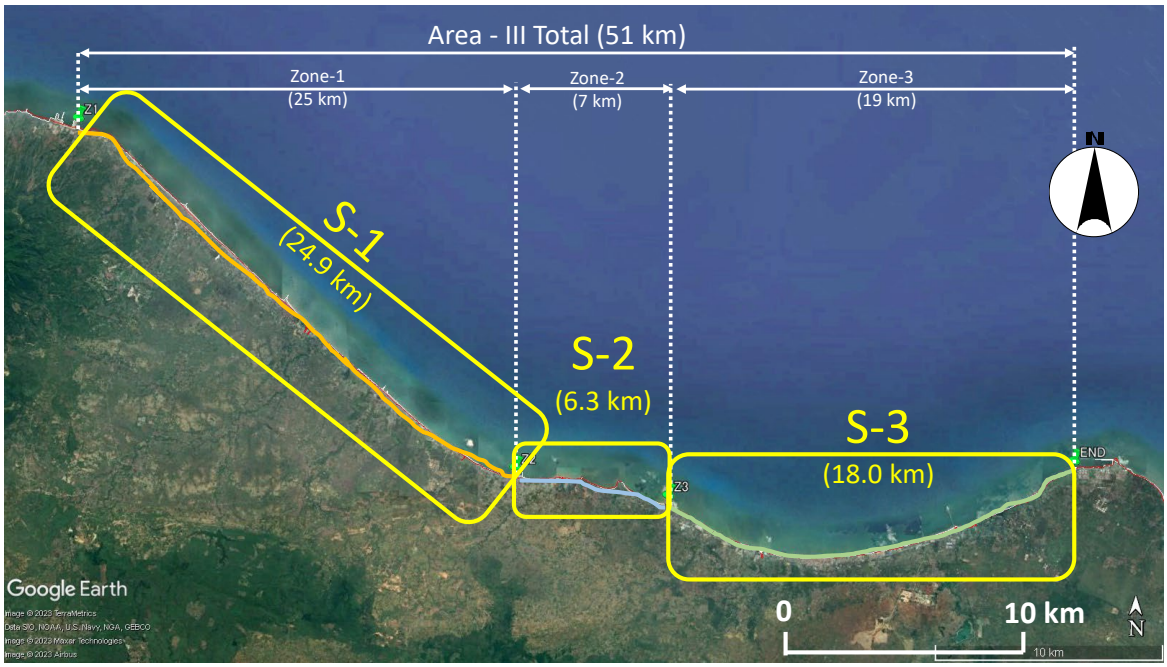


Source: Edited by JICA Study Team based on Google Earth

Figure 10.2.5 Draft of Basic Coastal Management Plan in Pemalang-Pekalongan Section-4

10.3 Area-III: Rembang-Tuban

Figure 10.3.1 shows the location of Sections. Figure 10.3.2-Figure 10.3.4 shows the draft of Basic Coastal Management Plan in Area-III: Rembang-Tuban.



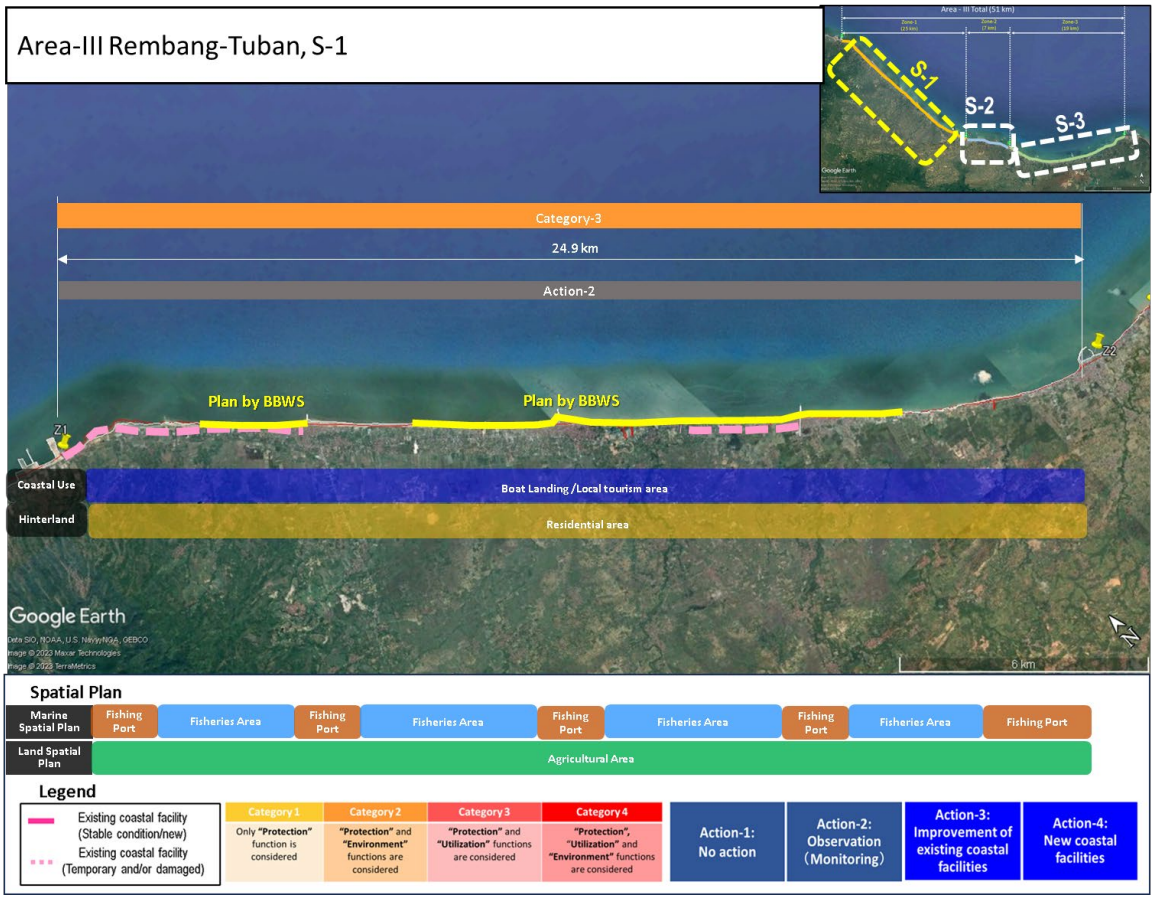
Source: Edited by JICA Study Team based on Google Earth

Figure 10.3.1 Location of Sections at Area-III (Rembang-Tuban)

10.3.1 Area-III: Rembang-Tuban S-1

Figure 10.3.2 shows the draft of Basic Coastal Management Plan in Area-III: Rembang-Tuban S-1.

■Evaluation/Issues: This Section has erosion tendency in recent years and almost 75 % of the coastline has already been man-made as a result of the hard measures implemented to protect fishing villages in the hinterland from high wave inundation damage. Due to continuous westward littoral drift beach, more than 70 % of the beaches have already been man-made, making it difficult to basically maintain the Section as a whole based on the continuity of the littoral drift. As long as the function of these structures is maintained by hard countermeasures, the protection function is expected to be maintained, but the natural sandy beaches that originally existed are almost disappearing and it makes coastal use difficult.
■Ideal coastal situation: Aim to ensure the safety of fishing communities.
■Required Coastal Functions: The hinterland is utilized as residential area. The coastal area is utilized for both boat mooring and as a local tourism area. Thus, the required coastal function is designated as Category-3 (Protection and Utilization).
■ Direction of Required Action and Selection of Coastal Measures: The Section has existing plan by BBWS for coastal facility development, and its impact on construction of new coastal facilities needs to be monitored. The Section is designated as the Action-2 (Observation (Monitoring)).



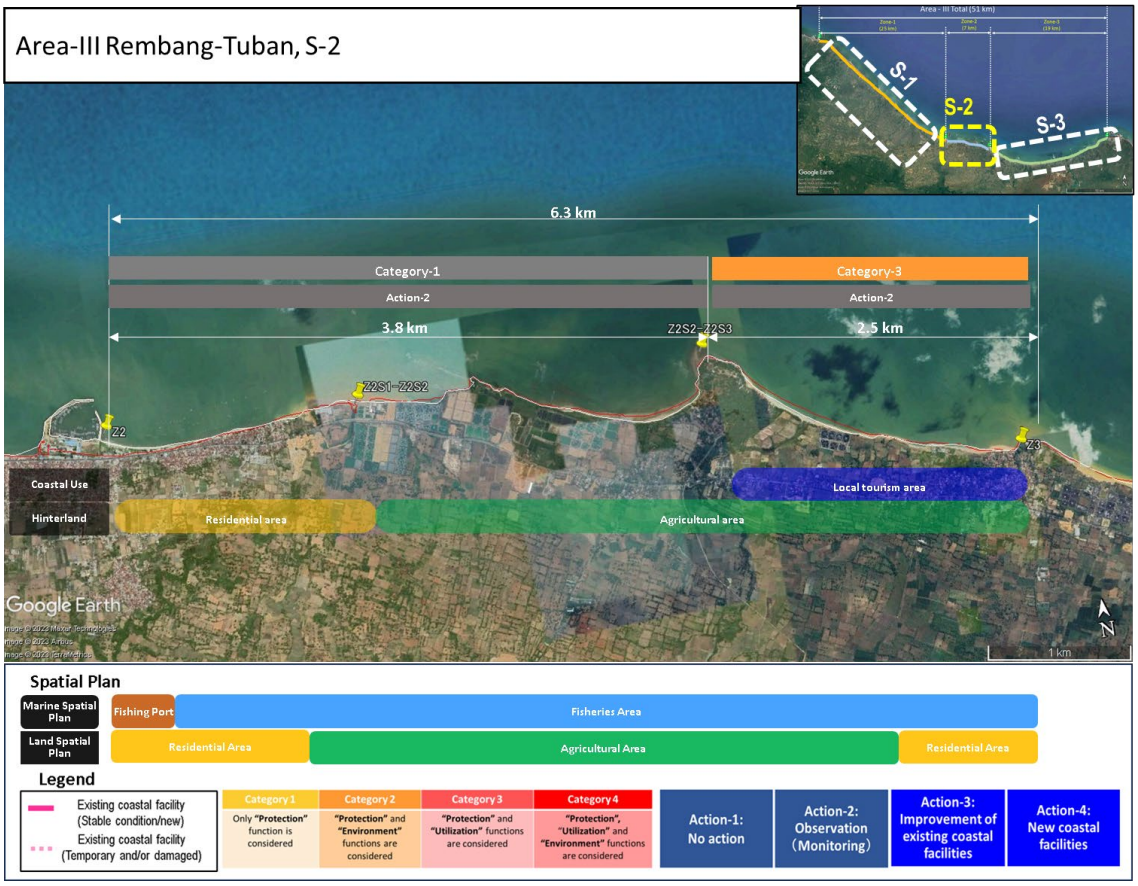
Source: Edited by JICA Study Team based on Google Earth

Figure 10.3.2 Draft of Basic Coastal Management Plan in Rembang-Tuban Section-1

10.3.2 Area-III: Rembang-Tuban S-2

Figure 10.3.3 shows the draft of Basic Coastal Management Plan in Area-III: Rembang-Tuban S-2.

■Evaluation/Issues: Most of area in this Section is located as a pocket beach surrounded by a fishing port and two capes and a relatively stable beach is maintained, especially in the absence of coastal facilities. Therefore, the first priority is to maintain this beach condition over the long term and the conservation of the current beach condition. In addition, land use regulations in the coastal area should be considered.
■Ideal coastal situation: Promote the maintenance and conservation of existing sandy beaches to ensure the safety of residential areas and the succession of natural beaches to the next generation.
■Required Coastal Functions: The hinterland is utilized by both residential and agricultural area. In the east area, the coastal area is utilized as local tourism area. Thus, the required coastal function is designated as Category-3 (Protection and Utilization) in east area, and Category-1 (Protection) in west area.
■Direction of Required Action and Selection of Coastal Measures: The Section forms a pocket beach and has a relatively stable shoreline with no existing facilities. To preserve the natural beach for future generations, it is crucial to avoid new coastal disasters (such as coastal erosion caused by blocking littoral drift) resulting from the construction of new coastal facilities. Therefore, the Section is designated as Action-2 (Observation (Monitoring)).



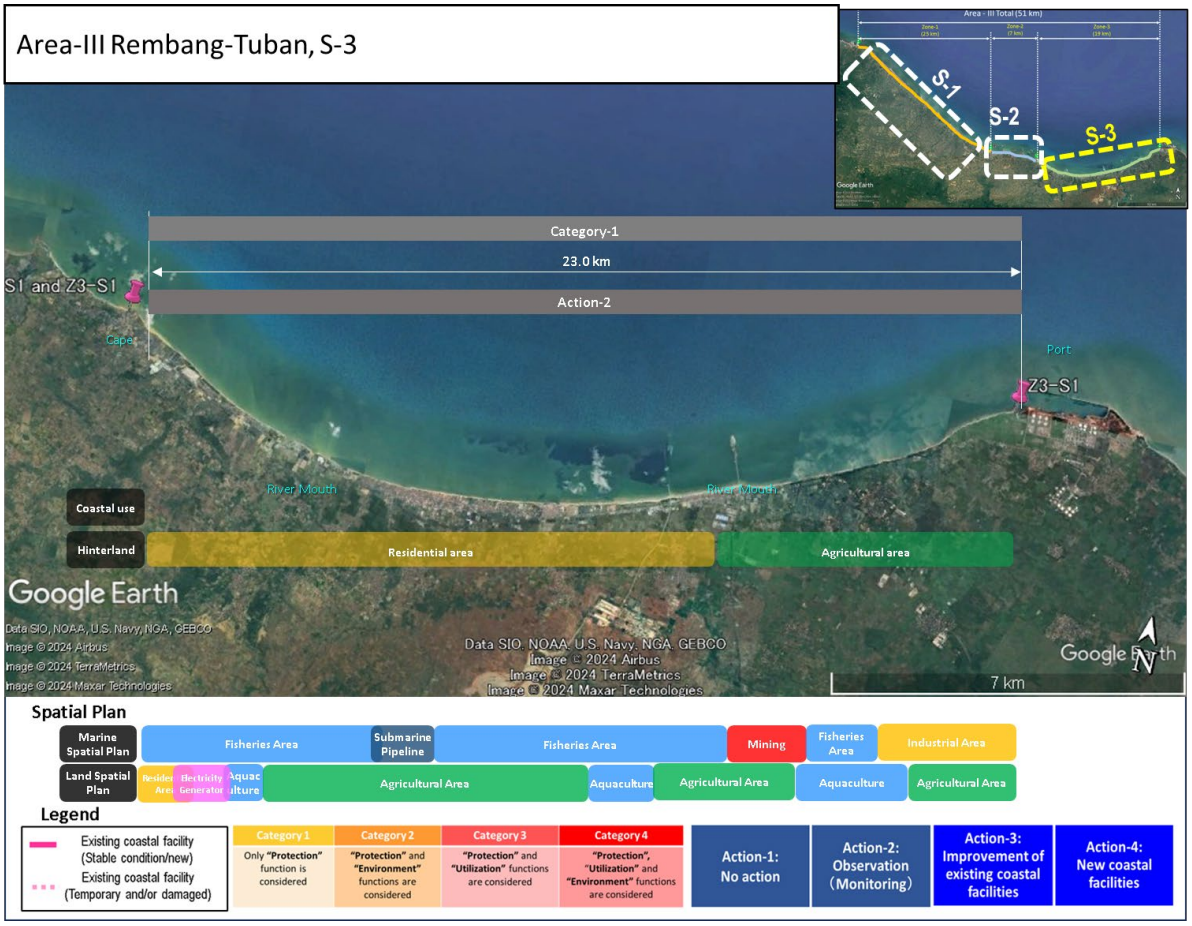
Source: Edited by JICA Study Team based on Google Earth

Figure 10.3.3 Draft of Basic Coastal Management Plan in Rembang-Tuban Section-2

10.3.3 Area-III: Rembang-Tuban S-3

Figure 10.3.4 shows the draft of Basic Coastal Management Plan in Area-III: Rembang-Tuban S-3.

■ Evaluation/Issues: Based on the direction of the shoreline, the current beach and past shoreline changes, this Section is relatively sediment balanced. There are no coastal facilities that would affect the movement of sediment. Therefore, the first priority is to maintain this beach condition over the long term and the conservation of the current beach condition. In addition, land use regulations in the coastal area should be considered.
■Ideal coastal situation: Promote the maintenance and conservation of existing sandy beaches to ensure the safety of residential areas and the succession of natural beaches to the next generation.
■Required Coastal Functions: The hinterland is utilized by both residential and agricultural area. The coastal area is mainly used as fishery purposes, whereas coastal utilization as tourism activity is limited. Thus. the required coastal function is designated as Category-1 (Protection).
■ Direction of Required Action and Selection of Coastal Measures: Given that the high elevation of the hinterland and the relatively balanced littoral drift, the current risk of coastal disasters is low. Moreover, as this coast has westward coastal drift, in which new coastal facilities may arise the negative impact on the downdrift side of littoral drift. Therefore, the Section is designated as Action-2 (Observation (Monitoring)).



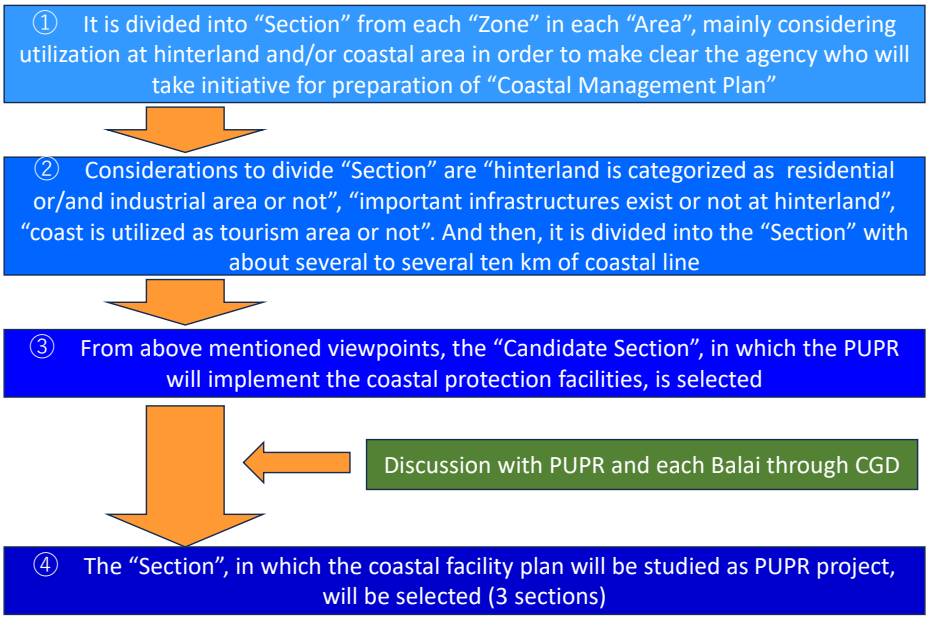
Source: Edited by JICA Study Team based on Google Earth

Figure 10.3.4 Draft of Basic Coastal Management Plan in Rembang-Tuban Section-3

CHAPTER 11 Selection Process of Study Areas for Coastal Facility Plans

11.1 Flow for Selection Procedure

The Coastal Facility Plan will be studied for the selected sections from the area of Basic Coastal Management Plan. The sections shall be selected based on the discussion with PUPR and each BBWS through the conducted Close Group Discussion (CGD). Figure 11.1.1 shows the procedure for the selection of sections.



Source: JICA Study Team

Figure 11.1.1 Flow of the Procedure for the Selection of Sections

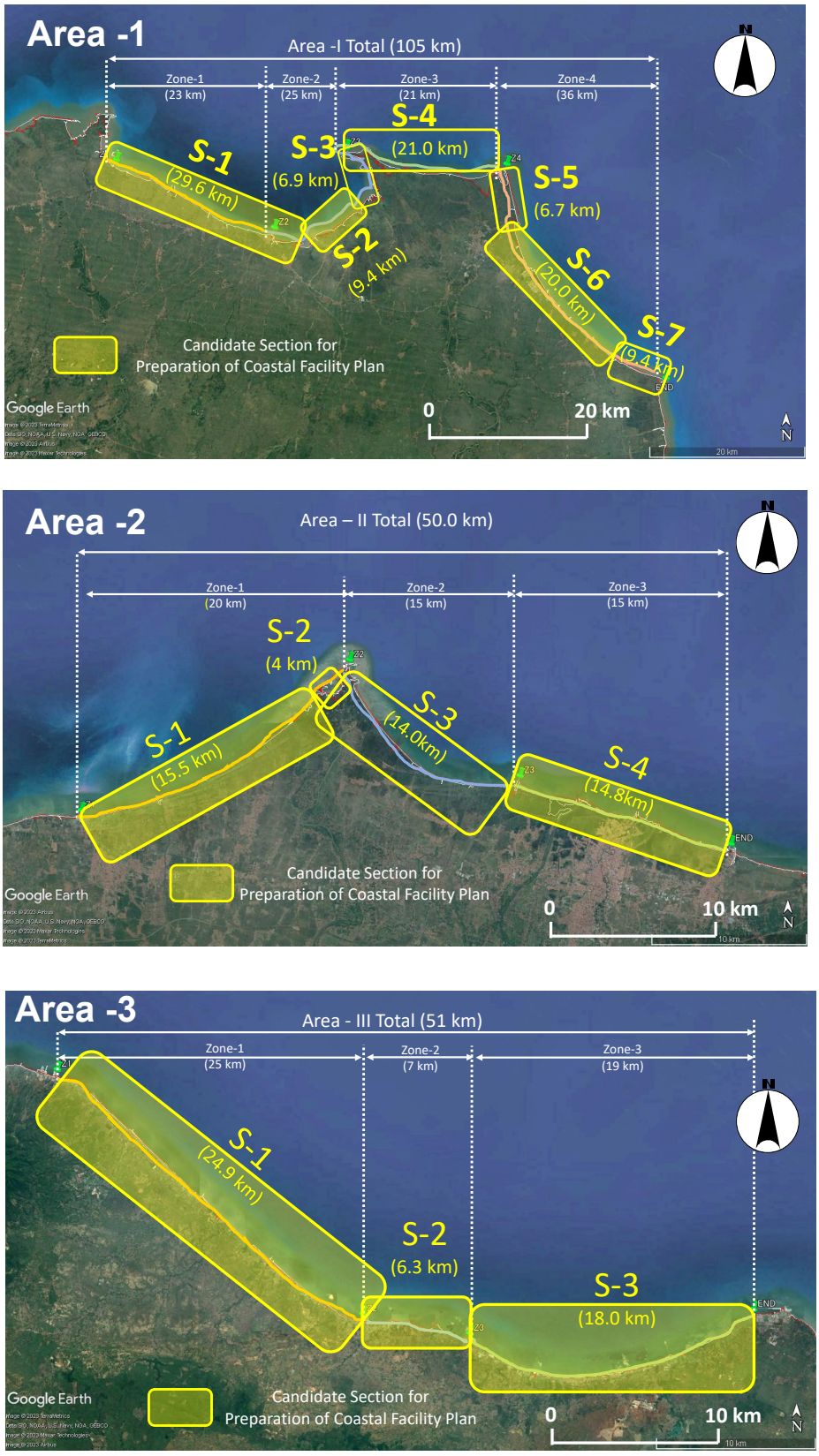
11.2 Extracted Sections as Candidate Sections

Table 11.2.1shows the candidate sections for the study Coastal Facilities Plan as future implemented project by the PUPR. Seven sections were selected as candidate sections as shown below.

Table 11.2.1 Summary of Selected Candidate Sections for Coastal Facility Plans

Area	Section	Length
Area-1	S-1	29.6 km
	S-6	20.0 km
Area-2	S-1	15.5 km
	S-4	14.8 km
Area-3	S-1	24.9 km
	S-2	6.3 km
	S-3	18.0 km

Source: JICA Study Team

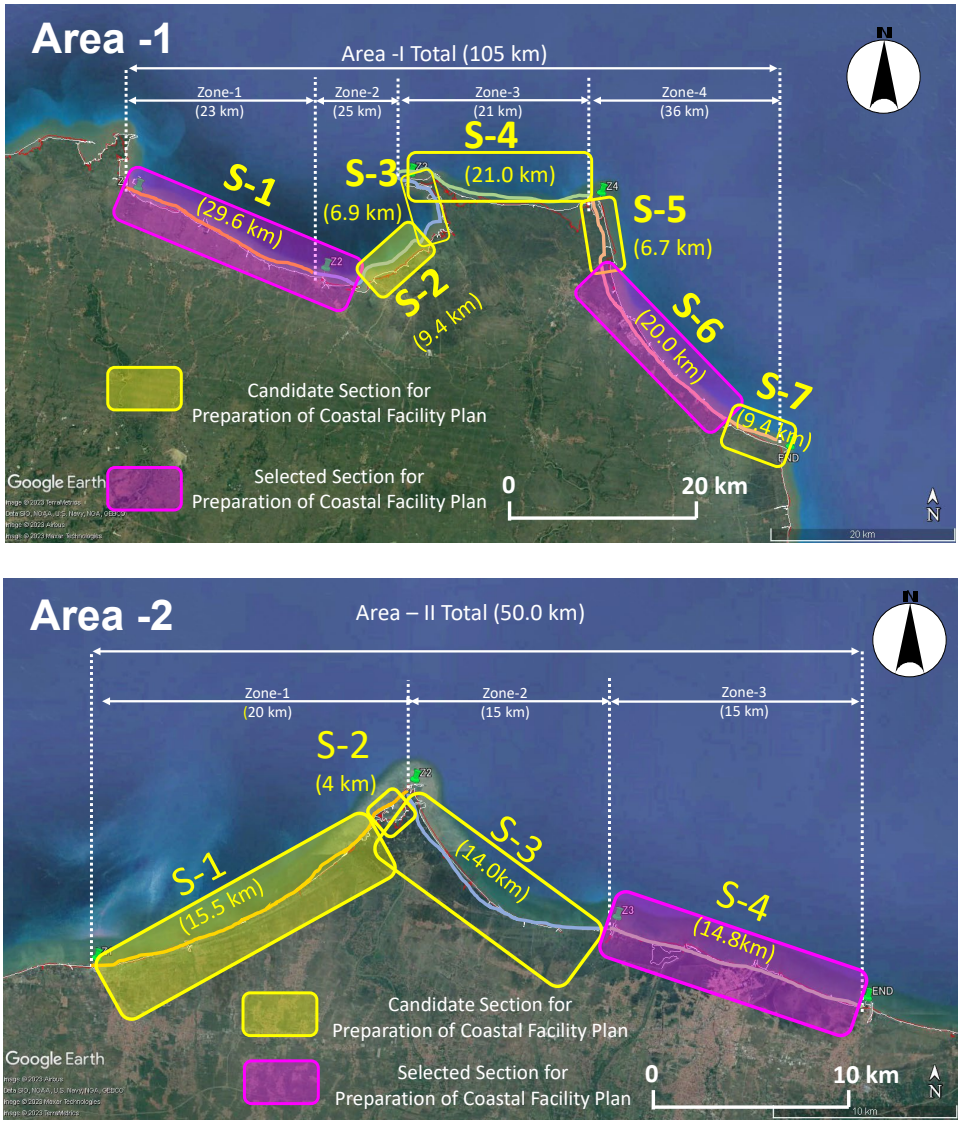


Source: Edited by JICA Study Team based on Google Earth

Figure 11.2.1 Selected Candidate Sections for Coastal Facility Plans

11.3 Selected Selections

As a result of the discussions with PUPR and BBWS through the CGD, three sections in total were selected for study on Coastal Facility Plan, which consists of two sections from Area-I and one section from Area-II. Meanwhile, in Area-III, BBWS is currently planning and implementing coastal protection measures, such as seawall construction, and the plans for further extension have been indicated. Therefore, it was determined that Area-III is unsuitable for consideration of a new coastal development project. Consequently, Area-III was excluded from the study area for Coastal Facility Plan based on the agreement with PUPR.

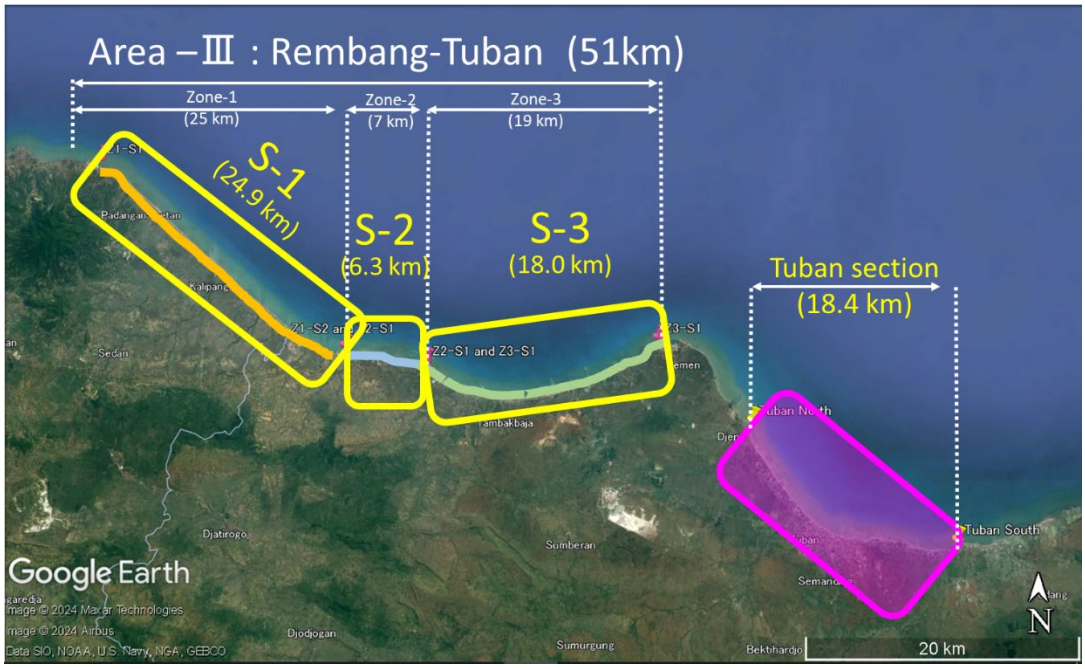


Source: Edited by JICA Study Team based on Google Earth

Figure 11.3.1 Selected Three Sections for Coastal Facility Plans

11.4 Additional Tuban Section

BBWS Bengawan Solo, that manages the east side of Area-III, reported that National Route 1, which is an important infrastructure located just behind the coast, had caused high waves and overtopping damage during severe wave conditions. Due to both the exclusion of Area-III from the study area for Coastal Facility Plan and the damage report from BBWS Bengawan Solo on the adjacent coast, PUPR requested to include this coast as a study area for Coastal Facility Plan. According to the discussion between PUPR and JICA, both parties agreed to include the coast as a study area for Coastal Facility Plan. This coast is hereinafter referred as to the Tuban section (18.4km), as shown in Figure 11.4.1.



Source: Edited by JICA Study Team based on Google Earth

Figure 11.4.1 Additional Tuban Section

CHAPTER 12 Preliminary Study for Coastal Facility Plan at Additional Tuban Section

12.1 Overview

The additional Tuban Section is located between a cape at the northern end and a port facility at the east end, with a coastal length of 18.4 km. Photographs of the north and east ends are shown in Figure 12.1.1 and Figure 12.1.2. In addition, no land subsidence has been observed in this area.

The littoral drift in this area is progressing southward on the west side, and westward on the east side with the central pier (Wisata Pantai Boom) as a branching point, as shown in the following pictures.

Currently, the existing revetments are being developed in highly public areas by the local government. In addition, in residential areas, each resident has constructed a vertical seawall independently, leading the shoreline alignment is uneven with areas both with and without a seawall.

The area behind the coast consists of; fishing villages, tourism areas, public facilities (national highways, etc.), and residential areas. The coastal utilization near the center pier (Wisata Pantai Boom) is obstructed during storm surges because the foreshore is narrow. In the area behind the coast, such as National Route 1, National Route 17, and Mangrove Center, the wave overtopping during storm surges hindered traffic and utilization.

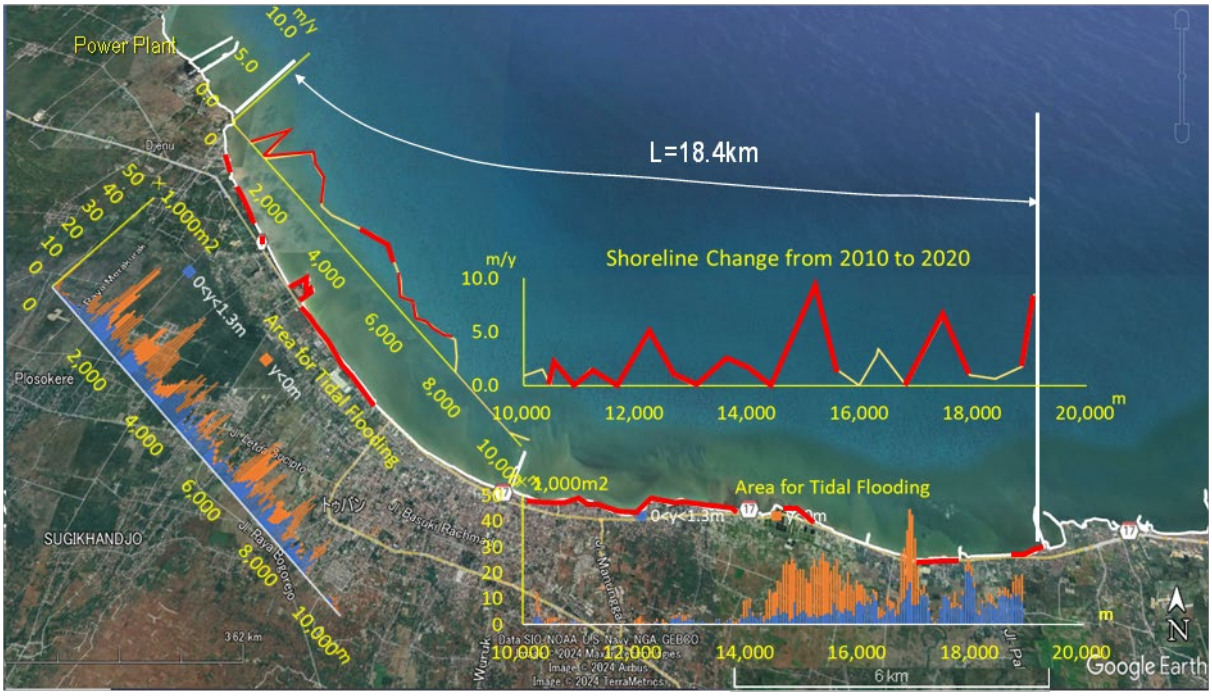
Source: Edited by JICA Study Team based on Google Earth

Figure 12.1.1 Starting Point and Surrounding Conditions in Turban Addition Section

Source: Edited by JICA Study Team based on Google Earth

Figure 12.1.2 End Point Surrounding Conditions in Turban Addition Section

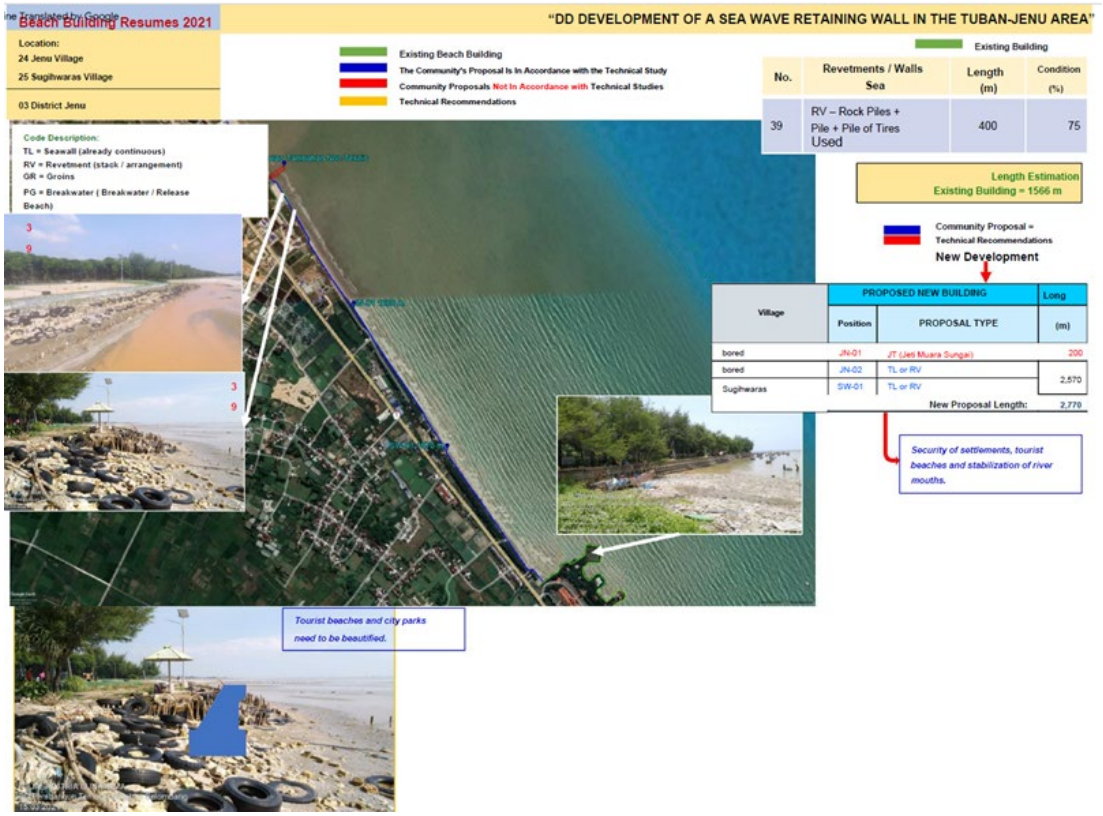
Significant amount of erosion was not observed according to the previous shoreline changes, showing the accumulation tendency as shown in Figure 12.1.3. This trend may be due to the construction of seawalls and jetties, but the area shown by the red line in the shoreline and shoreline changes graphs in Figure 12.1.3 is due to artificial advancement to offshore. In addition, the unchanged shoreline have been protected by the seawall. Therefore, it is likely that the protection provided by artificial activities and existing structures in and around the shoreline, as mentioned above, leads to increase nearshore water depth and wave overtopping damage.



Source: Edited by JICA Study Team based on Google Earth

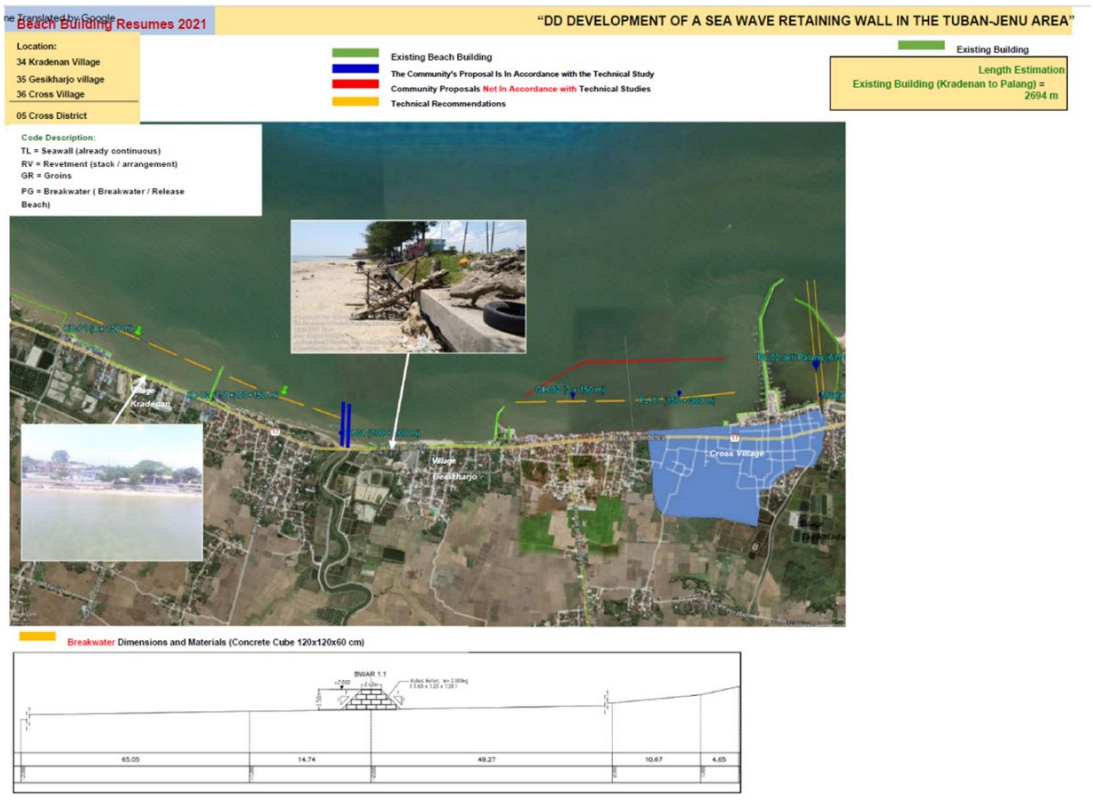
Figure 12.1.3 Shoreline Change and Risk of Inundation Area

BBWS Bengawan Solo have the existing plans of coastal facility development that includes some coastal facilities such as revetment close to the shoreline for the tourism area and offshore breakwater in front of the residential area. Figure 12.1.4 and Figure 12.1.5 show the revetment development plan for the tourist area and the offshore breakwater development plan for the residential area near the end point as samples respectively.



Source: Edited by JICA Study Team based on Google Earth

Figure 12.1.4 Coastal Facility Plan (Revetment Plan)



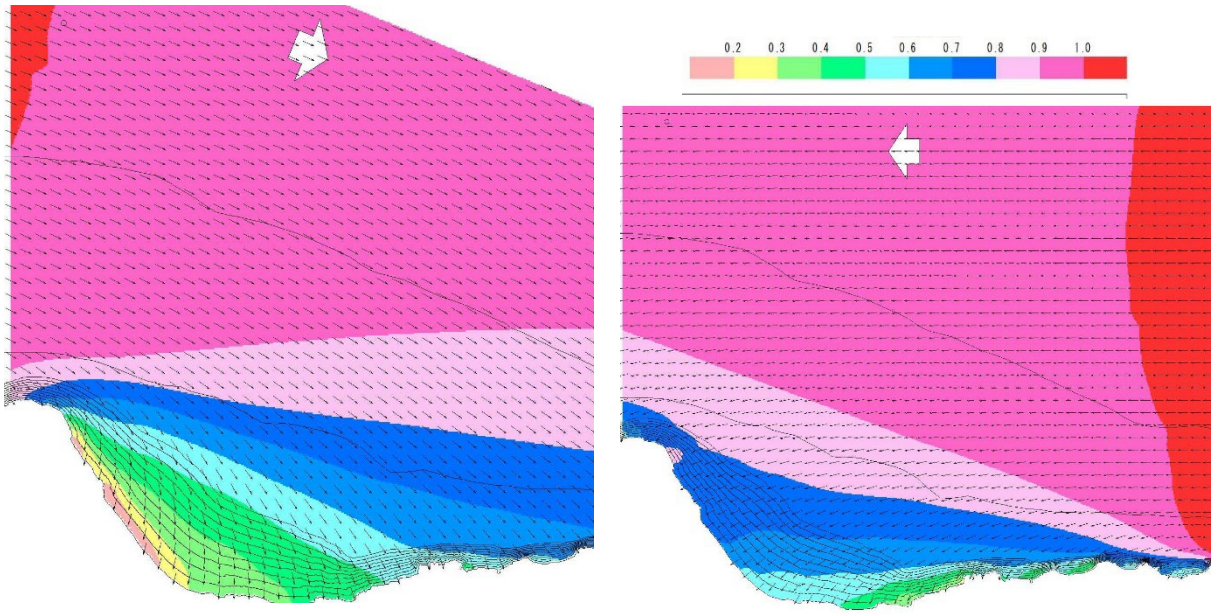
Source: Edited by JICA Study Team based on Google Earth

Figure 12.1.5 Coastal Facility Plan (Offshore Breakwater Plan)

12.2 Natural Conditions

12.2.1 Waves and Tide

According to the wave estimation data (ERA5) in the offshore coast of Rembang-Tuban shown previously, the wave characteristics of the coastal area of Rembang-Tuban were organized. Figure 12.2.1 shows the wave deformation calculation results for waves with a period of 6 s when the wave height is relatively high for waves from the E direction that predominate in the dry season and waves from the WNW direction that predominate in the rainy season. Since this figure is for an incident wave height of 1 m, it represents the wave height ratio. In the case of the incident wave orientation WNW, which is predominant in the rainy season, the wave height is less than 50 % of the offshore wave height because it is a shadow of the terrain that protrudes to the north at the northern end, while in the case of the incident wave direction E, which is predominant in the dry season, it is 80 % or less, which is higher than the wave direction WNW. Therefore, it is presumed that the coast is affected by waves from the east during the dry season.

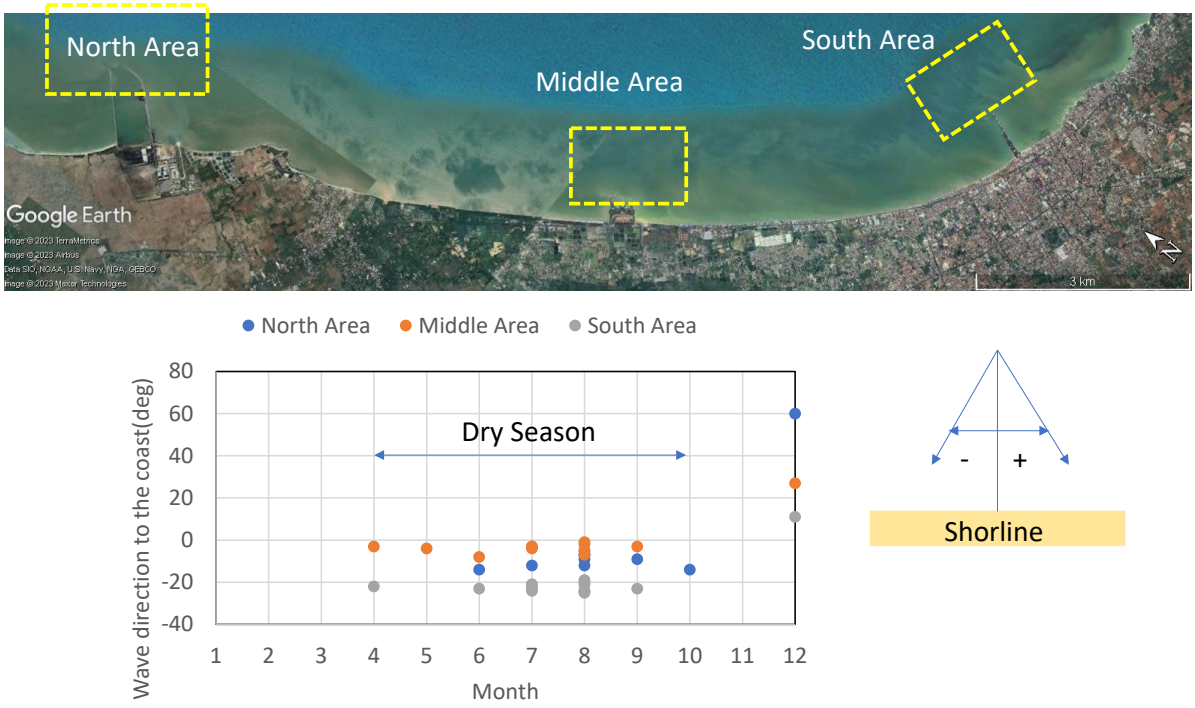


Source: JICA study team

Figure 12.2.1 Wave Height Distribution with a Period of 6 s and an Incident Wave Height of 1 m

(Direction of the Incident Wave, Left: WNW, Right: E).

Figure 12.2.2 shows the direction of wave incidence at three points from satellite images. Most of the images are from the dry season, and according to them, the waves are incident on the right hand (negative value) of the coastline during the dry season. On the other hand, there is only one image of the rainy season, but on the contrary, it is incident from the left hand (positive value) to the coastline. This is consistent with the wave direction characteristics analyzed from the wave estimation data off Rembang-Tuban.



Source: Edited by JICA Study Team based on Google Earth

Figure 12.2.2 Wave Direction Read from Satellite Imagery

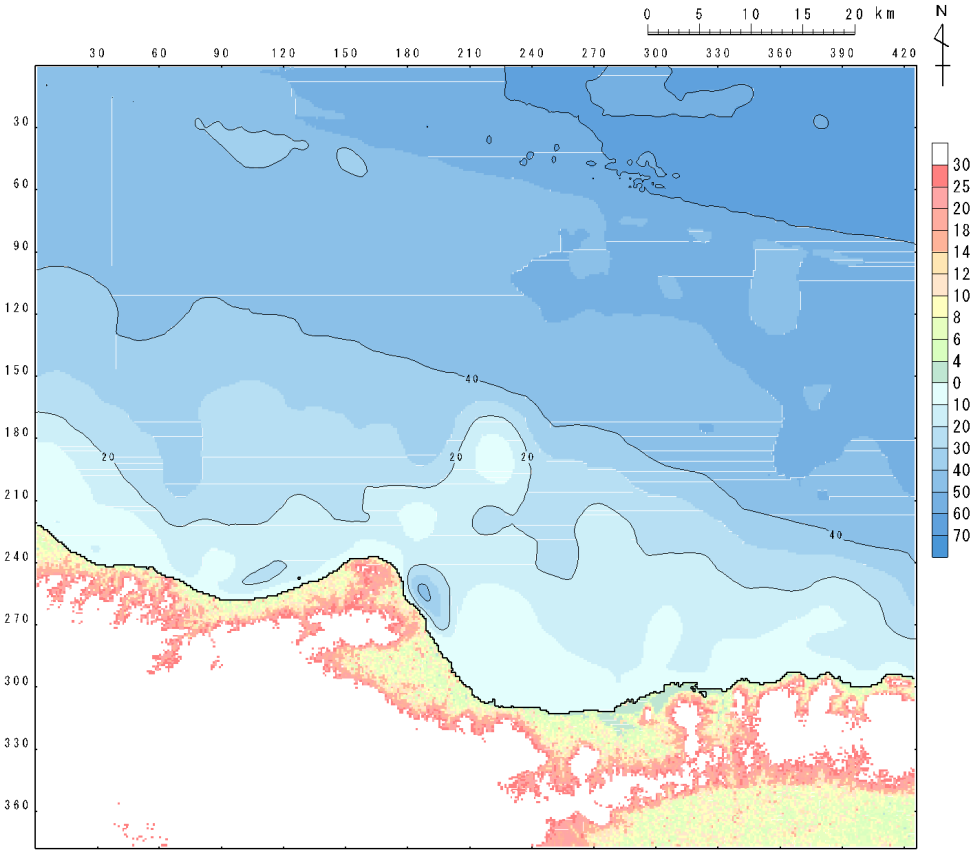
As for the tide level in the coastal area, since the annual maximum tide level is +0.95 m above the mean sea level, the tidal difference at that time reaches about 2 m. Therefore, the sea level rises as it approaches the top of the embankment at high tide, while a vast dry area appears due to the gentle slope of the seabed at low tide (Figure 12.2.3).

Source: JICA study team

Figure 12.2.3 Conditions at Low and High Tide (Upper Left: High Tide, Others: Low Tide)

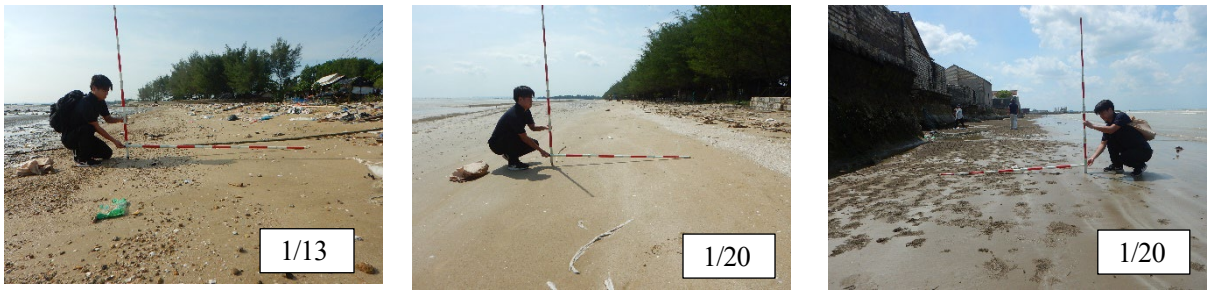
12.2.2 Topography

Figure 12.2.4 shows the bathymetric topography of the coastal area. Since the depth of the water is about 20 m about 10~20 km offshore, the seabed gradient is very gentle at about 1/500~1/1,000. The foreshore slope at sandy beaches is about 1/13~1/20 (Figure 12.2.5).



Source: Created from BANNAS

Figure 12.2.4 Bathymetry



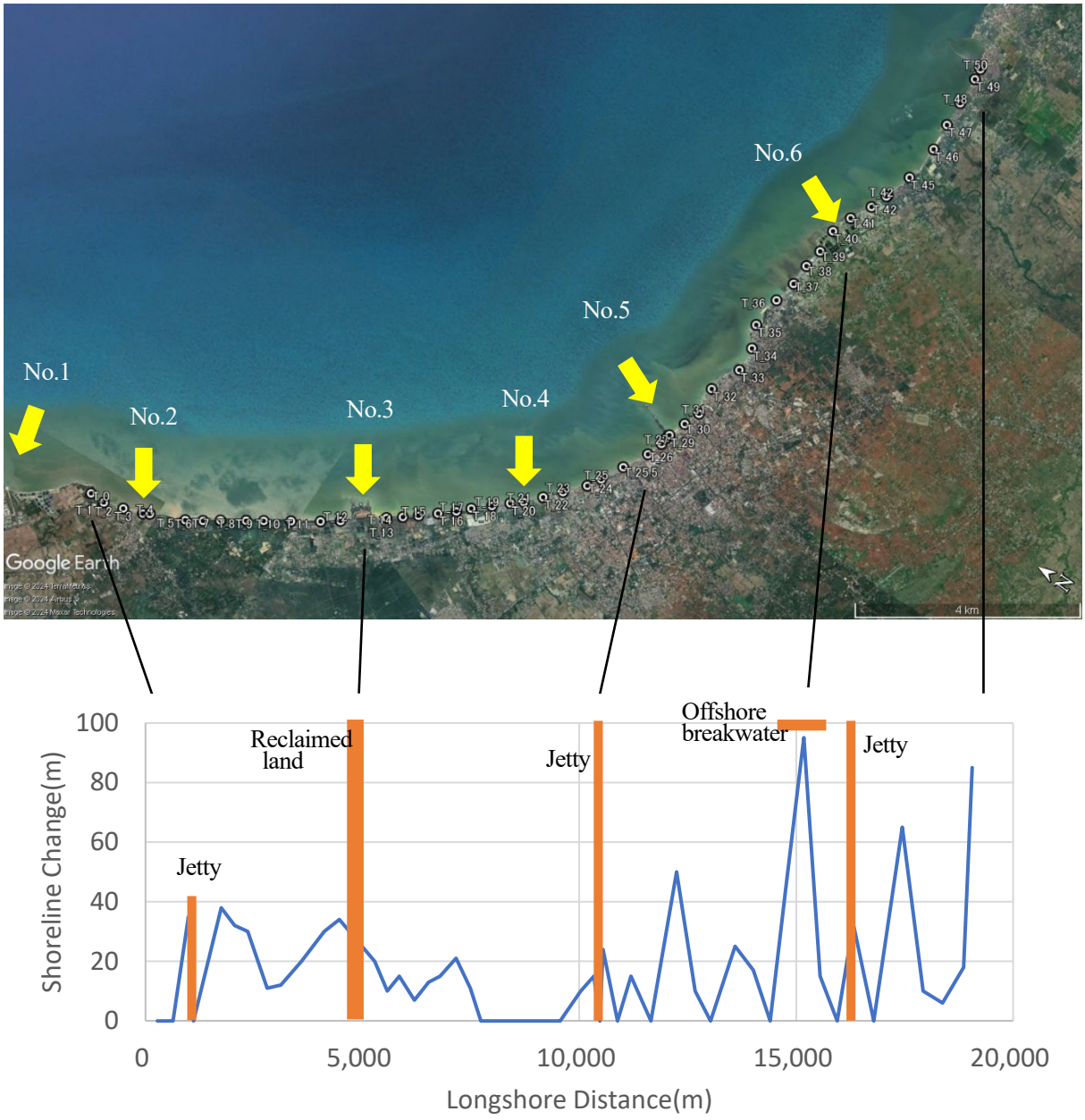
Note: the numerical value is the foreshore slope

Source: JICA study team

Figure 12.2.5 Beach Topography (Jan. 2024)

12.2.3 Topographic Changes

The shoreline changes in the coastal area were analyzed by satellite images. Figure12.2.6 shows the shoreline change over a period of about 20 years from 2000 to 2020. Throughout the entire area, there is a shoreline forward area, but no retreat area. However, many areas where there is no shoreline change have no beach, such as seawalls. Since shoreline changes are often caused by inhibition of littoral drift due to the structure. Shoreline change around a typical structure is shown in Figure 12.2.7-Figure 12.2.14.



Source: Edited by JICA Study Team based on Google Earth

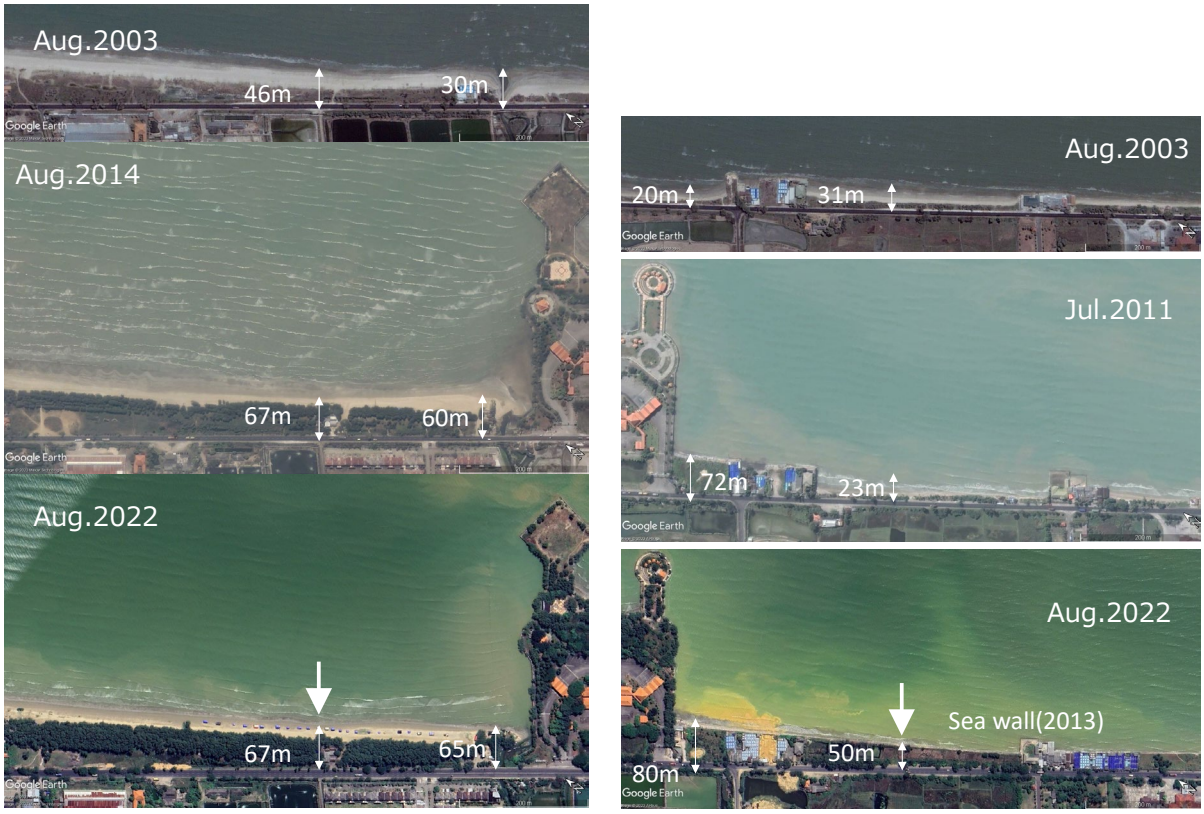
Figure12.2.6 Changes Read from Satellite Images (2000-2022)

Source: Edited by JICA Study Team based on Google Earth

Figure 12.2.7 Shoreline Change Around the Breakwater of Port (No.1)

Source: Edited by JICA Study Team based on Google Earth

Figure 12.2.8 Shoreline Change Around the Groin (No.2)



Source: Edited by JICA Study Team based on Google Earth

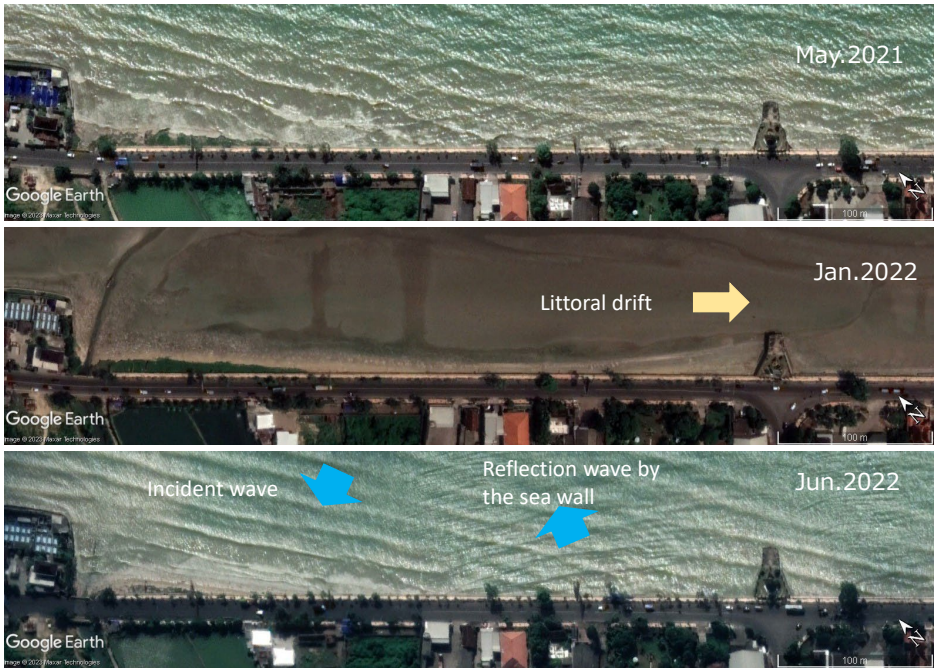
Figure 12.2.9 Shoreline Change Around the Reclaimed Land (No.3)

Source: Edited by JICA Study Team based on Google Earth

Figure 12.2.10 Topography Around the Reclaimed Land in Low Tide (No.3)

Source: Edited by JICA Study Team based on Google Earth

Figure 12.2.11 Shoreline Change Around the Reclaimed Land and the Groin (No.4-a)



Source: Edited by JICA Study Team based on Google Earth

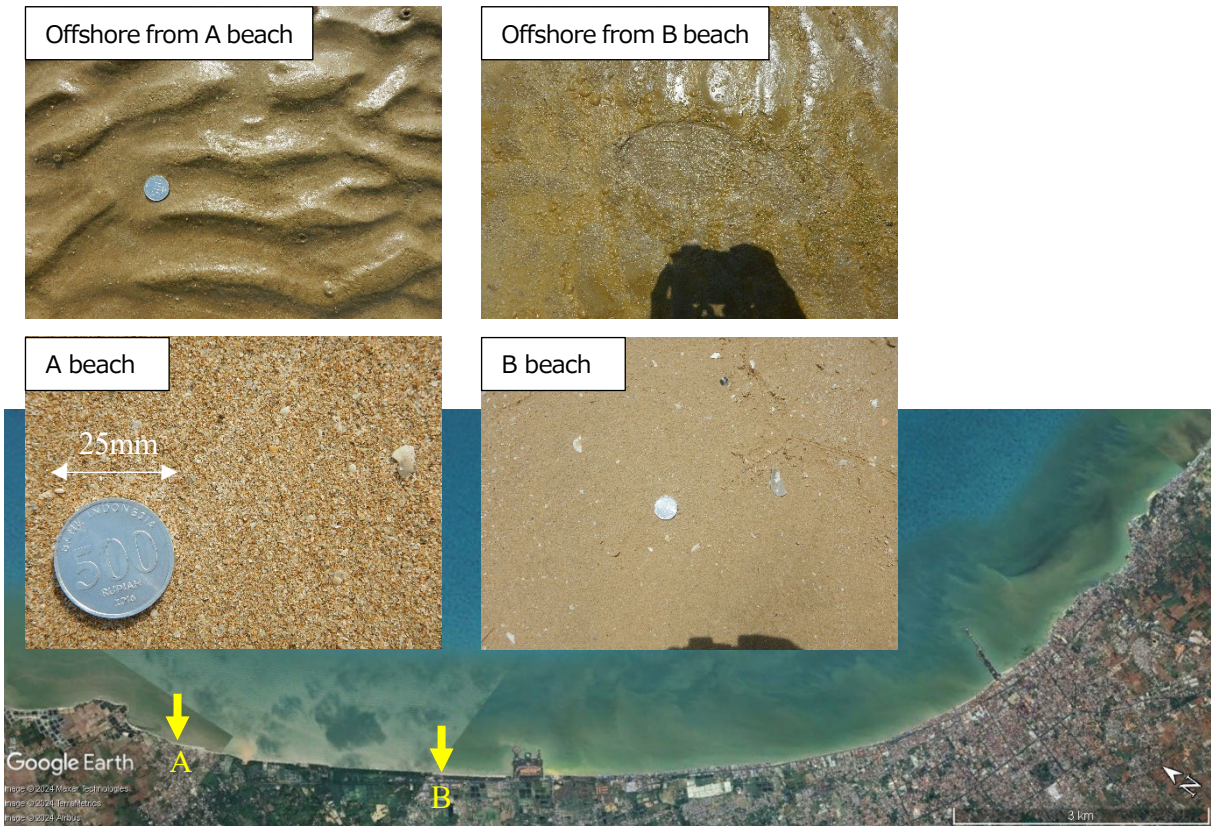
Figure 12.2.12 Shoreline Change Around the Reclaimed Land and the Groin (No.4-b)

Figure 12.2.13 Shoreline Change Around the Jetty (No.5)

Figure 12.2.14 Shoreline Change Around the Offshore Breakwater and Jetty (No.6)

12.2.4 Sediment

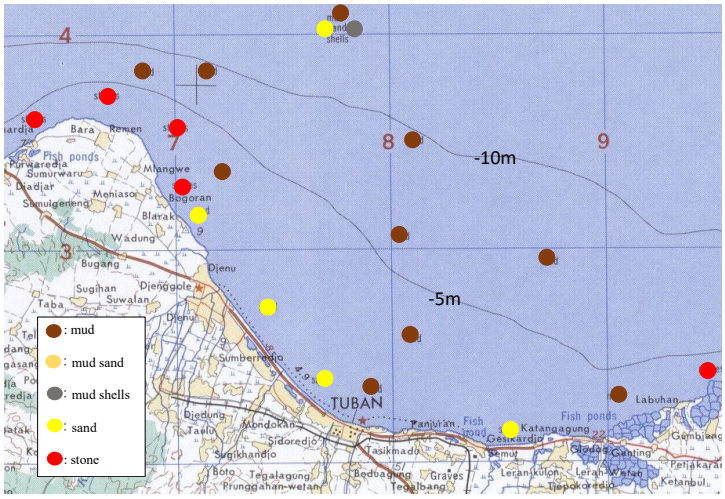
Figure 12.2.15 shows a photograph of the sediment situation near the shoreline. Both sandy beaches A and B are composed of fine sand, but both places offshore are composed of sediment with a lot of silt and clay. Figure 12.2.16 shows the sediment status of the seabed indicated on the sea chart.



※Photograph taken during the field survey in Jan.2024

Source: Edited by JICA Study Team based on Google Earth

Figure 12.2.15 Sediment on the Beaches

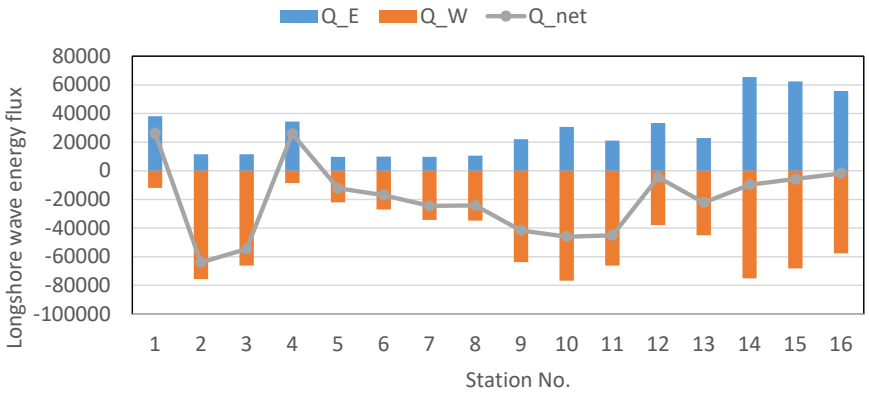


Source: JICA study team

Figure 12.2.16 Seabed Sediment (Created by Sea Chart)

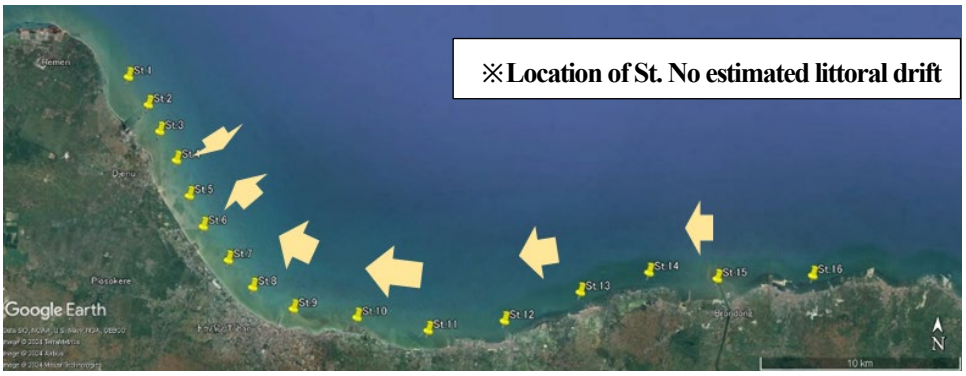
12.2.5 Characteristics of Littoral Drift

From the above analysis, the predominant direction of littoral drift on the coast is shown in Figure 12.2.18.



Source: JICA Study Team

Figure 12.2.17 Littoral Drift Estimated by Wave Analysis



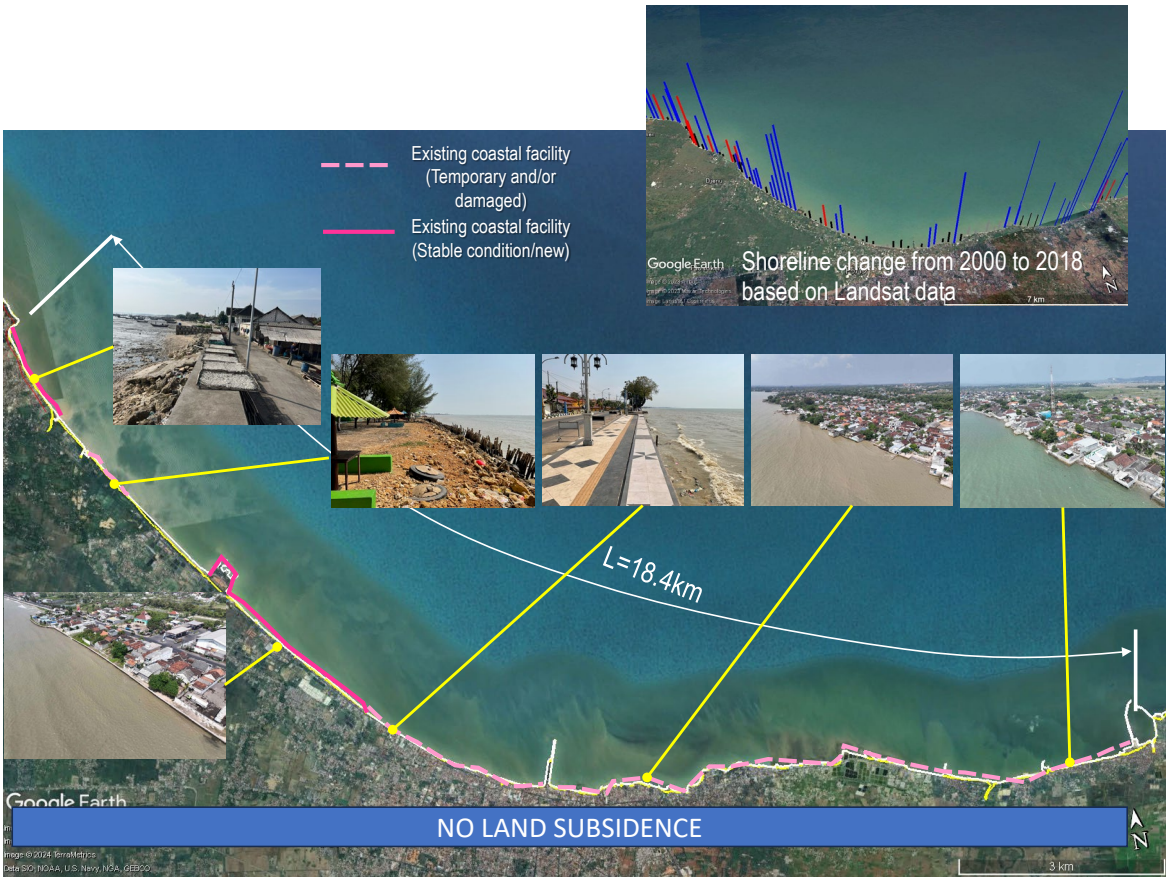
Source: Edited by JICA Study Team based on Google Earth

Figure 12.2.18 Estimated Predominant Direction of Littoral Drift

12.3 "Ideal Situation of Coast" from Assessment of Current Conditions, Problems and Issues

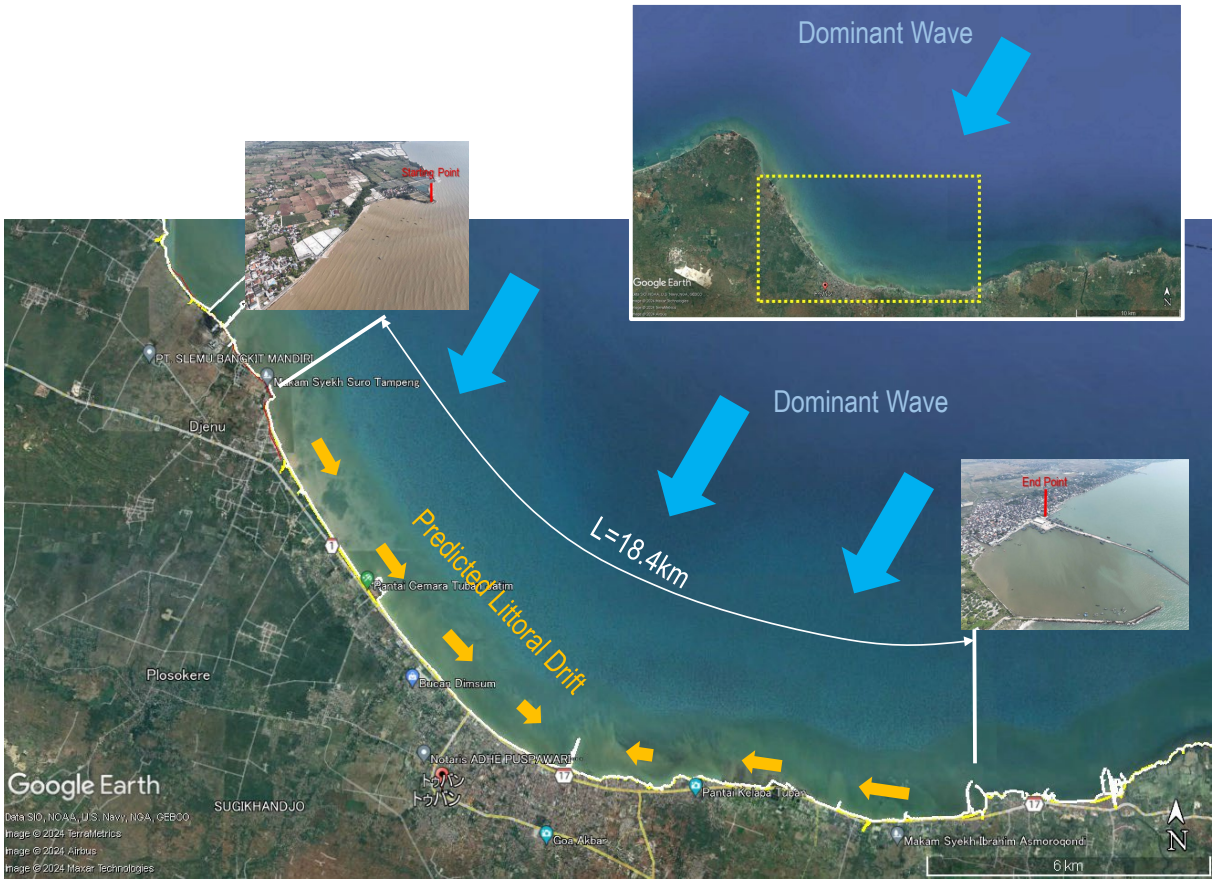
As an evaluation of current conditions, some information such as coastal erosion, land subsidence and utilization, and location of existing coastal facilities are summarized in Figure 12.3.1. Figure 12.3.2 shows the wave and littoral drift mechanisms in the area.

Based on the information and result of the evaluation of the current coastal condition in Figure 12.3.2, the issues and the " Ideal state of the coast" based on the information and evaluation of the current coastal condition are summarized in Table 12.3.1.



Source: Edited by JICA Study Team based on Google Earth

Figure 12.3.1 Current Conditions of the Coast in Tuban Section (East)



Source: Edited by JICA Study Team based on Google Earth

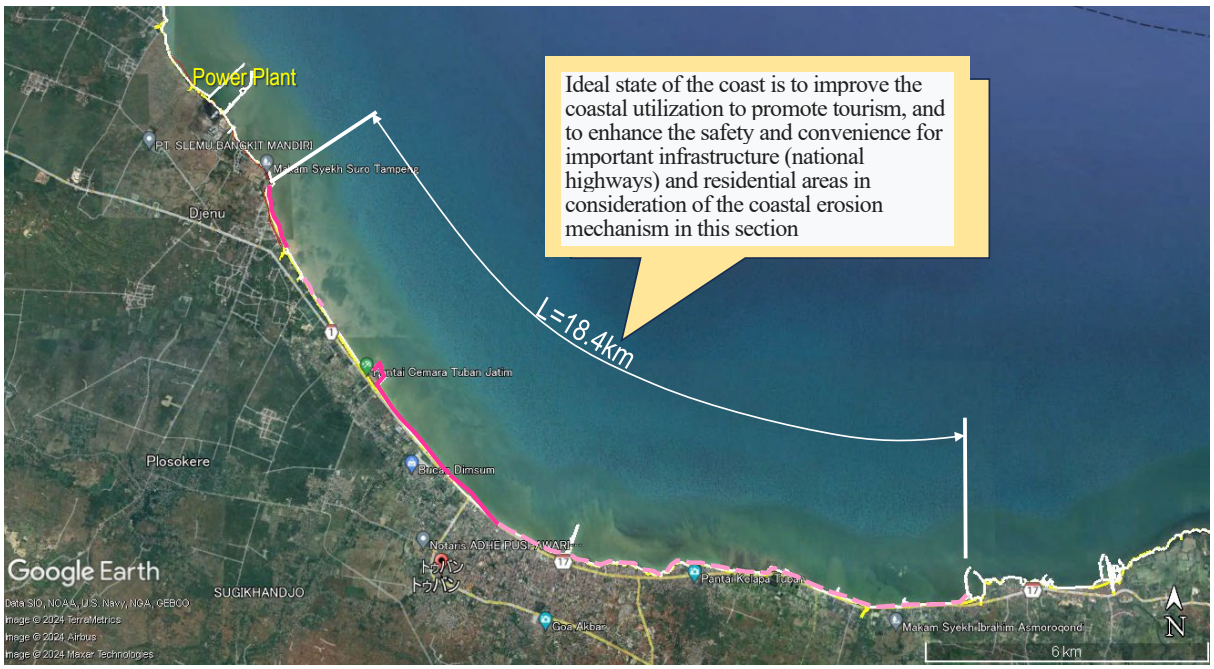
Figure 12.3.2 Conditions of Waves and Littoral Drift in Tuban (East)

Table 12.3.1 Current Condition Assessment and Issues of the Coast and the Ideal State of the Coast in Additional Tuban Section

Section	Coastal Disaster Risk	Hinterland and Coastal Use	Existing Facilities	Evaluation/Issues	Ideal State of the Coast
S-1	Significant overall erosion was not found from past shoreline changes in the area. Because the seawall, etc. have already been developed for the area with a high density of public property, and in the residential area, a vertical seawall was constructed by each resident. Though erosion is not observed near the seawall, wave overtopping towards the backshore has occurred and the existing seawalls were damaged in the high tide and storm surge conditions due to scoring in front of the existing seawall. Tourism areas, in which Cemara Beach and Mangrove Center are located, are originally narrow in the foreshore, however when the tide is high, it is also obstructed due to wave overtopping and overflow to the backshore and land. Temporary seawalls are installed around Mangrove Center, but there is already some damage such as scouring. The land subsidence has not occurred in the area.	The hinterlands are mixed with fishing villages, tourism areas, public facilities such as national roads, and residential areas. Most are residential areas, but there are also significant and valuable tourist areas such as Cemara Beach on the west side and Wisata Pantai Boom in the central part of the area. The foreshore is already in a narrow situation, and the coastal utilization above the high water area has been disturbed. In addition, parts of National Route 1 and Route 17 face the seashore, and wave overtopping during storm surges has affected road traffic.	For fishing villages and highly public areas, vertical concrete seawalls are in place. Though sandy beach is maintained in the tourist area, a temporary seawall was installed in the area where a part of the foreshore is narrow, and the utilization and landscape are obstructed. Most of the residential areas have vertical seawalls developed by each occupant, and the alignment of the shoreline is uneven with and without seawalls. In some cases, the seawalls are damaged and have also affected the backshore. Adequate coastal management and utilization are unavailable from coastal alignment and backshore conditions. BBWS Bengawan Solo is planning coastal conservation in this area. In the tourist area, the installation of a revetment near the shoreline is planned, and the valuable sandy beach will disappear. If this plan is implemented, utilization and tourism will be affected. For residential and public areas, offshore breakwaters were planned.	In the tourist area, valuable sandy beaches exist, but there are some places where the foreshore is not sufficiently secured, and its maintenance and improvement are important. On the other hand, in BBWS Bengawan Solo, there is a plan for revetment near the shoreline, and it is feared that the sand beach will be lost by this plan. In order to promote tourism in the future, it is necessary to maintain and manage the sandy beach coast in consideration of utilization and the environment. Since important infrastructure areas facing the coast, such as national roads, are affected by wave overtopping during storm surges, it is necessary to consider their use in addition to countermeasures against wave overtopping. In the residential area, there is an upright seawall maintained by each resident, the coastal alignment is uneven with and without a seawall, and the structure type and crown height are also irregular, so that preservation measures from the viewpoints of long-term seashore protection and coast management are desired.	Ideal state of the coast is to improve the coastal utilization to promote tourism, and to enhance the safety and convenience for important infrastructure (national highways) and residential areas in consideration of the coastal erosion mechanism in this section.

Source: JICA Study Team

Figure 12.3.3 shows the "Ideal state of the coast" in the Additional area-Tuban.



Source: Edited by JICA Study Team based on Google Earth

Figure 12.3.3 "Ideal State of the Coast" in Area-III-Additional Area-Tuban East

12.4 Identification of Required Coastal Functions

Figure 12.4.1 and Figure 12.4.2 show direction of the Coastal Facility Plan at Tuban Section, considering the utilization of hinterland and coastal area.

■Evaluation/Issues:

In tourism area, In the tourist area, valuable sandy beaches exist, but there are some places where the foreshore is not sufficiently secured, and its maintenance and improvement are important. On the other hand, in BBWS Bengawan Solo, there is a plan for revetment near the shoreline, and it is feared that the sand beach will be lost by this plan. In order to promote tourism in the future, it is necessary to maintain and manage the sandy beach coast in consideration of utilization and the environment. Since important infrastructure areas facing the coast, such as national roads, are affected by wave overtopping during storm surges, it is necessary to consider their use in addition to countermeasures against wave overtopping.In the residential area, there is an upright seawall maintained by each resident, the coastal alignment is uneven with and without a seawall, and the structure type and crown height are also irregular, so that preservation measures from the viewpoints of long-term seashore protection and coast

■Ideal coastal situation:

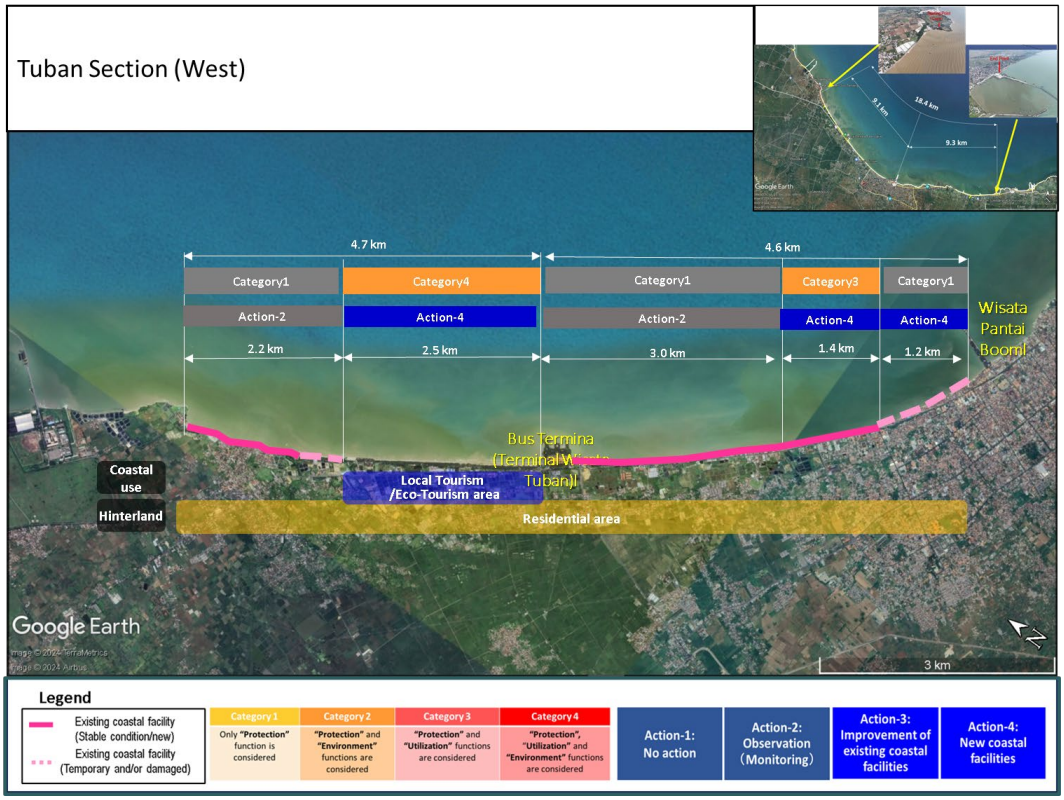
To improve the coastal utilization to promote tourism, and to enhance the safety and convenience for important infrastructure (national highways) and residential areas in consideration of the coastal erosion mechanism in this section

■Required Coastal Functions:

The hinterland of the coast is utilized up to the immediate vicinity for residential purposes and as a national highway. The coastal area maintains natural sandy beaches and is used as a local tourism area. Given these conditions, the coast utilized as tourism purposes are classified as Category-3 (Protection and Utilization) to preserve the sandy beaches as tourism resources and to actively utilize them. The coast utilized for residential areas and as national highways are classified as Category-1 (Protection) to ensure protection from inundation damage caused by high wave and high tide flooding.

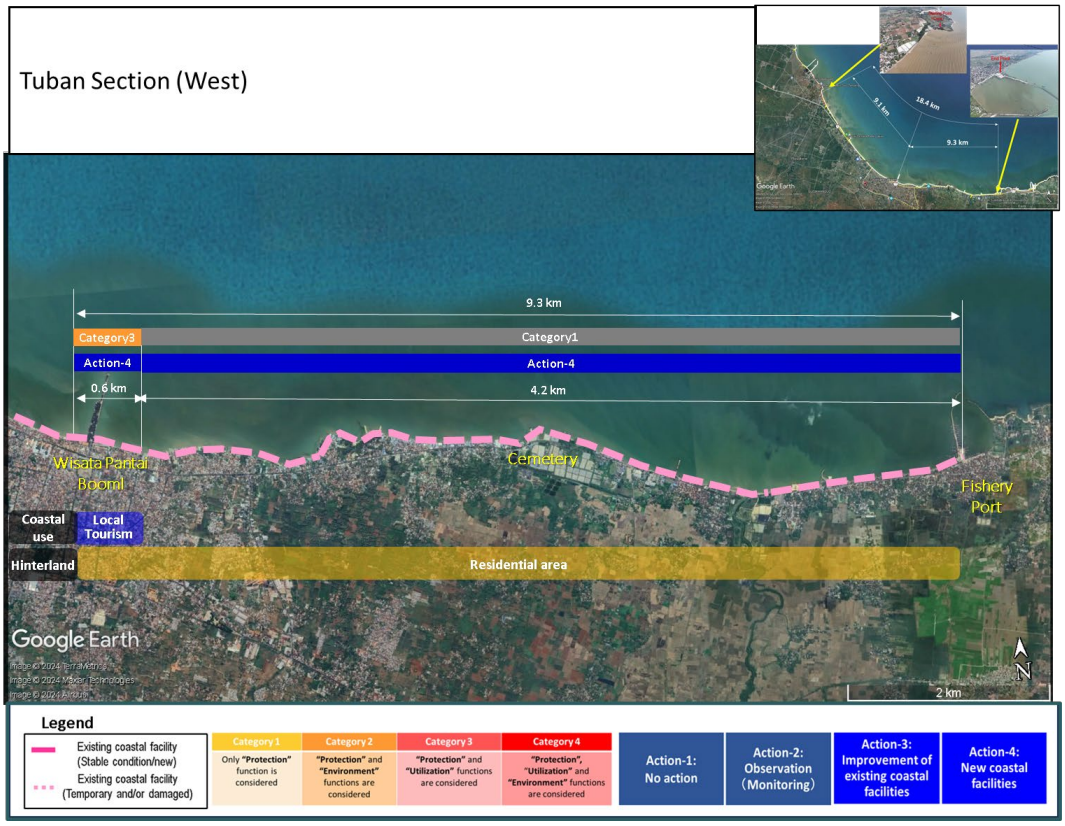
■Direction of Required Action and Selection of Coastal Measures:

In areas utilized for tourist purposes, designated as Category-3 (Protection and Utilization), beach nourishment with headlands/groins is proposed as Action-4 (New facilities) to both protect against coastal disasters and promote tourism. Conversely, since other areas designated as Category-1 (Protection) are vulnerable due to the proximity of residential buildings and highways to the coast, to enhance protection, revetment with backfill is proposed as Action-4 (New facilities) to ensure sufficient buffer zones from the sea. Figure 12.4.3 shows the implementation image of revetment with backfills.



Source: Edited by JICA Study Team based on Google Earth

Figure 12.4.1 Direction of Coastal Facility Plan at Tuban Section (West Area)



Source: Edited by JICA Study Team based on Google Earth

Figure 12.4.2 Direction of Coastal Facility Plan at Tuban Section (East Area)