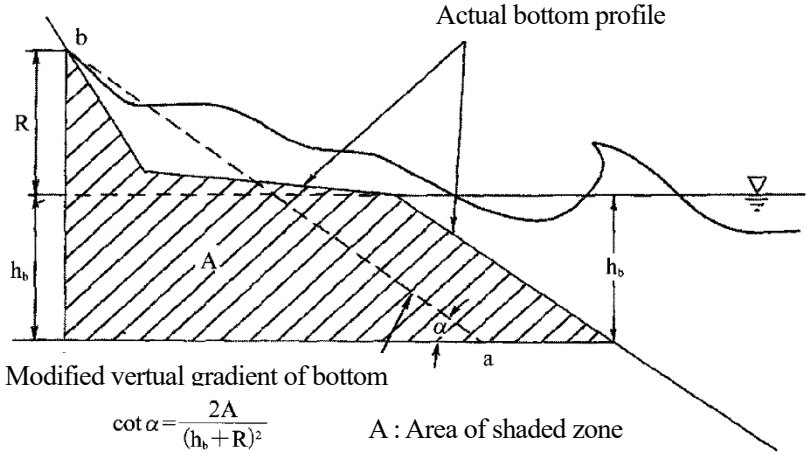
Lampiran-13
Kajian Numerik Rencana Fasilitas Pantai

Appendix-13 Study on Coastal Facilities plan for Selected Area

13.1 Required beach size for Wave runup

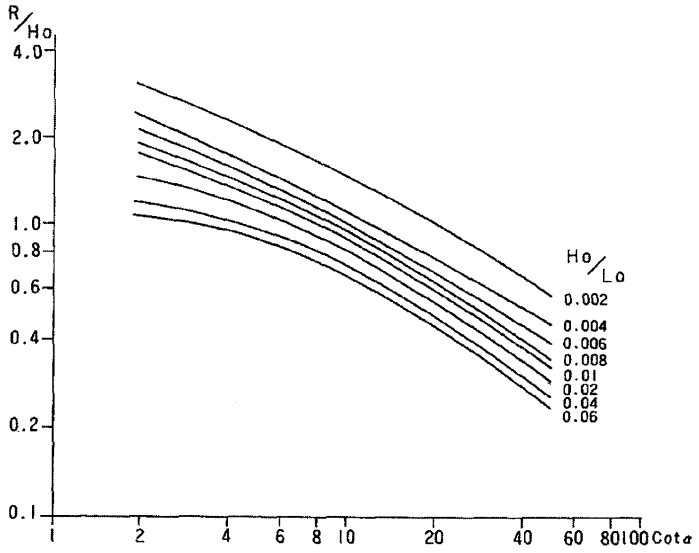
13.1.1 Procedure for wave runup

The wave runup height is estimated by the Diagrams of Nakamura et al. (1972). This method can be applied to the complex cross section of beach as shown in Figure 1. The wave runup height is obtained by the diagrams as shown in Figure 2 , inputting tide level and incident wave condition as the significant wave. However, the diagrams are based on the experiments for a regular wave.



Source: Technical Standard of Coastal Conservation Facility (Japanese Guideline)

Figure 1 Evaluation of wave runup using the Diagram of Nakamura et al.(1972)

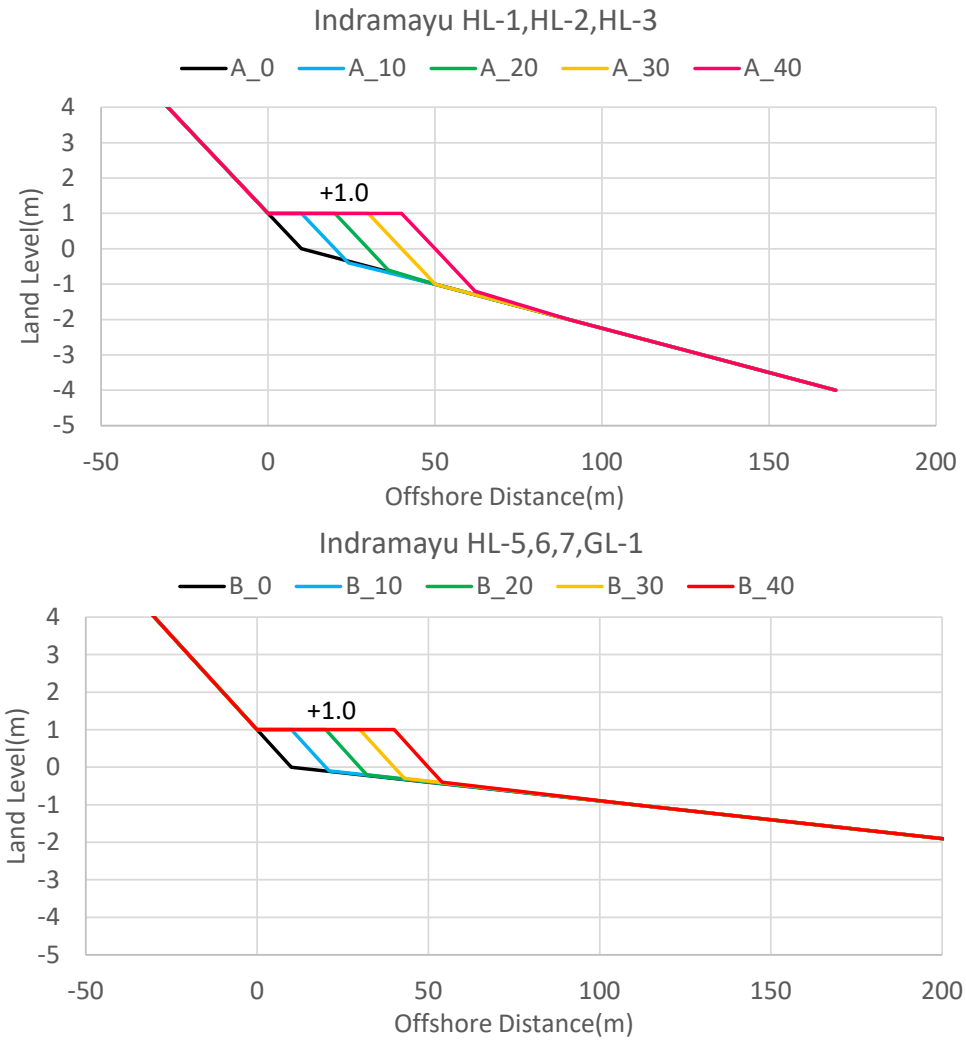


Source: Technical Standard of Coastal Conservation Facility (Japanese Guideline)

Figure 2 Diagram of Nakamura et al.(1972)

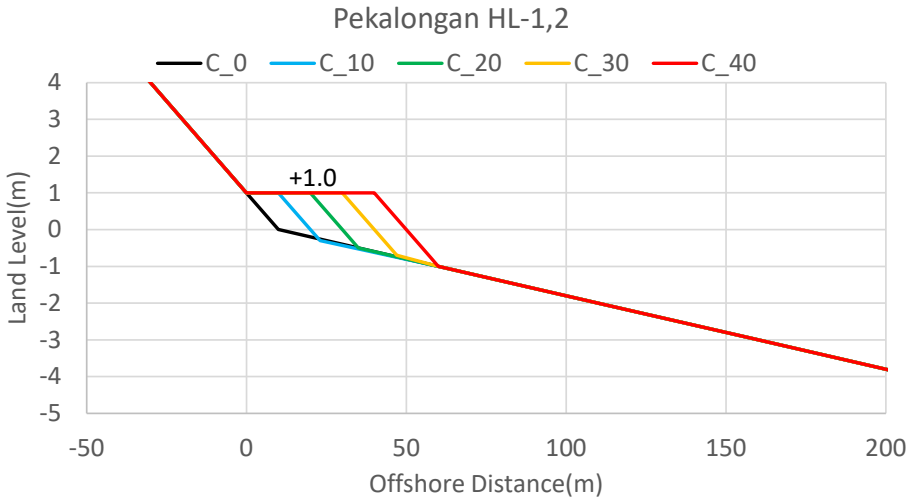
13.1.2 Cross section of beach fill in each section

The cross sections where beach fill is carried out by changing the beach width under the local topography are shown in Figure 3 to Figure 5. The crown height of beach fill in Indramayu and Pekalongan is +1.0 m, and that in Tuban is +1.2 m, corresponding to the berm height observed in each coast.



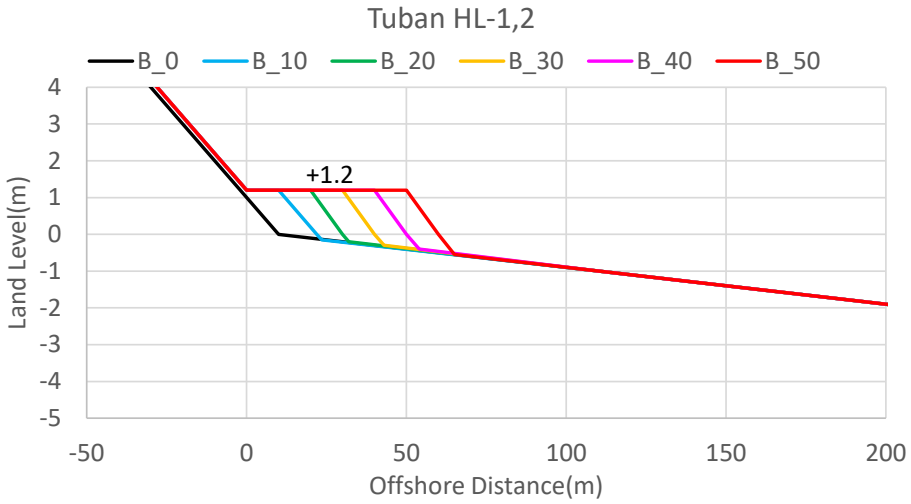
Source: JICA Study Team

Figure 3 Cross sections of beach fill in Indramayu



Source: JICA Study Team

Figure 4 Cross sections of beach fill in Pekalongan

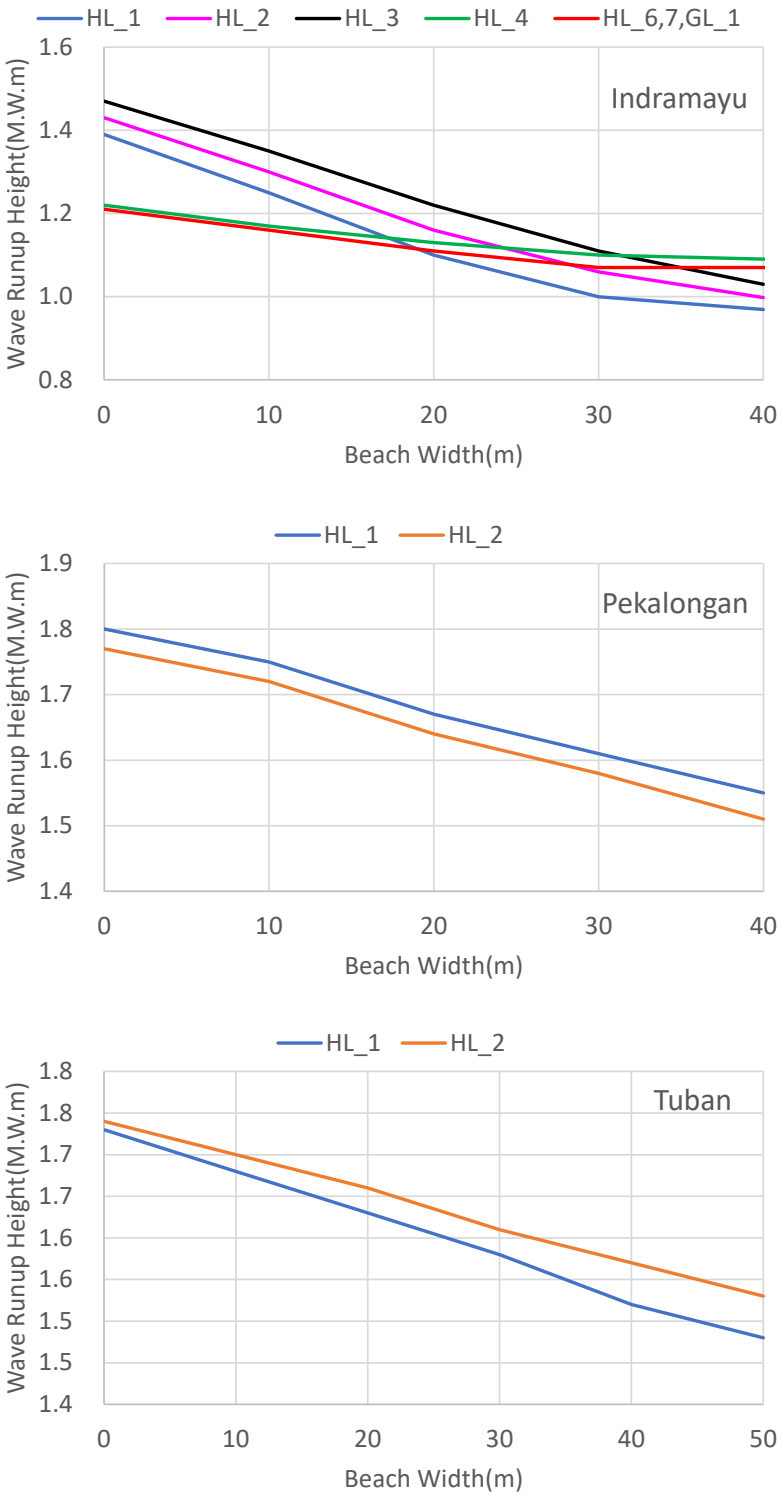


Source: JICA Study Team

Figure 5 Cross sections of beach fill in Tuban

13.1.3 Results of wave runup height

In the cross sections of the beach fill shown previously, the wave runup heights are obtained under the condition of the design waves (the equivalent deepwater waves) and the design tide levels. The results are shown in Table 1. Also, the relationship between the width of the beach and the wave runup height is shown in Figure 6. According to the results, the beach fill which is 30 m of width or more in Indramayu can prevent the wave overtopping. However, it is difficult to prevent the wave overtopping by the beach fill in Pekalongan and Tuban. Therefore, it is necessary to construct a seawall with a crown height of about +2.0 m behind the beach fill.



Source: JICA Study Team

Figure 6 The relationship between Beach width and wave runup height

Table 1 Wave runup heght on the cross section of beach fill

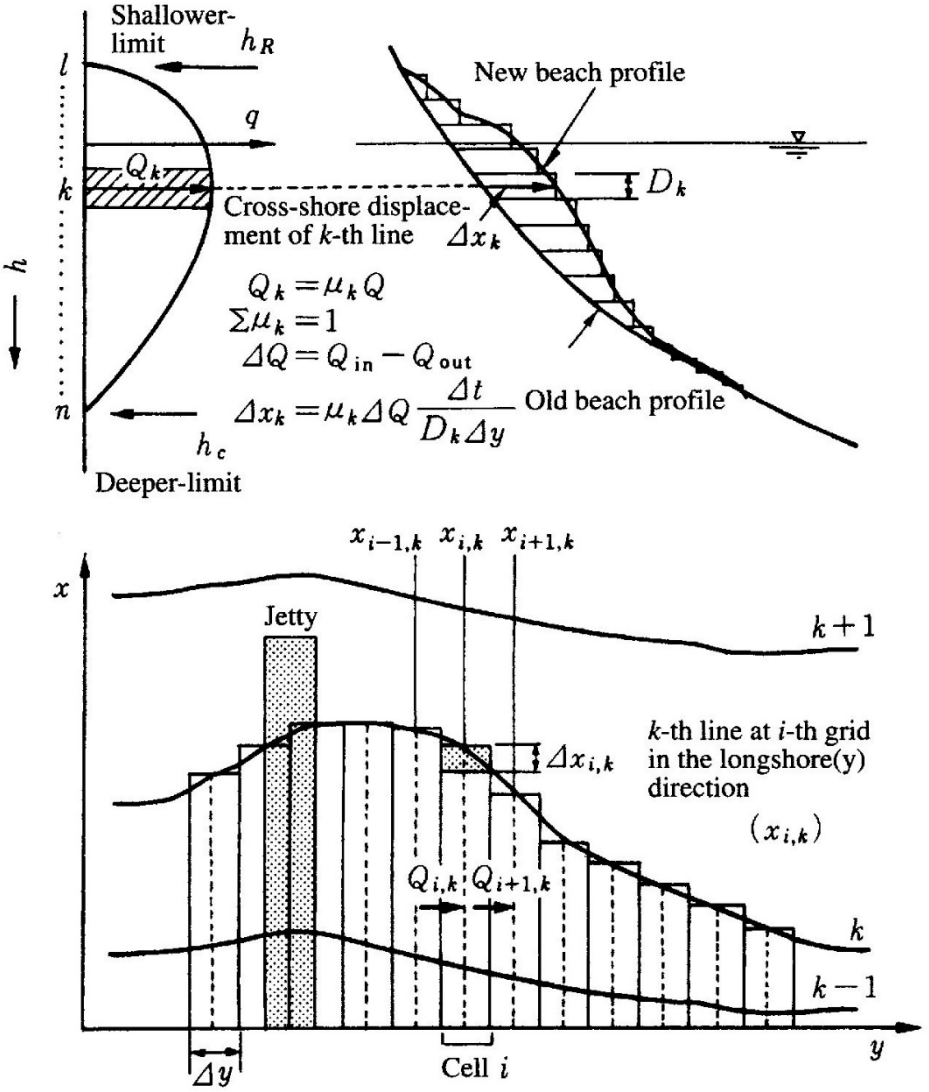
Area	HL,GL	Beach Topo.	H(m)	T(s)	Tide (M.W.m)	h_b(m)	Beach Width(m)	Beach Height (M.W.m)	R(m)	R+Tide (M.W.m)	Judge (R+Tide<Beach Height)
Indramayu	HL_1	A	1.1	5.8	0.65	1.42	0	0.0	0.74	1.39	×
			1.1	5.8	0.65	1.42	10	1.0	0.60	1.25	×
			1.1	5.8	0.65	1.42	20	1.0	0.45	1.10	×
			1.1	5.8	0.65	1.42	30	1.0	0.35	1.00	○
			1.1	5.8	0.65	1.42	40	1.0	0.32	0.97	○
	HL_2	A	1.2	5.8	0.65	1.54	0	0.0	0.78	1.43	×
			1.2	5.8	0.65	1.54	10	1.0	0.65	1.30	×
			1.2	5.8	0.65	1.54	20	1.0	0.51	1.16	×
			1.2	5.8	0.65	1.54	30	1.0	0.41	1.06	△
			1.2	5.8	0.65	1.54	40	1.0	0.35	1.00	○
	HL_3	A	1.3	5.8	0.65	1.66	0	0.0	0.82	1.47	×
			1.3	5.8	0.65	1.66	10	1.0	0.70	1.35	×
			1.3	5.8	0.65	1.66	20	1.0	0.57	1.22	×
			1.3	5.8	0.65	1.66	30	1.0	0.46	1.11	×
			1.3	5.8	0.65	1.66	40	1.0	0.38	1.03	△
	HL_4	B	1.6	5.8	0.65	2.02	0	0.0	0.57	1.22	×
			1.6	5.8	0.65	2.02	10	1.0	0.52	1.17	×
			1.6	5.8	0.65	2.02	20	1.0	0.48	1.13	×
			1.6	5.8	0.65	2.02	30	1.0	0.45	1.10	×
			1.6	5.8	0.65	2.02	40	1.0	0.44	1.09	△
			1.6	5.8	0.65	2.02	50	1.0	0.44	1.09	△
	HL_6,7,GL_1	B	1.5	5.8	0.65	1.90	0	0.0	0.56	1.21	×
			1.5	5.8	0.65	1.90	10	1.0	0.51	1.16	×
			1.5	5.8	0.65	1.90	20	1.0	0.46	1.11	×
			1.5	5.8	0.65	1.90	30	1.0	0.42	1.07	△
			1.5	5.8	0.65	1.90	40	1.0	0.42	1.07	△
			1.5	5.8	0.65	1.90	50	1.0	0.42	1.07	△
Pekalongan	HL_1	C	2.3	6.6	0.7	2.90	0	0.0	1.10	1.80	×
			2.3	6.6	0.7	2.90	10	1.0	1.05	1.75	×
			2.3	6.6	0.7	2.90	20	1.0	0.97	1.67	×
			2.3	6.6	0.7	2.90	30	1.0	0.91	1.61	×
			2.3	6.6	0.7	2.90	40	1.0	0.85	1.55	×
	HL_2	C	2.2	6.6	0.7	2.77	0	0.0	1.07	1.77	×
			2.2	6.6	0.7	2.77	10	1.0	1.02	1.72	×
			2.2	6.6	0.7	2.77	20	1.0	0.94	1.64	×
			2.2	6.6	0.7	2.77	30	1.0	0.88	1.58	×
			2.2	6.6	0.7	2.77	40	1.0	0.81	1.51	×
Tuban	HL_1	B	1.8	6.7	0.95	2.29	0	0.0	0.78	1.73	×
			1.8	6.7	0.95	2.29	10	1.2	0.73	1.68	×
			1.8	6.7	0.95	2.29	20	1.2	0.68	1.63	×
			1.8	6.7	0.95	2.29	30	1.2	0.63	1.58	×
			1.8	6.7	0.95	2.29	40	1.2	0.57	1.52	×
			1.8	6.7	0.95	2.29	50	1.2	0.53	1.48	×
Tuban	HL_2	B	2	6.7	0.95	2.53	0	0.0	0.79	1.74	×
			2	6.7	0.95	2.53	10	1.2	0.75	1.70	×
			2	6.7	0.95	2.53	20	1.2	0.71	1.66	×
			2	6.7	0.95	2.53	30	1.2	0.66	1.61	×
			2	6.7	0.95	2.53	40	1.2	0.62	1.57	×
			2	6.7	0.95	2.53	50	1.2	0.58	1.53	×

Source: JICA Study Team

13.2 Study by numerical prediction model

13.2.1 Overview of numerical model for prediction of shoreline change

An overview of a numerical model for predicting beach deformation to evaluate the effects of coastal facility plan is explained as follow. The model applied here is the N-Line model. The N-Line model can predict the displacements of multiple depth contour lines(N-lines) under the topography presented by multiple depth contour lines(Figure 7). At first, the littoral drift caused by the waves are calculated, secondly the littoral drift is distributed to each contours, thirdly the displacements of each contour line is calculated from the balance of littoral drift. The continuous equation for littoral drift as the basic equation is shown in eq.**0.1**. and the equation of littoral drift uses Ozasa-Brampton's formula as shown in eq.**0.2** .



Source: Design Manual for Coastal Facilities 2000

Figure 7 Overview of N-Line model

$$\frac{\partial x_k}{\partial t} + \frac{1}{D_k}\frac{\partial Q_k}{\partial y} = 0, k = 1 \ldots\ldots n$$

0.1

where x_k is the cross-shore position of the *k-th* contour line, D_k is the depth step of the *k-th* section, Q_k is the littoral drift rate of *k-th* section, and n is the total number of contour lines.

$$Q = \frac{\left(E \cdot C_g\right)_b}{(\rho_s - \rho)g(1-\lambda)} \times \left(K_1 \sin\alpha_b \cdot \cos\alpha_b - K_2 \cos\alpha_b \cot\beta \frac{\partial H_b}{\partial y}\right)$$

0.2

where ρ_s and ρ are the densities of sand and sea water, respectively, λ is the porosity, E is the wave energy, C_g is the group velocity of the wave, α is the angle between the shoreline and the wave crest line, $\tan\beta$ is the bottom slope, and the subscript b indicates values at the wave breaking point.

13.2.2 Conditions of calculation

The main calculation conditions are shown below. The topography is expressed by 16 contour lines with 0.2m intervals in the range of *+1.0m~-2.0m*. In addition, the cross-shore distribution of littoral drift has a peak at the shoreline, and the upper limit is h_R=*+1.0m*, which is almost same as the berm height, and the lower limit is h_c=*-3.5m*, where the movement of sediment by waves is not remarkable. Uda and Kono(1996) proposed bellow formula.

$$\xi(z^*) = (2/h_c^{*3})(h_c^*/2 - z^*)(z^* + h_c^*)^2, -h_c \le z \le h_R,$$

$$\xi(z^*) = 0\,, z \le -h_c, z \ge h_R,$$

0.3

where,

$$z^* = z/H_b\,, h_c^* = h_c/H_b.$$

0.4,**0.5**

The littoral drift coefficient are set to k_1=*0.1～0.5*,k_2=*0.3*, as the past topography change could be reproduced. The wave conditions are based on the energy equivalent waves. Two types of wave conditions, which come from right and left side of coastline was obtained by the result of wave deformation analysis. The detail process of verification of each coast is described below.

13.2.3 Verification of numerical model

Before the prediction of topography by the numerical model, the validity of the calculation conditions such as wave conditions, was verified by reproducing past topographic changes.

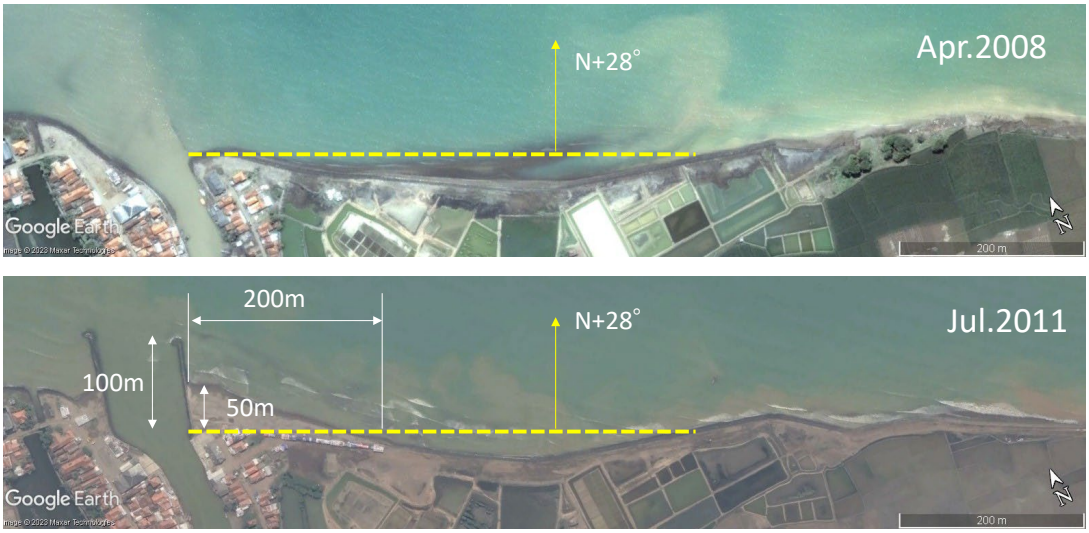
(1) Indramayu Section-1

The reproduction of topographies is shown in Figure 8. In this coast the littoral drift seems to be westward, so the jetty caught it. Consequently, the shoreline at the base of the jetty has advanced by about 50 m from 2008 to 2011. In the model, the coastline was simplified to straight, and a jetty of 100 m long was set up there, as shown in Figure 9. The waves coming to this coast were analyzed by the calculation of wave deformation based on the estimation data (ERA5). At the results, after the waves that generated eastward and westward littoral drift were separated, the energy equivalent waves for both directions were obtained. The energy equivalent wave height(H), its period(T), wave direction angle(ang) , and the frequency of occurrence (%) are shown below. Please refer to Appendix 6-2 for details.

Station : I-1
Wave_from West : H=0.20m,T=3.6s,ang=13.7° ,31%
Wave_from East : H=0.36m,T=3.7s,ang=-31.7° ,69%

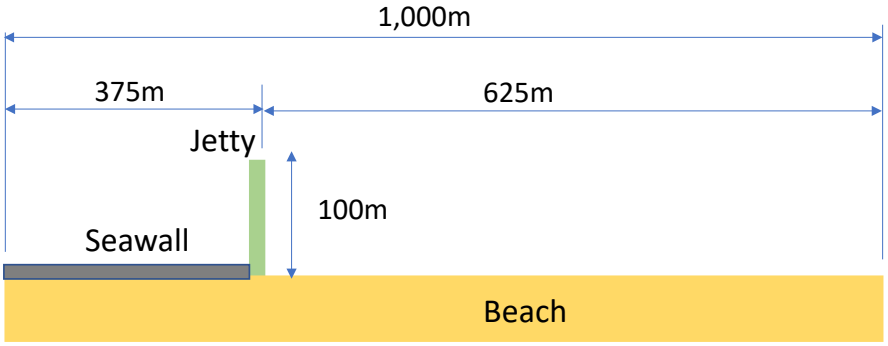
On the other hand, the wave direction information obtained from satellite images is shown in Figure 10 and Figure 11. According to this, in the dry season, waves from the east predominate, and the maximum angle of incidence is about 20 degrees. Therefore, the results of calculation under the waves from the east, which angles are 32 degrees and 20 degrees are shown in Figure 12. According to this, when the wave direction is 20 degrees, the amount of shoreline advance at the base of the jetty is about 50 m, which is almost same as the actual shoreline change (Figure 8). Therefore, the wave conditions shown below were adequate.

Wave_from West : H=0.20m,T=3.6s,ang=13.7° ,31%
Wave_from East : H=0.36m,T=3.7s,ang=-20.0° ,69%



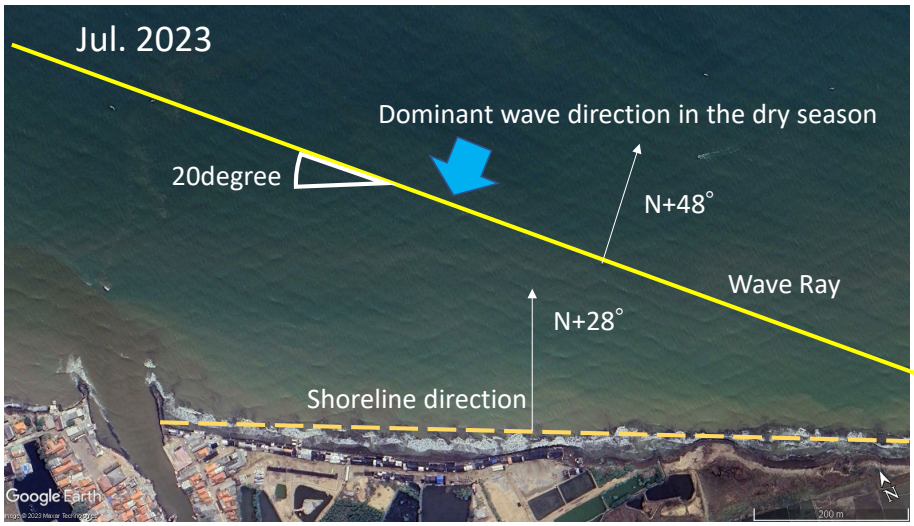
Source: Edited by JICA Study Team using

Figure 8 Topography change for reproduction (Indramayu S-1)



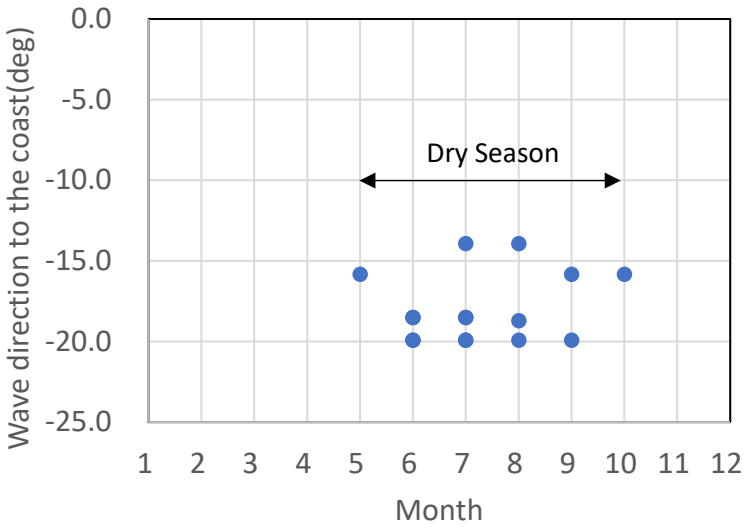
Sorce: JICA Study Team

Figure 9 Model topography (Indramayu S-1)



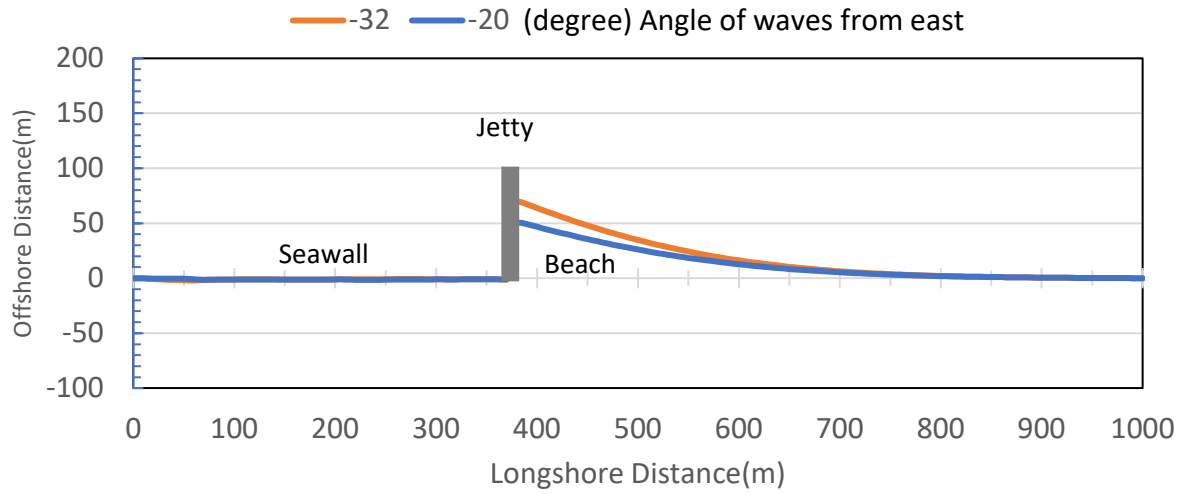
Source: Edited by JICA Study Team using

Figure 10 Wave crest line read from the satellite image(Google earth) (Indramayu S-1)



Source: JICA Study Team

Figure 11 Wave direction read from the satellite images(Google Earth) (Indramayu S-1)



Sorce: JICA Study Team

Figure 12 Calculation results of reproduction for shoreline (Indramayu S-1)

(2) Indramayu Section-6a

The reproduction of topographies is shown in Figure 13. In this site the littoral drift in the both directions, eastward and westward seems to be balanced. However, since the jetties of 720m long have been constructed during 2001-2008 on the river mouth in the west end, the wave shielding area has been generated in the east side of the jetty. The result has been driven the westward littoral drift, it caused the deposition at the base of the jetty, and the shoreline has advanced by about 120 m from 2008 to 2014.

In the model, the coastline was simplified to straight, and a jetty of 720 m long was set up in west side, and the port structure was set up in east end (Figure 14). The waves coming to this coast were analyzed by the calculation of wave deformation based on the estimation data (ERA5). At the results, after the waves that generated eastward and westward littoral drift were separated, the energy equivalent waves for both directions were obtained. The energy equivalent wave height(H), its period(T), wave direction angle(ang) , and the frequency of occurrence (%) are shown below. Please refer to Appendix 6-2 for details.

Station : I-15
Wave from West : H=0.36m,T=3.7s,ang=3.8° ,55%
Wave from East : H=0.44m,T=3.6s,ang=-5.9° ,45%

On the other hand, the wave direction information obtained from satellite images is shown in Figure 15. According to this, in the dry season, waves from the east predominate, and the maximum angle of incidence is about 10 degree. Also, since the littoral drift is almost balanced, both wave characteristics seems to be similar. Therefore, under the wave conditions below, the calculation of prediction between 2008 and 2014 was carried out.

Wave from West : H=0.40m,T=3.7s,ang=10.0° ,55%
Wave from East : H=0.40m,T=3.6s,ang=-10.0° ,45%

According to the result as shown in Figure 16, the amount of shoreline advance at the base of the jetty is about 120 m, which is almost the actual change in the shoreline. Therefore, the wave conditions shown above were adequate.

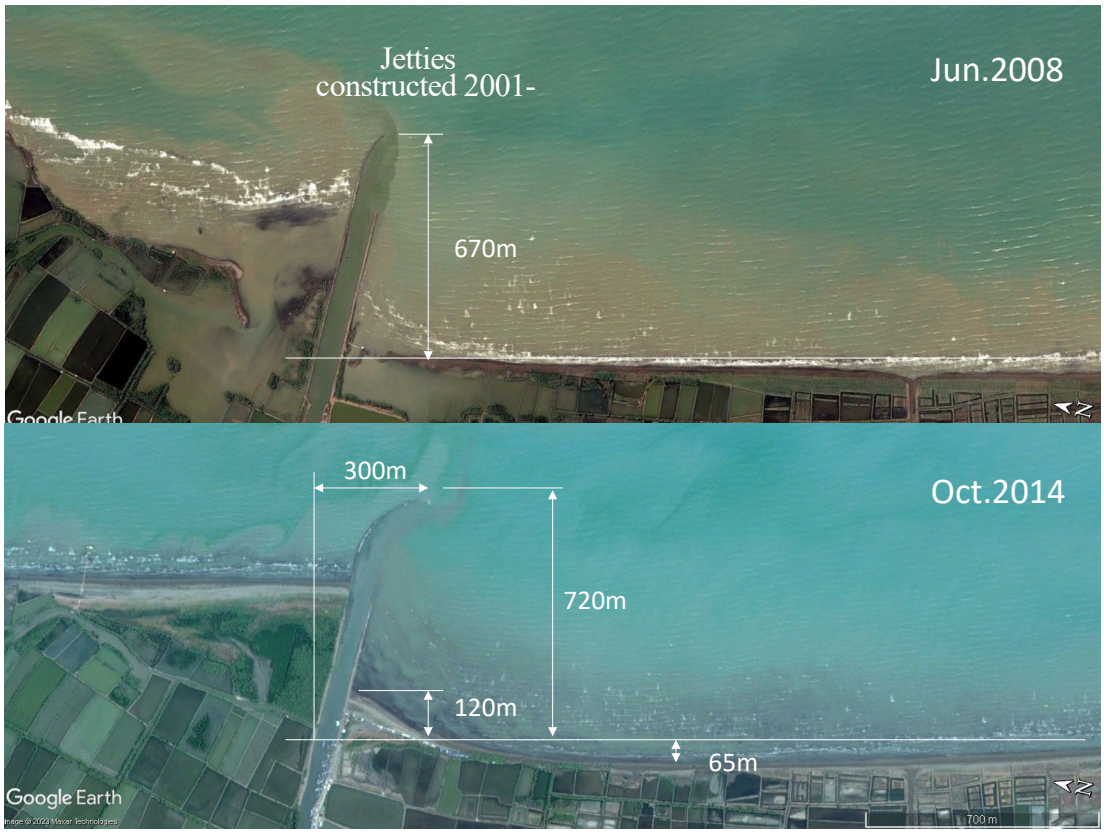


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Figure 13 Topography change for reproduction (Indramayu S-6a)

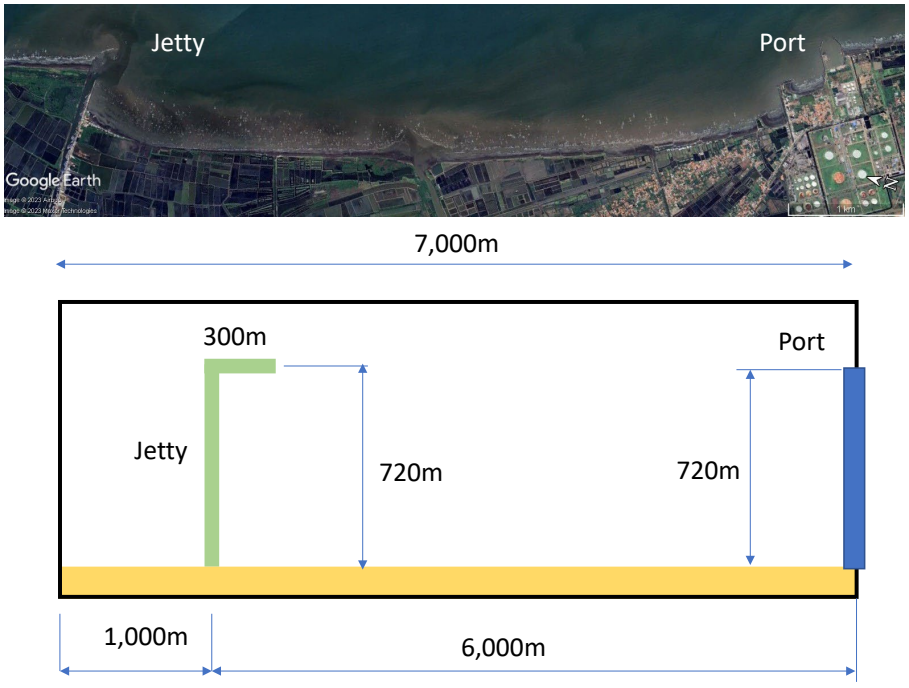

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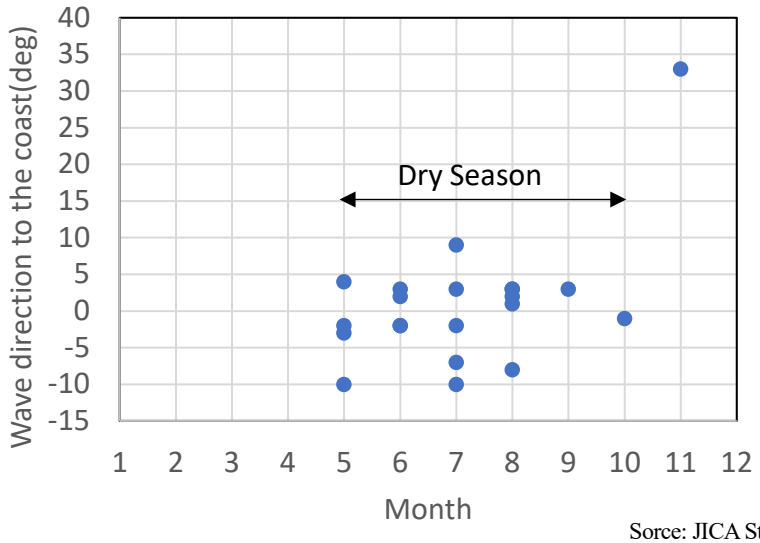
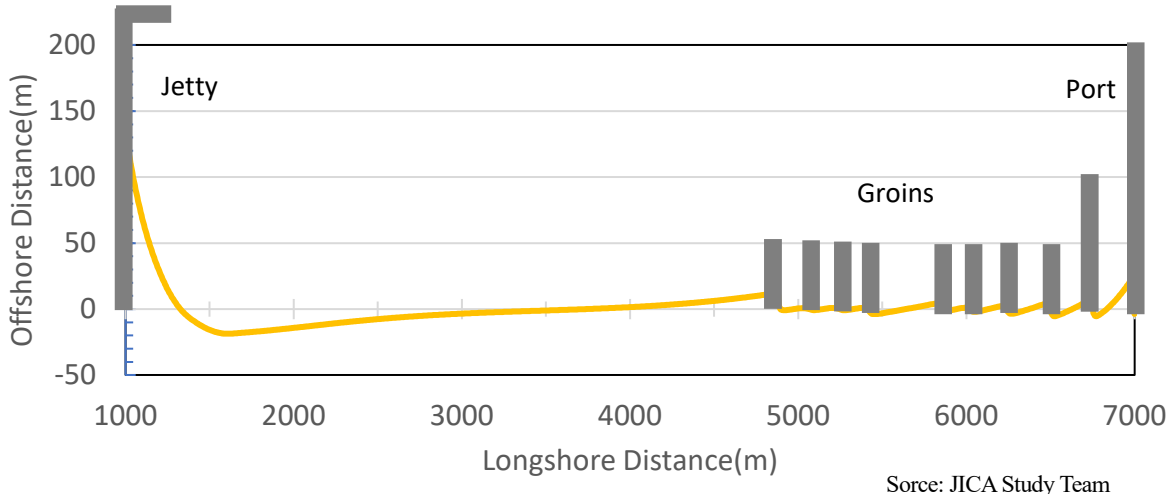
Figure 14 Model topography (Indramayu S-6a)



Sorce: JICA Study Team

Figure 15 Wave direction read from the satellite images(Google Earth) (Indramayu S-6a)



Sorce: JICA Study Team

Figure 16 Calculation result of reproduction for shoreline (Indramayu S-6a)

(3) Indramayu Section-6d

The reproduction of topographies is shown inFigure 17. In this site the littoral drift in the both directions, eastward and westward exist, however the westward littoral drift is slightly predominant. At the result, the shoreline in east side of the jetty has advanced about 80m and in west side of it has retreated about 50 m.

In the model, the coastline was simplified to straight, and a jetty of 200 m long was set up (Figure 18). The waves coming to this coast were analyzed by the calculation of wave deformation based on the estimation data (ERA5). At the results, after the waves that generated eastward and westward littoral drift were separated, the energy equivalent waves for both directions were obtained. The energy equivalent wave height(H), its period(T), wave direction angle(ang) , and the frequency of occurrence (%) are shown below. Please refer to Appendix 6-2 for details.

Station : I-22
Wave from West : H=0.25m,T=3.4s,ang=25.4° ,24%
Wave from East : H=0.44m,T=3.7s,ang=-16.8° ,76%

The results of the calculation are shown in Figure 19. According to the result, when the wave direction angle from the east is -16.8°, the amount of shoreline advance at the base of the jetty reaches the tip of the watershed at about 200 m, whereas when the wave direction angle is -5°, almost the actual shoreline change is reproduced. Therefore, the wave conditions shown below were adequate.

Wave from West : H=0.25m,T=3.4s,ang=25.4° ,24%
Wave from East : H=0.44m,T=3.7s,ang=-5.0° ,76%

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Figure 17 Topography change for reproduction (Indramayu S-6d)

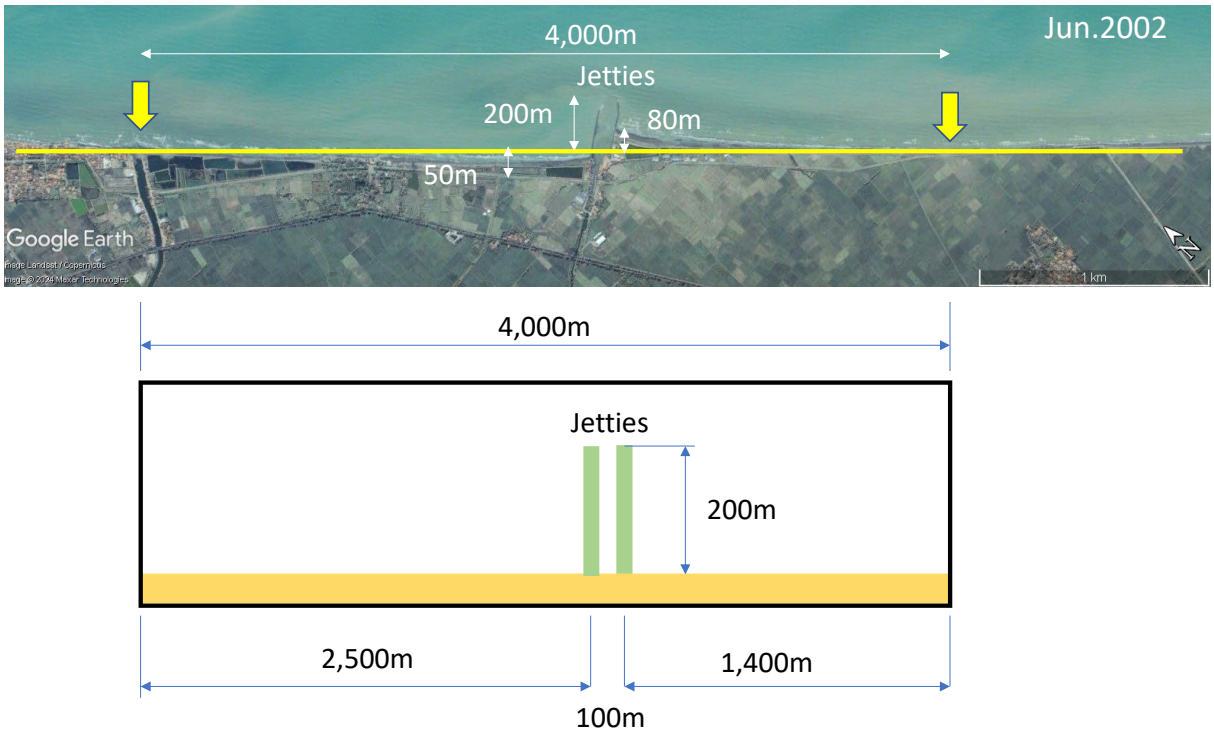

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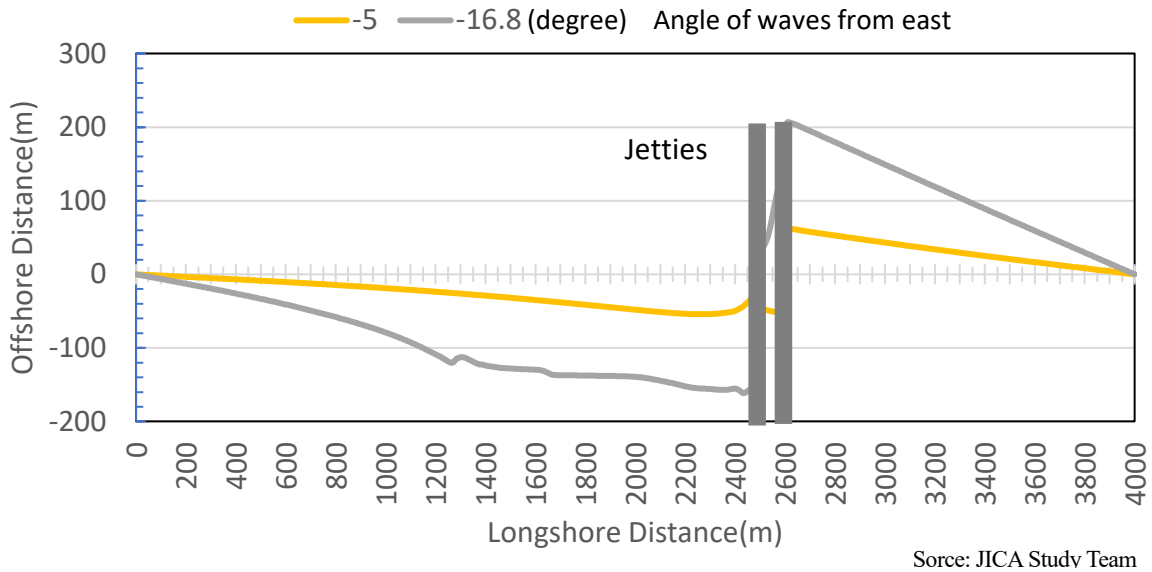
Figure 18 Model topography (Indramayu S-6d)



Sorce: JICA Study Team

Figure 19 Calculation results of reproduction for shoreline (Indramayu S-6d)

(4) Pemalang-Pekalongan Section-4a

The topographic changes for reproduction in the coastal area is shown in Figure 20 and the history of shoreline change in west side is shown in Figure 21. In 2003, there was a sandy beach, but after that, the shoreline retreated by about 30 m in 2009. After that, the shoreline reached the seawall, sandy beach was vanished in front of it, while the shoreline retreated further on the west side without a seawall. In the site the westward littoral drift was dominated, and the jetty located at estuary in the east end of the area interrupted the supply of littoral drift. Consequently, the shoreline has been retreated from east to west. In order to reproduce such changes, the model topography for reproduction is prepare as shown in Figure 22. In the model, the coastline was simplified to straight, and a jetty of 450 m long was set up in the east end of the area. In the western boundary at the area, the coastline remained almost unchanged since 1938 as shown in the top of Figure 22.

The waves coming to this coast were analyzed by the calculation of wave deformation based on the estimation data (ERA5). At the results, after the waves that generated eastward and westward littoral drift were separated, the energy equivalent waves for both directions were obtained. The energy equivalent wave height(H), its period(T), wave direction angle(ang) , and the frequency of occurrence (%) are shown below. Please refer to Appendix 6-2 for details.

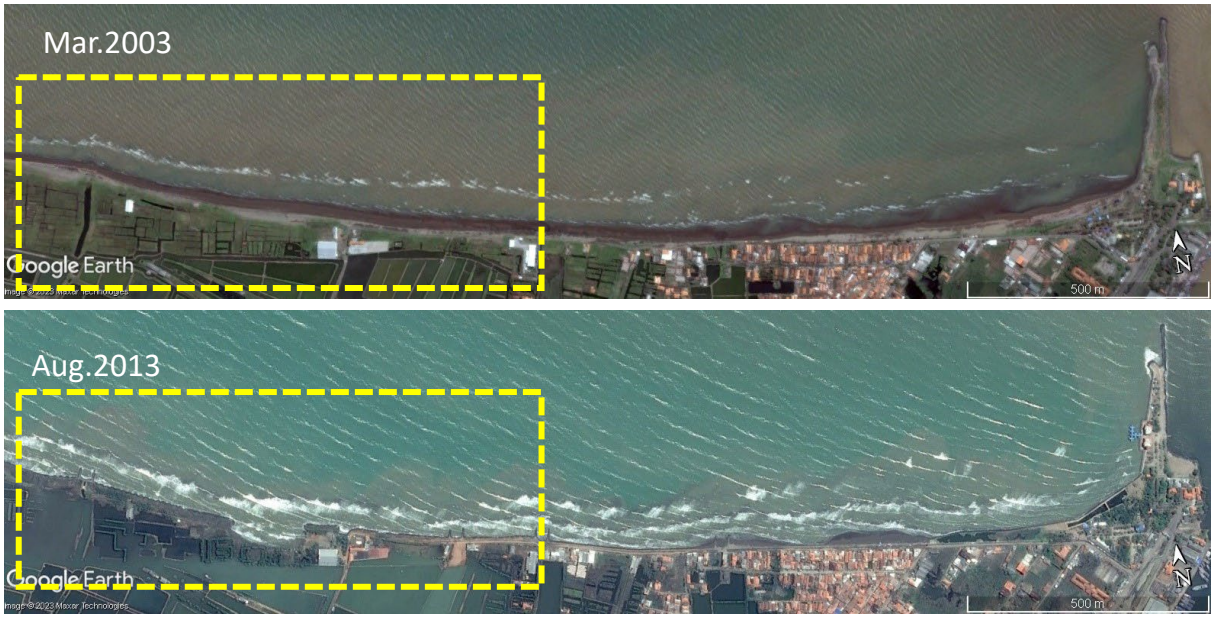
Station : P-11
Wave from West : H=0.51m,T=3.6s,ang=35° ,38%
Wave from East : H=0.33m,T=3.7s,ang=-32° ,62%

The waves were incident with an angle of about 30 degree from the east in the dry season, according to the satellite images (Figure 23). Therefore, in the calculation, the wave angle was set to 30 degree for both west and east directions. As a result of trial calculations, the incident wave height in the east-west direction was 0.5 m and the period was 3.7 s.

Wave from West : H=0.5m,T=3.6s,ang=30° ,38%
Wave from East : H=0.50m,T=3.7s,ang=-30° ,62%

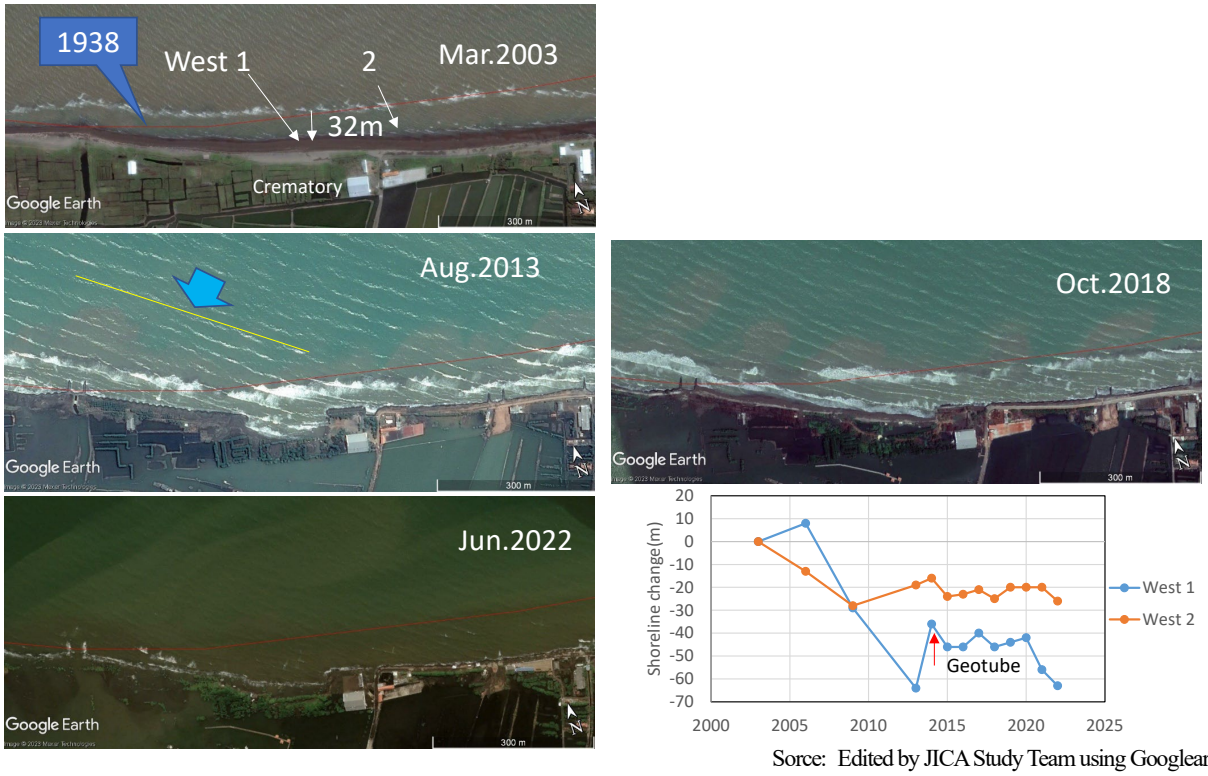
The results of the calculation are shown in Figure 24. According to the results, the westward littoral drift was obstructed by the jetty at the east end, so the shoreline retreated gradually from east to west, so that the beach in front of the seawall disappeared, and the shoreline retreated about 30 m from the seawall position at the west end of the seawall. Additionally, near the base of the jetty at the east end, the shoreline was initially advanced offshore due to the shielding effect of the jetty, but after that the shoreline has retreated over time as observed in the field.

Therefore, the wave conditions shown above were adequate.



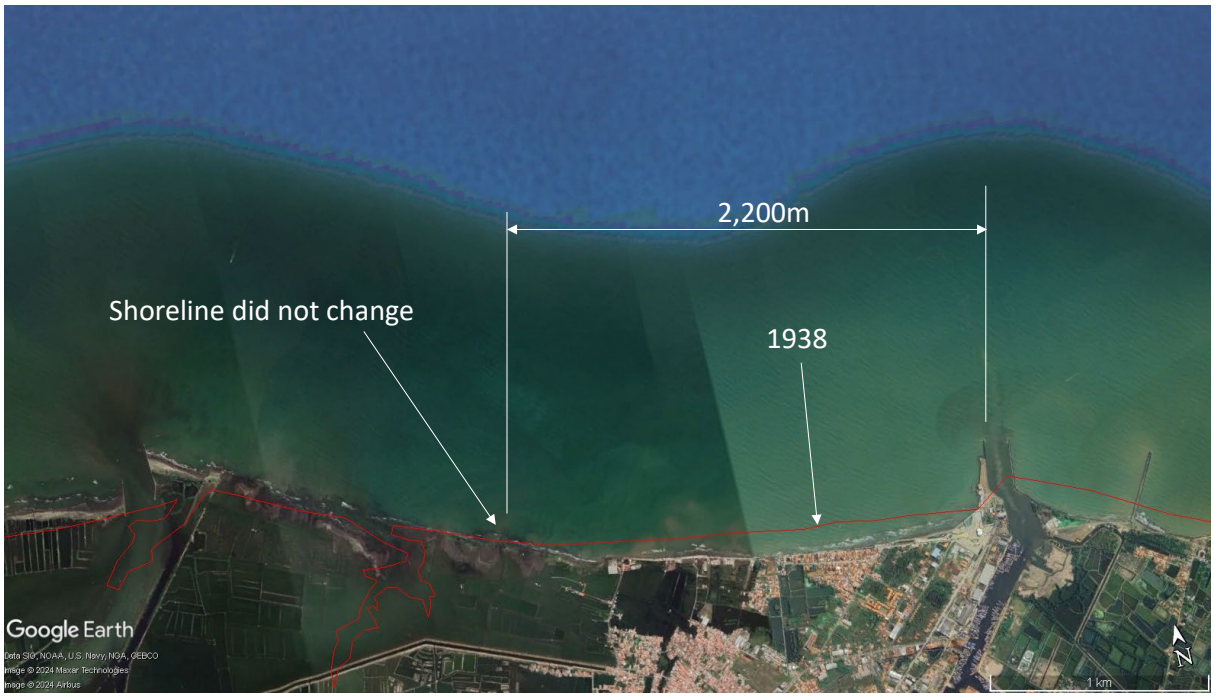
Sorce: Edited by JICA Study Team using Googlearth

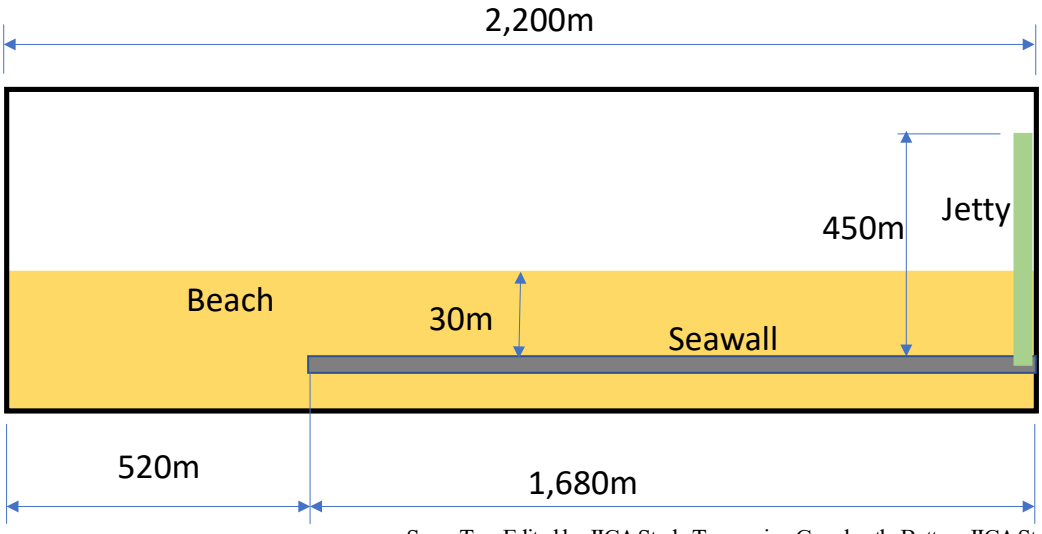
Figure 20 Topography change for reproduction (Pemalan-Pekalongan S-4a)



Sorce: Edited by JICA Study Team using Googlearth

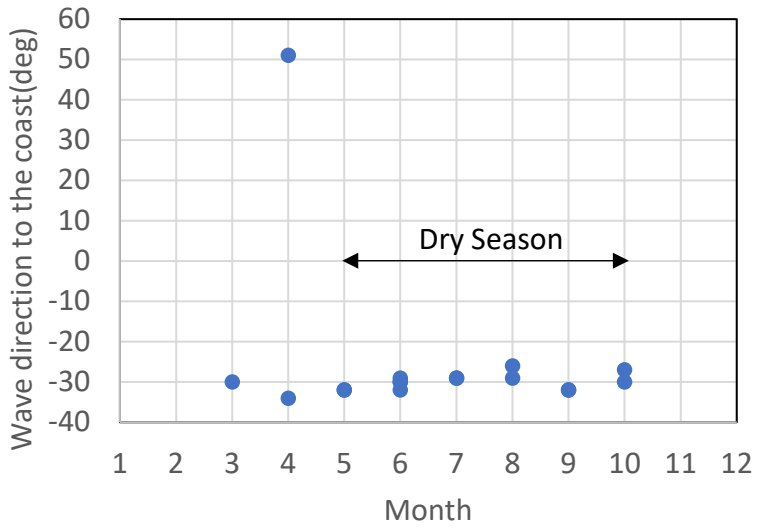
Figure 21 History of topography change (Pemalang-Pekalongan S-4a)





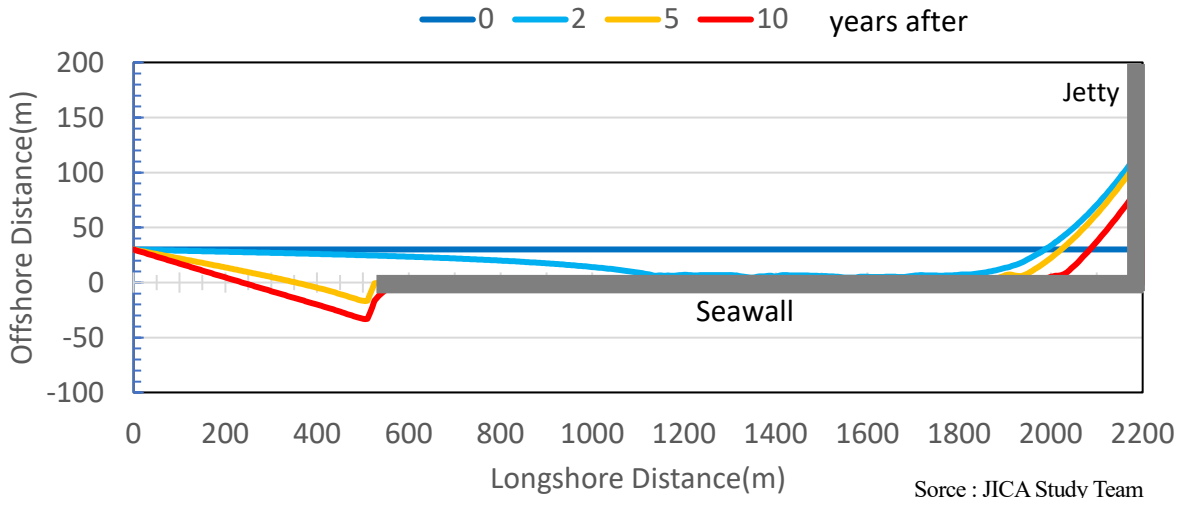
Sorce Top: Edited by JICA Study Team using Googlearth, Bottm : JICA Study Team

Figure 22 Model topography (Pemalang-Pekalongan S-4a)



Sorce : JICA Study Team

Figure 23 Wave direction read from the satellite images (Google Earth) (Pemalang-Pekalongan S-4a)



Sorce : JICA Study Team

Figure 24 Calculation results of reproduction for shoreline (Pemalang-Pekalongan S-4a)

(5) Pemalang-Pekalongan Section-4b

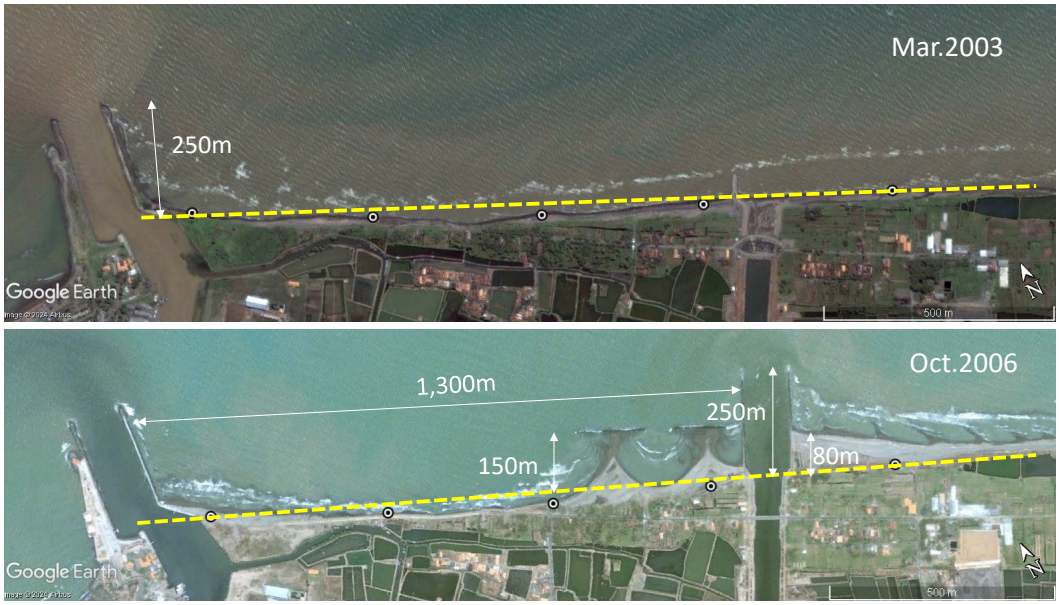
The topographic changes for reproduction in the coastal area is shown in Figure 25. In 2003, there was a jetty at a river mouth in the west end of the area, and later in 2006, another jetty of 250 m long at the river mouth was constructed in the east side of the area. At about the same time, two offshore breakwaters were constructed in the west side of the jetty. These structures caused the shoreline changes of about 100 m advance in the east side of jetty and deposition behind the offshore breakwaters. Such topography change can estimate the westward littoral drift.

In order to reproduce such changes, the model topography for reproduction is prepare as shown in Figure 26. The waves coming to this coast were analyzed by the calculation of wave deformation based on the estimation data (ERA5). At the results, after the waves that generated eastward and westward littoral drift were separated, the energy equivalent waves for both directions were obtained. The energy equivalent wave height(H), its period(T), wave direction angle(ang) , and the frequency of occurrence (%) are shown below. Please refer to Appendix 6-2 for details.

Station : P-14
Wave from West : H=0.52m,T=3.6s,ang=36° ,39%
Wave from East : H=0.35m,T=3.7s,ang=-20° ,61%

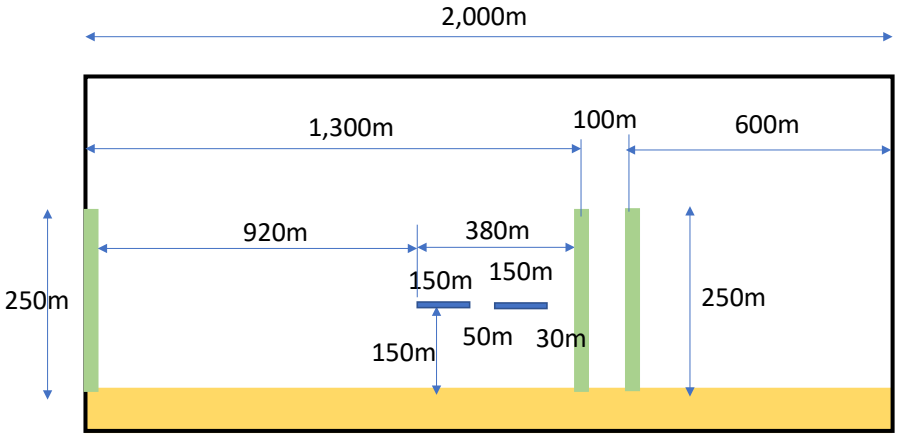
After the trial calculation, under the wave condition as shown below, the result of calculation for reproduction could be obtained as shown in Figure 27. According to the result, the shoreline moved offshore on the east side of the jetty due to obstruction of the westward littoral drift and the shoreline behind the offshore breakwaters was advanced due to the wave dissipation effect. Also, the shoreline retreated slightly between the offshore breakwaters and the dike at the western end. Since these shoreline changes is similar to the real changes as shown in Figure 25, the wave conditions shown below were adequate.

Wave from West : H=0.50m,T=3.7s,ang=10° ,39%
Wave from East : H=0.50m,T=3.7s,ang=-10° ,61%



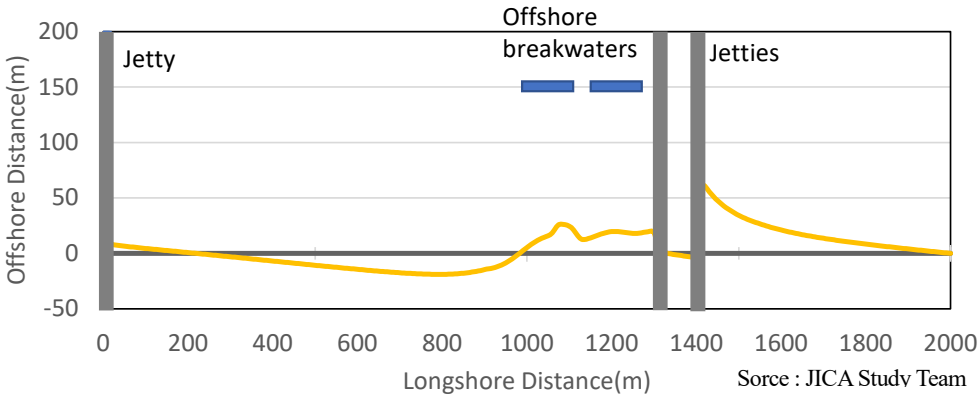
Source : Edited by JICA Study Team using

Figure 25 Topography change for reproduction (Pemalan-Pekalongan S-4b)



Sorce : JICA Study Team

Figure 26 Model topography (Pemalan-Pekalongan S-4b)



Sorce : JICA Study Team

Figure 27 Calculation result of reproduction for shoreline (Pemalan-Pekalongan S-4b)

(6) Tuban Site-1

The topographic changes for reproduction in the coastal area is shown in Figure 28 and Figure 29. The straight sandy beach was existed in 2000. In 2010, the reclaimed land of 360m offshore has been existed on the beach. At that time, the shoreline has advanced by about 50 m in the south side of the reclaimed land and by about 10m in the north side of it. In 2022 after 12 years, the shoreline in the south side of the reclaimed land had been remained, and the shoreline in the north side of it has advanced by 20m since 2010. According to the topography change the littoral drift of the both direction to south and north has been existed in the coast, however the northward littoral drift slightly was predominant. Furthermore, the offshore breakwaters have been constructed in the north side of the reclaimed land between 2000 and 2015 and the shoreline behind them has been advanced.

In order to reproduce such changes, the model topography for reproduction is prepare as shown in Figure 30. The calculation area is 5 km longshore, and the north and south boundaries are located the places where the shoreline has been stable.

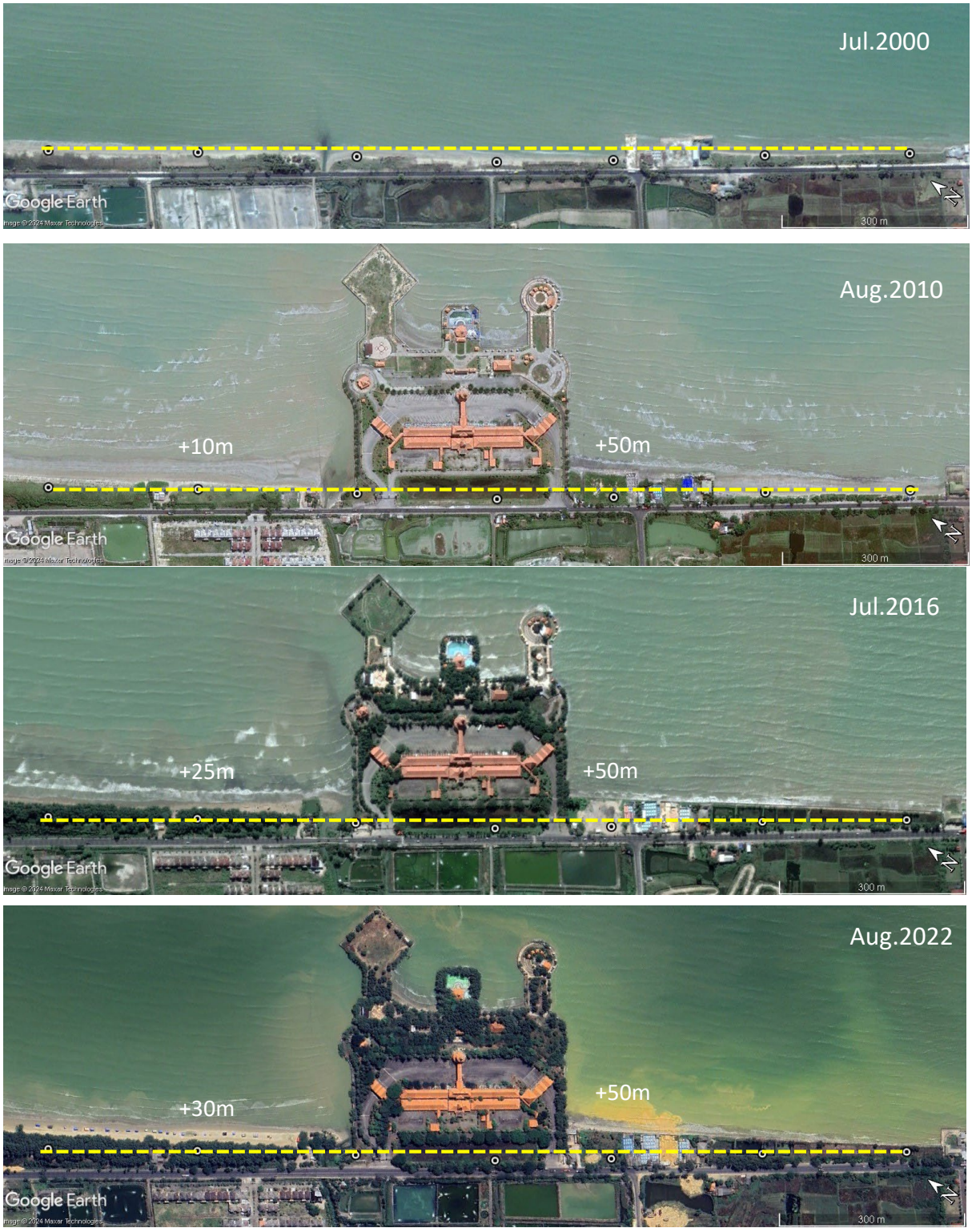
The waves coming to this coast were analyzed by the calculation of wave deformation based on the estimation data (ERA5). At the results, after the waves that generated eastward and westward littoral drift were separated, the energy equivalent waves for both directions were obtained. The energy equivalent wave height(H), its period(T), wave direction angle(ang) , and the frequency of occurrence (%) are shown below. Please refer to Appendix 6-2 for details.

St.6
Wave from North : H=0.32m,T=3.5s,ang=18° ,27%
Wave from South : H=0.48m,T=4.0s,ang=-7° ,73%

According to the wave direction read from satellite images (Figure 31) , the waves are incident at an angle of about 0~10 degrees from the south in the dry season, and about 5 degrees at the average value. Therefore, in the calculation, the wave direction angle from the south was set to 5 degrees. After the trial calculation, the wave direction from the north was set to 25 degrees, and the frequency of waves in the north and south was also revised as shown below.

Wave from North : H=0.32m,T=3.5s,ang=25° ,32%
Wave from South : H=0.48m,T=4.0s,ang=-5° ,68%

The result of the calculation is shown in Figure 32. According to the results, the shoreline on the south side of the reclaimed land was advanced by about 50 m due to the obstruction of the northbound littoral drift, while the shoreline behind the offshore breakwaters on the north side of the reclaimed land was advanced. Although the shoreline retreated slightly at the base of the northern part of the reclaimed land, the shape of the shoreline between the offshore breakwaters and the reclaimed land is deformed as the similar shoreline shape that occurs at the site. Therefore, the wave conditions shown above were adequate.

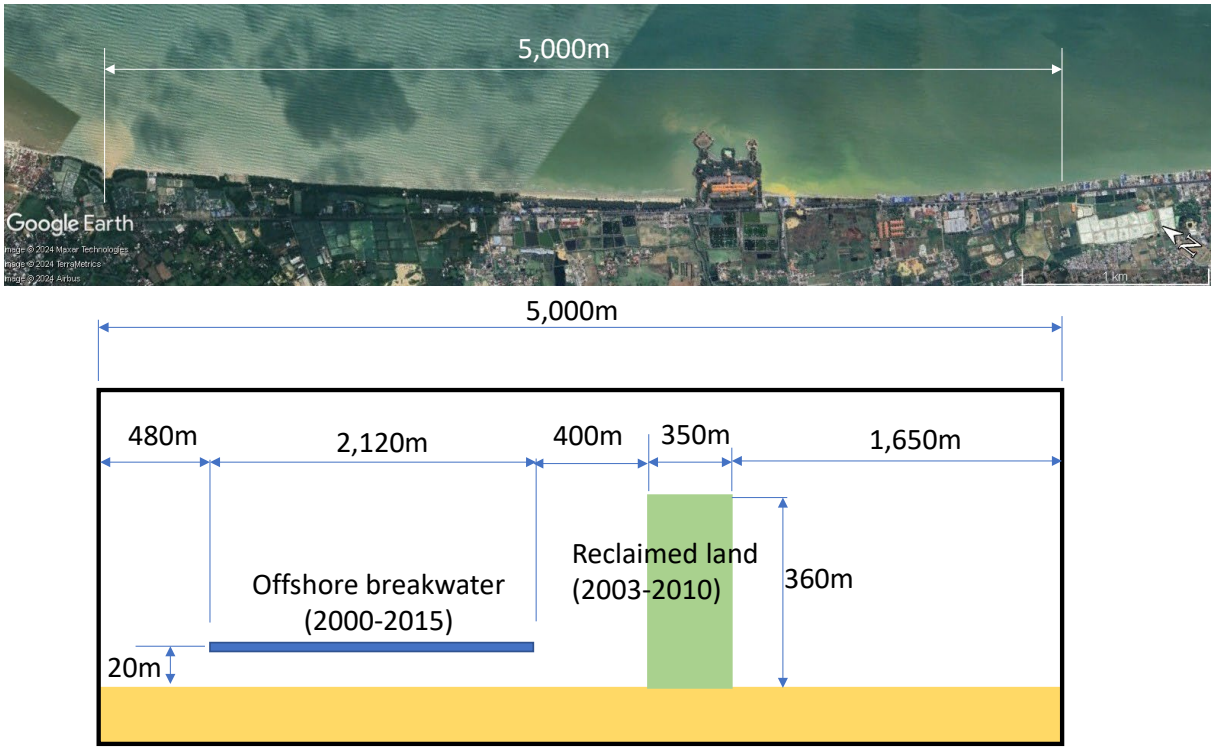


Source：Edited by JICA Study Team using

Figure 28 Topography change for reproduction (Tuban S-1, around the reclaimed land)

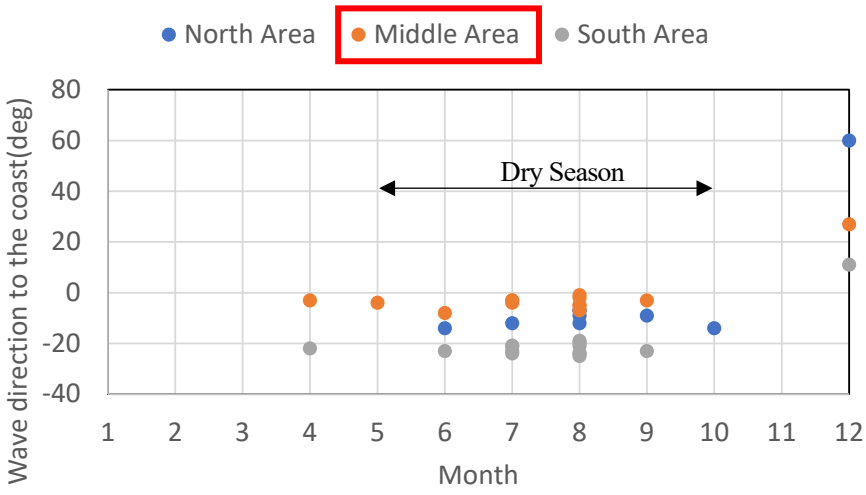
Source : Edited by JICA Study Team using

Figure 29 Topography change for reproduction (Tuban S-1, around the offshore breakwaters)



Source Top： Edited by JICA Study Team using Googlearth, Bottm : JICA Study

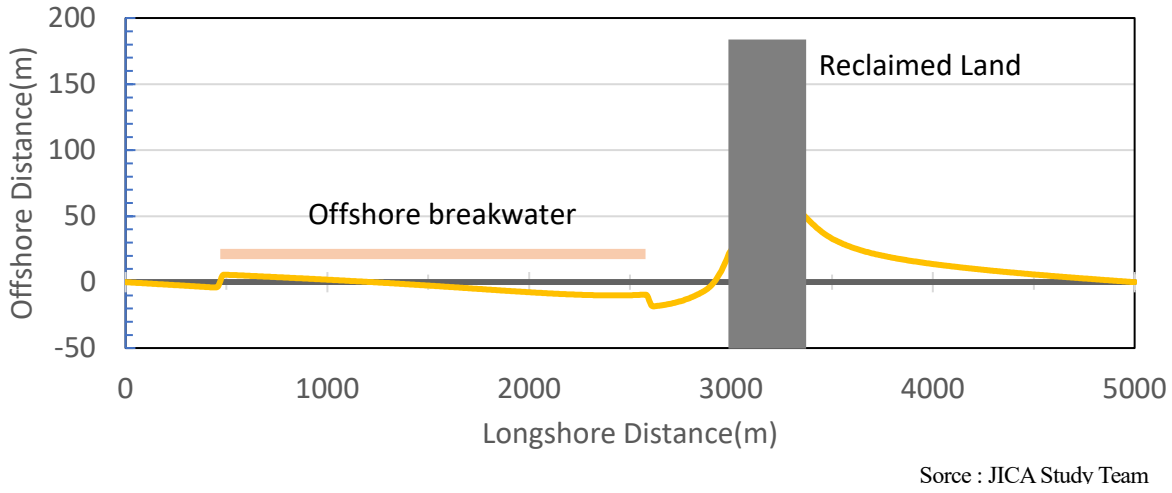
Figure 30 Model topography (Tuban S-1)



Sorce : JICA Study Team

※The target coast is the Middle Area

Figure 31 Wave direction read from the satellite images (Google Earth) (Tuban)



Sorce : JICA Study Team

Figure 32 Calculation result of reproduction for shoreline (Tuban S-1)

(7) Tuban Site-2

The topographic changes for reproduction in the coastal area is shown in Figure 33. Before 2000, a jetty of about 680 m long was built. In 2000, the shoreline has advanced by about 30 m at the east side of jetty and about 20 m at the western side from the shoreline estimated before the construction of the jetty. In 2022 after 22 years, the shoreline has advanced to 50 m in the east side of it and about 25 m in the west side of it. According to such topography change the littoral drift of the both direction to south and north has been existed in the coast, however the westward littoral drift slightly was predominant. Furthermore, the advance of shoreline in the west side of it seems to be caused by the shielding effect of the jetty against the waves coming from east. Also, the seawall has been constructed alongshore in both side of the jetty, and there is no beach in front of the seawall.

In order to reproduce such changes, the model topography for reproduction is prepare as shown in Figure 34. The calculation area is 2 km longshore with the jetty located in the center, and the north and south boundaries are located the places where the seawall has been constructed.

The waves coming to this coast were analyzed by the calculation of wave deformation based on the estimation data (ERA5). At the results, after the waves that generated eastward and westward littoral drift were separated, the energy equivalent waves for both directions were obtained. The energy equivalent wave height(H), its period(T), wave direction angle(ang) , and the frequency of occurrence (%) are shown below. Please refer to Appendix 6-2 for details.

St.9

Wave_+:H=0.41m,T=3.7s,ang=26° ,25%

Wave_-:H=0.41m,T=3.9s,ang=-23° ,75%

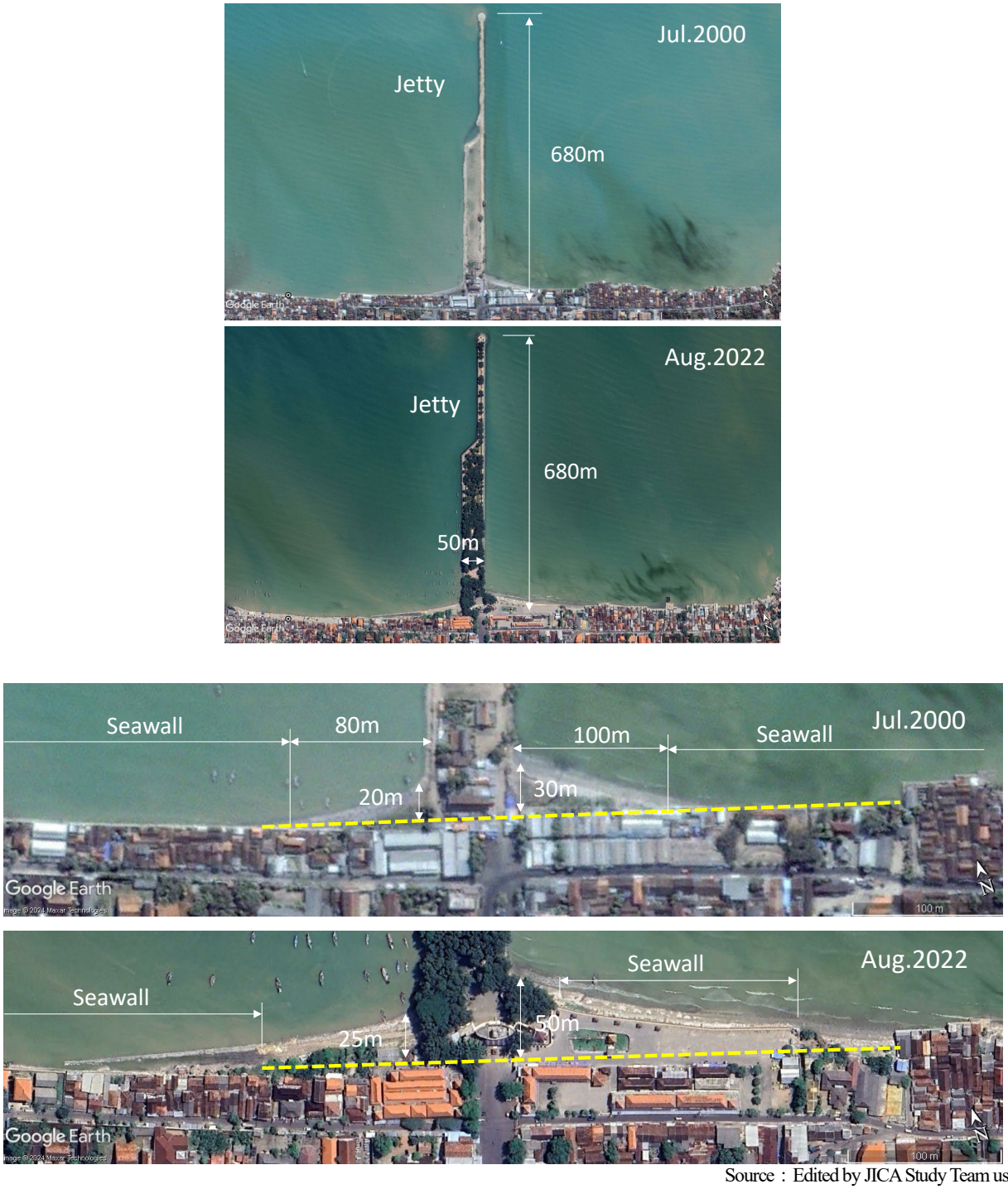
According to the wave direction read from satellite images (Figure 35), the waves are incident at an angle of about 20 degrees from the east in the dry season as same as the energy equivalent wave as shown above.

After the trial calculation, the wave direction from the east and west was set to 5 and -5 degrees as shown below.

Wave_+:H=0.41m,T=3.7s,ang=5° ,25%

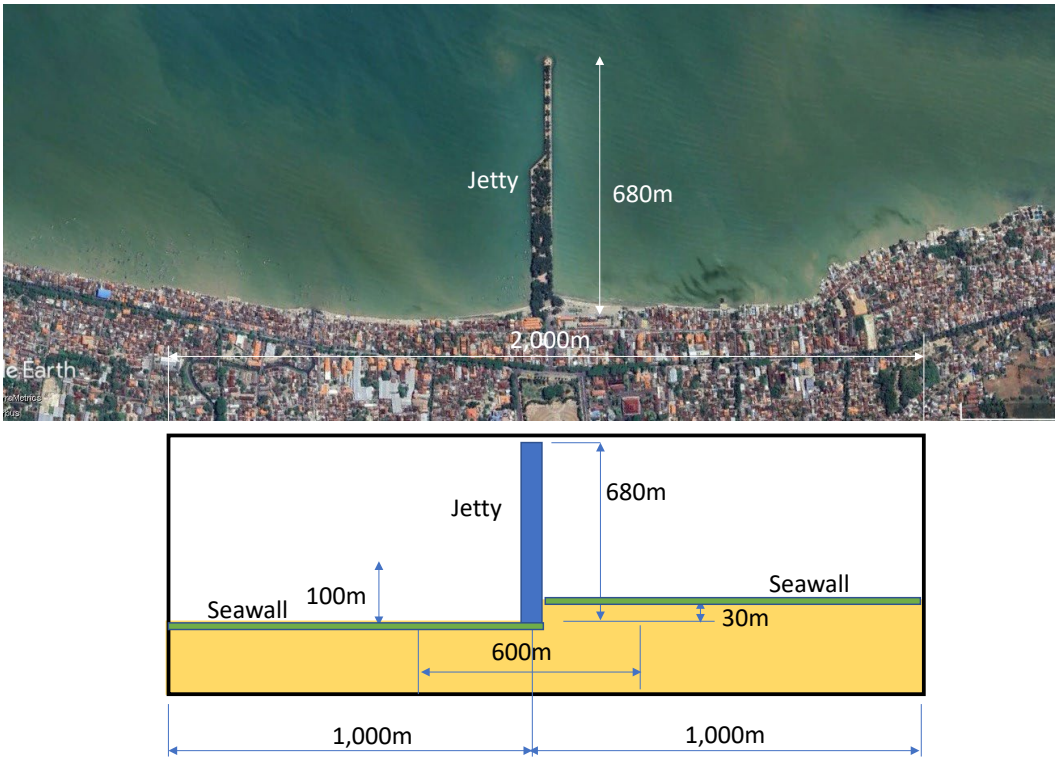
Wave_-:H=0.41m,T=3.9s,ang=-5° ,75%

The result of the calculation is shown in Figure 36. According to the results, the shoreline on the east side of the jetty was advanced by about 50 m due to the obstruction of the west littoral drift, while the shoreline on the west side of it was advanced by about 20 m due to the shielding effect of the jetty. Since such topography changes are almost same as the field, the wave conditions shown above were adequate.



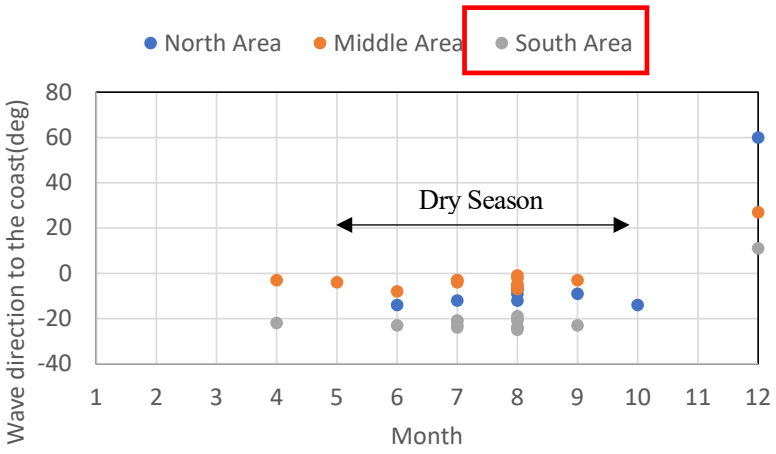
Source : Edited by JICA Study Team using

Figure 33 Topography change for reproduction (Tuban S-2, around jetty)



Source Top：Edited by JICA Study Team using Googlearth, Bottm : JICA Study

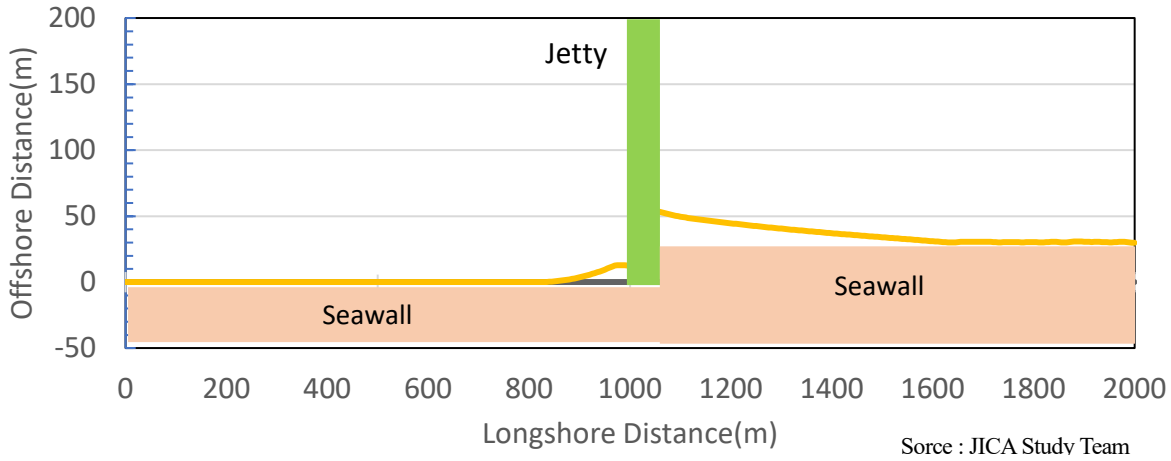
Figure 34　Model topography (Tuban S-2)



Sorce : JICA Study Team

※The target coast is the South Area

Figure 35　Wave direction read from the satellite images (Google Earth, Tuban)



Sorce : JICA Study Team

Figure 36 Calculation result of reproduction for shoreline (Tuban S-2)

13.2.4 Layout Speciffication by Numerical Simulation

(1) Indramayu Section-1

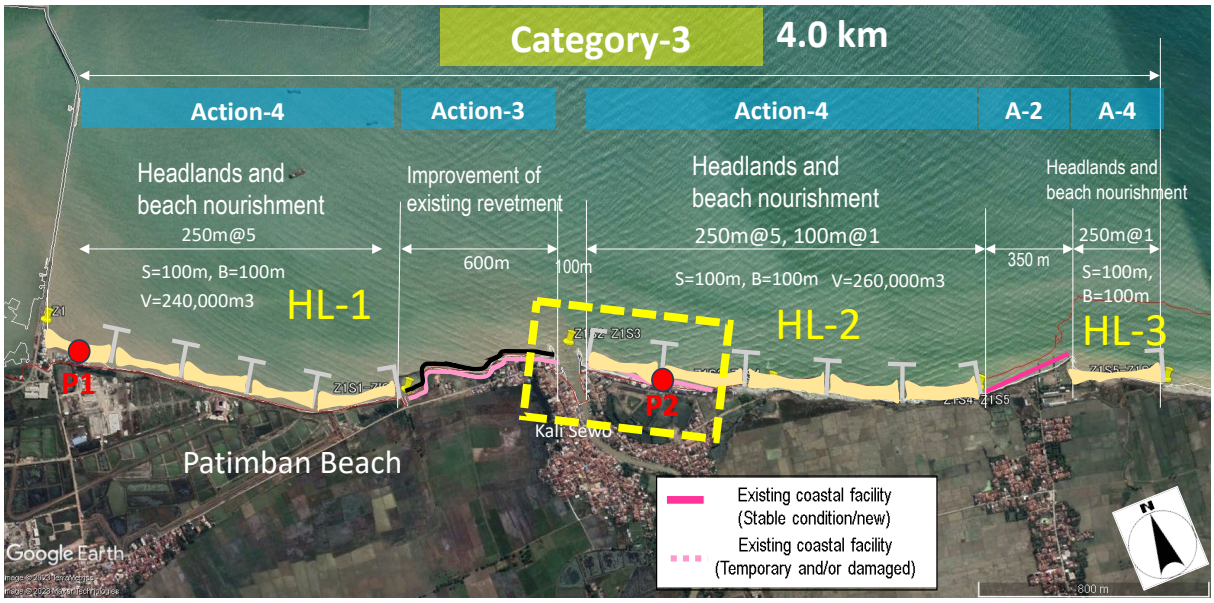
The facilities corresponding to this section are shown in the top of Figure 37. Three places where headland facilities are planned, HL-1, 2, and 3. These headland facilities are based on T-type headlands, with a vertical embankment length of 100 m, a horizontal embankment length of 100 m, and a space distance of 250 m. Under the conditions of modeling the local topography as shown in the bottom of Figure 37 the validity of the facility layout was examined together with the amount of beach fill.

In the local coast the shoreline is advancing at the eastern base of the central estuary jetty by blocking of the predominant westward littoral drift, and at the eastern base of the western jetty that is a part of road revetment. In addition, stone revetments are installed on the shoreline. However, in recent years, the shoreline behind it has receded due to its subsidence and scattering (Figure 38). Under the initial topography reproduces such characteristics of topography changes, the topography change in the next 10 years is shown in Figure 39. Since it is expected that the stone revetment currently installed on the shoreline will lose its function due to the progress of subsidence and scattering, the stone revetments are uninstalled under the simulation. Across the estuary, erosion is expected to progress on the east side of both the east and west coasts, and the shoreline is expected to recede. In addition, the shoreline at the eastern base of the road revetment at the western end and the eastern base of the estuary jetty is expected to move offshore, but since the sediment at the coast is very fine sand mixed with silt, it is expected that the shoreline will not advance, and much sediment will move offshore.

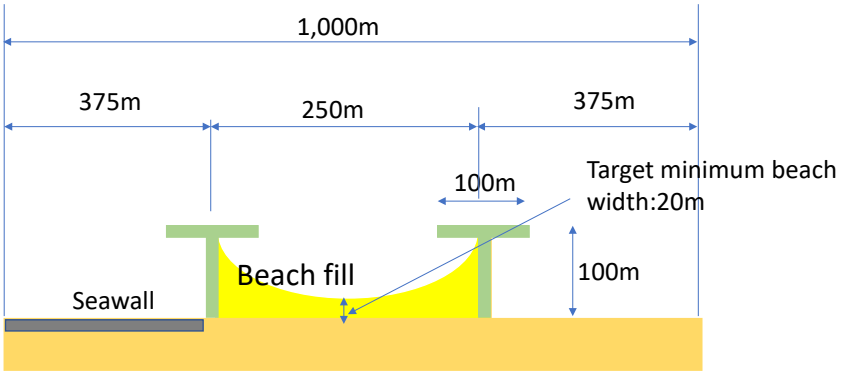
Figure 40 shows the result of shoreline prediction with the countermeasures proposed in the coastal facility plan. Under the T-type headland with a longitudinal embankment length of 100 m and a horizontal embankment length of 100 m, the average width of the beach is about 40 m with a beach fill volume of 24,000 m^3.

The amount of beach fill was estimated about 20,000 m^3 previously, but the calculation result reached about 24,000 m^3. The reason of a difference seems to be the strong asymmetry topography between headlands caused by predominant waves from the east.

On the other hand, in the case of a groin-type headlands (without a horizontal embankment), it is difficult to keep a minimum beach width of 20 m even with a similar beach fill volume of 24,000 m^3. Therefore, it indicates the validity of horizontal embankment in maintaining the beach (Figure 41). Furthermore, in the case of beach fill without facility, although a sandy beach will be formed at the time of completion of beach fill (after 2 years), the sandy beach will decrease over time. It is difficult to maintain a sandy beach without a facility (Figure 42).



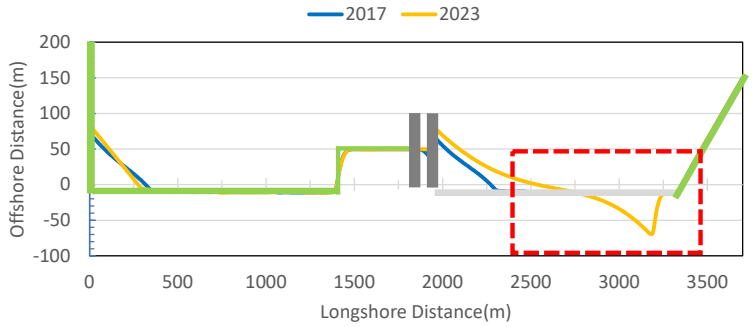
Source：Edited by JICA Study Team using Googlearth



Source：Edited by JICA Study Team

Figure 37　Modeled Topography and Coastal Facility Plan (Indramayu S-1)

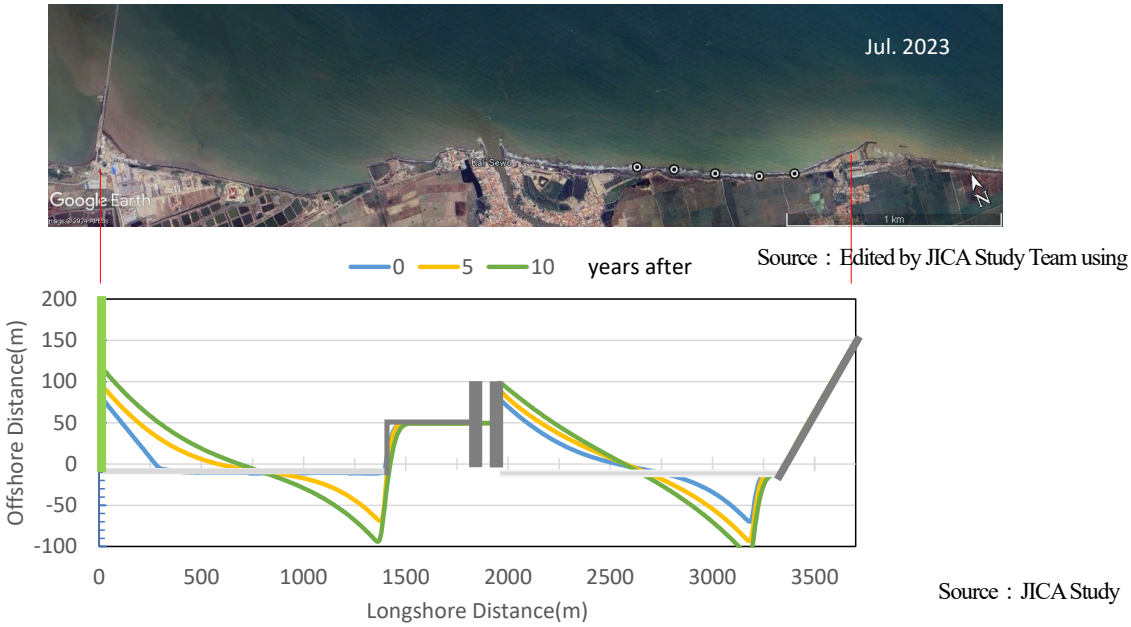
Source：Edited by JICA Study Team using



Source：JICA Study

Figure 38　Shoreline Retreat due to Subsidence and Scattering of Masonry Seawalls

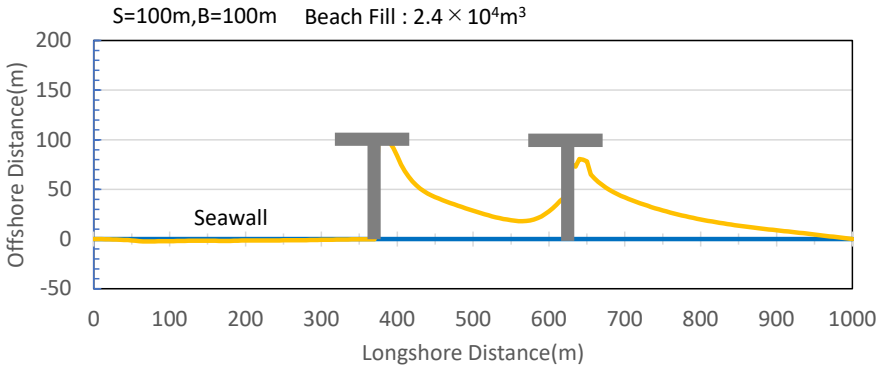
(Top: Shoreline changes by satellite images, Bottom: Reproduction calculation results)



Source：Edited by JICA Study Team using

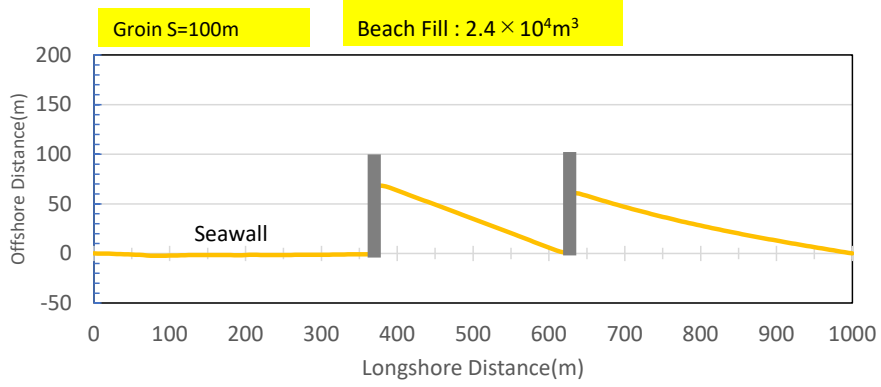
Source：JICA Study

Figure 39 Projected Topography at Present (No countermeasures, Indramayu S-1)



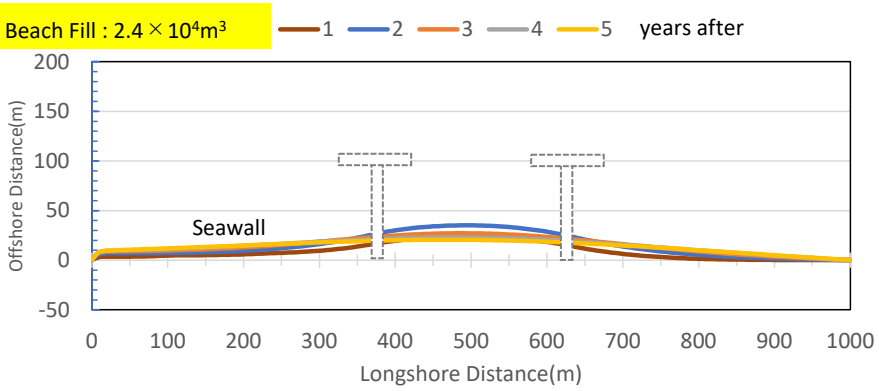
Source：JICA Study Team

Figure 40 Numerical Prediction of Shoreline Change for T-type Headland



Source：JICA Study Team

Figure 41 Numerical Prediction of Shoreline Change for Groins



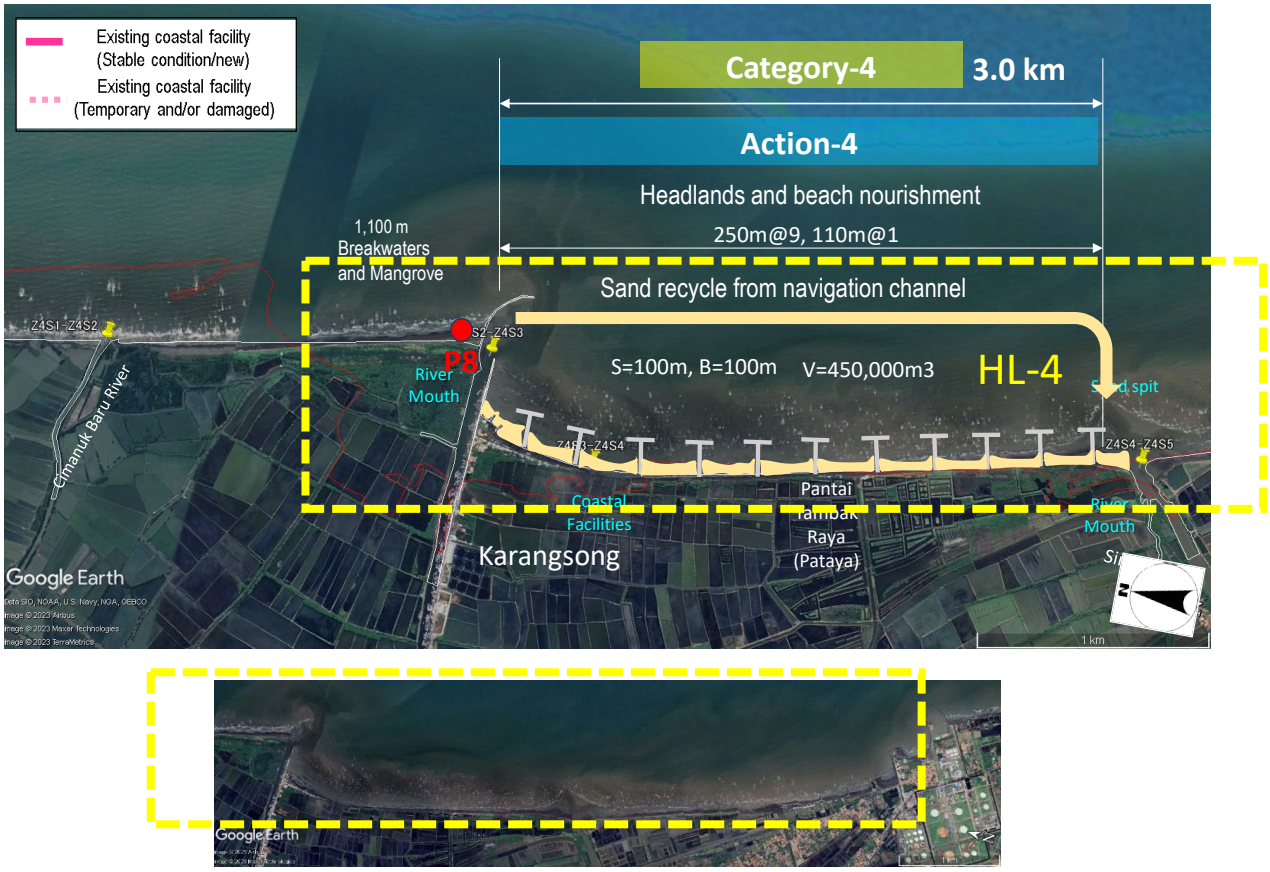
Source：JICA Study Team

※Implementation of beach fill from the initial stage to 2 years

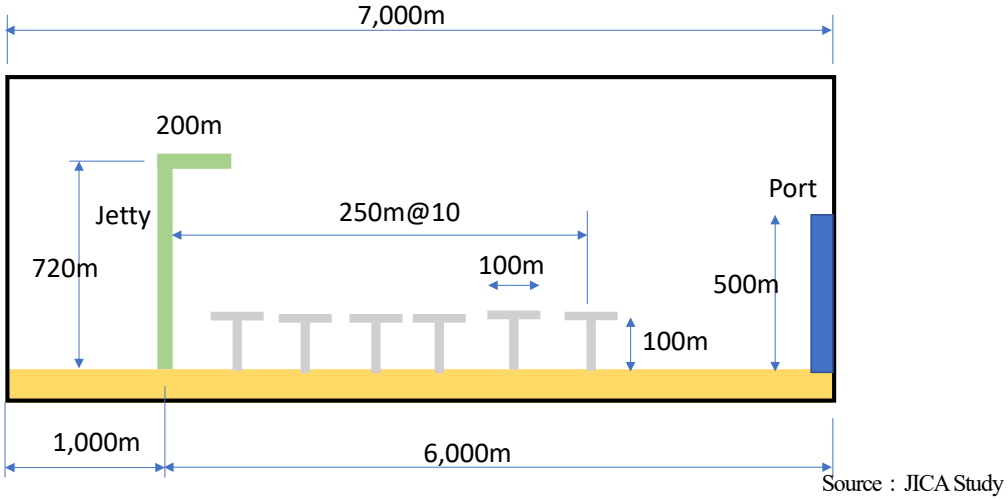
Figure 42 Numerical Prediction of Shoreline Change for Beach fill without Facility

(2) Indramayu Section-6a

The T-type headland and beach fill planned in this section are shown in top of Figure 43, the calculation area is shown in the middle of Figure 43 and the modeled topography and facility are shown in the bottom of Figure 43. In the northern end of calculation area, the jetties of 720 m long have been constructed at a river mouth, where littoral drift was almost blocked. In the southern end of calculation area, there is a port where the littoral drift was almost blocked.



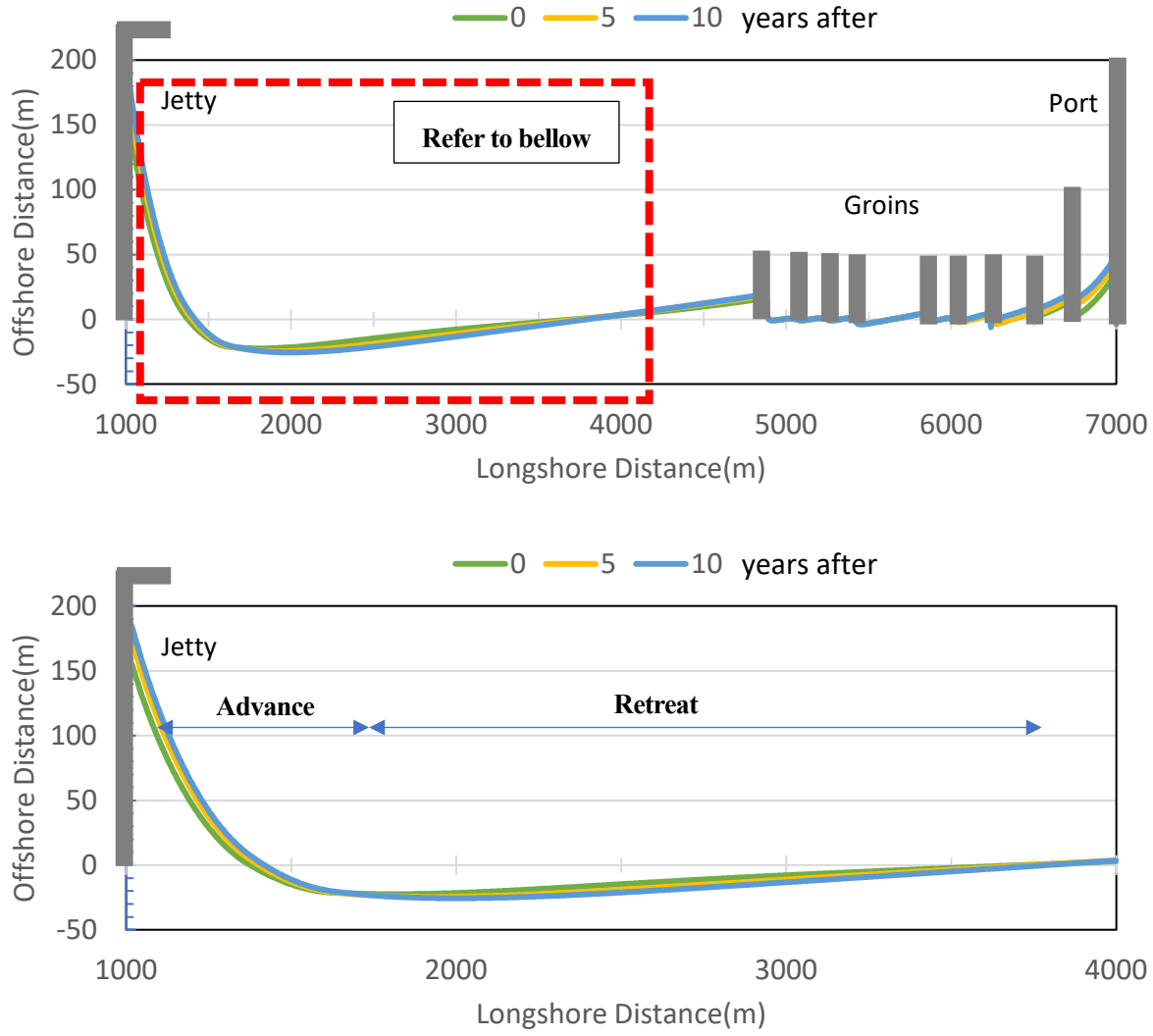
Source : Edited by JICA Study Team using



Source : JICA Study

Figure 43 Modeled Topography and Coastal Facility Plan (Indramayu S-6a)

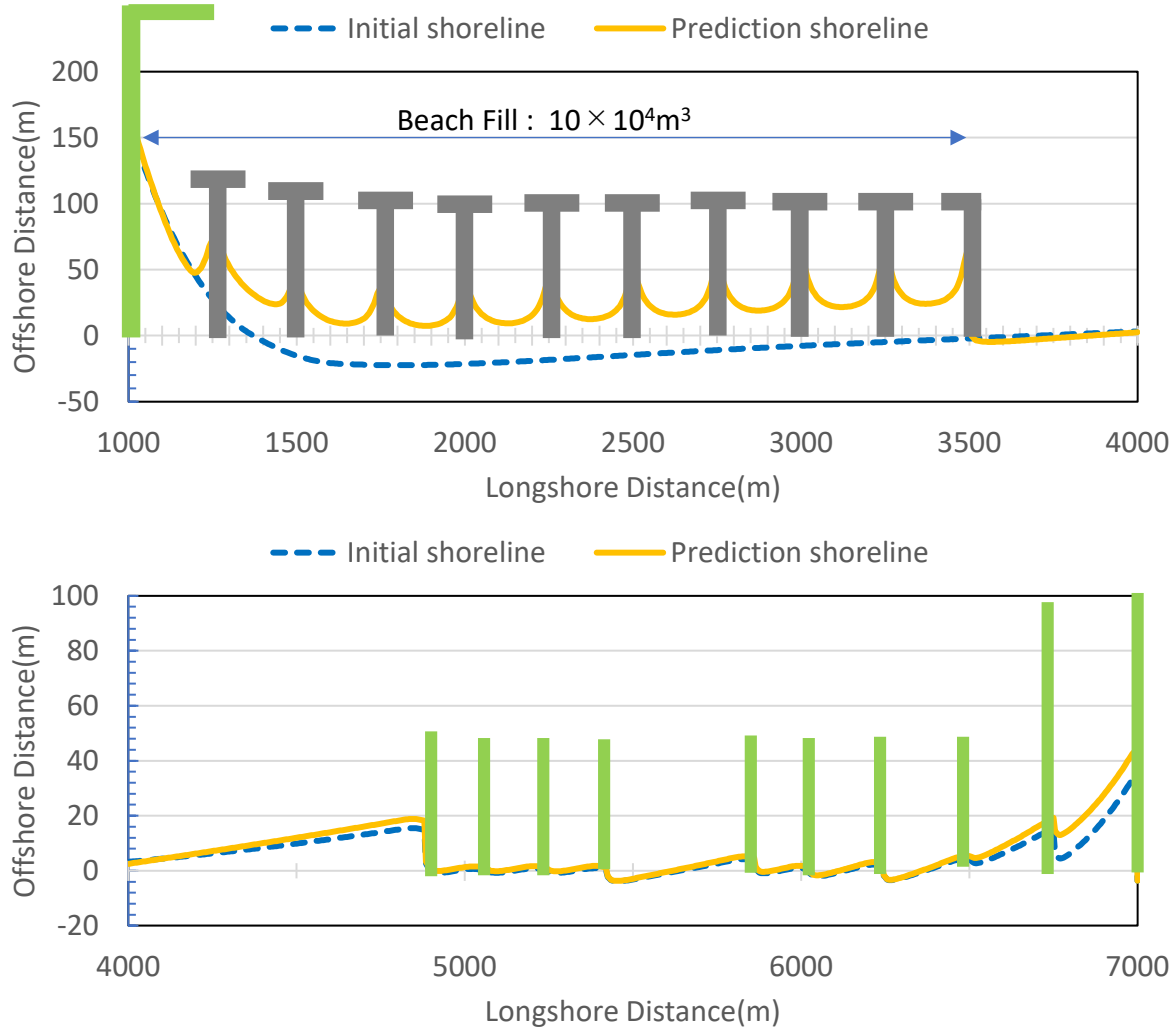
The results of prediction for shoreline change in the case without countermeasures is shown in Figure 44. The local topography change in the coast is characterized as follows. Near the base of the jetty the shoreline advances by littoral drift toward the base of the jetty due to the shielding effect of the jetty. On the other hand, the direction of the littoral drift reverses eastward from westward as it moves eastward, so there is a range where the shoreline retreats. In addition, there are several small groins on the east side, and the eastward littoral drift is controlled by them. As the result, the stepped shoreline shape was formed. Under the initial topography reproduces such characteristics of topography changes, the topography change in the next 10 years is shown in Figure 44. The shoreline at the base of the jetty at the western end of the river is expected to advance by about 30 m in the next 10 years, and the shoreline is expected to retreat by up to about 6 m at 1~1.5 km to the east from jetty.



Source：JICA Study Team

Figure 44 Projected Topography at Present (No countermeasures, Indramayu S-6a)

Figure 45 shows the result of shoreline prediction with the countermeasures proposed in the Coastal Facility Plan. The amount of beach fills of about 100,000 m^3 maintain the beach, which is the average width of about 41 m, and the minimum width of about 22 m. The amount of beach fill was slightly smaller than previous amount estimated about 136,000 m^3. In addition, since there is no significant shoreline retreat even on the eastern side of the headlands, it is considered that there is no impact on the surrounding coast of the countermeasure facilities.

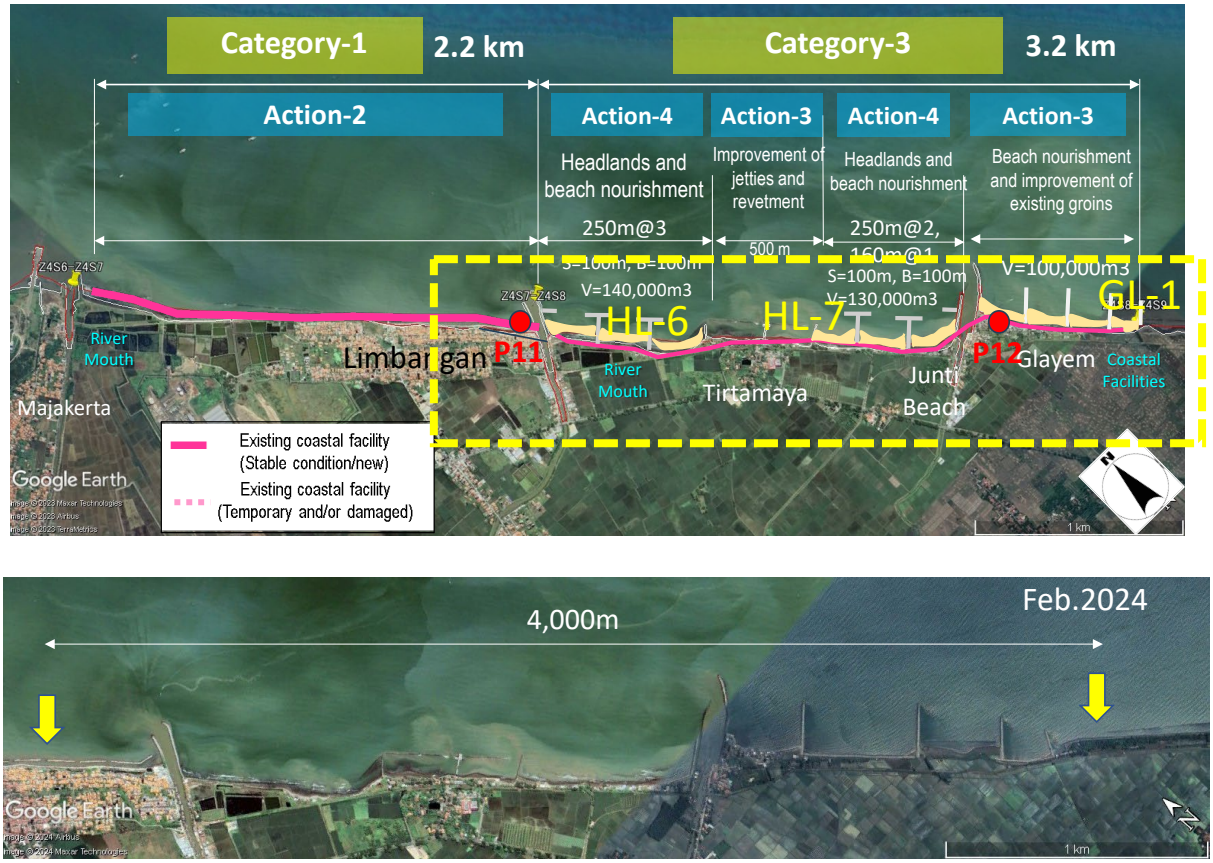


Source：JICA Study Team

Figure 45 Numerical Prediction of Shoreline Change for the Coastal Facility plan (Indramayu S-6a)

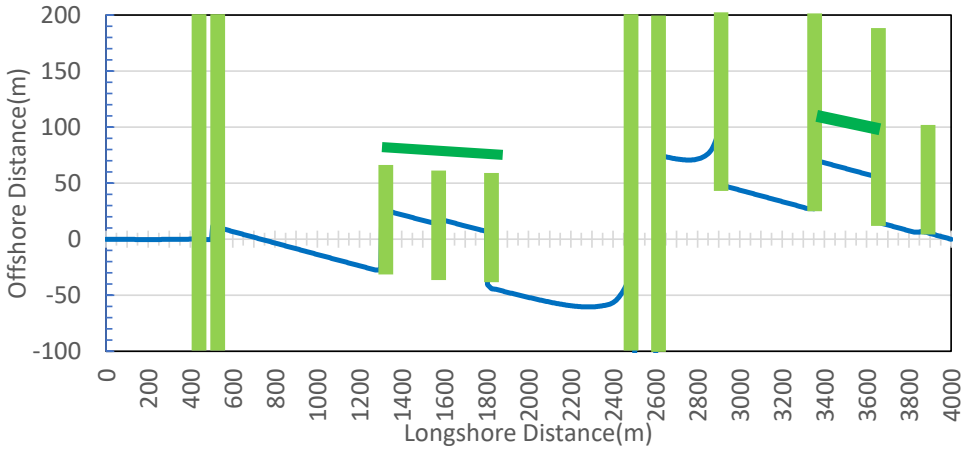
(3) Indramayu Section-6d

Figure 46 shows the T-type headland and beach fill planned in this section, the calculation area, and the modeled topography and facility. There are seawalls at the west and east ends, and there is no sandy beach in front of it. In addition, there are jetties at two estuaries, as well as groins and offshore breakwaters in the area. In the coastal facility plan proposed, T-type headlands and a beach fill are planned in the area between the jetties at estuaries, and a beach fill is planned between the existing groins on the east side. To reflect the impact of the existing structures for topography, the present topography as shown in Figure 47 is reproduced in the model. Under the obtained topography as initial condition, the topographic changes were predicted with and without of countermeasures. The results of prediction for shoreline change in the case without countermeasures is shown in Figure 48. Since there are many existing structures on the coast, and topographic changes corresponding to the structures have already occurred and stabilized, there is almost no change from the present topography even if no measures are taken. Figure 49 shows the result of shoreline prediction with the countermeasures proposed in the coastal facility plan. The amount of beach fills of about 114,000 m^3 maintains the stable beach. The amount of beach fill was almost same as previous amount estimated about 110,000 m^3. On the other hand, the impact of the countermeasure facility on the surrounding coast, especially on the western coast, which is the down drift side of the predominant littoral drift, is considered to have no major impact such as erosion because the littoral drift is still hindered by the existing jetties and groins and is already protected by seawalls.



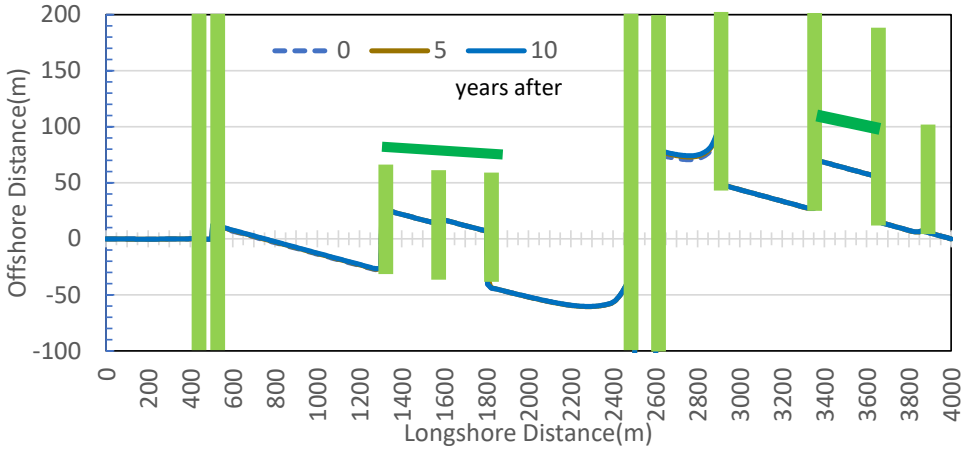
Top and Middle: Edited by JICA Study Team based on Google Earth, Bottom: JICA Study Team

Figure 46 Modeled Topography and Coastal Facility Plan (Indramayu S-6d)



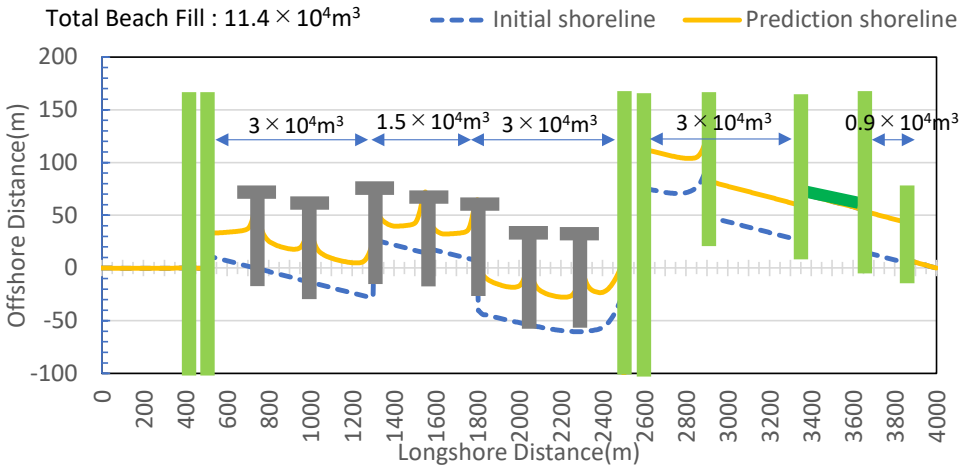
Source：JICA Study Team

Figure 47 Initial Topography and Facilities for Prediction (Indramayu S-6d)



Source: JICA Study Team

Figure 48 Projected Topography at Present (No countermeasures, Indramayu S-6d)

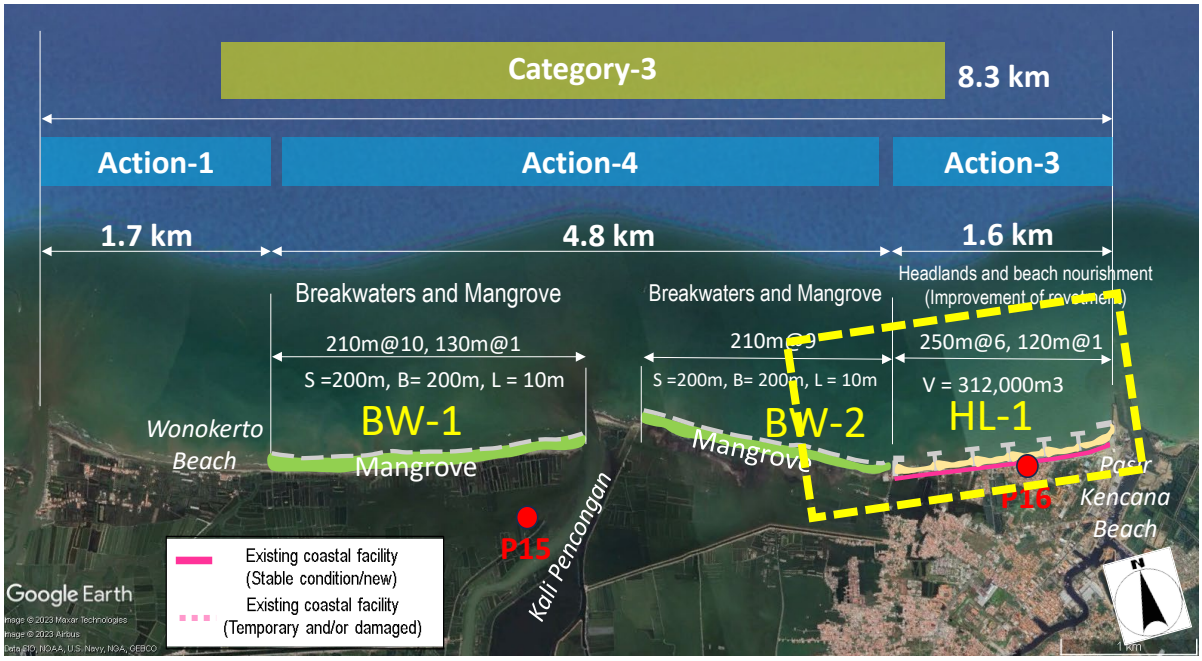


Source：JICA Study Team

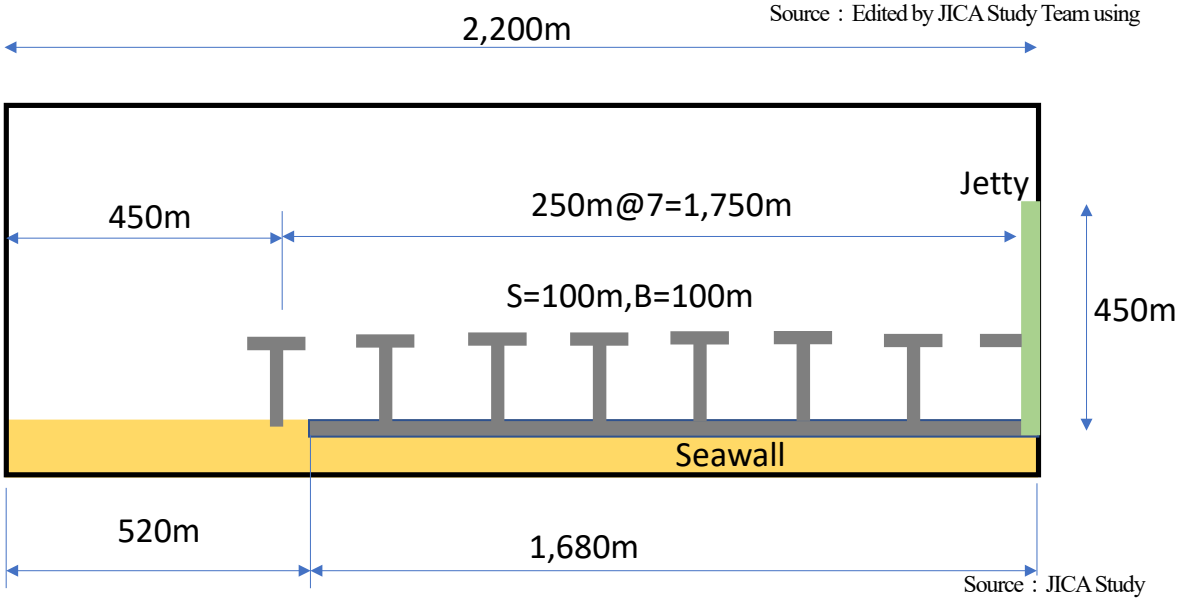
Figure 49 Numerical Prediction of Shoreline Change for the Coastal Facility Plan (Indramayu S-6d)

(4) Pemalang-Pekalongan Section-4a

The T-type headland and beach fill planned in this section is shown in the top of Figure 50 and the modeled topography and facility are shown in the bottom of Figure 50. The western end was a place where the shoreline position did not change over a long period of time, and the eastern end was a place where the jetty of 450m long is located. It has almost stopped the littoral drift.



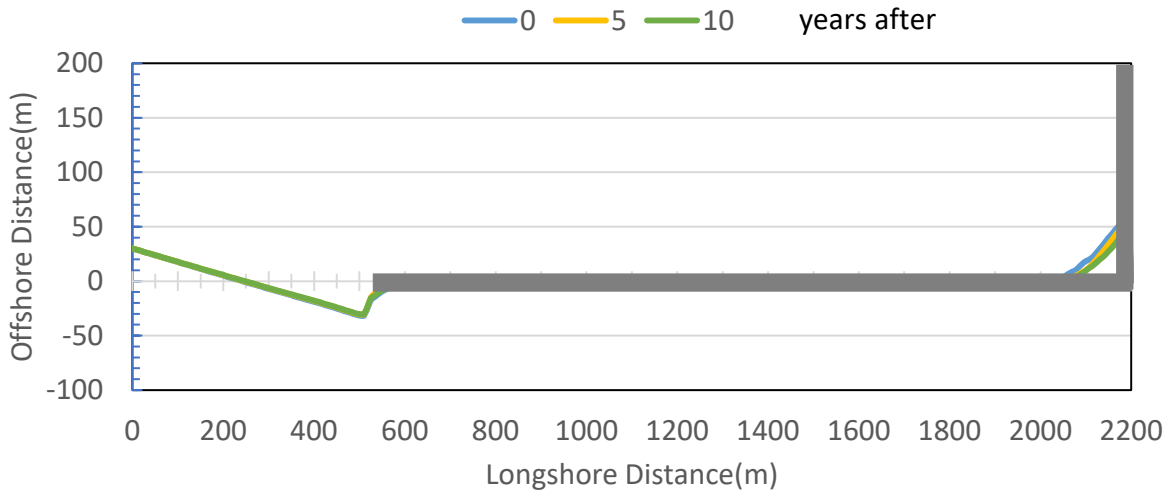
Source : Edited by JICA Study Team using



Source : JICA Study

Figure 50 Modeled Topography and Coastal Facility Plan (Pemalang-Pekalongan S-4a)

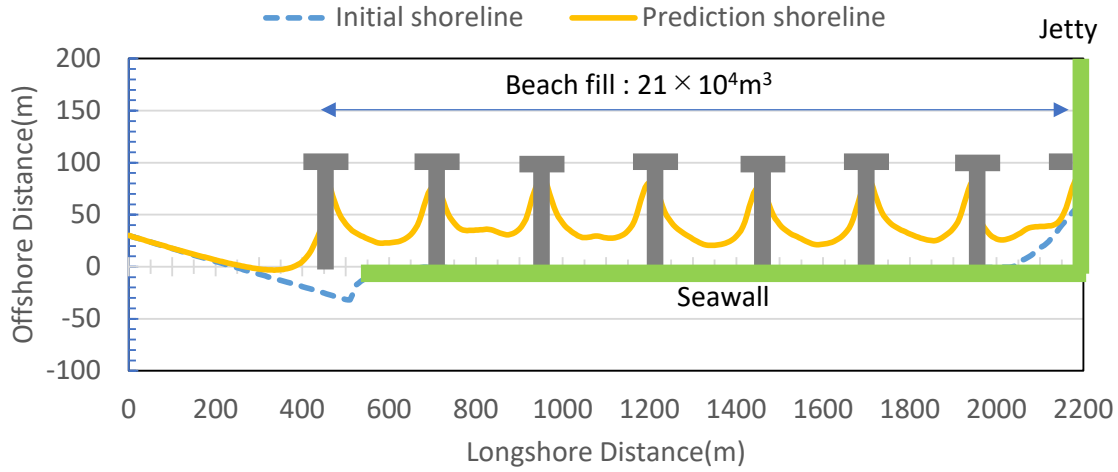
The results of prediction for shoreline change in the case without countermeasures is shown in Figure 51. No further erosion will occur along a seawall. In addition, the shoreline near the west end where there is no seawall has already been retracted, but no further shoreline retreat has occurred. However, since land subsidence continues over a wide area of the coast, it is expected that shoreline retreat due to land subsidence will continue to occur.



Source：JICA Study Team

Figure 51 Projected Topography at Present (No countermeasures, Pemalang-Pekalongan S-4a)

Figure 52 shows the result of shoreline prediction with the countermeasures proposed in the coastal facility plan. The amount of beach fills of about 210,000 m^3 maintains the stable beach, which is the average width of about 41 m, and the minimum width of about 20 m. The amount of beach fill was a slightly larger than previous amount estimated about 170,000 m^3. The difference is caused by the difference of topography; In the simulation, the topography in front of the seawall differs alongshore. However, in the estimation of amount for beach fill, the topography is the same alongshore.

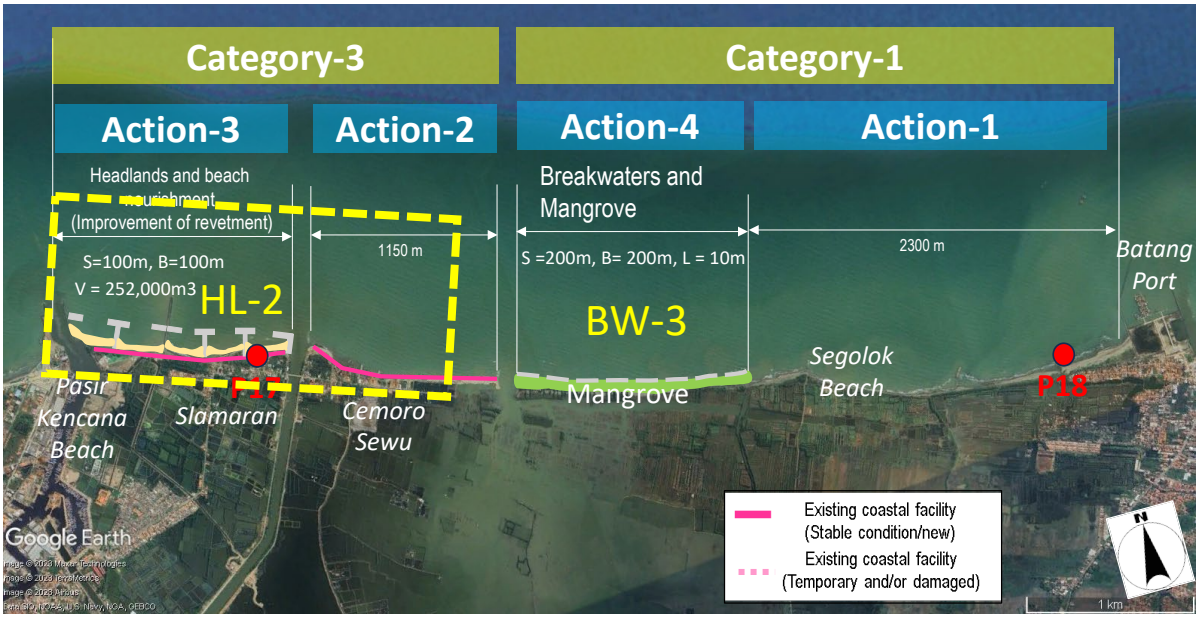


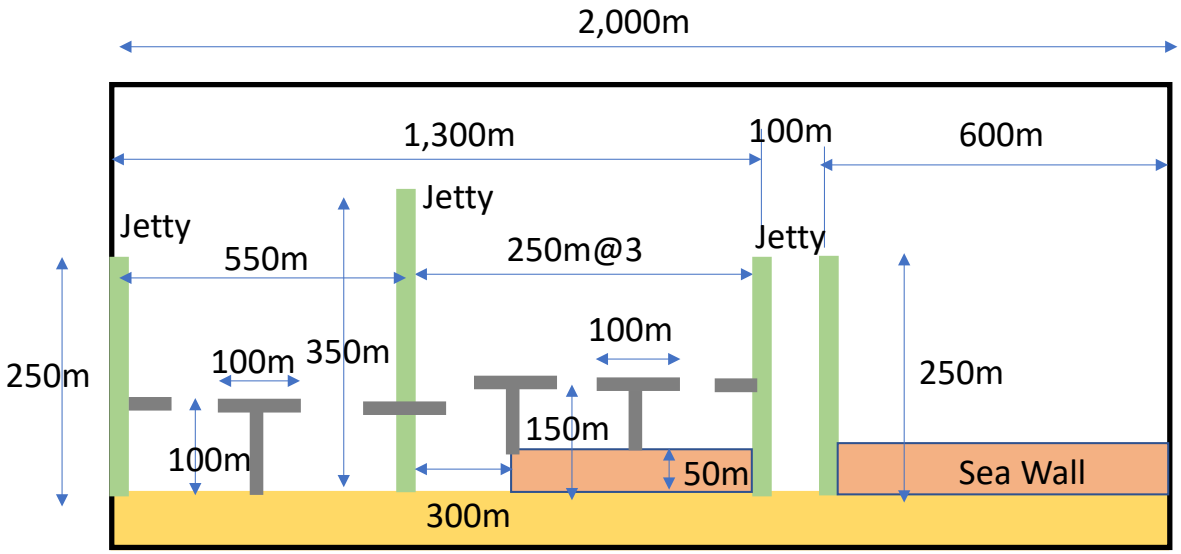
Source：JICA Study Team

Figure 52 Numerical Prediction of Shoreline Change for the Coastal Facility Plan (Pemalang-Pekalongan S-4a)

(5) Pemalang-Pekalongan Section-4b

Figure 53 shows the T-type headland and beach fill planned in this section (the top of Figure 53) and the modeled topography and facility (the bottom of Figure 53). At the western end, there is a jetty of 250 m long where littoral drift is almost blocked, and on the east side, there is jetties of 250 m length that almost blocks littoral drift.



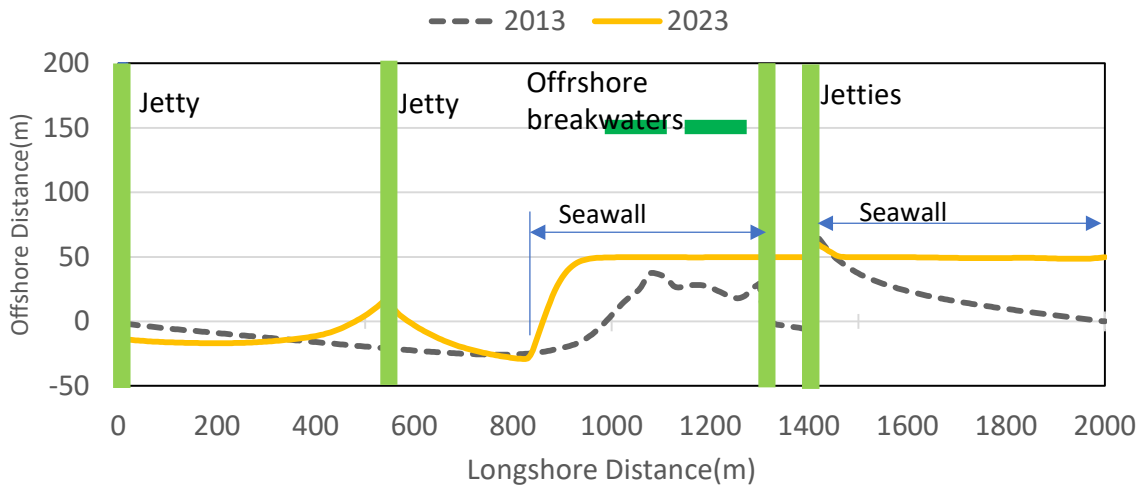


To: Edited by JICA Study Team bases on Googlearth, Botto: JICA Study Team

Figure 53 Modeled Topography and Coastal Facility Plan ((Pemalang-Pekalongan S-4b)

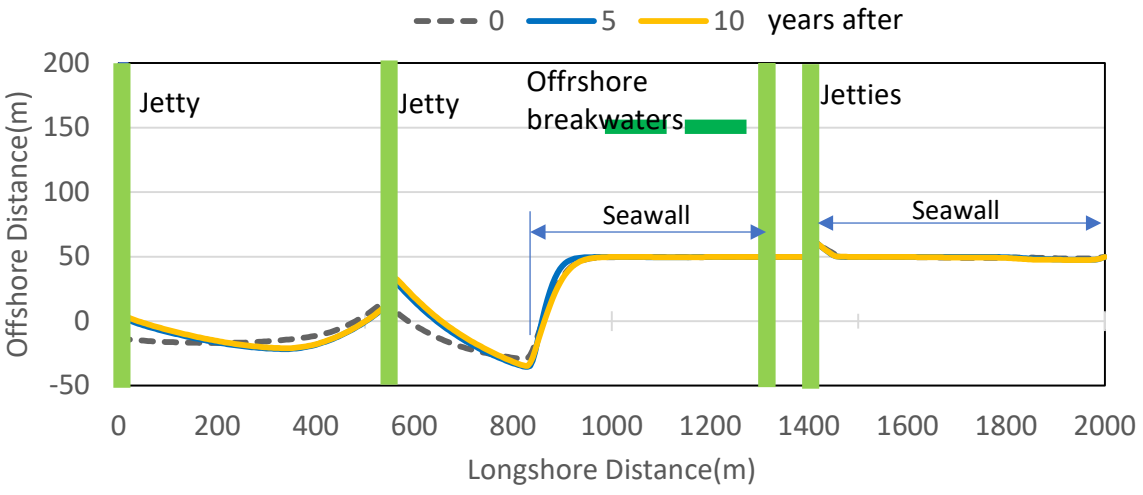
The results of reproducing the present topography are shown in Figure 54. On the east side, a seawall has already been installed across the estuary embankment, and there is no sandy beach. On the other hand, on the west side, there is a narrow sandy beach across Jetty. The results of the prediction topography change under the present topography without countermeasures are shown in Figure 55. It is predicted that there will be no major shoreline change because the littoral drift is controlled by seawalls and jetties on the coast.

The projected topography for the case of the measures proposed in the coastal facility plan is shown in Figure 56. Under the planned facility, the average beach width of about 42 m can be maintained due to the amount of beach fill of about 150,000 m^3, which is almost same as the estimated amount of beach fill of 138,000 m^3.



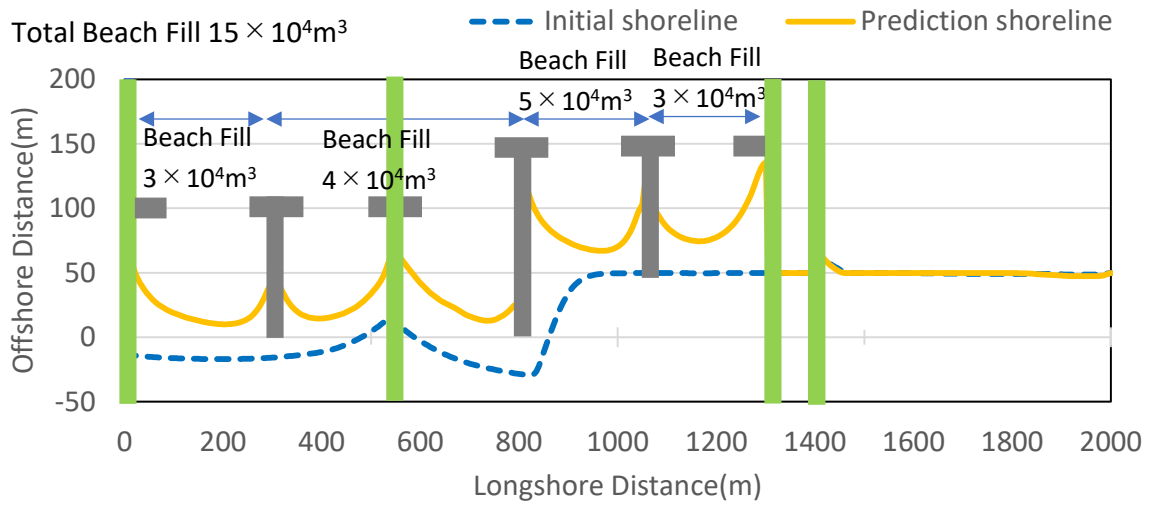
Source：JICA Study Team

Figure 54 Initial Topography and Facilities for Prediction (Pemalang-Pekalongan S-4b)



Source：JICA Study Team

Figure 55 Projected Topography at Present (No countermeasures, Pemalang-Pekalongan S-4b)

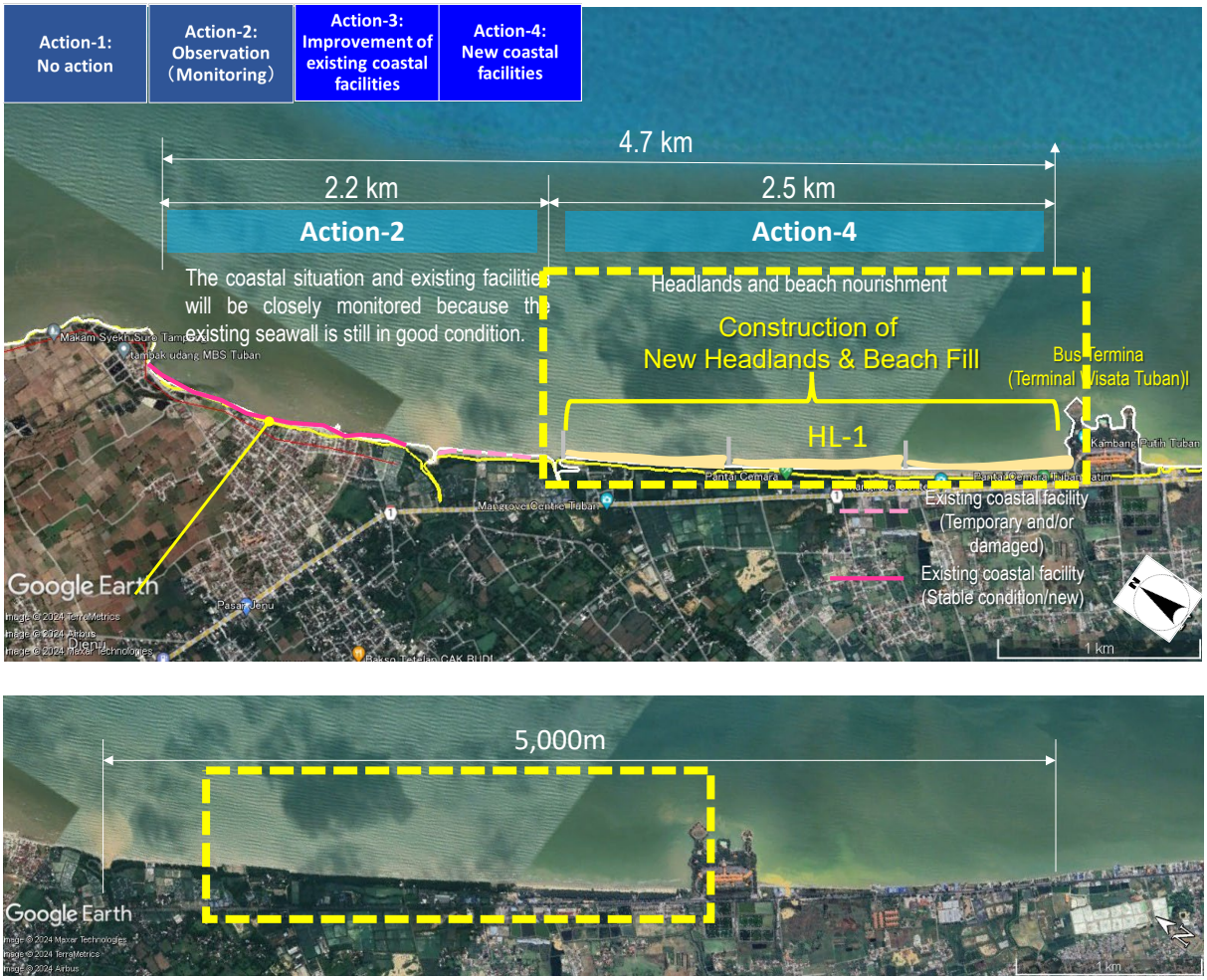


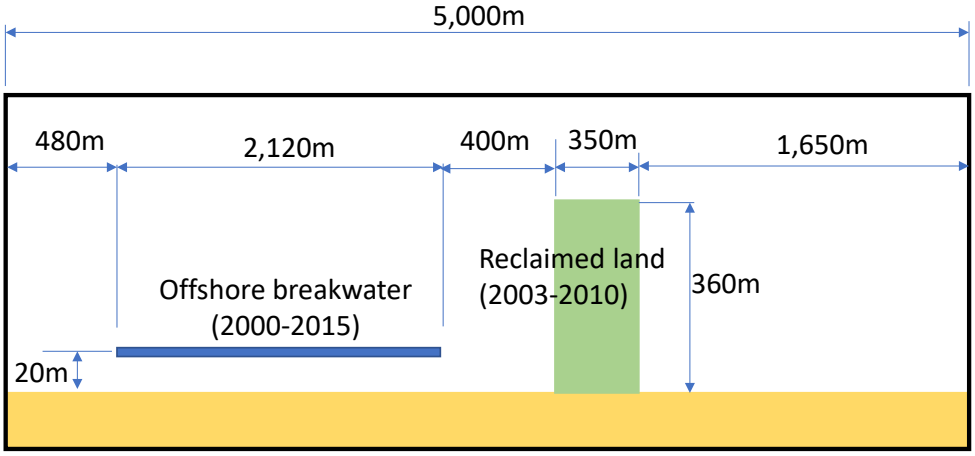
Source：JICA Study Team

Figure 56 Numerical Prediction of Shoreline Change for the Coastal Facility Plan (Pemalang-Pekalongan S-4b)

(6) Tuban Site-1

Groins and beach fill planned at this site and them model are shown in Figure 57. The northern and southern ends of calculation area are the places where the shoreline is relatively stable, and in the center of the area there is a reclaimed land that protrudes about 360 m offshore, where littoral drift is almost blocked.

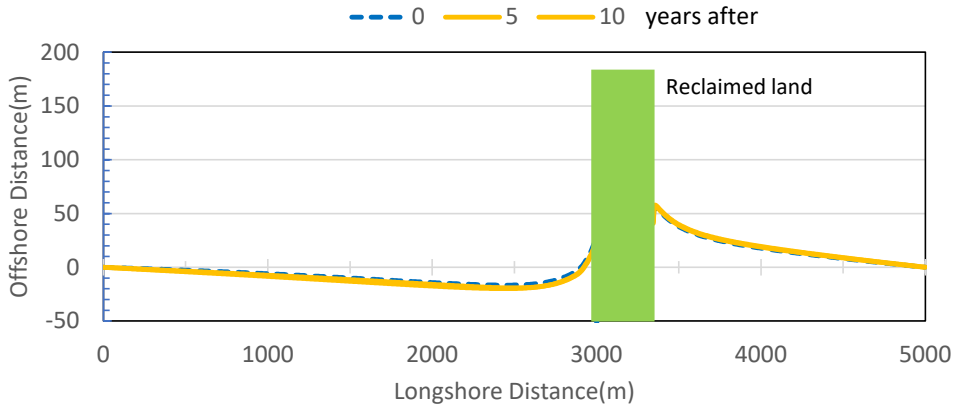




Top and Middle: Edited by JICA Study Team based on Google Earth, BottomSource: JICA Study Team

Figure 57 Modeled Topography and Coastal Facility Plan (Tuban Site-1)

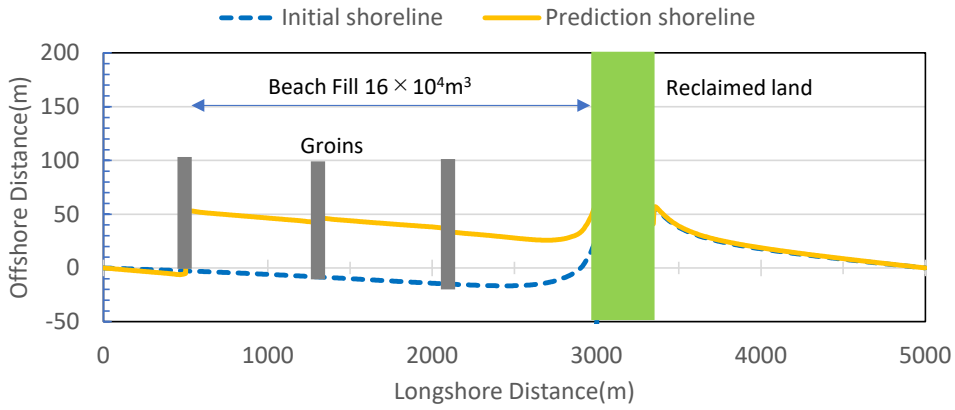
The results of the prediction topography for the case without countermeasures are shown in Figure 58. The existing offshore breakwater is not considered as it is currently almost subsiding and is not fulfilling its function. The present topography more than 10 years have passed since the construction of the reclaimed land is almost stable. Therefore, it is expected that there will be no major changes in the shoreline in the next 10 years.



Source：JICA Study Team

Figure 58 Projected Topography at Present (No countermeasures, Tuban Site-1)

The projected topography for the case of the measures proposed in the coastal facility plan is shown in Figure 59. Under the planned facility, the average beach width of about 52 m and minimum beach width of about 48 m can be maintained due to the amount of beach fill of about 160,000 m^3, which is slightly larger than the estimated amount of beach fill of 120,000 m^3.

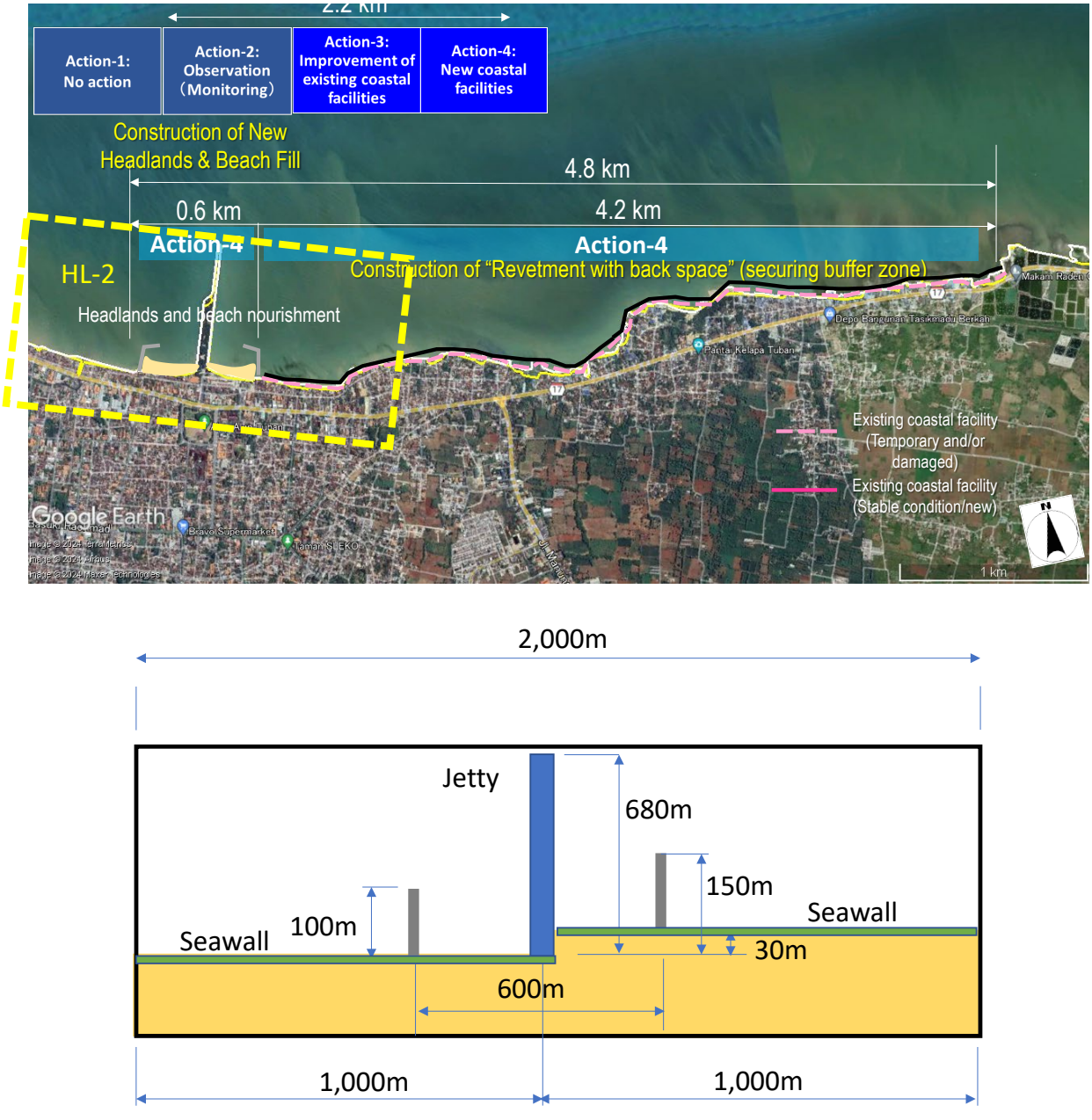


Source：JICA Study Team

Figure 59 Numerical Prediction of Shoreline Change for the Coastal Facility Plan (Tuban Site-1)

(7) Tuban Site-3

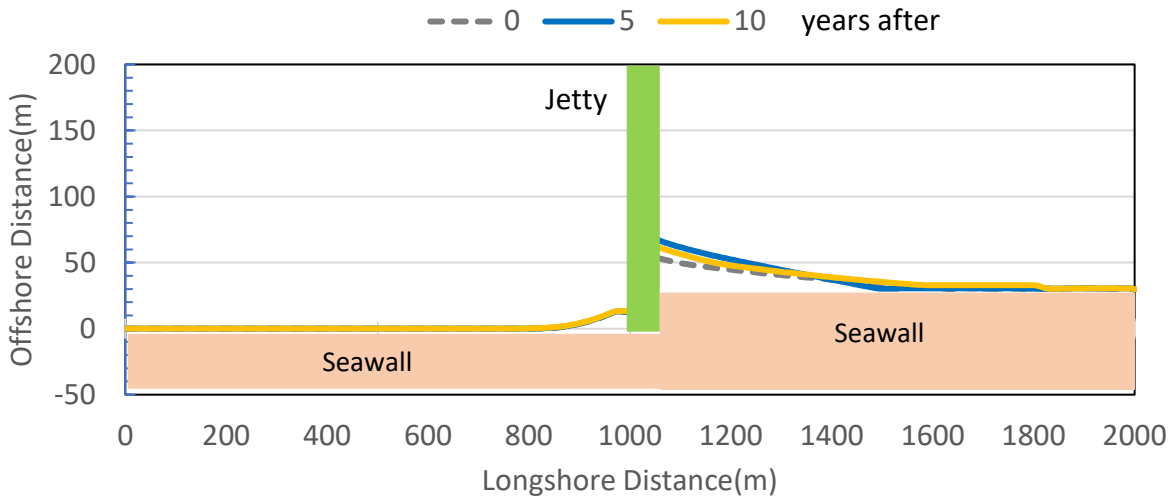
Groins and beach fill planned at this site and the model are shown in Figure 60. The existing jetty of 680m length offshore located in the center of area. The eastern shoreline of the jetty is about 30 m ahead of the western shoreline. In addition, there is currently a seawall near the shoreline, and there is no sandy beach in front of it except for the base of the Jetty.



Top: Edited by JICA Study Team based on Google Earth, Bottom： JICA Study Team

Figure 60 Modeled Topography and Coastal Facility Plan (Tuban Site-3)

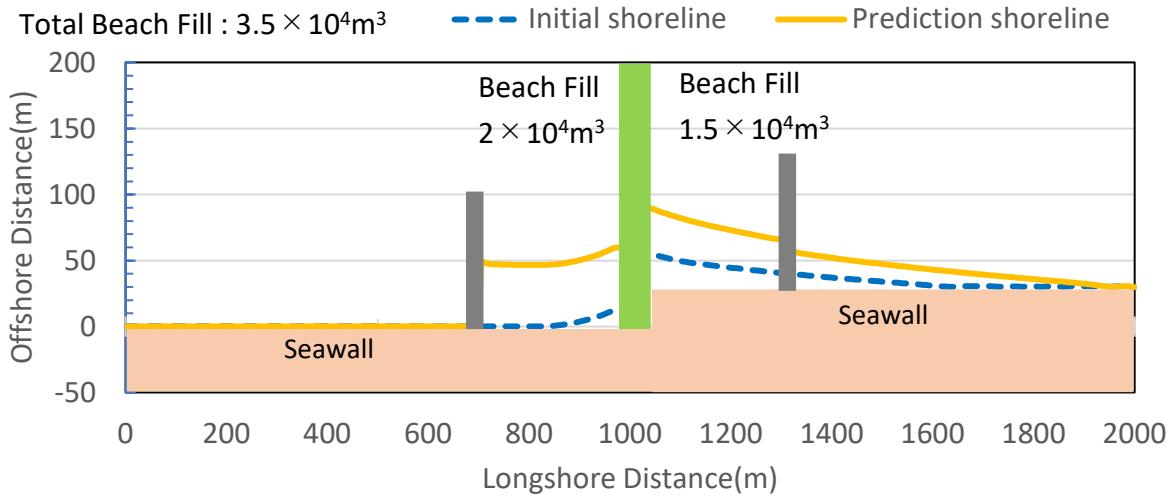
The results of the prediction topography for the case without countermeasures are shown in Figure 61. The present topography around the jetty more than 20 years have passed since the construction of the jetty is almost stable. Also, almost the shoreline around the jetty is covered by seawall. Therefore, it is expected that there will be no major changes in the shoreline in the next 10 years.



Source：JICA Study Team

Figure 61 Projected Topography at Present (No countermeasures, Tuban Site-3)

The projected topography for the case of the measures proposed in the coastal facility plan is shown in Figure 62. Under the planned facility, the average beach width of about 40 m and minimum beach width of about 35 m can be maintained due to the amount of beach fill of about 35,000 m^3, (the west side: 20,000 m^3, the east side: 15,000 m^3) which is slightly larger than the estimated amount of beach fill of 29,000 m^3.



Source：JICA Study Team

Figure 62 Numerical Prediction of Shoreline Change for the Coastal Facility Plan (Tuban Site-3)

Lampiran-16

Tabel Perhitungan Analisis Ekonomi

Detailed Flow of Economic Costs and Economic Benefits

Indramayu West, Flow of Economic Costs and Economic Benefits

Year	EIRR	B/C	Total	NPV			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
					2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Economic Costs			-498,324	-363,015	0	0	-139,440	-139,440	-139,440	0	0	0	0	0	-16,001	0	0	0	0	-16,001	0	0	0	0	-16,001	0	0	0	0	-16,001	0	0	0	0	-16,001	0	0	0	0
1) Initial Cost			-418,319	-346,766	0	0	-139,440	-139,440	-139,440	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2) O&M Cost			-80,005	-16,249	0	0	0	0	0	0	0	0	0	0	-16,001	0	0	0	0	-16,001	0	0	0	0	-16,001	0	0	0	0	-16,001	0	0	0	0	-16,001	0	0	0	0
Ecoomic Benefits			1,813,198	399,145	0	0	0	0	0	45,903	46,925	49,774	52,623	55,472	56,170	56,902	57,670	58,476	59,321	60,208	61,138	62,113	63,137	64,210	64,210	64,210	64,210	64,210	64,210	64,210	64,210	64,210	64,210	64,210	64,210	64,210	64,210	64,210	64,210
1)Reduction of Erosion			812,714	191,871	0	0	0	0	0	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090	27,090
2)Reduction of Flood Damage			424,092	100,122	0	0	0	0	0	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136	14,136
3)Increase of Tourism			574,565	105,904	0	0	0	0	0	2,849	5,698	8,547	11,396	14,245	14,943	15,675	16,443	17,249	18,094	18,981	19,911	20,887	21,910	22,984	22,984	22,984	22,984	22,984	22,984	22,984	22,984	22,984	22,984	22,984	22,984	22,984	22,984	22,984	22,984
4)Land Increase by Manglove			1,827	1,248	0	0	0	0	0	1,827	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost/Benefit Balance	11.0%	1.10	1,314,874	36,130	0	0	-139,440	-139,440	-139,440	45,903	46,925	49,774	52,623	55,472	40,169	56,902	57,670	58,476	59,321	44,207	61,138	62,113	63,137	64,210	48,209	64,210	64,210	64,210	64,210	48,209	64,210	64,210	64,210	64,210	48,209	64,210	64,210	64,210	64,210

Indramayu East, Flow of Economic Costs and Economic Benefits

Year	EIRR	B/C	Total	NPV			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
					2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Economic Costs			-221,875	-162,936	0	0	-62,780	-62,780	-62,780	0	0	0	0	0	-6,707	0	0	0	0	-6,707	0	0	0	0	-6,707	0	0	0	0	-6,707	0	0	0	0	-6,707	0	0	0	0
1) Initial Cost			-188,340	-156,125	0	0	-62,780	-62,780	-62,780	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2) O&M Cost			-33,535	-6,811	0	0	0	0	0	0	0	0	0	0	-6,707	0	0	0	0	-6,707	0	0	0	0	-6,707	0	0	0	0	-6,707	0	0	0	0	-6,707	0	0	0	0
Ecoomic Benefits			1,223,018	244,123	0	0	0	0	0	16,313	20,586	24,860	29,133	33,407	34,454	35,552	36,704	37,913	39,180	40,510	41,905	43,369	44,904	46,514	46,514	46,514	46,514	46,514	46,514	46,514	46,514	46,514	46,514	46,514	46,514	46,514	46,514	46,514	46,514
1)Reduction of Erosion			184,770	43,622	0	0	0	0	0	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159	6,159
2)Reduction of Flood Damage			176,401	41,646	0	0	0	0	0	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880
3)Increase of Tourism			861,847	158,856	0	0	0	0	0	4,274	8,547	12,821	17,094	21,368	22,415	23,513	24,665	25,874	27,141	28,471	29,866	31,330	32,865	34,475	34,475	34,475	34,475	34,475	34,475	34,475	34,475	34,475	34,475	34,475	34,475	34,475	34,475	34,475	34,475
Cost/Benefit Flow	14.2%	1.50	1,001,143	81,188	0	0	-62,780	-62,780	-62,780	16,313	20,586	24,860	29,133	33,407	27,747	35,552	36,704	37,913	39,180	33,803	41,905	43,369	44,904	46,514	39,807	46,514	46,514	46,514	46,514	39,807	46,514	46,514	46,514	46,514	39,807	46,514	46,514	46,514	46,514

Pekalongan, Flow of Economic Costs and Economic Benefits

Year	EIRR	B/C	Total	NPV			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
					2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Economic Costs			-495,585	-361,965	0	0	-139,177	-139,177	-139,177	0	0	0	0	0	-15,611	0	0	0	0	-15,611	0	0	0	0	-15,611	0	0	0	0	-15,611	0	0	0	0	-15,611	0	0	0	0
1) Initial Cost			-417,530	-346,112	0	0	-139,177	-139,177	-139,177	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2) O&M Cost			-78,055	-15,853	0	0	0	0	0	0	0	0	0	0	-15,611	0	0	0	0	-15,611	0	0	0	0	-15,611	0	0	0	0	-15,611	0	0	0	0	-15,611	0	0	0	0
Ecoomic Benefits			2,166,359	465,187	0	0	0	0	0	47,014	50,548	55,338	60,127	64,917	65,971	67,078	68,238	69,456	70,733	72,073	73,478	74,952	76,499	78,121	78,121	78,121	78,121	78,121	78,121	78,121	78,121	78,121	78,121	78,121	78,121	78,121	78,121	78,121	78,121
1)Reduction of Erosion			688,819	162,620	0	0	0	0	0	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961	22,961
2)Reduction of Flood Damage			608,084	141,682	0	0	0	0	0	18,493	18,977	19,462	19,946	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431	20,431
3)Increase of Tourism			868,200	160,027	0	0	0	0	0	4,305	8,610	12,915	17,220	21,525	22,580	23,686	24,847	26,064	27,341	28,681	30,086	31,561	33,107	34,729	34,729	34,729	34,729	34,729	34,729	34,729	34,729	34,729	34,729	34,729	34,729	34,729	34,729	34,729	34,729
4)Land Increase by Manglove			1,255	857	0	0	0	0	0	1,255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost/Benefit Flow	12.8%	1.29	1,670,773	103,222	0	0	-139,177	-139,177	-139,177	47,014	50,548	55,338	60,127	64,917	50,360	67,078	68,238	69,456	70,733	56,462	73,478	74,952	76,499	78,121	62,510	78,121	78,121	78,121	78,121	62,510	78,121	78,121	78,121	78,121	62,510	78,121	78,121	78,121	78,121

Tuban, Flow of Economic Costs and Economic Benefits

Year	EIRR	B/C	Total	NPV			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
					2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Economic Costs			-514,379	-415,045	0	0	-165,415	-165,415	-165,415	0	0	0	0	0	-3,627	0	0	0	0	-3,627	0	0	0	0	-3,627	0	0	0	0	-3,627	0	0	0	0	-3,627	0	0	0	0
1) Initial Cost			-496,244	-411,362	0	0	-165,415	-165,415	-165,415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2) O&M Cost			-18,135	-3,683	0	0	0	0	0	0	0	0	0	0	-3,627	0	0	0	0	-3,627	0	0	0	0	-3,627	0	0	0	0	-3,627	0	0	0	0	-3,627	0	0	0	0
Ecoomic Benefits			2,125,253	414,487	0	0	0	0	0	23,014	31,372	39,730	48,088	56,446	58,494	60,642	62,895	65,259	67,738	70,339	73,068	75,930	78,932	82,082	82,082	82,082	82,082	82,082	82,082	82,082	82,082	82,082	82,082	82,082	82,082	82,082	82,082	82,082	82,082
1)Reduction of Erosion			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2)Reduction of Flood Damage			439,674	103,801	0	0	0	0	0	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656	14,656
3)Increase of Tourism			1,685,579	310,686	0	0	0	0	0	8,358	16,716	25,074	33,432	41,790	43,838	45,986	48,239	50,603	53,082	55,683	58,412	61,274	64,276	67,426	67,426	67,426	67,426	67,426	67,426	67,426	67,426	67,426	67,426	67,426	67,426	67,426	67,426	67,426	67,426
Cost/Benefit Flow	10.0%	1.00	1,610,874	-558	0	0	-165,415	-165,415	-165,415	23,014	31,372	39,730	48,088	56,446	54,867	60,642	62,895	65,259	67,738	66,712	73,068	75,930	78,932	82,082	78,455	82,082	82,082	82,082	82,082	78,455	82,082	82,082	82,082	82,082	78,455	82,082	82,082	82,082	82,082

Sensitivity Analysis

Year	EIRR	B/C	Total	NPV	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059
Economic Costs			-1,730,163	-1,302,961	0	0	-506,811	-506,811	-506,811	0	0	0	0	0	-41,946	0	0	0	0	-41,946	0	0	0	0	-41,946	0	0	0	0	-41,946	0	0	0	0	-41,946	0	0	0	0
Ecoomic Benefits			7,327,829	1,522,942	0	0	0	0	0	132,243	149,431	169,701	189,971	210,241	215,088	220,173	225,507	231,103	236,973	243,130	249,589	256,364	263,472	270,928	270,928	270,928	270,928	270,928	270,928	270,928	270,928	270,928	270,928	270,928	270,928	270,928	270,928	270,928	270,928
Cost/Benefit Flow	11.6%	1.17	5,597,665	219,982	0	0	-506,811	-506,811	-506,811	132,243	149,431	169,701	189,971	210,241	173,142	220,173	225,507	231,103	236,973	201,184	249,589	256,364	263,472	270,928	228,982	270,928	270,928	270,928	270,928	228,982	270,928	270,928	270,928	270,928	228,982	270,928	270,928	270,928	270,928
Sensitivity 1 (Benefit+10%)	12.6%	1.29	6,330,448	372,276	0	0	-506,811	-506,811	-506,811	145,467	164,374	186,671	208,968	231,265	194,651	242,191	248,058	254,213	260,670	225,497	274,548	282,001	289,819	298,020	256,074	298,020	298,020	298,020	298,020	256,074	298,020	298,020	298,020	298,020	256,074	298,020	298,020	298,020	298,020
Sensitivity 2 (Cost+10%)	10.6%	1.06	5,424,649	89,686	0	0	-557,492	-557,492	-557,492	132,243	149,431	169,701	189,971	210,241	168,948	220,173	225,507	231,103	236,973	196,989	249,589	256,364	263,472	270,928	224,787	270,928	270,928	270,928	270,928	224,787	270,928	270,928	270,928	270,928	224,787	270,928	270,928	270,928	270,928
Sensitivity 3 (Benefit-10%)	10.5%	1.05	4,864,882	67,687	0	0	-506,811	-506,811	-506,811	119,019	134,488	152,731	170,974	189,217	151,633	198,156	202,957	207,993	213,275	176,871	224,630	230,728	237,125	243,835	201,889	243,835	243,835	243,835	243,835	201,889	243,835	243,835	243,835	243,835	201,889	243,835	243,835	243,835	243,835
Sensitivity 4 (Cost+10%, Benefit-10%)	9.6%	0.96	4,691,866	-62,609	0	0	-557,492	-557,492	-557,492	119,019	134,488	152,731	170,974	189,217	147,439	198,156	202,957	207,993	213,275	172,676	224,630	230,728	237,125	243,835	197,694	243,835	243,835	243,835	243,835	197,694	243,835	243,835	243,835	243,835	197,694	243,835	243,835	243,835	243,835

Lampiran-17
Kajian Sosial dan Lingkungan

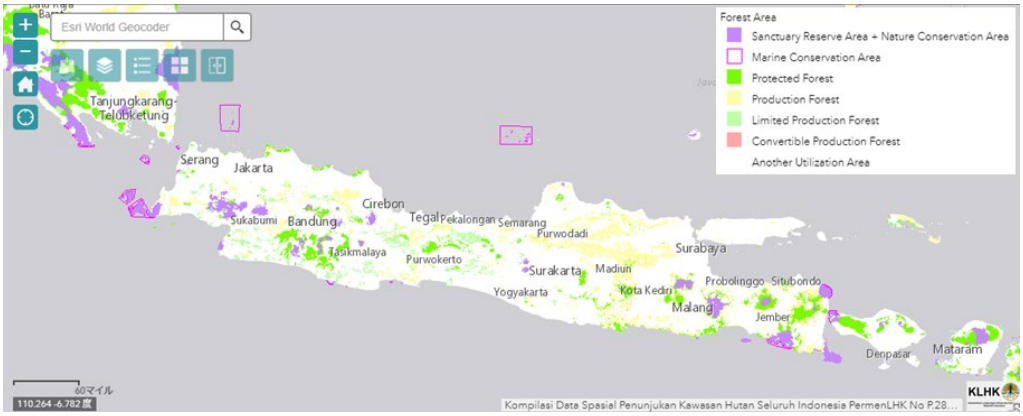
APPENDIX-17 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS MATERIALS..... A17-1

Appendix-17 Environmental and Social Considerations Materials

1. Natural Environment

Terrestrial Protected Area

Terrestrial protected areas are mainly managed by KLHK. Protected areas are classified by Law No. 41 of 1999 (Forest Law) into two types: Conservation forests and Protected forests. The location of protected areas in Java is shown in Figure 1.

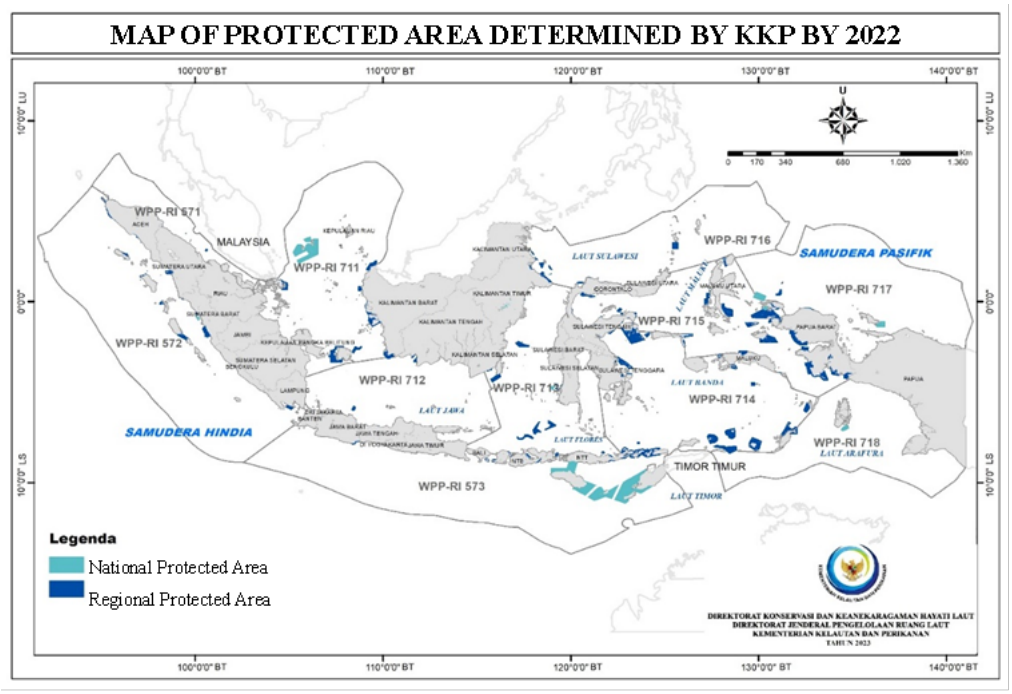


Source: KLHK（https: //geoportal.menlhk.go.id）

Figure 1 Map of Terrestrial Protected Areas

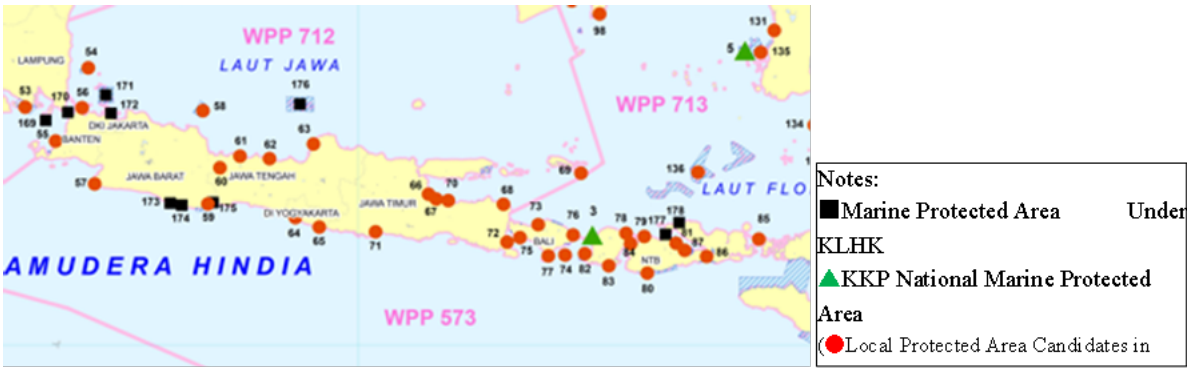
Marine Protected Area

Marine Protected Areas in Indonesia are designated by KKP Ministerial Decree No. 31 /2020 for the purpose of ecosystem conservation, fisheries resources protection, cultural resources protection. There are 10 national marine protected areas under the jurisdiction of KKP and 7 under the jurisdiction of KLHK throughout Indonesia, but none in the northern Java coastal area. Figure 2 shows the location of marine protected areas in Indonesia. The locations of marine protected areas under the jurisdiction of KLHK are also shown in Figure 3.



Source: KKP

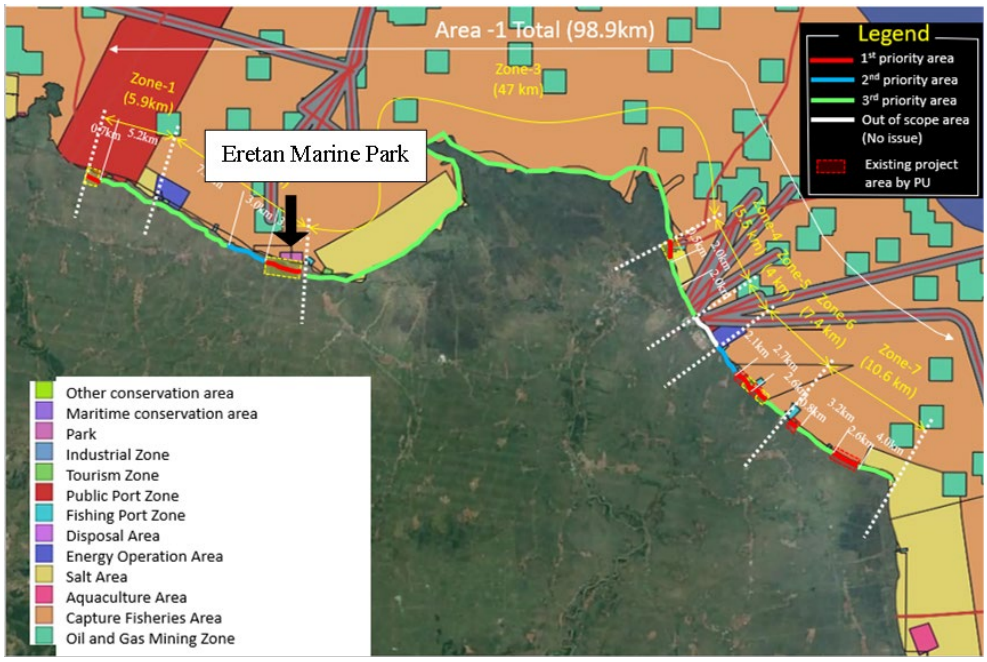
Figure 2 Location Map of Marine Protected Areas Under KKP Jurisdiction



Source: Edited by JICA Study Team based on maps as of KKP 2019

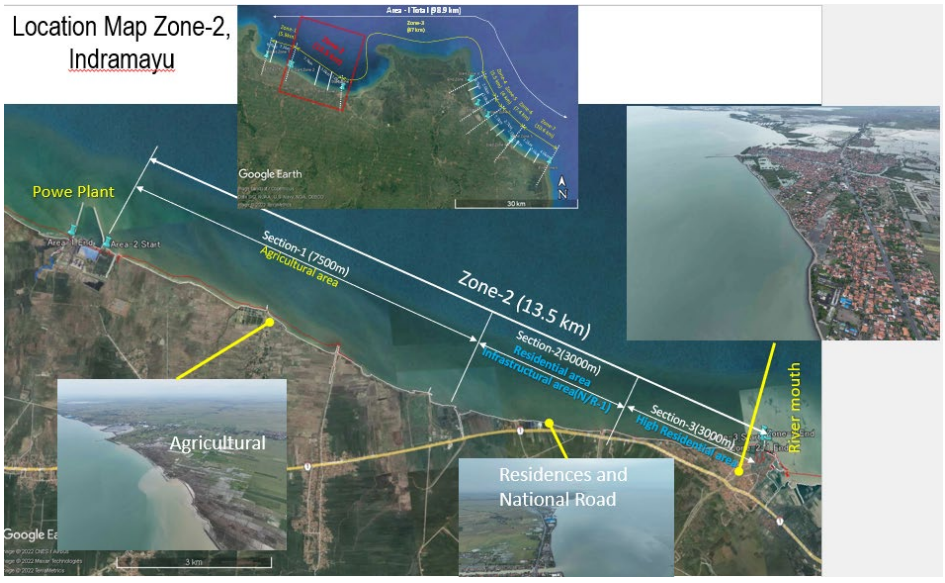
Figure 3 Location of Marine Protected Areas Under KLHK Jurisdiction

Regarding marine protected areas at the provincial level, Area-I Indramayu Eretan coastal and marine areas have been designated as marine parks by the West Java Provincial Spatial Plan (Figure 4). According to the West Java Provincial Spatial Plan (Provincial Regulation No. 9 of 2022 West Java Provincial Spatial Plan), the purpose of designating marine parks is for the conservation and utilization of ecosystems and resources (tourism, fisheries, and aquaculture areas). The park is classified as Category VI Resource Conservation Area among the IUCN Protected Areas Management Categories, and the main focus is the sustainable use of resources. Currently, as shown in , the backlands are a densely populated fishing village and fishponds, with a river to the east that is accessed by large fishing boats.



Source: Prepared by JICA Study Team based on Provincial Regulation No. 9 of 2022 West Java Provincial Spatial Plan

Figure 4 Location of Eretan Marine Park in Spatial Plan



Source: Edited by JICA Study Team based on Google Earth

Figure 5 Current Conditions at Eretan Marine Park

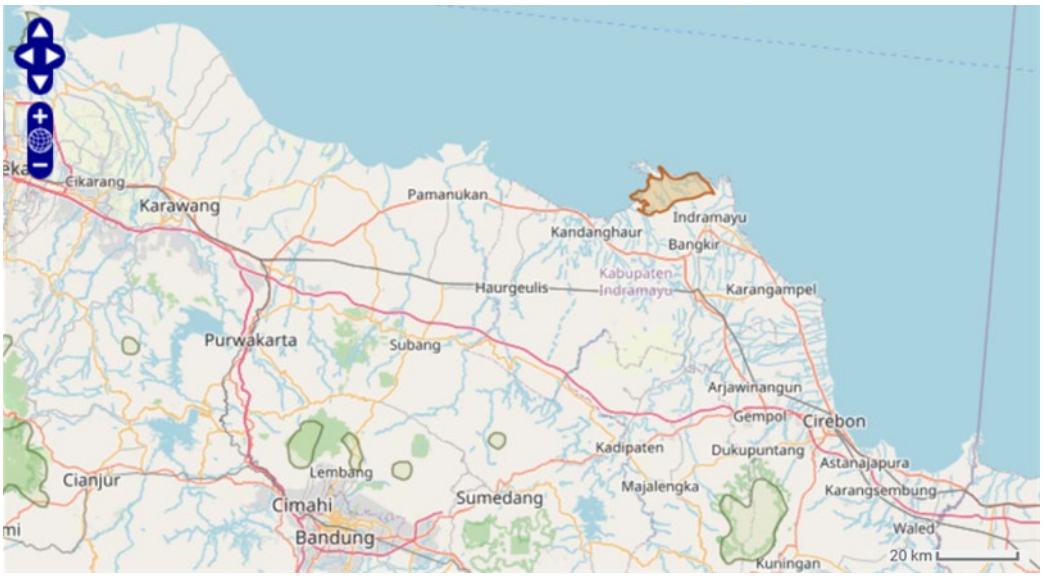
International Protected Area

Besides, some parts of the northern coast of Java are designated as Key Biodiversity Area (KBA) and Important Bird and Biodiversity Area (IBA), which are proposed by international NGOs for the purpose of biodiversity conservation. All KBAs and IBAs on the northern coast are designated as the same area. The locations of KBAs and IBAs in Java are shown in Figure 6.

Source: IBA Data

Figure 6 Location of KBA and IBA

Within the priority area of Indramayu, Muara Cimanuk (Figure 7), located 10 km northwest of the city center of Indramayu, is designated as an IBA and KBA.

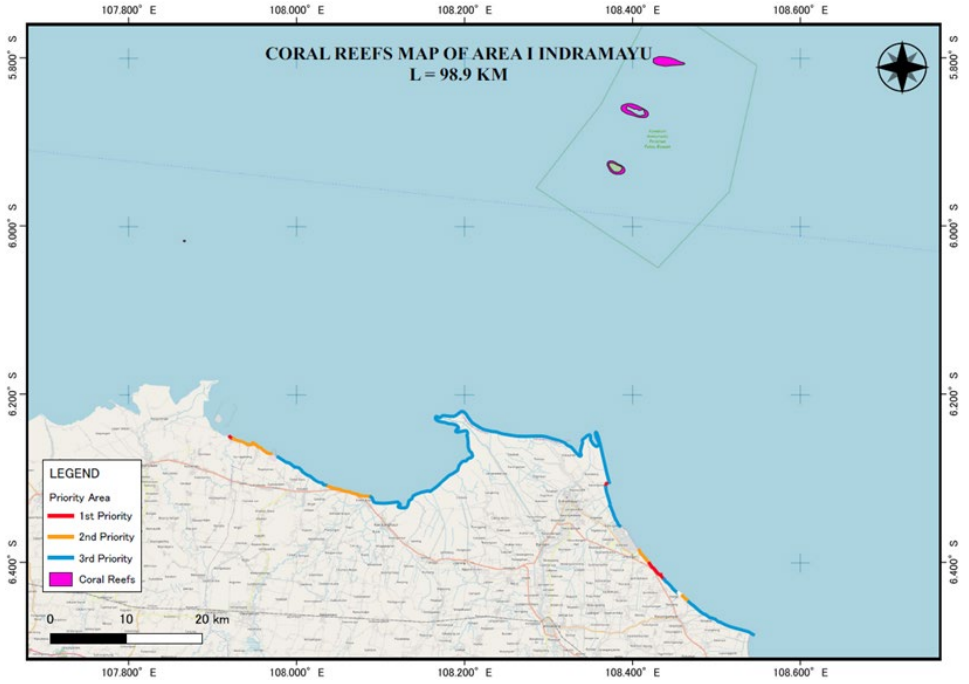


Source: JICA Study Team Edited Based on Birdlife International

Figure 7 Location of Muara Cimanuk

Coral Reefs

The coral reef area in Indonesia forms part of the Coral Triangle, an area of great marine biodiversity in the tropical western Pacific Ocean, and is home to the second largest coral reef in the world. There is no coral reef distribution along most of the coastline around the northern coast of Java Island, except for a few remote islands. As shown in Figure 8 and Figure 9, no coral reef distribution data have been confirmed in the project sections of the three priority areas. Since there is no coral reef distribution data around Pemalang-Pekalongan, the map is omitted.



Source: Compiled by JICA Study Team from UNEP-WCMC

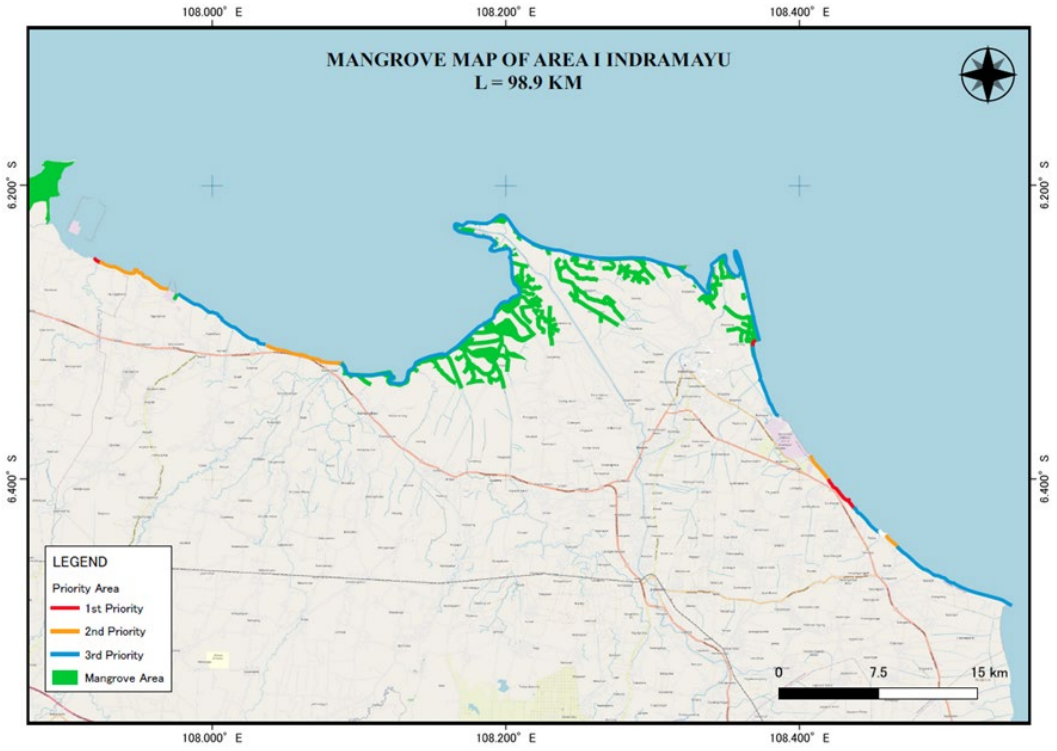
Figure 8 Distribution Map of Coral Reefs in Area-I (2002)

Source: Compiled by JICA Study Team from UNEP-WCMC

Figure 9 Distribution of Coral Reefs in Area-III (2002)

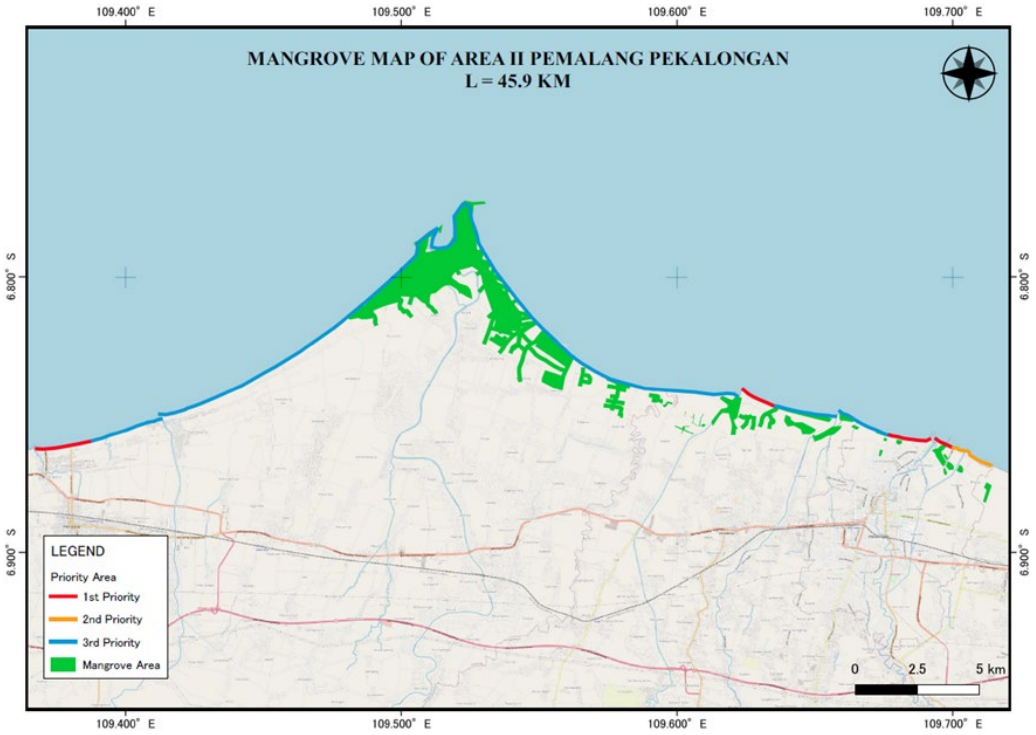
Mangrove Forest

As of 2010, mangrove forests in Indonesia accounted for about 21% of the world's total area of mangrove forests, making it the largest mangrove forest distribution area in the world. Figure 10, Figure 11, and Figure 12 shows the location of mangrove forests planted and managed by the mangrove rehabilitation project of KLHK.



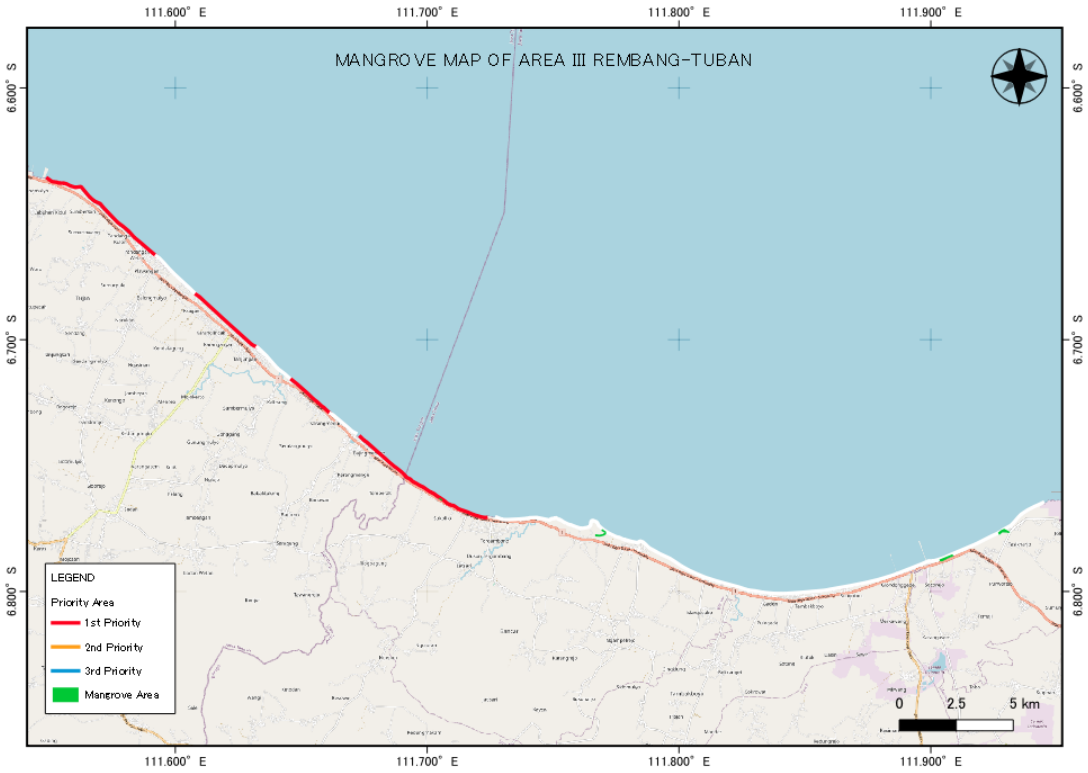
Source: Edited by JICA Study Team from KLHK-BRGM

Figure 10 Mangrove Distribution Map in Indramayu



Source: Edited by JICA Study Team from KLHK-BRGM

Figure 11 Mangrove Distribution Map in Pekalongan-Pemalang



Source: Edited by JICA Study Team from KLHK-BRGM

Figure 12 Mangrove Distribution Map in Rembang-Tuban

2. Scoping

Scoping was conducted based on the specific measures considered during the formulation stage of the draft Basic Coastal Management Plan (Master Plan).

Table 1 Specific measures planned in the draft Basic Coastal Management Plan

Expecting Measures
Beach nourishment (installing sand from sand quarries) + jetties/headlands, etc.
Mangrove planting + breakwaters
Conventional revetment (Linea protection)
Amenity-oriented revetment (Area protection)

Source: JICA Study Team

(1) Area-I: Indramayu

Based on the results of the natural and social environment survey in Indramayu, scoping was conducted based on JICA environmental guidelines for the current study stage plan.

Table 2 Scoping in Area-I

	No.	Impacts	Assessment		Description of the Assessment
			Pre-CP/CP	AC	
Pollution	1	Air pollution	✓	✓	**CP**: Temporary air pollution due to operation of construction machines and vehicles and construction of basecamp is expected. **AC:** Temporary air pollution due to operation of construction machines and vehicles and construction of basecamp is expected. Temporary operation of construction vehicles and machinery during maintenance of the beach nourishment will result in air pollutant emissions and generation of dust.
	2	Water pollution	✓	✓	**CP:** Turbidity is generated when sand is loaded in the beach nourishment works. **AC:** Some types of beach use change may affect water quality. In addition, beach nourishment inputs are expected to improve water quality.
	3	Waste	✓	✓	**CP:** Construction waste will be generated. **AC:** Waste will be generated depending on the type of coastal use.
	4	Soil contamination			There are no plans to use hazardous substances that may cause soil contamination during construction or when the site is in service.
	5	Noise and vibration	✓	✓	**CP:** Noise and vibration will be generated by the construction. **AC:** Noise may be generated depending on the type of beach use change.
	6	Ground subsidence			Activities that would cause subsidence (e.g., use of large volumes of groundwater) are not anticipated. Measures to address subsidence are not included in the project.
	7	Odor			No odor-producing activities are anticipated, both during construction and in operation.
	8	Sediment quality	✓	✓	**CP:** Sand application changes the bottom sediment quality of the seabed. **AC:** Seabed sediment quality due to beach nourishment may change over the long term due to current conditions and sediment supply.
N	9	Protected area	✓	✓	A provincial-level marine park is located in a part of the priority area.

	No.	Impacts	Assessment		Description of the Assessment
			Pre-CP/CP	AC	
	10	Ecosystem	✓	✓	Mangrove forests are scattered throughout the priority areas. Many of them have not taken root due to high waves and erosion, and only some of them are growing in clusters. On the other hand, mangrove forests may provide important habitats and ecosystems, and valuable and endemic species may be found in the area. Although facility development is not being considered inside of mangrove forests, the ecological connectivity between land and sea and the network of habitats may be affected by the installation of hard infrastructure by green infra.
	11	Hydrology	✓	✓	**CP:** Construction of jetties/headlands will alter coastal currents and drifting sand. **AC:** If changes occur in the topography of the nourished beach, the flow regime in surrounding areas may change.
	12	Topography and geology	✓	✓	**CP:** The construction of the facility and beach nourishment will change the topography of the beach. In addition, impacts at sand extraction sites should be identified. **AC:** The topography of the nourished beach may be altered by currents and waves.
Social environment	13	Involuntary resettlement	✓	✓	**Pre-CP:** Involuntary resettlement may occur as a result of the construction of structures. **AC:** Involuntary resettlement may occur if nearby residents construct houses or stores on the land expanded by beach nourishment or sand storage area.
	14	Poverty	✓	✓	**Pre-CP:** Relocated residents may include the poor. **CP:** The residents affected by the construction may include the poor. **AC:** Residents subject to relocation may include the poor.
	15	Indigenous groups and ethnic minority	✓	✓	No ethnic minorities or indigenous groups have been identified living within the priority areas. It is necessary to confirm if there is any use of the coast for religious or ceremonial purposes by the minorities residing inland.
	16	Local economy such as employment and livelihood	✓	✓	**CP:** Fishing, agriculture, and other activities in the coastal area may be affected. On the other hand, employment opportunities will be created due to construction. **AC:** Although the current land use is planned to be utilized, activities such as fishing and agriculture in the coastal area may be affected. On the other hand, nourished beaches and structures may create new fishing grounds and habitats for fishery resources. The reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region.
	17	Land use and local resources	✓	✓	**CP:** Construction activities may impact existing land and water uses. **AC:** Although current land uses are planned to remain, existing land and water uses, such as fishing and agriculture, may be affected. On the other hand, nourished beaches and structures may become new fishing grounds, nurseries for fishery resources, recreational areas, and other local resources.
	18	Water usage			No large amounts of water use will occur during construction and in service.
	19	Existing social infrastructures and	✓	✓	**CP:** Existing social infrastructure and services such as roads and local transportation may be affected by the transportation of construction

	No.	Impacts	Assessment		Description of the Assessment
			Pre-CP/CP	AC	
		services			materials. **AC:** Land use changes in tourist areas and other areas may affect social services such as local transportation.
	20	Social institutions such as social infrastructure and local decision-making institutions	✓	✓	**Pre-CP:** In developing the master plan, the coastal users, including the local community, need to be briefed. **AC:** Consent of coastal users, including local communities, is required.
	21	Misdistribution of benefit and damage	✓	✓	Facility development may cause damage and uneven distribution of benefits to beach users and land users.
	22	Local conflict of interests	✓	✓	Need to confirm with stakeholders.
	23	Cultural heritage	✓		Although no cultural heritage sites have been identified in the priority areas, if any are discovered during construction, the location of cultural heritage sites should be confirmed to ensure that construction will not be affected.
	24	Landscape	✓	✓	Installation of facilities and beach nourishment will alter the coastal landscape. Seawalls obstruct views of the sea.
	25	Gender	✓	✓	**CP:** Employment opportunities need to be equal regardless of gender. **AC:** The development of a sales area, such as selling refreshments on the beach, may affect women's means of livelihood.
	26	Right of children	✓	✓	**CP:** Child labor in construction work must be eliminated. In addition, if the project site is a playground, safety must be ensured. **AC:** Beach nourishment and seawall installation/renovation could expand playgrounds and improve safety.
	27	Water usage Existing social infrastructures and services	✓	✓	**CP:** Influx of construction workers may spread infectious diseases. **AC:** Recreational use of beaches can be used for prostitution businesses that can lead to the spread of infectious diseases. 。
	28	Occupational environment (including work safety)	✓		**CP:** Construction work safety and working environment must be properly ensured in accordance with laws and regulations. **AC:** No employment of workers is expected.
Other	29	Accidents	✓	✓	**CP:** Risk of construction accidents and traffic accidents caused by construction vehicles is expected. **AC:** Possible accidents during recreational use or other shore use.
Other	30	Climate Change		✓	**CP:** Construction equipment and vehicles emit greenhouse gases, but the amount and duration of emissions are limited and their impact on global warming is negligible. **AC:** Coastal management may be one of the adaptation measures to climate change.

Note: Pre-CP: pre-construction period, CP: construction period, AC: after construction

Source: JICA Study Team

(2) Area-II: Pemalang-Pekalongan

Based on the results of the natural and social environment survey in Pemalang-Pekalongan, scoping was conducted based on JICA environmental guidelines for the current study stage plan.

Table 3 Scoping in Area-II

	No.	Category	Impacts		Description of the Assessment
			Pre-CP/CP	AC	
Pollution	1	Air pollution	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	2	Water pollution	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	3	Waste	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	4	Soil contamination			Same as Area-I both during and after construction.
	5	Noise and vibration	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	6	Ground subsidence			Same as Area-I
	7	Odor			Same as Area-I
	8	Sediment quality	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
Natural environment	9	Protected area			No protected areas have been designated in priority areas.
	10	Ecosystem	✓	✓	Mangrove forests are growing in the Mojo area, a priority area. In this area, green infrastructure including hybrid engineers is currently planned, but no logging is planned in this area. On the other hand, mangrove forests may have important habitats and ecosystems in the vicinity, and valuable and endemic species may be found in the surrounding area. Although constructing structures in mangrove forests is not considered, the ecological continuity between land and sea and the network of habitats may be affected by the establishment of detached breakwaters or other structures by combined with green infrastructure.
	11	Hydrology	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	12	Topography and geology	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
Social environment	13	Involuntary resettlement	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	14	Poverty	✓	✓	**Pre-CP:** Same as Area-I **CP: Same as Area-I** **AC:** Same as Area-I
	15	Indigenous groups and ethnic minority			No ethnic or indigenous minority groups have been identified in the priority area and surrounding area.

	No.	Category	Impacts		Description of the Assessment
			Pre-CP/CP	AC	
	16	Local economy such as employment and livelihood	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	17	Land use and local resources	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	18	Water usage			Same as Area-I
	19	Existing social infrastructures and services	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	20	Social institutions such as social infrastructure and local decision-making institutions	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	21	Misdistribution of benefit and damage	✓	✓	Same as Area-I
	22	Local conflict of interests	✓	✓	Same as Area-I
	23	Cultural heritage	✓		Same as Area-I
	24	Landscape	✓	✓	Same as Area-I
	25	Gender	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	26	Right of children	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	27	Water usage Existing social infrastructures and services	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	28	Occupational environment (including work safety)	✓		**CP:** Same as Area-I **AC:** Same as Area-I
Other	29	Accidents	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	30	Climate Change		✓	**CP:** Same as Area-I **AC:** Same as Area-I

Note: Pre-CP: pre-construction period, CP: construction period, AC: after construction

Source: JICA Study Team

(3) Area-III: Rembang-Tuban

Based on the results of the natural and social environment survey in Rembang-Tuban, scoping was conducted based on JICA environmental guidelines for the current study stage plan.

Table 4 Scoping in Area-III

	No.	Impacts	Assessment		Description of the Assessment
			Pre-CP/CP	AC	
Pollution	1	Air pollution	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	2	Water pollution	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	3	Waste	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	4	Soil contamination			Same as Area-I both during and after construction.
	5	Noise and vibration	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	6	Ground subsidence			Same as Area-I
	7	Odor			Same as Area-I
	8	Sediment quality	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
Natural environment	9	Protected area			No protected areas have been designated in priority areas.
	10	Ecosystem	✓	✓	There are almost no mangrove forests in the priority areas, and the potential for critical habitat and ecosystems is limited, but impacts should be identified when structures are developed.
	11	Hydrology	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	12	Topography and geology	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
Social environment	13	Involuntary resettlement	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	14	Poverty	✓	✓	**Pre-CP:** Same as Area-I **CP:** Same as Area-I **AC:** Same as Area-I
	15	Indigenous groups and ethnic minority			No ethnic or indigenous minority groups have been identified in the priority area and surrounding area.
	16	Local economy such as employment and livelihood	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	17	Land use and	✓	✓	**CP:** Same as Area-I

	No.	Impacts	Assessment		Description of the Assessment
			Pre-CP/CP	AC	
		local resources			**AC:** Same as Area-I
	18	Water usage			Same as Area-I
	19	Existing social infrastructures and services	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	20	Social institutions such as social infrastructure and local decision-making institutions	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	21	Misdistribution of benefit and damage	✓	✓	Same as Area-I
	22	Local conflict of interests	✓	✓	Same as Area-I
	23	Cultural heritage	✓		Same as Area-I
	24	Landscape	✓	✓	Same as Area-I
	25	Gender	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	26	Right of children	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	27	Water usage Existing social infrastructures and services	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	28	Occupational environment (including work safety)	✓		**CP:** Same as Area-I **AC:** Same as Area-I
Other	29	Accidents	✓	✓	**CP:** Same as Area-I **AC:** Same as Area-I
	30	Climate Change		✓	**CP:** Same as Area-I **AC:** Same as Area-I

Note: Pre-CP: pre-construction period, CP: construction period, AC: after construction

Source: JICA Study Team

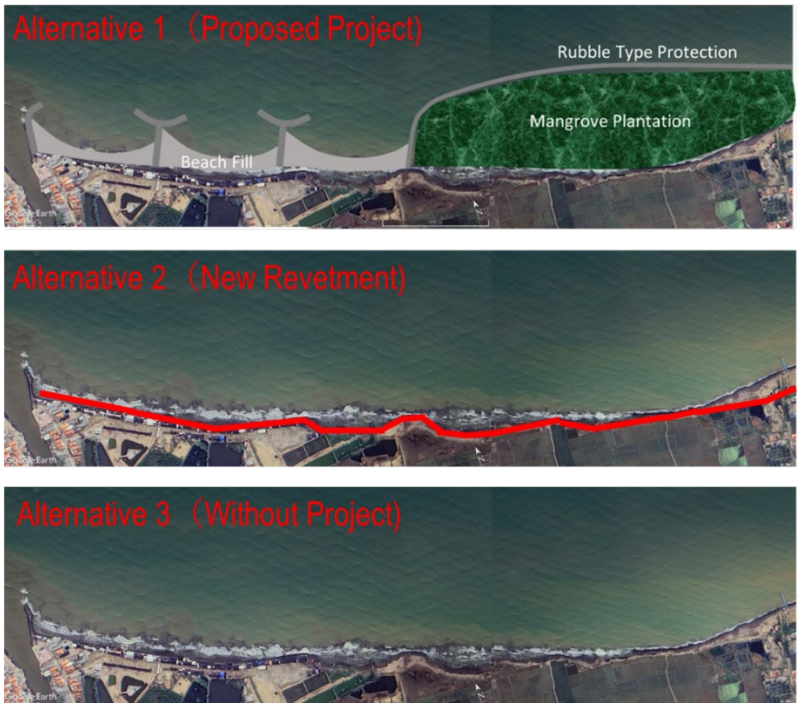
3. Comparison of Alternatives for Each Section

In this project, after the draft Basic Coastal Management Plan (Master Plan) has been developed, Coastal Facility Plans have been proposed for Section-1 and Section-6 in Area-I Indramayu, Section-4 in Area-II Pemalang-Pekalongan, and the Tuban Section adjacent to Area-III Rembang-Tuban.

Here, a comparative examination from the perspectives of natural and social environments and project costs using three alternatives, i.e. Alternative 1 (Proposed project), Alternative 2 (Construction of new revetment), and Alternative 3 (Without project). The images of the three alternatives are shown in the diagram below.

In this project, after the draft Basic Coastal Management Plan (Master Plan) has been developed, Coastal Facility Plans have been proposed for Section-1 and Section-6 in Area-I Indramayu, Section-4 in Area-II Pemalang-Pekalongan, and an Tuban Section adjacent to Area-III Rembang-Tuban.

Here, a comparative examination from the perspectives of natural and social environments and project costs using three alternatives, i.e. Alternative 1 (Proposed project), Alternative 2 (Construction of new revetment), and Alternative 3 (Without project).



Source: Edited by JICA Study Team based on Google Earth

Figure 13 Comparison of alternatives

(1) Area-I: Indramayu Section-1

In this project, Section-1 is further divided into S-1a, S-1b, S-1c, S-1d, and S-1e, and Coastal Facility Plans have been proposed for each subdivided section.

The comparative examination results of the alternatives for Section-1 are as follows:

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
Outline	*(Referring to the plan drawings below the table)* (S-1a) • Constructing jetties/headlands and implementing beach nourishment at certain parts of the coastline. • Implementing improvement works for existing deteriorating revetments. • Monitoring existing stable revetments. (S-1b) • Planting mangroves and constructing breakwaters for protecting the mangroves at certain parts of the coastline. • Implementing improvement works for existing deteriorating revetments. (S-1c) • Planting mangroves and constructing breakwaters for protecting the mangroves at certain parts of the coastline. • Implementing improvement works for existing deteriorating revetments. (S-1d) • Implementing improvement works for existing deteriorating revetments. • Monitoring existing stable revetments. (S-1e) • Constructing jetties/headlands and implementing beach nourishment.	• In all sections, constructing new revetments along all coastlines and implementing improvement works for existing revetments as needed.	The proposed project will not be implemented.
Beneficiary effects on local residents	The reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. **Furthermore, in certain coastal areas, tourism revenue is expected to significantly increase due to beach nourishment.**	The reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region.	No beneficial effects on local residents are expected.
Consistency with urban development	Highly consistent. **Furthermore, instead of conventional linear protection measures using hard infrastructure, the implementation of soft engineering methods such as beach nourishment combined with green infrastructure will lead to area protection measures, which will contribute to developing more resilient communities.**	Highly consistent.	It is not consistent with the urban development of Freetown City.
Impacts on natural environment	1) Air pollution and water pollution. In the construction phase, temporary impacts on air pollution and water pollution are expected. **On the other hand, in the operation phase, beach nourishment inputs are expected to improve water quality.** 2) Waste and noise/vibration. Temporary impacts are expected in the construction phase. 3) Sediment quality. **In the construction phase, sand application changes the bottom sediment quality of the seabed. In the operation phase, seabed sediment quality due to beach nourishment may change over the long term**	1) Air pollution and water pollution. In the construction phase, temporary impacts on air pollution and water pollution are expected. 2) Waste and noise/vibration. Same as Alternative 1. 3) Sediment quality. Changes on the bottom sediment quality of the seabed are not expected.	No impact on the natural environment is expected.

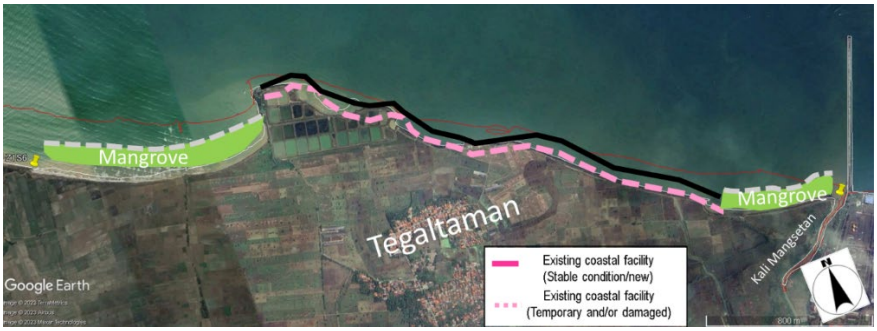
Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
	due to current conditions and sediment supply. 4) Ecosystem. The ecological connectivity between land and sea and the network of habitats may be affected by the installation of green infrastructures (detached breakwaters). 5) Hydrology. **In the construction phase, construction of jetties/headlands and breakwaters (mangroves) will alter coastal currents and drifting sand. In the operation phase, if changes occur in the topography of the nourished beach, the flow regime in surrounding areas may change.** 6) Topography and geology. In the construction phase, the construction of the facility and beach nourishment will change the topography of the beach. **In the operation phase, the topography of the nourished beach may be altered by currents and waves.**	4) Ecosystem. Same as Alternative 1. 5) Hydrology. Changes on coastal currents and drifting sand are not expected. 6) Topography and geology. In the construction phase, the construction of the facility and beach nourishment will change the topography of the beach.	
Impacts on social environment	1) Involuntary resettlement. Land acquisition and resettlement are not expected. 2) Local economy such as employment and livelihood. In the construction and operation phases, fishing, agriculture, and other activities in the coastal area may be affected. On the other hand, employment opportunities will be created due to construction. **And nourished beaches and structures may create new fishing grounds and habitats for fishery resources.** Furthermore, the reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. 3) Land use and local resources. The impact is locally limited in the construction phase. **On the other hand, nourished beaches and structures may become new fishing grounds, nurseries for fishery resources, recreational areas, and other local resources.**	1) Involuntary resettlement. Same as Alternative 1. 2) Local economy such as employment and livelihood. In the construction and operation phases, fishing, agriculture, and other activities in the coastal area may be affected. On the other hand, employment opportunities will be created due to construction. Furthermore, the reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. 3) Land use and local resources. The impact is locally limited in the construction phase.	No impact on the social environment is expected.
Project cost	Compared with Alternative 2, **the project cost is relatively low.**	Compared with Alternative 1, **the project cost is relatively very high.**	No project costs are incurred.
Beneficiary effects	◎	○	×
Urban development	◎	○	×
Natural environment	○	○	◎
Social environment	○	○	◎
Project cost	○	×	◎
Evaluation	◎ (Alternative 1 is recommended in terms of beneficiary effect, consistency with urban	× (Alternative 2 is not recommended in terms of project	× (without project alternative is not recommended in

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
	development, and project cost.)	cost.)	terms of beneficiary effect and consistency with urban development.)

Source: JICA Study Team

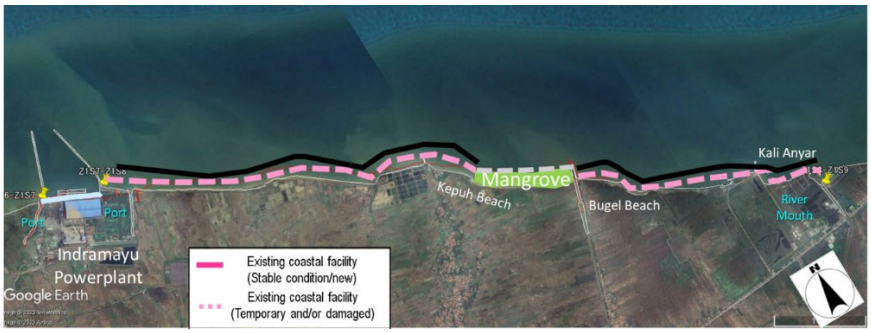
Source: Edited by JICA Study Team based on Google Earth

Figure 14 (Area-I, S-1b Proposed project)



Source: Edited by JICA Study Team based on Google Earth

Figure 15 (Area-I, S-1b Proposed project)

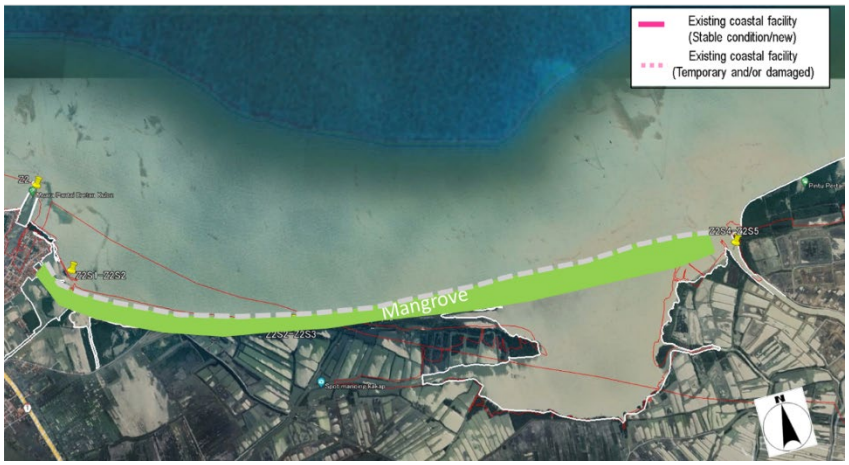


Source: Edited by JICA Study Team based on Google Earth

Figure 16 (Area-I, S-1c Proposed project)

Source: Edited by JICA Study Team based on Google Earth

Figure 17 (Area-I, S-1d Proposed project)



Source: Edited by JICA Study Team based on Google Earth

Figure 18 (Area-I, S-1e Proposed project)

(2) Area-I: Indramayu: Section-6

In this project, Section-6 is further divided into S-6a, S-6b, S-6c, S-6d, S-6e and S-6f, and Coastal Facility Plans have been proposed for each subdivided section.

The comparative examination results of the alternatives for Section-6 are as follows:

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
Outline	*(Referring to the plan drawings below the table)* (S-6a) • Constructing jetties/headlands and implementing beach nourishment. (S-6b) (S-6c) • Monitoring existing stable revetments. (S-6d) • Constructing jetties/headlands and implementing beach nourishment at certain parts of the coastline. • Implementing improvement works for existing deteriorating revetments. • Monitoring existing stable revetments. (S-6e) (S-6f) • Monitoring existing stable revetments.	• In S-6a, constructing new revetments, and in S-6d, constructing new revetments at a certain parts of the coastline in addition to the existing revetments.	The proposed project will not be implemented.
Beneficiary effects on local residents	The reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. **Furthermore, in certain coastal areas, tourism revenue is expected to significantly increase due to beach nourishment.**	The reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region.	No beneficial effects on local residents are expected.
Consistency with urban development	Highly consistent. **Furthermore, instead of conventional linear protection measures using hard infrastructure, soft infrastructure combined with beach nourishment will lead to area protection measures, which will contribute to developing more resilient communities.**	Highly consistent.	It is not consistent with the urban development of Freetown City.
Impacts on natural environment	1) Air pollution and water pollution. In the construction phase, temporary impacts on air pollution and water pollution are expected. **On the other hand, in the operation phase, beach nourishment inputs are expected to improve water quality.** 2) Waste and noise/vibration. Temporary impacts are expected in the construction phase. 3) Sediment quality. **In the construction phase, sand application changes the bottom sediment quality of the seabed. In the operation phase, seabed sediment quality due to beach nourishment may change over the long term due to current conditions and sediment supply.** 4) Ecosystem. The ecological connectivity between land and sea and the network of habitats may be affected by the installation of	1) Air pollution and water pollution. In the construction phase, temporary impacts on air pollution and water pollution are expected. 2) Waste and noise/vibration. Same as Alternative 1. 3) Sediment quality. Changes on the bottom sediment quality of the seabed are not expected. 4) Ecosystem. Same as Alternative 1. 5) Hydrology. Changes on	No impact on the natural environment is expected.

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
	coastal facilities. 5) Hydrology. **In the construction phase, construction of jetties/headlands will alter coastal currents and drifting sand. In the operation phase, if changes occur in the topography of the nourished beach, the flow regime in surrounding areas may change.** 6) Topography and geology. In the construction phase, the construction of the facility and beach nourishment will change the topography of the beach. **In the operation phase, the topography of the nourished beach may be altered by currents and waves.**	coastal currents and drifting sand are not expected. 6) Topography and geology. In the construction phase, the construction of the facility and beach nourishment will change the topography of the beach.	
Impacts on social environment	1) Involuntary resettlement. Land acquisition and resettlement are not expected. 2) Local economy such as employment and livelihood. In the construction and operation phases, fishing, agriculture, and other activities in the coastal area may be affected. On the other hand, employment opportunities will be created due to construction. **And nourished beaches and structures may create new fishing grounds and habitats for fishery resources.** Furthermore, the reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. 3) Land use and local resources. The impact is locally limited in the construction phase. **On the other hand, nourished beaches and structures may become new fishing grounds, nurseries for fishery resources, recreational areas, and other local resources.**	1) Involuntary resettlement. Same as Alternative 1. 2) Local economy such as employment and livelihood. In the construction and operation phases, fishing, agriculture, and other activities in the coastal area may be affected. On the other hand, employment opportunities will be created due to construction. Furthermore, the reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. 3) Land use and local resources. The impact is locally limited in the construction phase.	No impact on the social environment is expected.
Project cost	Compared with Alternative 2, **the project cost is relatively low.**	Compared with Alternative 1, **the project cost is relatively very high.**	No project costs are incurred.
Beneficiary effects	◎	○	×
Urban development	◎	○	×
Natural environment	○	○	◎
Social environment	○	○	◎
Project cost	○	×	◎
Evaluation	◎ (Alternative 1 is recommended in terms of beneficiary effect, consistency with urban development, and project cost.)	× (Alternative 2 is not recommended in terms of project cost.)	× (without project alternative is not recommended in terms of beneficiary effect and consistency with urban development.)

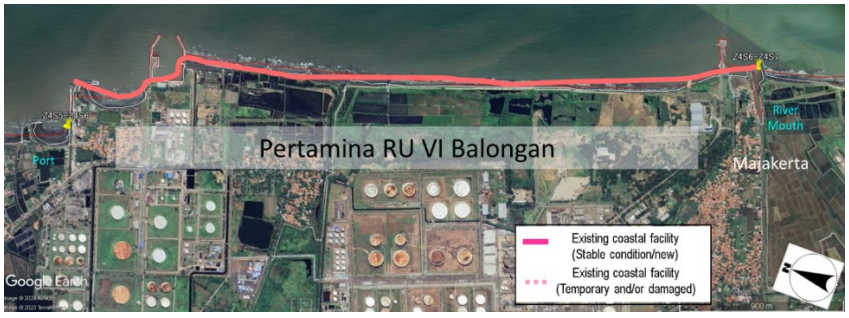
Source: JICA Study Team

Source: Edited by JICA Study Team based on Google Earth

Figure 19 (Area-I, S-6a Proposed project)

Source: Edited by JICA Study Team based on Google Earth

Figure 20 (Area-I, S-6b Proposed project)



Source: Edited by JICA Study Team based on Google Earth

Figure 21 (Area-I, S-6c Proposed project)

Source: Edited by JICA Study Team based on Google Earth

Figure 22 (Area-I, S-6d Proposed project)

Source: Edited by JICA Study Team based on Google Earth

Figure 23 (Area-I, S-6e Proposed project)

Source: Edited by JICA Study Team based on Google Earth

Figure 24 (Area-I, S-6f Proposed project)

(3) Area-II Pemalang-Pekalongan: Section 4

In this project, Section-4 is further divided into S-4a and S-4b, and Coastal Facility Plans have been proposed for each subdivided section.

The comparative examination results of the alternatives for Section-4 are as follows:

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
Outline	*(Referring to the plan drawings below the table)* (S-4a) • Constructing jetties/headlands and implementing beach nourishment at certain parts of the coastline. • Implementing improvement works for existing deteriorating revetments. (S-4b) • Planting mangroves and constructing breakwaters for protecting the mangroves at certain parts of the coastline. • Constructing jetties/headlands and implementing beach nourishment to reinforce some of the existing deteriorating revetments. • Implementing improvement works for existing deteriorating revetments not mentioned above.	• In all sections, constructing new revetments along all coastlines and implementing improvement works for existing revetments as needed.	The proposed project will not be implemented.
Beneficiary effects on local residents	The reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. **Furthermore, in certain coastal areas, tourism revenue is expected to significantly increase due to beach nourishment.**	The reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region.	No beneficial effects on local residents are expected.
Consistency with urban development	Highly consistent. **Furthermore, instead of conventional linear protection measures using hard infrastructure, the implementation of soft engineering methods such as beach nourishment combined with green infrastructure will lead to area protection measures, which will contribute to developing more resilient communities.**	Highly consistent.	It is not consistent with the urban development of Freetown City.
Impacts on natural environment	1) Air pollution and water pollution. In the construction phase, temporary impacts on air pollution and water pollution are expected. **On the other hand, in the operation phase, beach nourishment inputs are expected to improve water quality.** 2) Waste and noise/vibration. Temporary impacts are expected in the construction phase. 3) Sediment quality. **In the construction phase, sand application changes the bottom sediment quality of the seabed. In the operation phase, seabed sediment quality**	1) Air pollution and water pollution. In the construction phase, temporary impacts on air pollution and water pollution are expected. 2) Waste and noise/vibration. Same as Alternative 1. 3) Sediment quality. Changes on the bottom sediment quality of the seabed are not expected.	No impact on the natural environment is expected.

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
	due to beach nourishment may change over the long term due to current conditions and sediment supply. 4) Ecosystem. The ecological connectivity between land and sea and the network of habitats may be affected by the installation of green infrastructures (detached breakwaters). 5) Hydrology. **In the construction phase, construction of jetties/headlands and breakwaters (mangroves) will alter coastal currents and drifting sand. In the operation phase, if changes occur in the topography of the nourished beach, the flow regime in surrounding areas may change.** 6) Topography and geology. In the construction phase, the construction of the facility and beach nourishment will change the topography of the beach. **In the operation phase, the topography of the nourished beach may be altered by currents and waves.**	4) Ecosystem. Same as Alternative 1. 5) Hydrology. Changes on coastal currents and drifting sand are not expected. 6) Topography and geology. In the construction phase, the construction of the facility and beach nourishment will change the topography of the beach.	
Impacts on social environment	1) Involuntary resettlement. Land acquisition and resettlement are not expected. 2) Local economy such as employment and livelihood. In the construction and operation phases, fishing, agriculture, and other activities in the coastal area may be affected. On the other hand, employment opportunities will be created due to construction. **And nourished beaches and structures may create new fishing grounds and habitats for fishery resources.** Furthermore, the reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. 3) Land use and local resources. The impact is locally limited in the construction phase. **On the other hand, nourished beaches and structures may become new fishing grounds, nurseries for fishery resources, recreational areas, and other local resources.**	1) Involuntary resettlement. Same as Alternative 1. 2) Local economy such as employment and livelihood. In the construction and operation phases, fishing, agriculture, and other activities in the coastal area may be affected. On the other hand, employment opportunities will be created due to construction. Furthermore, the reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. 3) Land use and local resources. The impact is locally limited in the construction phase.	No impact on the social environment is expected.
Project cost	Compared with Alternative 2, **the project cost is relatively low.**	Compared with Alternative 1, **the project cost is relatively very high.**	No project costs are incurred.
Beneficiary effects	◎	◎	×
Urban development	◎	◎	×
Natural environment	○	◎	◎
Social environment	○	◎	◎
Project cost	○	×	◎
Evaluation	◎ (Alternative 1 is recommended in terms of	× (Alternative 2 is not	× (without project

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
	beneficiary effect, consistency with urban development, and project cost.)	recommended in terms of project cost.)	alternative is not recommended in terms of beneficiary effect and consistency with urban development.)

Source: JICA Study Team

Source: Edited by JICA Study Team based on Google Earth

Figure 25 (Area-II, S-4a Proposed project)

Source: Edited by JICA Study Team based on Google Earth

Figure 26 (Area-II, S-4b Proposed project)

(4) Area-III Rembang-Tuban: Tuban Section

In this project, Tuban Section is further divided into Site-1, Site-2, Site-3 and Site-4, and Coastal Facility Plans have been proposed for each subdivided section.

The comparative examination results of the alternatives for Tuban Section are as follows:

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
Outline	*(Referring to the plan drawings below the table)* (Site-1) • Constructing jetties/headlands and implementing beach nourishment at certain parts of the coastlines.	• In all sites, constructing new revetments along all coastlines and implementing improvement works for	The proposed project will not be implemented.

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
	• Monitoring existing stable revetments. (Site-2) • Constructing amenity-oriented revetments or mild slope revetments with back spaces at certain parts of the coastlines. • Constructing revetments with back spaces (securing buffer zones) to reinforce some of the existing deteriorating revetments. • Monitoring existing stable revetments. (Site-3) • Constructing jetties/headlands and implementing beach nourishment at certain parts of the coastline. • Constructing revetments with back spaces (securing buffer zones) to reinforce some of the existing deteriorating revetments. (Sight-4) • Constructing revetments with back spaces (securing buffer zones) to reinforce some of the existing deteriorating revetments.	existing revetments as needed.	
Beneficiary effects on local residents	The reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. **Furthermore, in certain coastal areas, tourism revenue is expected to significantly increase due to beach nourishment.**	The reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region.	No beneficial effects on local residents are expected.
Consistency with urban development	Highly consistent. **Furthermore, instead of conventional linear protection measures using hard infrastructure, revetments with back spaces (securing buffer zones combined with beach nourishment will lead to area protection measures, which will contribute to developing more resilient communities.**	Highly consistent.	It is not consistent with the urban development of Freetown City.
Impacts on natural environment	1) Air pollution and water pollution. In the construction phase, temporary impacts on air pollution and water pollution are expected. **On the other hand, in the operation phase, beach nourishment inputs are expected to improve water quality.** 2) Waste and noise/vibration. Temporary impacts are expected in the construction phase. 3) Sediment quality. **In the construction phase, sand application changes the bottom sediment quality of the seabed. In the operation phase, seabed sediment quality due to beach nourishment may change over the long term due to current conditions and sediment supply.** 4) Ecosystem. The ecological connectivity between land and sea and the network of	1) Air pollution and water pollution. In the construction phase, temporary impacts on air pollution and water pollution are expected. 2) Waste and noise/vibration. Same as Alternative 1. 3) Sediment quality. Changes on the bottom sediment quality of the seabed are not expected. 4) Ecosystem. Same as Alternative 1.	No impact on the natural environment is expected.

Item	Alternative 1 (Proposed project)	Alternative 2 (Construction of new revetment)	Alternative 3 (Without project)
	habitats may be affected by the installation of coastal facilities. 5) Hydrology. **In the construction phase, construction of jetties/headlands will alter coastal currents and drifting sand. In the operation phase, if changes occur in the topography of the nourished beach, the flow regime in surrounding areas may change.** 6) Topography and geology. In the construction phase, the construction of the facility and beach nourishment will change the topography of the beach. **In the operation phase, the topography of the nourished beach may be altered by currents and waves.**	5) Hydrology. Changes on coastal currents and drifting sand are not expected. 6) Topography and geology. In the construction phase, the construction of the facility and beach nourishment will change the topography of the beach.	
Impacts on social environment	1) Involuntary resettlement. Land acquisition and resettlement are not expected. 2) Local economy such as employment and livelihood. In the construction and operation phases, fishing, agriculture, and other activities in the coastal area may be affected. On the other hand, employment opportunities will be created due to construction. **And nourished beaches and structures may create new fishing grounds and habitats for fishery resources.** Furthermore, the reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. 3) Land use and local resources. The impact is locally limited in the construction phase. **On the other hand, nourished beaches and structures may become new fishing grounds, nurseries for fishery resources, recreational areas, and other local resources.**	1) Involuntary resettlement. Same as Alternative 1. 2) Local economy such as employment and livelihood. In the construction and operation phases, fishing, agriculture, and other activities in the coastal area may be affected. On the other hand, employment opportunities will be created due to construction. Furthermore, the reduction of disaster risk through coastal protection measures will contribute to the economic growth of the region. 3) Land use and local resources. The impact is locally limited in the construction phase.	No impact on the social environment is expected.
Project cost	Compared with Alternative 2, **the project cost is relatively low.**	Compared with Alternative 1, **the project cost is relatively very high.**	No project costs are incurred.
Beneficiary effects	◎	○	×
Urban development	◎	○	×
Natural environment	○	○	◎
Social environment	○	○	◎
Project cost	○	×	◎
Evaluation	◎ (Alternative 1 is recommended in terms of beneficiary effect, consistency with urban development, and project cost.)	× (Alternative 2 is not recommended in terms of project cost.)	× (without project alternative is not recommended in terms of beneficiary effect and consistency with urban development.)

Source: JICA Study Team

Source: Edited by JICA Study Team based on Google Earth

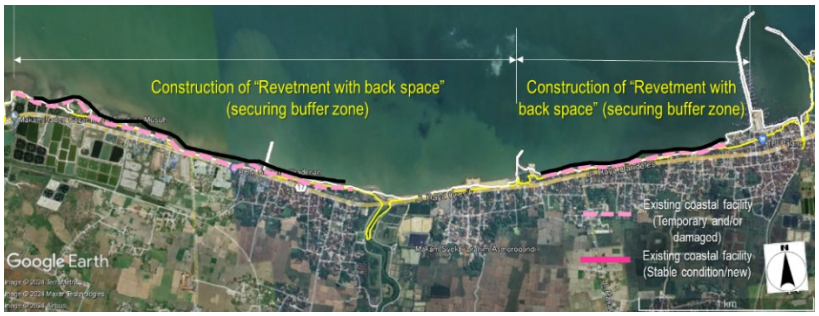
Figure 27 (Area-III, Site-1 Proposed project)

Source: Edited by JICA Study Team based on Google Earth

Figure 28 (Area-III, Site-2 Proposed project)

Source: Edited by JICA Study Team based on Google Earth

Figure 29 (Area-III, Site-3 Proposed project)



Source: Edited by JICA Study Team based on Google Earth

Figure 30 (Area-III, Site-4 Proposed project)

4. Results of Stakeholder Meeting (SHM) and Focus Group Discussion (FGD)

(1) Results of the First SHM

Date & Time	Wednesday, October 26th 2022, 9: 00-13: 00	Venue	SHM@Semarang, BBWS Pemali Juana
Participants	35 organizations: PUPR, BBWS Pemali Juana, BBWS Bengawan Solo, Dinas Public Works and Spatial Planning (Pusdataru), Environment Agency (DLHK) and other public organizations under Pekalongan, Pemalang, Rembang and Tuban.		
Outlines	・ In Pemalang, tidal flooding is severe happening every day in east side, which damaged farmlands and fishponds for 3000 ha. There are recommendations for interventions other than structural measures, and regarding protection construction, non-structural interventions such as Geotubes. ・ The main problems that Rembang has are sedimentation and abrasion. For abrasion interventions, environmental treatments such as mangroves are suggested, and not only structural treatments. It is hoped that this study will be comprehensive, focusing not only on the environment and structural issues, but also on Rembang's tourism potential. ・ In Pekalongan area, problems that tidal flooding including sea level rise, some fishponds being submerged, and then impacting the surrounding environment. ・ Tuban has industry, tourism, and a port and each beach has different characteristics so the actions implemented will depend on each beach location. ・ Many participants agreed to combine nature and structure for countermeasures, and the concept of harmonization of protection, utilization and environment.		

Date & Time	Wed, November 16th 022, 10: 00-12: 30	Venue	SHM@Cirebon
Participants	32 organizations: PUPR River and Ocean Director, BBWS Cimanuk-Cisanggarung, Dinas Public Works and Spatial Planning, Environment Agency (DLHK) and other public organizations under Indramayu		
Outlines	・ Erosion and flood are the most severer issue in Indramayu, which affect residents, farming lands fishponds. Garbage is a common issue in beaches. (Bappeda Indramayu) ・ The most severe damage is still in Eretan and Karangson experiencing tidal flood every day, even though it has been constructed breakwater. (Dinas PUPR Indramayu, BBWS Citarum) ・ One of main North Java coastal usage is fishery and its port (Karangsong, Eretan, Eretan Kulon). Especially, there are fishery ports on estuaries, boats exit and enter the ocean through estuaries. Their main issues are sedimentation. (DKP of West Java) ・ BBWS Cimanuk-Cisanggarung wants to know the mechanism of issues with current countermeasures. Opinions from head of BBWS Cimanuk-Cisanggarung is to consider both structural and non-structural intervention. (BBWS Cimanuk-Cisanggarung) ・ Spatial planning classifying Karangsong as tourism and fishery, but we want integration as JICA team explained harmonizing with environment, protection, and utilization. (Bappeda Indramayu) ・ Regarding beach nourishment, it may not be suitable to North Java coast because mostly it is used by fishermen. Especially for structural plan, I want consultants to consider people usage. (Director Supan, PUPR River and Ocean)		

(2) Results of the First FGD

■ **Area-I: Indramayu**

Date & Time	Tuesday, November 15th 2022, 9: 00-11: 00	Venue	FGD@Juntikedokan, Indramayu
Participants	Total of 19 people (fishermen, retail and service workers, housewives, village hall staff. 17 men, 2 women)		
Outlines	・ This area experienced erosion and sedimentation. Many people lost their job because they lost farmlands by erosion. ・ Breakwater helps to catch sediment, however, it makes difficult for fishermen boats traffics. ・ Breakwater was built for 20 m 2 years ago, but it was damaged and now it is 16m long. ・ One of tourism beach is managed by governments. They limit the number of shops by the coast and exceeded ones were not allowed to operate there. ・ Many people here are depending on revenue from fishing, farming and shops on the coast. Those are easily affected by the coastal condition. Female participants had been working in shops and they have been unemployed. They mentioned that they want to be independent from the coastal issue. ・ Participants want a sloping, sandy, natural beach with adequate road access.		
Picture	  		

Date & Time	Tuesday, November 15th 2022, 15: 00-17: 00	Venue	FGD@Ujunggebang, Indramayu
Participants	Total of 23 people (fishermen, farmers, retail and service workers, construction workers, village hall staff. 21 men, 2 women)		
Outlines	・ From June to August, this area experience tidal flood. ・ They also experience erosion. Breakwater is working well but countermeasure is not enough. ・ Some of area is sandy beach but it is mixed with mud. 80% of coastal line is used as tourism. ・ They want to enhance tourism here so that they hope sandy beach and land rehabilitation. ・ However, they also show concerned that there might be dispute for new land. ・ As explanation of risk of living on beach and idea of zoning, participants show understandings. ・ They are willing to cooperate with community coastal management and they are welcoming beach nourishment.		
Picture	  		

■ **Area-II: Pemalang-Pekalongan**

Date & Time	Friday, October 28th 2022, 14: 00~16: 00	Venue	FGD@Widuri, Pemalang
Participants	Total 14 participants (fishermen, retailers, construction workers, etc., All male.)		
Outlines	・ Coasts are mostly utilized for tourist areas and aquaculture. There are restaurants and shops along the beach, but most of them are vacant now. ・ Tanjungsari Village to Widuri Beach is currently severely damaged by erosion. ・ The influence of waves is very strong and has an impact on the surrounding area, in order for the condition of the beach to be better like the condition of Widuri Beach in the past. ・ The community feel coastal safety building and the current condition is not strong enough to protect Widuri Beach. ・ Susukan River estuary is sedimented resulted in the inoperability of TPI Widuri, as larger fishing boats cannot dock and unload their catches. ・ Widuri Beach is severely damaged by abrasion. If the damage continues, it is feared that future generations will not be able to enjoy it. ・ This community believes a strong beach building by concrete is required to face this coastal condition. ・ Another environmental problem at Widuri Beach is garbage, which is a very serious problem especially during the rainy season. The Pemalang Regency Tourism Office once placed two cleaning personnel, but they only lasted for 6 months. ・ As sandy beach has positive impact on erosion and waves, it may suite on Widuri beach condition. The community wants sandy beach especially for leisure.		
Picture	   		

Date & Time	Saturday, October 29th 2022 9: 00~12: 00	Venue	FGD@Mojo, Pemalang
Participants	Total 23 participants (fishermen, aquaculture workers, ship owners, etc.; 17 males, 6 females).		
Outlines	・ The existing problems in Mojo Village are Rob Flooding, abrasion, siltation of the estuary, and seasonal high wave. The West Season and the East Season. The West Season occurs in December, January and February. While the East Season occurs from April to October. ・ Many participants have been suffered by flood. ・ Fishermen anchor boats a fishery port on river because they cannot anchor on the sea due to high waves. The river is also sedimented. ・ Planting mangrove project was done by Japanese NGO and KLHK, which expanded land. ・ Some lands damaged due to tidal flood and or expanded land due to mangrove are empty so many people reclaim to have those land, which causes conflicts. ・ However, mangroves are decreasing affected by high waves		

Picture	  

Date & Time	Monday, October 31st 2022 9: 00~11: 00	Venue	FGD@Panjang Wetan, Pekalongan
Participants	Total 20 participants (community association presidents (RW), teachers, dyers, fishermen, day laborers, etc.; 11 men, 8 women)		
Outlines	・ Panjang Wetan Urban Village is one of the areas in Pekalongan City affected by abrasion, land subsidence, tidal flood and the destruction of mangrove ecosystems. ・ The community pointed out major ground water intake is done by ice cube company in Pekalongan, not batik clothing industry (even though it is one of the largest industries in Pekalongan). ・ Tidal flood damages have been severer than before. There is a retention wall along coastal line and it will be strengthen. However, most of participants agree that it needs different and comprehensive countermeasure with green such as mangrove. ・ Pekalongan city is also touristic place. There used to be a sandy beach, but it's lost by erosion and land subsidence. ・ Most of participants also agree with that most coastal line is covered by concrete structures and it is not good for utilization and landscape. Many participants said they want sandy beach, especially from female participants.		
Picture	  		

■Area-III: Rembang-Tuban

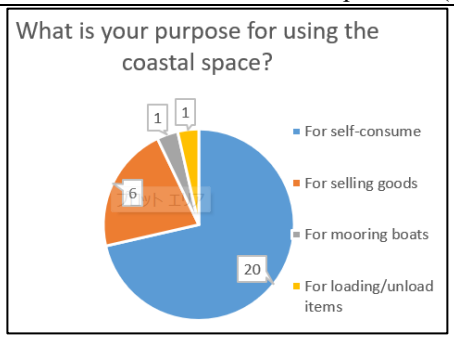
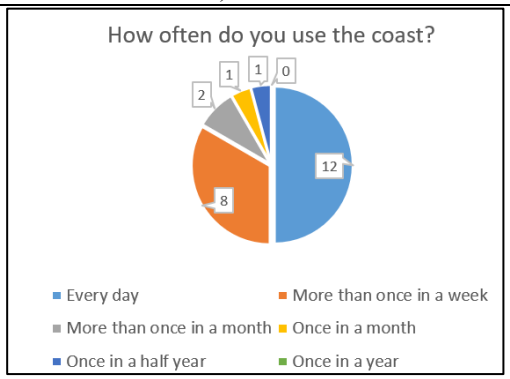
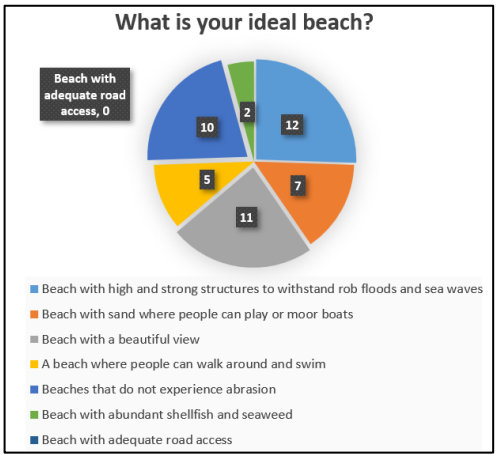
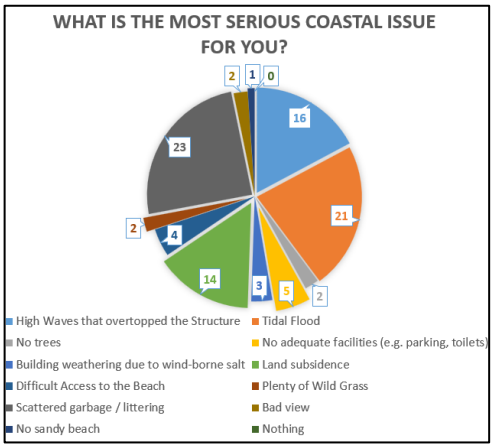
Date & Time	Wednesday, November 2nd 2022, 9: 00~12: 00	Venue	FGD@Bajingmeduro, Rembang
Participants	Total 25 participants (fishermen, village office staff, community association president, teachers, students, etc.; 16 males and 9 females)		
Outlines	・ The village of Bajingmeduro has experienced abrasion at least once a year, from the east coast to the west coast. Abrasion has also occurred in the most severe areas of Kalipang Village, Sendangmulyo Village, and Karang Maju Village. ・ The majority of the people of Bajingmeduro Village 95% work as fishermen and 5% are boat builders, etc. ・ The main problem in Bajingmeduro Village is wave abrasion, especially in the west season. In		

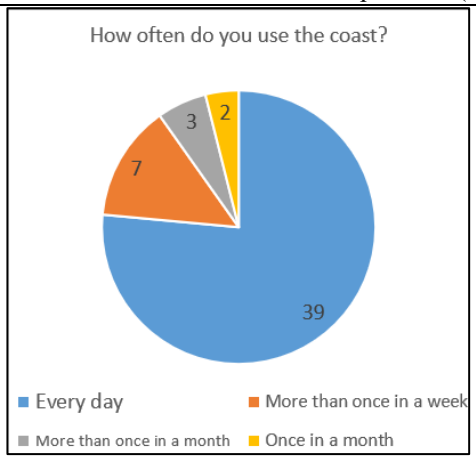
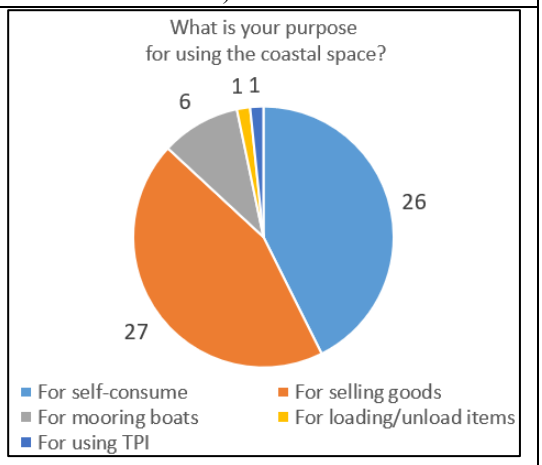
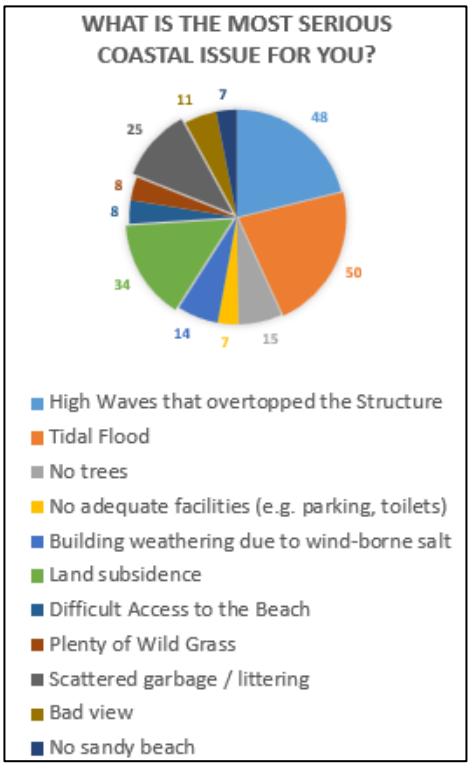
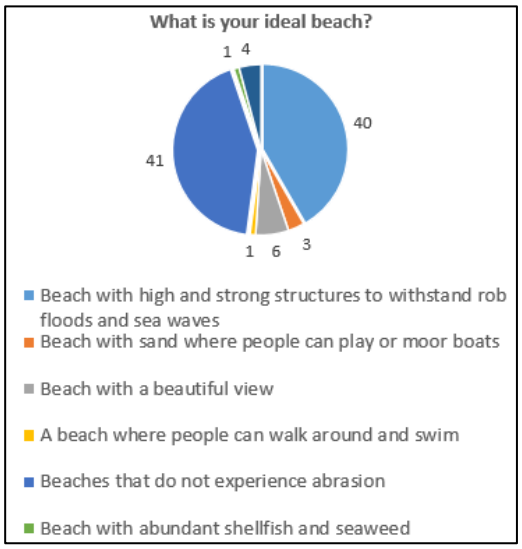
	1981-1982, abrasion eliminated the land owned by the community that had been certified. Approximately 30 meters of land along the coastal area including the Mushola (Place of Worship) collapsed and road access was also reduced. The current abrasion is not severe compared to the abrasion that occurred in the 80s. ・ During the high wave season, ships are not parked on the coast directly. But ships can be parked in sheltered coastal waters, such as the ships at Bulu Beach in East Java. The village aspires fishery port. ・ The local community utilizes coastline for religious activities, opening businesses (food stalls and grocery stores) and for recreation. ・ Regarding garbage, the village has conducted a beach cleaning program in collaboration with the boarding school management. But it did not las long. After cleaning in the morning, in the afternoon the garbage was again scattered. ・ The community wants a safe beach from abrasion, a sandy beach so that it can be utilized. ・ Participants do not agree if it has to be planted with mangroves because waters are a busy area for fishing boat activities.
Picture	  

Date & Time	Wednesday, November 2nd 2022, 14: 00~16: 00	Venue	FGD@Pandangan Wetan, Rembang
Participants	Total 17 participants (fishermen, shipbuilders, unloading workers, etc.; 13 males and 4 females)		
Outlines	・ The problem in this coastal area is abrasion and tidal flood. ・ Some houses were damaged and collapsed by abrasion when there were high waves. There is a plan to build breakwater with completed environmental impact assessment since 2015, however, it has not been financed yet. ・ Some houses are heightened to counter tidal flood. ・ The problem of waste management is a common homework that has not yet been resolved. ・ Beach is used for anchoring boats, processing fish, playground, and community gathering for local community everyday. That is why beach access and protecting sandy beach are very important. ・ There has been a big opposition to planting mangrove from old fishermen concerning it limits access to the sea.		
Picture	  		

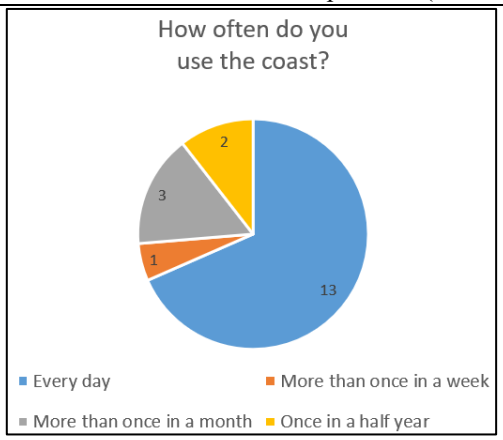
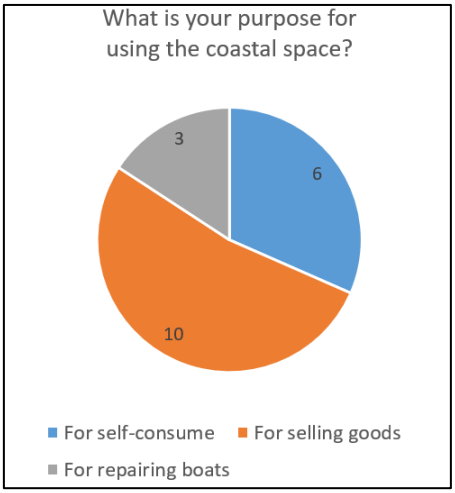
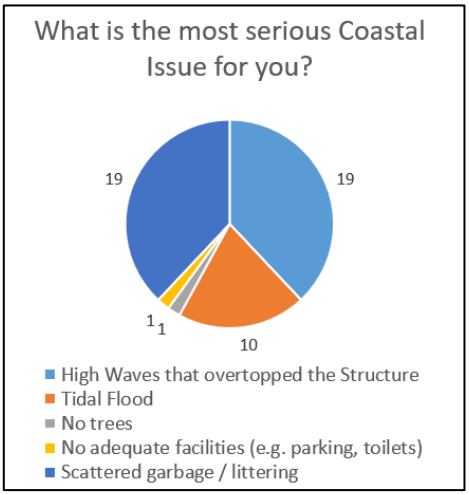
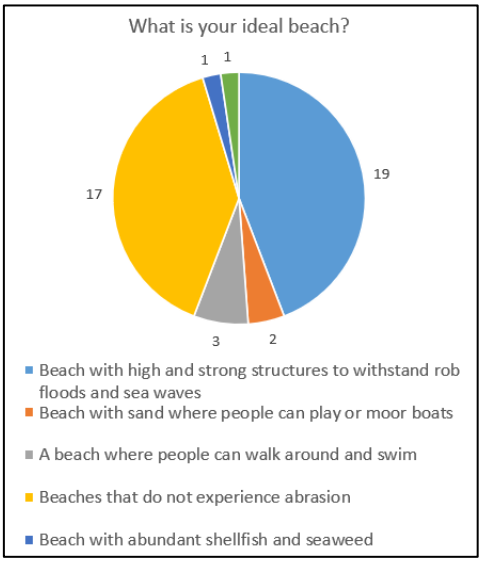
(3) Questionnaire Survey Results

■ Area-I: Indramayu

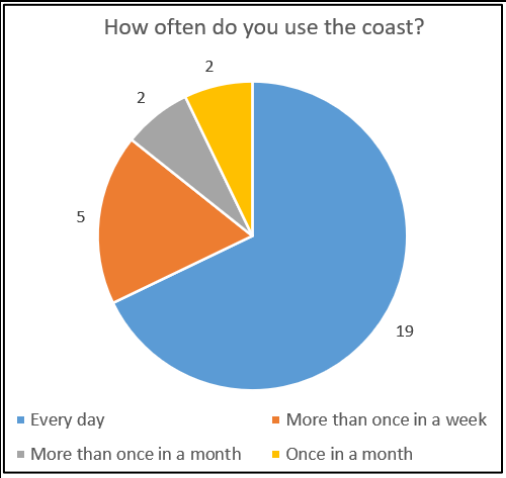
Venue	Juntikedokan, Indramayu
Respondent	24 respondents (23 Males and 1 Female)
Result	   

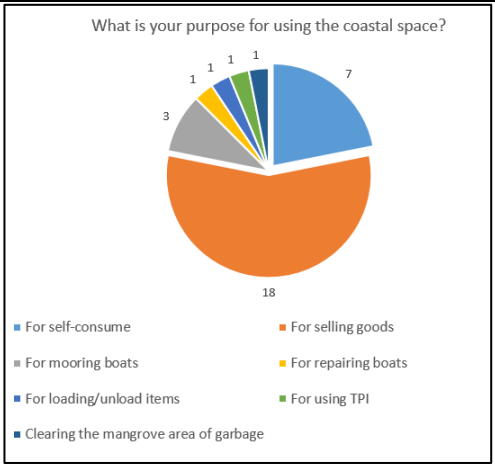
Venue	Ujunggebang, Indramayu
Respondent	51 respondents (50 Males and 1 Female)
Result	   

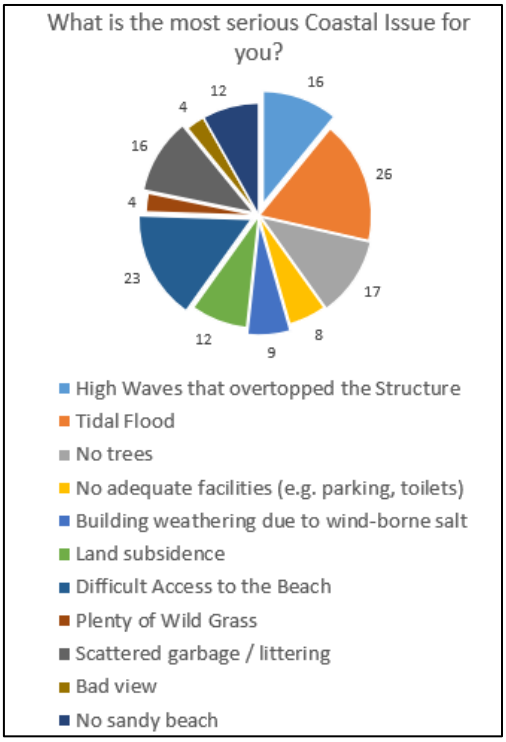
■Area-II: Pemalang-Pekalongan

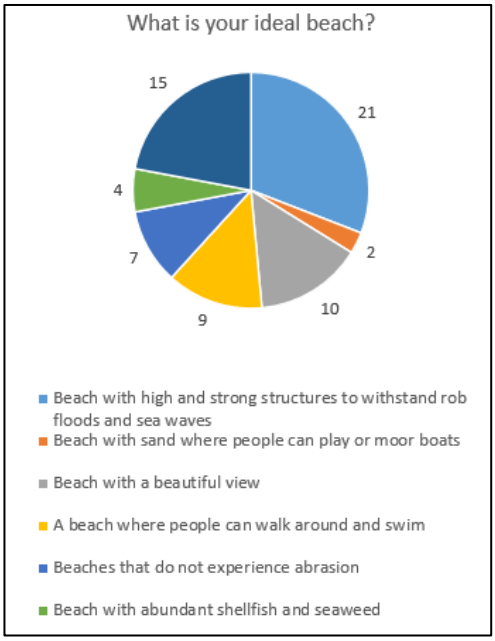
Venue	Widuri, Pemalang
Respondent	28 respondents (22 males and 6 females)
Result	   

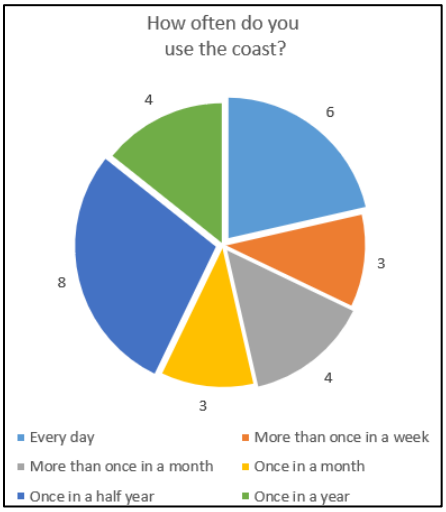
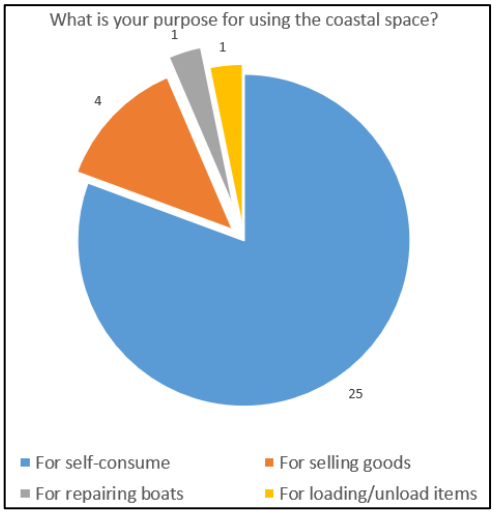
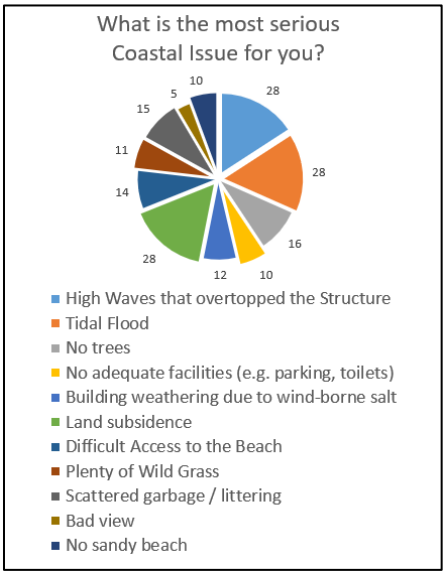
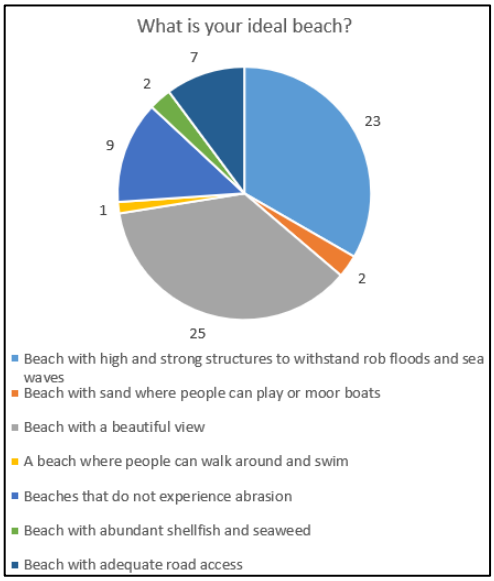
Venue	Mojo, Pemalang
Respondent	19 respondents (17 males and 2 females)
Result	



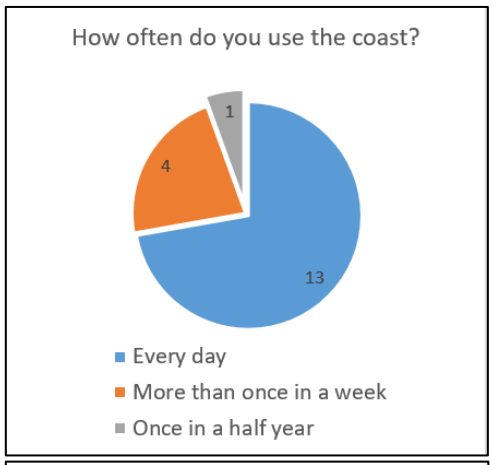
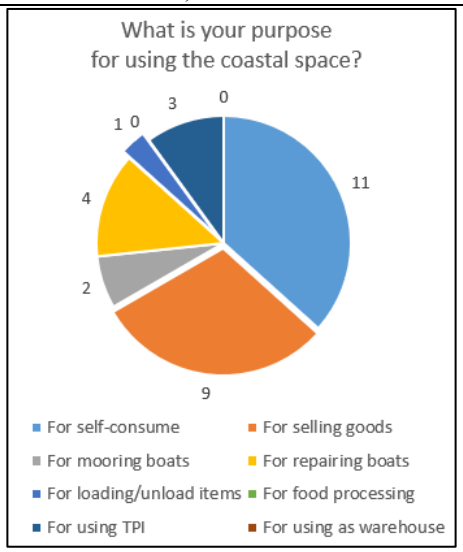
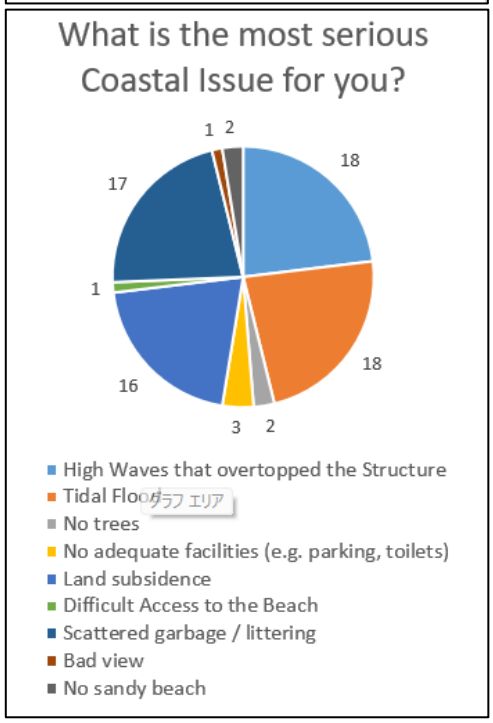
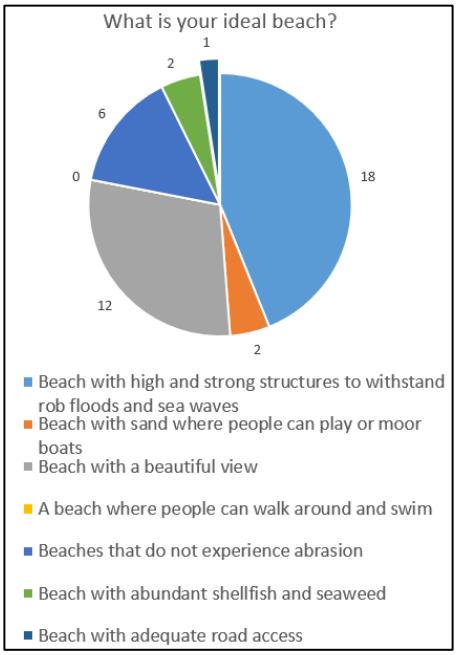


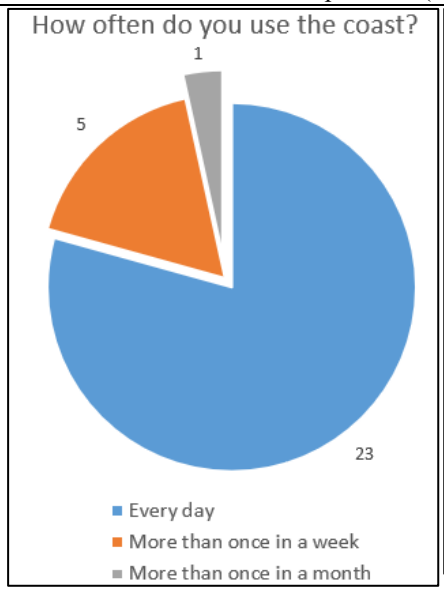
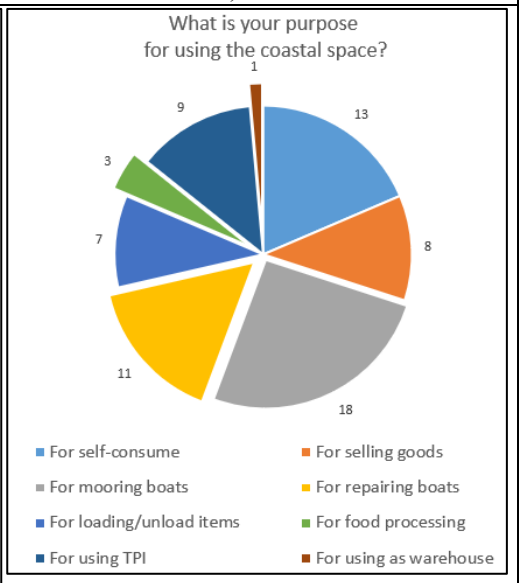
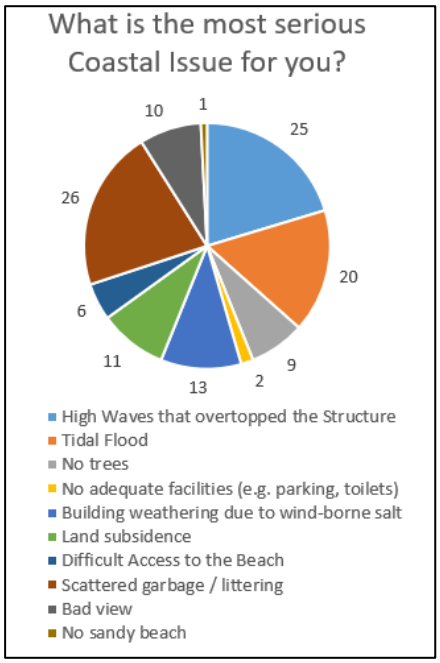
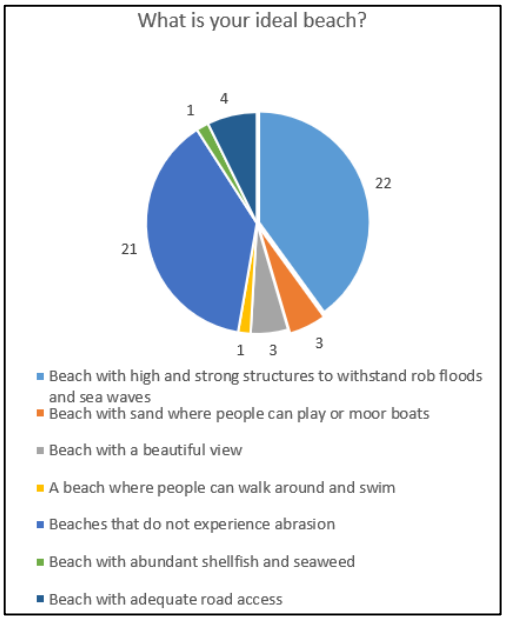




Venue	Panjang Wetan, Pekalongan
Respondent	28 respondents (22 males and 6 females)
Result	   

■Area-III: Rembang-Tuban

Venue	Pandangan Wetan, Rembang
Respondent	19 respondents (16 males and 3 females)
Result	   

Venue	Pandangan Wetan, Rembang
Respondent	19 respondents (14 males and 5 females)
Result	   

(4) Results of the Second SHM

Below shows an overview of the results of the second SHM held in each priority area.

■ **Area-I: Indramayu**

Date & Time	Wednesday, January 31st 2024, 9: 15-11: 15	Venue	BBWS Cimanuk Cisanggarung @Cirebon
Participants	Total of 44 participants (10 on-site, 34 online) PUPR, BBWS Cimanuk Cisanggarung, BBWS Citarum, Dinas PUPR Indramayu, Bappeda West Java (Development Planning Agency), DKP West Java, DLHK Indramayu (Environment Agency) and other public organizations under Indramayu.		
Outlines	The discussions centered on addressing coastal protection, sediment management, infrastructure improvement, and environmental conservation while ensuring community involvement and effective coordination among relevant stakeholders. **1. Coastal Protection and Sediment Management** ・ BBWS Cimanuk Cisanggarung highlighted that coastal protection structures perpendicular to the coast cause erosion on the downdrift side and sedimentation on the updrift side. ・ It was noted that sand nourishment usually comes from sedimentation areas. **2. Roles and Responsibilities** ・ BBWS Citarum raised concerns about specific roles and responsibilities, particularly regarding facility and management plans. For example, in Eretan of West Java, there was a plan to build a fishery port. But in 2021 when BBWS Citarum was planning to construct seawall there, the implementation was delayed due to some conflicting projects. ・ There were discussions about who would be responsible for various aspects such as protecting ports, managing fisheries, and overseeing residential areas. **3. Integration with Spatial Planning** ・ Bappeda West Java emphasized the integration of coastal management plans with the integrated spatial plan of West Java (Peraturan Daerah Provinsi Jawa Barat Nomor 9 Tahun 2022 Tentang Rencana Tata Ruang Wilayah Provinsi Jawa Barat Tahun 2022-2042), providing relevant documentation for consideration. **4. Saltwater Intrusion and Environmental Impact** ・ Dinas PUPR Indramayu highlighted urgent areas impacted by saltwater intrusion, affecting agricultural land and rice production in the estuary areas between the Citarum and Cimancis watersheds. Over the past five years, a total of 3,000 hectares of this area have become unsuitable for cultivation, particularly during periods when agriculture relies solely on rainwater. ・ The need for studies and prioritization of affected areas was discussed, with a list of urgent areas (Eretan Wetan, Bulak, Parian Girang, Santing, Krimun, and Losarang) provided. The land subsidence in Eretan is 5 cm/year. In the last 20 years it is around 1 m. **5. Infrastructure Improvement and Environmental Concerns** ・ Concerns were raised about ineffective structures and the need for improvement, including jetties used for fishing boat access in Bungko Beach and breakwaters. ・ Environmental agencies emphasized the importance of vegetation management for sedimentation control and disaster risk reduction. **6. Community Engagement and Disaster Risk Reduction** ・ Suggestions were made for community-based disaster risk reduction strategies, including		

	planting approaches and coordination with local disaster management agencies and social volunteers.
Picture	  

■ **Area-II: Pemalang-Pekalongan**

Date & Time	Thursday, February 1st 2024, 9: 30~12: 50	Venue	BBWS Pemali Juana @Semarang
Participants	Total of 57 participants (41 on-site, 16 online) PUPR, BBWS Pemali Juana, Dinas PUPR Pekalongan Regency, Dinas PUPR Pemalang Regency, Bappeda Pekalongan Regency (Development Planning Agency), Bappeda Central Java, DKP Pekalongan Regency, DKP Central Java, Dinas Pusdataru Central Java (Public Works, Water Resources, and Spatial Planning), DLHK Semarang (Environment Agency) and other public organizations under Pemalang and Pekalongan.		
Outlines	The discussions highlighted the multifaceted nature of coastal challenges and the importance of holistic, participatory approaches to sustainable coastal management and resilience-building efforts. **1. Coastal Protection and Infrastructure Development** ・ Concerns were raised about the inadequacy of existing coastal protection measures, such as revetments and breakwaters, against land subsidence and coastal erosion. In 2016, a breakwater about 1,800 m in Depok Beach was constructed, however it has been submerged. ・ Proposed projects included the construction of breakwaters, revetments, and onshore ports to mitigate erosion, tidal flooding, and sedimentation. In 2022, DKP Pekalongan Regency proposed the construction of a hybrid engineering solution. However, a study focusing on coastal erosion, concluded that soft structures alone are insufficient due to the high waves. The recommended approach is a hard structure, including breakwater and groin along the Pekalongan Regency coast. Unfortunately, the KKP does not have the budget for such hard structures. Therefore, PUPR/BBWS is requested to address this issue. ・ The need to balance infrastructure development with environmental conservation, particularly in the context of mangrove protection and shoreline restoration, was emphasized. ・ Discussions also touched upon the importance of sand nourishment for restoring beaches and enhancing tourism potential, alongside considerations for equitable access to coastal resources for fishpond cultivators. **2. Land Subsidence and Environmental Impact** ・ High rates of land subsidence, ranging from 7 to 12 cm per year (in Pekalongan, 10 to 12 cm per year), were highlighted as significant challenges exacerbating coastal vulnerabilities. Land subsidence has already destroyed fish/shrimp ponds and seaweed cultivation. ・ The depletion of mangrove ecosystems, loss of agricultural land, and disruption of fisheries due to environmental degradation and tidal flooding were major concerns. ・ Efforts to address these issues included proposals for mangrove rehabilitation, coastal reforestation, and the restoration of degraded ecosystems to enhance coastal resilience and		

	biodiversity. Mangroves without protection are difficult to thrive. **3. Community Resilience and Livelihoods** ・ Discussions underscored the importance of empowering coastal communities through livelihood diversification, training, and infrastructure resilience measures. ・ Strategies to support affected communities, particularly those reliant on coastal activities such as fishing and agriculture, were emphasized. ・ Adaptive measures, such as raised platforms for housing and floating structures, were proposed to address the challenges posed by land subsidence and tidal flooding. The communities affected are reluctant to relocate because the communities rely on the coastal activities for their livelihood. West side 2 villages (Depok and Blacanan) and 3 other villages in the West side are affected by tidal flooding, with no existing measures. The settlements are starting to get submerged. There should be comprehensive measures from both Pemalang Regency and Pekalongan Regency. ・ Efforts to enhance community engagement, awareness, and participation in coastal management initiatives were highlighted as essential for fostering resilience and sustainable development. **4. Government Collaboration and Planning** ・ Bappeda Central Java has pushed for North Java to be a national priority and has been initiating efforts in relation to integrated coastal management since 2014. Collaboration among government agencies, NGOs, and international partners like JICA was deemed crucial for effective coastal management and infrastructure development. ・ Challenges related to land ownership, compensation for lost land, and regulatory frameworks were discussed, with calls for integrated spatial planning and policy coordination. ・ The importance of technical studies, data sharing, and community consultations in formulating comprehensive coastal management plans and infrastructure projects was emphasized. ・ Discussions also focused on the need for adaptive governance structures, flexible funding mechanisms, and transparent decision-making processes to address the dynamic nature of coastal hazards and environmental risks.
Picture	  

■Area-III: Rembang-Tuban

Date & Time	Friday, February 2nd 2024 9: 15~11: 15	Venue	BBWS Bengawan Solo @Solo
Participants	Total of 48 participants (23 on-site, 25 online) PUPR, BBWS Bengawan Solo, Dinas PUPR East Java, Dinas PUPR Tuban Regency, Bappeda East Java (Development Planning Agency), DKP East Java, DLHK East Java (Environment Agency), National Land Agency East Java, National Road Agency East Java and Bali Province, and other public organizations under Rembang and Tuban.		
Outlines	The discussions highlighted the complexities of coastal management, including technical, regulatory, and community resilience aspects, emphasizing the importance of integrated planning and collaboration among stakeholders.		

	1. Technical Details and Regulations ・ The need for specific technical details, such as sand material specifications, for proposed coastal protection measures was emphasized. ・ DKP East Java highlighted conflicts with spatial planning regulations regarding proposed revetment construction in designated capture fishery zones. ・ The importance of aligning proposals with existing regulations, citing Presidential Regulation No. 80 of 2019, which includes Tuban in strategic national projects, was stressed. **2. Coastal Infrastructure and Mangrove Conservation** ・ Dinas PUPR East Java discussed challenges with existing coastal infrastructure, such as roads close to the sea, and proposed measures like mangrove planting and wave overtopping mitigation. ・ Local KLHK East Java emphasized the importance of mangrove protection as part of environmental quality indices and highlighted challenges with mangrove loss due to community activities. ・ BPN/Land Agency East Java discussed land ownership issues and the need for detailed spatial planning to address coastal development challenges. **3. Community Resilience and Tourism** ・ Dinas PUPR Tuban Regency highlighted Tuban's reliance on fishing communities and tourism, with challenges including erosion and mangrove planting difficulties. ・ Suggestions were made to synchronize coastal protection efforts with spatial planning and to address flood control and settlement issues. ・ BBWS Bengawan Solo emphasized the need to consider community prosperity and the importance of harmonizing plans with local regulations. **4. Government Collaboration and Planning** ・ Various stakeholders discussed the importance of collaboration and information sharing, including providing technical input and sharing development plans. ・ DGWR PUPR emphasized the need for clear policies on sand nourishment and environmental assessments. ・ The integration of sectors and harmonization of plans to address technical and future impact considerations was stressed. **5. Required Actions** ・ Key actions include sharing detailed spatial planning studies, coordinating with Tuban government contacts, and sharing road planning documents for further collaboration and implementation.
Picture	  

Lampiran-18
Konsep Rencana Kebijakan Pengelolaan Pantai (*Basic Policy of Coastal Management*)

Basic Policy for Coastal Management

Purpose of enforcing Basic Policy for Coastal Management

- In order to protect and preserve human lives, assets and territorial land under the continues coastal development, the purpose of enforcing the Basic Policy for Coastal Management is to establish the fundamental principles on coastal management and development to address coastal vulnerability such as coastal erosion, tidal flood, wave overtopping, sea level rise associate with climate change, while ensuring the harmonization of "protection,' utilization," and "environment."
- The designated coastal areas, in which the Basic Coastal Management Plan is required to be prepared, are coastal areas of the five main islands, that is Sulawesi, Kalimantan, Java, Papua, and Sumatra, and the two main islands group, that is Maluku Islands and Nusa Tenggara.
- The purpose of the Basic Policy for Coastal Management is to clearly define the fundamental requirements and procedures for the Basic Coastal Management Plan which will be issued by the ministers of primary ministry – PUPR, KKP, and KLHK, as the guideline for coastal management in Indonesia

Definition of Basic Terms on Coastal Management

(1) Definition of Area on Coastal Management

- The area for coastal management, in which the Basic Coastal Management Plan shall be prepared, is defined as follows:

    a. Area which defined as coastal area are at least 50 meters from the lowest water level (LWL) offshore and 100 meters from the highest water level (HWS) onshore principally. The final area for each coastline should take account of shore condition, seabed slope and other considerations that may widens the area for specific site.

    b. The "Buffer zone" against coastal disaster is defined on Presidential Decree 51/2016 as public property. It is recommended to keep consistency of both its range and its public status at onshore side.

    c. Boundary of 12 nautical mile defined as provincial jurisdiction area for offshore side is deemed too far for coastal management, thus it is not considered on this plan.

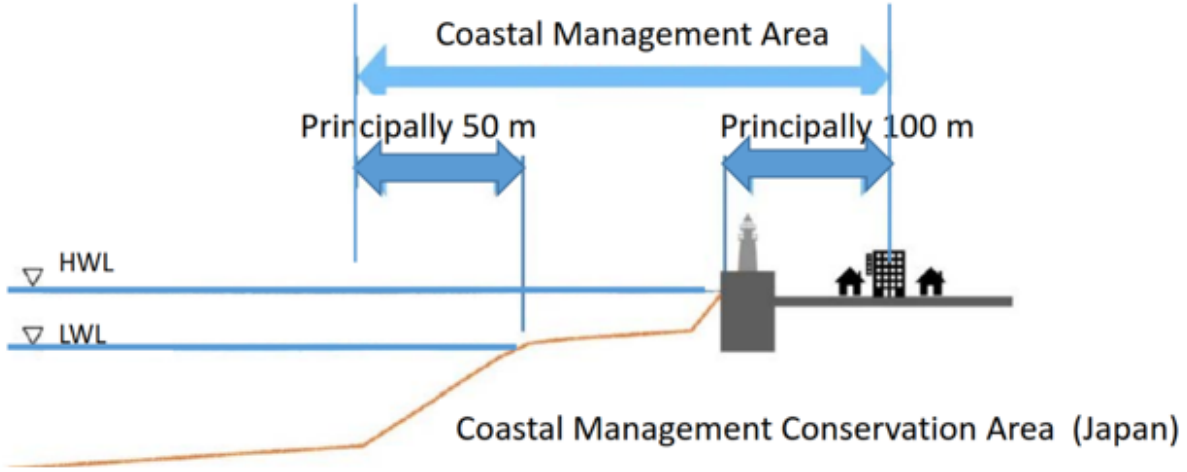


Figure 1. Definition of Coastal Management Area

(2) Position of Basic Coastal Management Plan

- To make it clear that objective and position of coastal management plan and spatial plan (known as Rencana Tata Ruang Wilayah, RTRW) difference, both are defined on this section.
    a. The O
    b. objective of RTRW is to clarify the zoning to show the area for existing – and future development – coastal and marine utilization and activities.
    c. On the other hand, the "Basic Coastal Management Plan" is to clarify the middle and long-term goals on coastal management and its plan at the coastal area, considering the coastal condition and its process, and socio-cultural condition as well as impact of future development of infrastructures at coastal area.

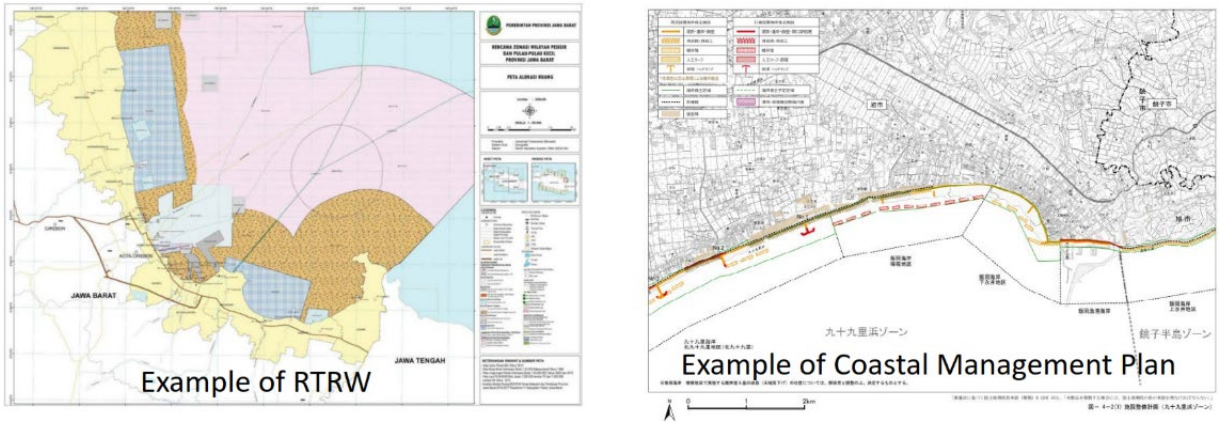


Figure 2. Difference between RTRW and Coastal Management Plan

(3) Definition of Coastal Facility

- Coastal facilities have a variety of types. Examples of coastal facilities such as both "hard" and "soft" or "gray" and "green" facility (measures) are defined as follows:
    a. Groin, revetment, breakwater, detached break water, artificial headland, etc., as hard and gray facilities/measures
    b. Beach nourishment, sand back-pass, sand bypassing, etc. as "soft" measures
    c. Mangrove and other vegetation plantation, coral transplantation, etc. as "green" facilities/measures
    d. Combination of above facilities
    e. Other public facilities to enhance beach utilization such as walkway, parking, rest house, etc.

(4) Agencies who mainly take initiative for preparation and issuing of the Basic Coastal Management Plan;

- Agencies involved in preparation of the Basic Coastal Management Plan are defined as follows:
    a. The Local Governments, mainly DINAS PU and BAPPEDA, prepare the Basic Coastal Management Plan as the leading agencies in cooperation with relevant agencies from the central governments, such as PUPR, KLHK, and KKP.
    b. For the preparation of the Basic Coastal Management Plan in each area, it is recommended to establish the "Ad-Hoc Council" which consists of at least PUPR, KKP, and KLHK from Central Government; and Dinas PU, BAPPEDA and other corresponding agencies from the Local Governments as required; communities, technical adviser of coastal engineering and management, etc.
    c. The Governor in each province shall issue the Coastal Management Plan and submit it to the Central Government (under ATR) to archive and integrate, as same system as that for the Spatial Plan.

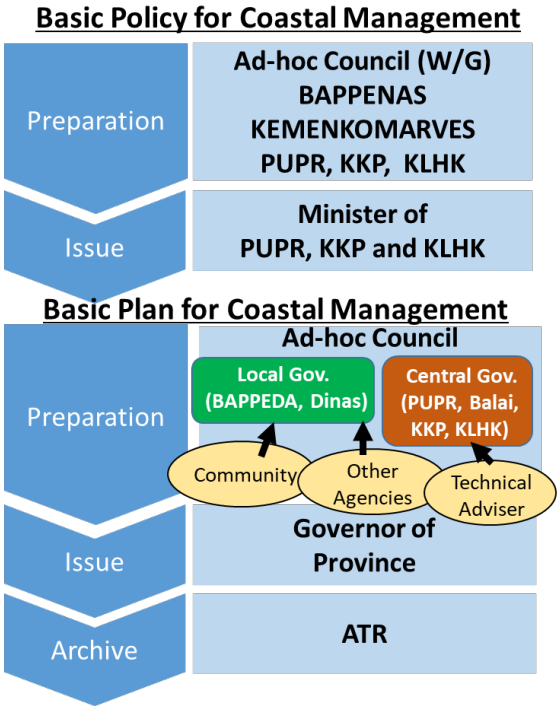


Figure 1 Flowchart on Coastal Management Plan Sequencing

Clause 1 Basic Guidelines for Coastal Management

1. Basic philosophy of coastal management

"Basic philosophy of coastal management based on overview of coastal conditions in Indonesia"

- In Indonesia, which has the second-longest coastal length in the world, each island and area possesses distinct coastal characteristics, coastal hazards, and coastal utilization.
- The basic philosophy is to pass on the coast with "coastal protection and coastal protection in harmony with utilization and environment" to future generation as a shared national asset.

"Ideal situation for coastal management to achieve above mentioned basic philosophy "

- Comprehensive and integrated coastal facility development, conservation, and management from mid-to long-term and wide-area viewpoints are promoted.
- Coastal facility development with the local governance is promoted.

2. Direction on Coastal Management

"Direction on coastal facility development and conservation"

- Coastal facility development and coastal conservation from the three perspectives of protection, environment, utilization is promoted.
- In the context of coastal protection, it shall be promoted to ensure appropriate protection levels considering high waves, wave overtopping, coastal erosion, topographical change and sedimentation surrounding river mouth, land subsidence, climate change, etc., and take integrate measures incorporating both hard and soft measurers.
- In the context of coastal environment, the conservation and maintenance of natural sandy beaches, coral reefs, mangrove forests, as well as conservation of coastal and marine ecosystems including coral and fish and other marine species, shall be promoted.
- In the context of coastal utilization, coastal utilization by tourism and the local society shall be well-considered and enhanced.

2.1 Direction on Coastal Protection

"Classification of targeted coastal disasters"

- In the context of coastal protection, ensuring appropriate protection levels, considering high waves, wave overtopping, coastal erosion, sedimentation, topographical change at river mouth, land subsidence, climate change, etc., shall be clarified.
- Indonesian's coasts vary significantly from one region to another, with distinct natural condition and socio-economic condition of hinterland. Thus, it is required to determine targeted coastal disasters and appropriate protection levels against the disaster, taking into account natural conditions, occurrence of coastal disasters, and population and assets of hinterland, and coastal utilization.

"Setting appropriate protection levels against coastal disasters."

- For coasts targeted to protect against high wavs, overtopping, and tidal flood, the target protection levels are set considering the status of hinterland.

- For coasts targeted to protect against coastal erosion, the basic target of protection level is to maintain the current shoreline, and the further target protection level is to restore the shoreline to a greater extent taking into account coastal utilization, as required.
- For coasts targeted to protect against land subsidence, the protection level is to secure the safety against land suboscine with a timescale ranging from 10 years to 100 years.
- For coasts targeted to protect against Tsunami, the target protection level is set is to protect against relatively frequent tsunamis that occurs once a few decades to a hundred and few decades years, based on records of past inundation and other relevant data.
- For coasts targeted to protect against storm Surge, the target protection level is set to protect against either the highest high tides based on records of past storm surges caused by typhoons, etc., or the tides appropriately estimated based on records or future projections, in addition to the effects of waves appropriately estimated based on records or future projections.

"Direction of measures for coastal protection"

- For developing coastal facilities, considering the status of the hinterland, the goal is to set to prevent seawater intrusion or erosion, and if the sea water overflows the levees, to mitigate the damage to hinterland. Moreover, integrated coastal measures, that is the protection not only by the single structure, but also by the combination of multiples coastal measures including the establishment of buffer zone.
- Conservation and maintenance of natural protection functions such as existing sandy beach, coral reefs, mangrove forests, etc. is promoted.
- Regarding tsunami and storm surge countermeasures, in addition to the development of coastal facilities, comprehensive measures should be implemented that combine hard and soft measures.
- For the countermeasures against coastal erosion, it is promoted to implement measures through adaptive management of beach and from a wide-area perspective taking into account the entire cell of littoral drift.
- Since river mouths experience significant topographic changes in response to wave dynamics and sedimentation due to sediment inflow from the river, measures are promoted from both mid- to long-term and wide-area perspectives. Particularly in sedimentation areas, comprehensive sediment management in the sediment transport system and land management are carried out.

2.2 Direction on Development and Conservation of Coastal Environment

"Functions of coastal environment"

- The coast provides a diverse habitat and growth environment for organisms.
- The coast forms a part of outstanding natural landscapes.

"Direction of measures for coastal environment"

- Conservation and maintenance of coastal environment that coexists harmoniously with nature is promoted.
- Preservation of outstanding landscapes, academically valuable assets, and diverse ecosystems is promoted.
- Regulations for coastal environmental conservation is established.
- In order to create favorable coastal environment, coastal facilities are developed as necessary.
- Environmental impacts resulting from sudden incidents such as oil spills is appropriately managed.
- In order to maintain and conserve the rich biodiversity, conservation of mangrove forests and coral reefs are promoted.
- It is promoted to secure that all parties concerned can share a common understanding of the coastal environment that need to be conserved.

2.3 Direction on Proper Coastal Utilization by Public

"Functions of coastal utilization"

- The coast forms and preserves regional culture of local community.
- The coast encourages diverse coastal utilizations such as leisure, sports, education activities, and recreational spaces.

"Direction for measures of coastal use"

- Coastal facilities that contribute to the enhancement of coastal utilization is promoted to be developed.
- Actions are necessary to deal with the degradation of coastal facilities and abandoned vessels that significantly impair the scenery and convenience of the coast.
- Ensuring public access to the seashore is promoted.
- Awareness rising activities for users of the coast is promoted so as to improve their etiquette and behavior in their coastal utilization is promoted.

3. Direction of Implementation on Coastal Facilities

3.1 Direction on New Implementation or Repair of Coastal Facilities

1) Promotion of development of safer coast

"Measures promoted to achieve target protection level "

- In development of coastal facilities, integrated coastal measures are promoted, including, not only hard structure, but also soft measures such as beach nourishment (including sand bypass from sedimentation area, etc.) as well as green infrastructure such as mangrove plantation, and various measures such as combining these structures are fostered. To enable this, furthermore, the appropriate land management in evolving coastal areas is promoted.
- To prevent widespread and catastrophic damages by Tsunami and storm surges, it is promoted to take measures that efficiently and comprehensively combines multiple coastal facilities.
- The appropriate management of sediment is required, including non-structural measures such as sand nourishment from sedimentation areas to erosion areas on a series of beaches, taking into consideration the movement of sand transport over a wide area.
- To address land subsidence, integrated measures are promoted including non-structural measures such as establishment and enforcement of regulations considering the estimated subsidence amount.
- For protection against Tidal Flood, high waves, and wave overtopping, it is promoted to take measures to prevent negative impacts to surrounding coasts taking into account the continuity of sand transport.

2) Promotion of measures for the conservation of nature-rich coast, and their creation as required.

"Measures to be promoted for the conservation of divers ecosystems and beautiful landscapes."

- Development of coastal facilities in accordance with the natural characteristics.
- Conservations and restoration of sandy beaches, coral reefs, and mangrove forests is promoted.
- Development of coastal facilities in consideration of the natural environment is promoted.

3) Promotion of measures for the beloved coast

"Measures to be promoted for the maintenance and improvement of user convenience and local community's living environment."

- Coastal facilities for enhancing user convenience and maintaining the living environment of the local community area promoted.
- In order to secure the continues access to the seashore, coastal facilities such as stairs, staircase- revetment, and gently sloping revetment, etc. are promoted.
- Conservation and development of sandy beaches is promoted as sandy beaches are an important space for tourism, recreational activities for local residents, and the preservation of local culture.
- Facilitating handicapped accessibility is encouraged.

3.2 Promotion of Implementation of Planned and Effective Maintenance and Repair of Coastal Facilities

"Necessity of maintenance"

- As existing coastal facilities continue to degrade, it is necessary to satisfy the required functions while reducing and equalizing costs.

"Measures to be promoted."

- Patrols or inspections of coastal facilities at appropriate times shall be conducted.
- Systematic and effective maintenance and repair of coastal facilities are promoted.
- The records related to inspections and repairs as well as new construction or repair of coastal facilities are properly prepared and stored.

4. Other Considerations on Coastal Management

4.1 Promotion of Initiatives from Broad and Comprehensive Perspective

"Initiatives that should be promoted from a broad and comprehensive perspective."

- Regarding sea level rise due to climate change, the common understanding about the target sea level is shared within a society.
- Integrated and systematic disaster prevention and mitigation measures is promoted in cooperation with related organizations.
- Against coastal erosion, it is promoted to take wide-area and comprehensive measures in cooperation with various relevant organizations, such as comprehensive sediment management measures in the entire sediment system from upstream to the coast.
- Further cooperation with various measures implemented in and around the coast is encouraged so as to promote coastal utilization.

4.2 Promotion of Cooperation with Local Communities and Raising Awareness of Coastal Management

"Items which cooperation with local communities and raising awareness of coastal management."

- In order to archive the creation of a disaster-resistant community, enhancing local communities' awareness is promoted.
- Beautification of coasts is promoted with cooperation of participants from local residents, volunteers, etc.
- Awareness-raising activities to improve users' morale in coastal environmental conservation are recommended.
- It is encouraged to create rules for safe and proper coastal utilization.
- Promotion of coastal conservation philosophy and capacity building in local communities are encouraged.
- Coastal management in cooperation with local community is promoted.
- In order to encourage private sector involvement in coastal conservation, coastal conservation programs as part of CSR (Corporate Social Responsibility) initiatives is recommended.

4.3 Promotion of Research, Studies, and Monitoring

"Items that require the promotion of research, studies, and monitoring."

- Collecting basic information on the coasts is promoted.
- It is encouraged to collaborate and share information across a wide range of sectors, including the private sector, and to facilitate international technological exchanges.
- To address the climate change impact, tidal levels and waves is monitored continuously, and the data shall be store and accumulated.
- Continuous monitoring and data accumulation for implemented coastal facilities for both gray and green measures is promoted to be conducted in order to clarify the effectiveness of facilities and impact to surrounding coastal area.

Clause 2 Area for Preparation of Basic Coastal Management Plan

- Five main islands (Sulawesi, Kalimantan, Java, Papua, Sumatra) and two islands group (Maluku Islands and Nusa Tenggara) is designated to prepare the Basic Coastal Management Plan.
- Division of one coastal area, in which one coastal management plan is prepared, shall be determined based on the similarity of topographical and oceanographical condition, the continuity of littoral drift as broadly as possible, and administrative boundary by setting an approximately 50 to 100 kilometers as the extent of a one of unified coastal area.

Clause 3 Basic Items for the Preparation of the Basic Coastal Management Plan

1. Basic Items to be included in the Basic Coastal Management Plan

1.1 Basic items concerning Coastal Management

1) Current status of the coast and the direction of coastal conservation

- The long-term vision of the coast shall be determined based on natural and social characteristics and other factors.

2) Items related to coastal protection.

- It is required to determine the area to be protected, the goals of coastal protection such as the protection level against coastal disasters, and the details of the measures to be implemented to achieve these goals.

3) Items related to the management, maintenance and conservation of the coastal environment.

- It is required to determine the detail of the measures that are to be implemented for the conservation of the coastal environment, and, if necessary, development of the coastal environment.

4) Items related to proper public utilization of the coast.

- It is required to determine the details of the measures that are to be implemented to promote proper coastal utilization by public.

1.2 Basic items concerning the development of Coastal Facilities

1) Items related to new development or improvement of coastal facilities.

a. The area in which coastal facilities are to be newly constructed or improved shall be determined.
b. The type, size, and layout of coastal facilities in each area determined in (a) shall be determined.
c. It is required to show the beneficiary areas through the new construction or improvement of coastal facilities.

2) Items concerning the maintenance or repair of coastal facilities.

a. The area in which existing coastal facilities are subject to maintenance or repair shall be determined.
b. The type, size, and layout of existing coastal facilities in each area determined in (a) shall be determined.
c. The method of maintenance or repair of each type of coastal facilities that identified in (b) shall be determined.

2. Important items to be considered in the Basic Coastal Management Plan

2. 1 Ensuring consistency with relevant development plans

- Basic Coastal Management Plan shall be in line with the relevant plans such as national land use plan, plans on environmental conservation, etc.

2.2 Cooperation and coordination with relevant administrative agencies

- Adequate cooperation and close coordination with relevant administrative agencies related to the coast shall be conducted.
- Local risks, including climate changes, land subsidence, etc. shall be shared with hose involved in community development.

2.3 Participation of residents and information disclosure

- Participation of local residents shall be facilitated.
- Disclosure of information related to the coast shall be carried out in order to enhance the transparency of the project,

2.4 Review of plan and revision properly

- Basic Coastal Management Plan is basically reviewed approximately every five years to assess the need for updates, and it is revised as necessary.
- Basic Coastal Management Plan and the development plan of coastal facilities stated in the Basic Coastal Management Plan shall be revised in response to changes in local condition, socio-economic condition, and the effect of climate change.

Kebijakan Dasar Pengelolaan Pantai

Tujuan Penerapan Kebijakan Dasar Pengelolaan Pantai

- Berlandaskan kepentingan untuk melindungi dan melestarikan kehidupan manusia, aset, dan wilayah teritorial sebagai pengembangan kawasan pantai yang berkelanjutan, tujuan penerapan Kebijakan Dasar Pengelolaan Pantai adalah menjadi prinsip-prinsip dasar pengembangan dan manajemen pantai untuk menjawab ancaman seperti erosi pantai, banjir pantai (rob), limpasan gelombang, kenaikan muka air laut akibat perubahan iklim, dengan memastikan harmonisasi antara "proteksi", "utilitas", dan "lingkungan".
- Wilayah pantai yang perlu dipersiapkan dokumen Rencana Dasar Pengelolaan Pantai adalah wilayah pantai dari lima pulau utama: Sulawesi, Kalimantan, Jawa, Papua, dan Sumatera, serta dua gugus kepulauan besar, yaitu gugus pulau Maluku dan gugus pulau Nusa Tenggara.
- Tujuan dari Kebijakan Dasar Pengelolaan Pantai adalah untuk mendefinisikan dengan jelas persyaratan dan prosedur fundamental untuk Rencana Dasar Pengelolaan Pantai yang akan diterbitkan oleh kementerian utama yang terkait – Kementerian Pekerjaan Umum dan Perumahan Rakyat (PUPR), Kementerian Kelautan dan Perikanan (KKP), dan Kementerian Lingkungan Hidup dan Kehutanan (KLHK), sebagai panduan untuk pengelolaan pantai di Indonesia.

Definisi Istilah yang Digunakan dalam Dokumen Pengelolaan Pantai

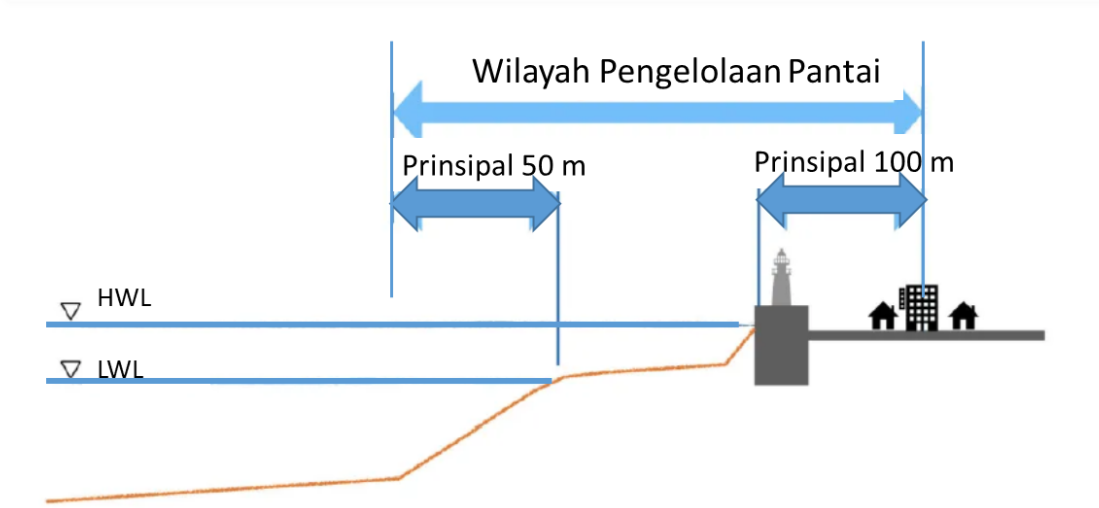
Definisi Wilayah Pengelolaan Pantai

- Wilayah pantai yang didefinisikan dalam penyusunan dokumen Rencana Dasar Pengelolaan Pantai adalah sebagai berikut:

    a. Wilayah yang didefinisikan sebagai area pantai adalah sekurangnya 50 meter dari muka air surut terendah (*Lowest Water Level*, LWL) ke arah laut dan 100 meter dari muka air pasang tertinggi (*Highest Water Level*, HWL) ke arah darat. Wilayah akhir yang ditentukan untuk tiap garis pantai harus mempertimbangkan kondisi pantai, kemiringan pantai, dan pertimbangan lain yang dapat mempengaruhi lebar wilayah di lokasi spesifik.

    b. Berdasarkan Peraturan Presiden Nomor 51 Tahun 2016 tentang Batas Sempadan Pantai, sempadan pantai memiliki lebar minimal 100 (seratus) meter dari titik pasang tertinggi ke arah darat. Sempadan pantai memiliki fungsi sebagai daerah penyangga untuk menghadapi bencana pesisir, pelestarian fungsi ekosistem, alokasi ruang, dan merupakan area publik. Direkomendasikan untuk menjaga konsistensi dan status publik lahan di sisi darat.

    c. Jarak 12 (dua belas) mil laut yang didefinisikan sebagai batas wewenang provinsi untuk arah laut dinilai terlalu jauh untuk keperluan dokumen manajemen pantai sehingga tidak dipertimbangkan dalam dokumen perencanaan manajemen pantai ini.



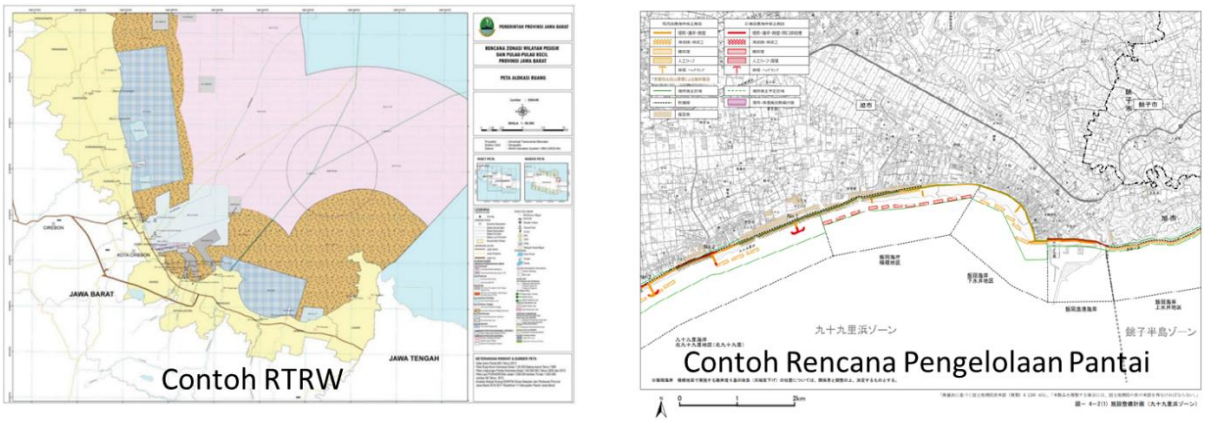
Gambar 1 Definisi Wilayah Pengelolaan Pantai

Posisi Dokumen Rencana Dasar Pengelolaan Pesisir

- Untuk memperjelas perbedaan tujuan dan posisi antara Rencana Pengelolaan Pantai (RPP) dan Rencana Tata Ruang Wilayah (RTRW), penjelasan mengenai keduanya dijelaskan pada bagian ini.

    a. Tujuan RTRW adalah memperjelas pembagian wilayah untuk menunjukkan pemanfaatan aktivitas pantai dan laut, baik eksisting maupun rencana pengembangan di masa mendatang.

    b. Di sisi lain, RPP bertujuan untuk memperjelas tujuan jangka menengah dan jangka panjang dari pengelolaan pantai dan perencanaan wilayah pantai terkait, dengan mempertimbangkan kondisi pantai dan proses pantai di lokasi yang dimaksud, kondisi sosial kultural serta dampak rencana pengembangan infrastruktur kawasan pantai di masa mendatang.



Gambar 2 Perbedaan antara RTRW dan RPP

Definisi Fasilitas Pantai

- Terdapat berbagai jenis fasilitas pantai. Secara umum, fasilitas pantai dapat dikategorikan meniadi “keras” dan “lunak”, atau “abu-abu” dan “hijau”. Contoh dari fasilitas pantai yang dimaksud di antaranya:

a. Groin, revetment, pemecah gelombang (*breakwater*), pemecah gelombang lepas pantai (*detached breakwater*), tanjung buatan, dan sebagainya sebagai fasilitas/tindakan "keras" dan "abu-abu". Kategori ini umumnya berupa infrastruktur keras yang melibatkan pekerjaan sipil dengan memanfaatkan struktur beton dan/atau batuan keras, pembentukan daratan buatan dengan manipulasi topografi pesisir, dan sebagainya;

b. *Beach nourishment, sand back-pass, sand bypassing*, sebagai tindakan "lunak";

c. Penanaman mangrove vegetasi lainnya, transplantasi terumbu karang, dst sebagai fasilitas/tindakan "hijau";

d. Kombinasi fasilitas/tindakan di atas;

e. Fasilitas publik lainnya yang bertujuan untuk meningkatkan utilitas pantai seperti jalan setapak, area parkir, pendopo, dst.

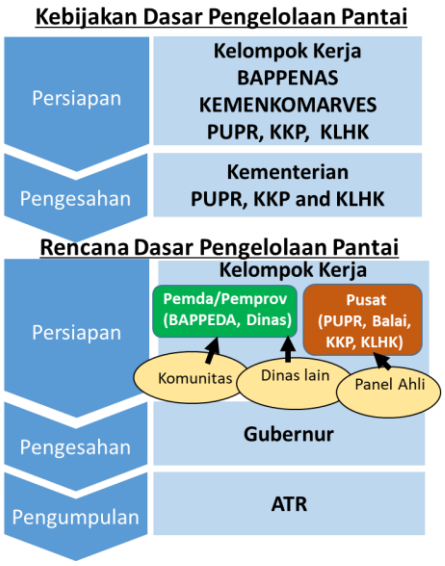
Kementerian yang Bertanggungjawab dalam Menginisiasi Persiapan dan Melaksanakan Rencana Dasar Pengelolaan Pantai;

- Kementerian yang terlibat dalam persiapan Rencana Dasar Pengelolaan Pantai didefinisikan sebagai berikut:

a. Pemerintah Daerah, terutama Dinas PU dan BAPPEDA, memppersiapkan Rencana Dasar Pengelolaan Pantai sebagai lembaga utama (*leading agency*) dengan bantuan dan kerjasama dengan institusi terkait dari Pemerintah Pusat seperti PUPR, KLHK, dan KKP.

b. Untuk persiapan dokumen Rencana Dasar Pengelolaan Pantai di tiap lokasi, direkomendasikan untuk membentuk Kelompok Kerja (*Ad-Hoc Council*) yang terdiri dari perwakilan pusat (sekurangnya PUPR, KKP, dan KLHK), perwakilan daerah (BAPPEDA, Dinas PU, dan dinas terkait dari Pemerintah Daerah/Provinsi), komunitas lokal, panel ahli untuk rekayasa dan pengelolaan pantai, dan sejenisnya.

c. Gubernur dari tiap provinsi lalu akan merilis Rencana Manajemen Pantai dalam bentuk Peraturan Gubernur dan direkap di Kementerian Agraria dan Tata Ruang (ATR) untuk integrasi dengan RPP provinsi lain – sistem yang sama dengan RTRW.



Gambar 3 Bagan alir tahapan RPP

Pasal 1. Panduan Dasar Pengelolaan Pantai

1.1 Filosofi Dasar Pengelolaan Pantai

"Filosofi Dasar Pengelolaan Pantai berdasarkan kondisi pantai di Indonesia"

- Indonesia memiliki garis pantai kedua terpanjang di dunia. Setiap pulau dan wilayah pantainya memiliki karakteristik, ancaman, dan pemanfaatan yang unik untuk lokasi yang terkait.
- Filosofi dasar dalam pengelolaan pantai adalah untuk mewariskan pantai ke generasi mendatang sebagai aset nasional bersama
- Oleh karena itu, diperlukan cara berpikir yang menyelaraskan usaha perlindungan pantai dengan pemanfaatan dan konservasi lingkungan sekitarnya.

"Pengelolaan pantai yang bertujuan untuk mencapai filosofi dasar"

- Direkomendasikan untuk mempromosikan pengembangan, konservasi, dan pengelolaan pantai yang komprehensif dalam jangka menengah dan panjang untuk cakupan wilayah yang luas.
- Pengembangan pantai difokuskan untuk bertumpu pada Pemerintah Daerah.

1.2 Arahan Pengelolaan Pantai

"Arah pengembangan fasilitas dan konservasi pantai"

- Penggalakkan pengembangan dan konservasi pantai yang didasarkan pada tiga (3) perspektif: perlindungan, penjagaan lingkungan, dan utilitas pantai.
- Dalam konteks perlindungan pantai, direkomendasikan untuk menjamin tercapainya tingkat perlindungan yang memadai dengan mempertimbangkan gelombang tinggi, limpasan gelombang/ombak, erosi pantai, perubahan topografi dan sedimentasi di sekitar muara sungai, penurunan muka tanah, perubahan iklim, dan sebagainya, dan melakukan integrasi pendekatan tindakan "keras" dan "lunak".
- Dalam konteks penjagaan lingkungan pantai, digalakkan konservasi dan perawatan pantai alami, terumbu karang, hutan bakau (*mangrove*), konservasi ekosistem pantai dan laut termasuk karang, ikan, dan spesies laut lainnya.
- Dalam konteks utilitas pantai, pengembangan utilitas dilakukan berdasarkan masukan dari komunitas lokal dan manfaat untuk menunjang kemudahan akses kepariwisataan.

1.2.1 Arahan Perlindungan Pantai

"Klasifikasi bencana pantai yang dipertimbangkan"

- Dalam konteks perlindungan pantai, direkomendasikan untuk memastikan tingkat perlindungan yang memadai terpenuhi. Pertimbangkan kondisi gelombang tinggi, limpasan gelombang/ombak, erosi pantai, sedimentasi, perubahan topografi muara sungai, penurunan muka tanah, perubahan iklim, dan sebagainya.
- Pantai Indonesia memiliki variasi yang signifikan untuk tiap daerah, dengan kondisi alami dan sosial ekonomi beragam tergantung kondisi daratan (hinterland) sekitarnya. Oleh karena itu, diperlukan penentuan target bencana pantai serta tingkat perlindungan yang memadai untuk menjawab ancaman tersebut, dengan mempertimbangkan kondisi alami, kejadian bencana pantai, populasi dan aset daratan di belakang pantai tinjauan, dan utilitas pantai.

"Mendesain perlindungan yang memadai menghadapi ancaman bencana pantai."

- Untuk pantai dengan sistem perlindungan yang didesain untuk menghadapi gelombang tinggi, limpasan gelombang, dan banjir laut, tingkat perlindungan didesain dengan mempertimbangkan status penggunaan lahan di belakang pantainya.
- Untuk pantai dengan sistem perlindungan yang didesain untuk menghadapi erosi pantai, tingkat perlindungan dasar didesain untuk mempertahankan garis pantai saat ini, dan target perlindungan lanjutannya adalah untuk mengembalikan garis pantai hingga titik tertentu dengan mempertimbangkan pemanfaatan pantai jika diperlukan.
- Untuk pantai dengan sistem perlindungan yang didesain untuk menghadapi penurunan muka tanah, tingkat perlindungan didesain untuk mengamankan wilayah dengan rentang waktu sepuluh (10) hingga seratus (100) tahun.
- Untuk pantai dengan sistem perlindungan yang didesain untuk menghadapi tsunami, tingkat perlindungan didesain untuk menghadapi tsunami dengan kriteria tertentu yang didasarkan pada studi kejadian terdahulu dan informasi lain yang dinilai relevan.
- Untuk pantai dengan sistem perlindungan yang didesain untuk menghadapi gelombang badai (*storm surge*), tingkat perlindungan didesain untuk menghadapi pasang tertinggi berdasarkan rekam historis badai sebelumnya yang disebabkan oleh angin topan dan sejenisnya, atau berdasarkan estimasi elevasi muka air di masa mendatang berdasarkan proyeksi masa depan, dengan mempertimbangkan kondisi gelombang tinggi pada saat prediksi mendatang tersebut pula.

"Arahan terhadap tindakan perlindungan pantai"

- Tujuan pengembangan fasilitas pantai, mempertimbangkan status penggunaan lahan di belakang pantai tersebut, adalah untuk mencegah masuknya air laut, erosi pantai. Jika air laut melimpas ke dalam tanggul, maka tujuan dari tindakan pantai adalah untuk mencegah kerusakan pada lahan yang dilindungi. Integrasi tindakan pantai berupa kombinasi dari beberapa tindakan dan struktur pelindung, termasuk pembentukan area sempadan pantai sebagai area penyangga.
- Direkomendasikan penggalakkan konservasi dan pemeliharaan perlindungan alami pantai seperti keberadaan pantai berpasir, terumbu karang, hutan bakau, dan sebagainya.
- Terkait tindakan penanggulangan menghadapi tsunami dan gelombang badai, selain pengembangan fasilitas pantai, diperlukan pula implementasi komprehensif yang mengombinasikan tindakan "keras" dan "lunak".
- Terkait tindakan penanggulangan menghadapi erosi pantai, direkomendasikan untuk mengimplementasikan tindakan dengan melakukan tindakan adaptif pengelolaan pantai dengan mempertimbangkan seluruh sel *littoral drift*.
- Mengingat muara sungai mengalami perubahan topografis yang signifikan sebagai respon dinamika gelombang dan suplai sedimen dari hulu, setiap tindakan di wilayah muara sungai perlu memperhatikan dampak jangka menengah dan panjang serta melingkupi area yang cukup luas untuk mengakomodasi keseimbangan suplai sedimen di sel wilayah tersebut. Pengelolaan sedimen yang komprehensif pada sistem transportasi sedimen dan pengelolaan lahan penting untuk ditekankan, terutama di daerah yang mengalami sedimentasi.

1.2.2 Arahan Pengembangan dan Konservasi Lingkungan Pantai

"Fungsi lingkungan pantai"

- Pantai menyediakan ekosistem untuk habitat yang beragam dan tempat tumbuh kembangnya organisme
- Pantai membentuk sebagian dari pemandangan alam yang luar biasa.

"Arahan tindakan untuk lingkungan pantai"

- Konservasi dan pemeliharaan lingkungan pantai harus hidup berdampingan dengan alam secara harmonis.
- Digalakkan pelestarian bentang alam, aset bernilai akademis, dan ekosistem beragam
- Bentuk peraturan dan regulasi konservasi lingkungan pantai.
- Untuk menciptakan lingkungan pantai yang memadai, pengembangan fasilitas pantai dilakukan sesuai kebutuhan
- Dampak lingkungan yang diakibatkan oleh kejadian insidental seperti tumpahan minyak harus ditangani dengan tepat
- Konservasi hutan bakau dan terumbu karang digalakkan untuk menjaga dan melestarikan kekayaan keanekaragaman hayati.
- Direkomendasikan untuk memastikan bahwa semua pihak yang terlibat dapat berbagi pemahaman bahwa lingkungan pantai harus dilestarikan.

1.2.3 Arahan Pemanfaatan Pantai oleh Masyarakat

"Pemanfaatan fungsi pantai"

- Pantai membentuk dan menjaga budaya regional komunitas lokal
- Pantai mendorong ragam pemanfaatan pantai seperti wisata, olahraga, aktivitas pendidikan, dan memberi ruang rekreasi.

"Arahan tindakan pemanfaatan pantai"

- Fasilitas pantai yang berkontribusi dalam peningkatan pemanfaatan pantai direkomendasikan untuk dikembangkan
- Diperlukan tindakan yang menjawab masalah penurunan kapasitas fasilitas pantai dan kapal karam dan/atau ditinggalkan yang secara signifikan mengganggu pemandangan dan kenyamanan pantai.
- Pastikan kelayakan dan keterjaminan akses masyarakat ke pantai
- Galakkan aktivitas yang meningkatkan kesadaran pengguna pantai untuk meningkatkan etika dan perilaku dalam memanfaatkan pantai.

1.3 Arahan Implementasi Fasilitas Pantai

1.3.1 Arahan Implementasi Fasilitas Baru atau Perbaikan Fasilitas Pantai

1.3.1.1 Penggalakkan pengembangan pantai yang lebih aman

"Tindakan yang dilakukan untuk mencapai target perlindungan yang diharapkan "

- Dalam pengembangan fasilitas pantai, direkomendasikan untuk melakukan integrasi berbagai tindakan di pantai termasuk namun tidak terbatas pada struktur "keras", melainkan pula memanfaatkan tindakan "lunak" seperti suplai pasir pantai (termasuk *sand bypassing* dari daerah tersedimentasi, dst). Pemanfaatan infrastruktur "hijau" seperti penanaman bakau dan mengombinasikan metode-metode di atas sangat dianjutkan. Untuk mendukung hal tersebut, manajemen penggunaan lahan yang mampu beradaptasi dengan perubahan kondisi wilayah pantai harus dikedepankan.
- Untuk mencegah kerusakan yang massif dan fatal akibat tsunami dan gelombang badai, direkomendasikan untuk dilakukan berbagai tindakan yang mengombinasikan beberapa fasilitas pantai secara komprehensif dengan efektif dan efisien.

- Pengelolaan sedimen pantai yang memadai harus dilakukan, termasuk dengan melakukan pendekan non structural seperti pengisian pasir (*sand nourishment*) dari daerah yang mengalami sedimentasi ke daerah yang mengalami erosi pada satu kesatuan garis pantai, dengan mempertimbangkan pergerakan pasir di wilayah tersebut.
- Untuk menjawab permasalahan penurunan muka tanah, integrasi pendekatan harus dilakukan, termasuk tindakan non struktural seperti penguatan peraturan, dengan mempertimbangkan perkiraan laju penurunan tanah dan perkiraan penyebab fenomena tersebut.
- Untuk perlindungan terhadap banjir pantai, gelombang tinggi, dan limpasan gelombang, direkomendasikan tindakan pencegahan dampak negatif akibat fasilitas pelindung tersebut ke pantai sekitarnya dengan mempertimbangkan kesetimbangan dinamika pantai di cakupan wilayah tersebut.

1.3.1.2 Penggalakkan tindakan konservasi pantai yang kaya akan alam, dan pembentukan pantai tersebut jika diperlukan

"Tindakan yang direkomendasikan untuk konservasi ekosistem penyelaman dan keindahan bentang alam."

- Pengembangan fasilitas pantai harus memperhatikan karakteristik alami pantai tersebut
- Konservasi dan restorasi pantai berpasir, terumbu karang, dan hutan bakau harus dikedepankan
- Pengembangan fasilitas pantai harus memperhatikan lingkungan alami sekitar pantai tersebut

1.3.1.3 Promosi tindakan untuk pantai yang berharga

"Tindakan yang direkomendasikan untuk memelihara dan meningkatkan kenyamanan pengunjung pantai dan lingkungan hidup komunitas lokal."

- Peningkatan kenyamanan pengunjung pantai dan pemeliharaan lingkungan hidup komunitas lokal harus diprioritaskan
- Dalam rangka mengamankan akses ke pantai, direkomendasikan penggunaan fasilitas seperti tangga, revetment berundak, dan revetment landai.
- Pelestarian dan pengembangan pantai berpasir direkomendasikan mengingat pantai berpasir merupakan ruang penting untuk pariwisata, aktivitas rekreasi penduduk setempat, dan pelestarian budaya lokal.
- Sangat dianjurkan untuk memfasilitasi aksesibilitas terhadap penyandang disabilitas.

1.3.2 Implementasi pemeliharaan dan perbaikan fasilitas pantai yang terencana dan efektif

"Perlunya pemeliharaan"

- Seiring penurunan fungsional fasilitas pantai, perlu dilakukan pemeliharaan untuk menjaga fungsi fasilitas tersebut dengan memperhatikan keseimbangan biaya perawatan dan manfaat yang diterima.

"Tindakan yang dianjurkan"

- Patrolia tau inspeksi fasilitas pantai yang berkala harus disiplin dilakukan
- Perawatan yang sistematis dan efektif serta perbaikan fasilitas pantai yang mengalami kerusakan harus dilakukan
- Catatan dan rekam historis hasil inspeksi, perbaikan, dan/atau penambahan konstruksi baru fasilitas pantai harus disimpan dan diarsipkan dengan baik.

1.4 Pertimbangan Lain dalam Pengelolaan Pantai

1.4.1 Inisiatif dari perspektif yang luas dan komprehensif

"Inisiatif tindakan harus didasarkan pada pandangan yang luas dan komprehensif."

- Terkait kenaikan muka air laut akibat perubahan iklim, pemahaman umum mengenai besaran elevasi muka air laut harus dimiliki masyarakat.
- Upaya-upaya pencegahan dan mitigasi bencana yang terpadu dan sistematis dilakukan melalui kerjasama dengan lembaga-lembaga terkait.
- Direkomendasikan untuk meninjau secara komprehensif dan dengan cakupan wilayah yang luas dalam menghadapi erosi pantai. Lakukan kerjasama dengan berbagai lembaga terkait. Tindakan sedimentasi dilakukan dengan mempertimbangkan seluruh sistem sedimen dari hulu sungai hingga sistem pesisir.
- Pemaduan berbagai tindakan yang diimplementasikan di dan sekitar lokasi pantai direkomendasikan untuk mengedepankan pemanfaatan pantai secara terpadu.

1.4.2 Kerjasama dengan Komunitas Lokal dan Meningkatkan Kesadaran Terkait Pengelolaan Pantai

"Hal-hal yang dilakukan bersama komunitas lokal untuk meningkatkan pemahaman dan kesadaran pengelolaan pantai"

- Dalam rangka menciptakan komunitas tahan bencana, peningkatan kesadaran dan pemahaman komunitas lokal terhadap ancaman bahaya di pantai penting untuk dilakukan
- Keindahan pantai ditingkatkan dengan melibatkan kerjasama dengan penduduk setempat, sukarelawan, dst.
- Sosialisasi peningkatan kesadaran pelestarian lingkungan pantai harus dilakukan untuk meningkatkan kepedulian public
- Direkomendasikan untuk menciptakan peraturan dan regulasi pemanfaatan pantai yang aman dan patut.
- Promosi filosofi pelestarian pantai dan *capacity building* di komunitas lokal
- Pelibatan komunitas lokal dalam pengelolaan pantai
- Untuk mendorong keterlibatan sektor privat pada konservasi pantai, canangkan program konservasi pantai dalam skema inisiasi CSR (*Corporate Social Responsibility*)

1.4.3 Mendorong Riset, Studi, dan Pemantauan

"Hal-hal yang perlu didorong oleh riset, studi, dan pemantauan."

- Mengumpulkan informasi dasar mengenai pantai
- Direkomendasikan untuk berkolaborasi dan saling berbagi informasi lintas berbagai sektor, termasuk sektor privat, dan memfasilitasi pertukaran teknologi internasional sebagai ajang pembelajaran
- Pemantauan elevasi muka air laut dan gelombang secara menerus untuk memantau dampak perubahan iklim. Akumulasi hasil pemantauan harus dapat disimpan dan diarsipkan secara cermat dan rapi.
- Pemantauan menerus dan akumulasi data terhadap implementasi fasilitas pantai untuk tindakan "abu-abu" dan "hijau" direkomendasikan untuk dilakukan untuk mengevaluasi efektivitas fasilitas tersebut dan dampaknya terhadap lingkungan pantai sekitar.

Pasal 2. Lokasi Persiapan Rencana Dasar Pengelolaan Pantai

- Lima pulau utama (Sulawesi, Kalimantan, Java, Papua, Sumatra) dan dua gugus kepulauan (Maluku dan Nusa Tenggara) ditunjuk untuk mempersiapkan dokumen Rencana Dasar Pengelolaan Pantai.
- Penentuan pembagian satu wilayah pantai, yang mana satu rencana pengelolaan pantai tersebut disiapkan, dilakukan berdasarkan kesamaan kondisi topografi dan oseanografi, keberlanjutan *littoral drift*, dan batas

administratif wilayah dengan rekomendasi pembagian sekitar 50-100 km per satuan wilayah rencana pengelolaan pantai.

Pasal 3. Pokok-pokok Penyusunan Rencana Dasar Pengelolaan Pantai

3.1 Hal-hal Mendasar yang Perlu Dicantumkan pada Rencana Dasar Pengelolaan Pantai

3.1.1 Hal-hal Mendasar Mengenai Pengelolaan Pantai

3.1.1.1 Status pantai saat ini dan arah konservasi pantai

- Visi jangka panjang pantai ditentukan berdasarkan karakteristik natural, sosial, dan faktor lainnya.

3.1.1.2 Hal-hal terkait perlindungan pantai

- Perlu ditentukan wilayah yang akan dilindungi. Tujuan dari perlindungan pantai adalah perlindungan terhadap bencana pantai, dan detail dari tindakan yang akan diimplementasikan untuk mencapai tujuan tersebut

3.1.1.3 Hal-hal terkait pengelolaan, pemeliharaan, dan konservasi lingkungan pantai

- Perlu ditentukan detail tindakan yang akan diimplementasikan untuk pelestarian lingkungan pantai, dan jika diperlukan pengembangan lingkungan pantai

3.1.1.4 Hal-hal terkait pemanfaatan pantai yang layak oleh publik

- Perlu ditentukan detail tindakan yang akan diimplementasikan untuk meningkatkan pemanfaatan dan utilitas pantai oleh publik.

3.1.2 Hal-hal Mendasar Mengenai Fasilitas Pantai

1) Hal-hal terkait peningkatan atau pengembangan baru fasilitas pantai

a. Lokasi konstruksi fasilitas pantai, baik baru maupun peningkatan yang sudah ada, harus ditentukan
b. Jenis, ukuran, dan denah fasilitas pantai di tiap lokasi yang didefinisikan pada poin (a) harus ditentukan
c. Tunjukkan area penerima manfaat konstruksi fasilitas pantai tersebut.

2) Hal-hal terkait pemeliharaan atau perbaikan fasilitas pantai

a. Lokasi fasilitas pantai yang akan dilakukan pemeliharaan atau perbaikan harus ditentukan
b. Jenis, ukuran, dan denah fasilitas pantai eksisting yang akan dilakukan pemeliharaan atau perbaikan di tiap lokasi yang didefinisikan pada poin (a) harus ditentukan
c. Metode pemeliharaan atau perbaikan tiap jenis fasilitas pantai yang diidentifikadi pada poin (b) harus ditentukan.

3.2 Hal-hal Penting yang Harus Diperhatikan terkait Rencana Dasar Pengelolaan Pantai

3.2.1 Memastikan Konsistensi dengan Rencana Pengembangan Terkait Lainnya

- Rencana Dasar Pengelolaan Pantai harus sejalan dengan rencana-rencana yang relevan seperti Rencana Tata Ruang Wilayah Nasional, rencana konservasi lingkungan, dan sebagainya.

3.2.2 Kerjasama dan Koordinasi dengan Lembaga Administratif Terkait

- Kerjasama yang memadai dan koordinasi yang intensif dengan lembaga administratif terkait pengelolaan pantai harus dilaksanakan secara efektif dan efisien
- Risiko lokal, termasuk sensitivitas terhadap perubahan iklim, penurunan muka tanah, dan sebagainya, harus diinformasikan kepada semua pihak yang terlibat dalam pengembangan komunitas

3.2.3 Partisipasi Penduduk dan Keterbukaan Informasi

- Partisipasi penduduk setempat harus difasilitasi
- Keterbukaan informasi terkait pantai harus dilaksanakan untuk meningkatkan transparansi proyek

3.2.4 Peninjauan Kembali Dokumen Perencanaan

- Dokumen Rencana Dasar Pengelolaan Pantai pada dasarnya ditinjau kembali setiap lima (5) tahun untuk menilai keperluan pembaruan, dan akan direvisi sesuai keperluan
- Dokumen Rencana Dasar Pengelolaan Pantai dan rencana pengembangan fasilitas pantai yang dinyatakan dalam dokumen tersebut akan disesuaikan sebagai respon perubahan kondisi lokal, sosial ekonomi Masyarakat setempat, dan efek perubahan iklim.

Lampiran-21
Ulasan Terhadap Kajian Kecamatan Sayug Eksisting

Appendix-21 Review of Sayung Area, Demak

21.1 Background of Review Work

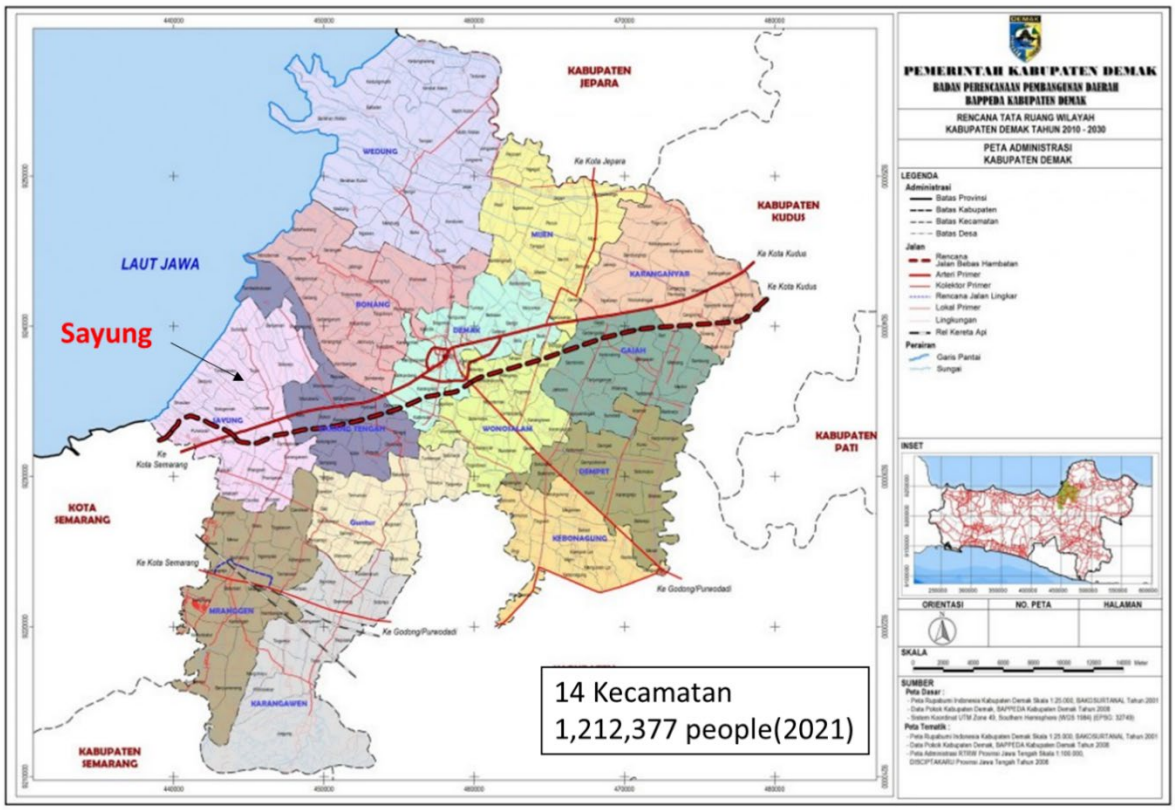
Demak is one of the five priority cities defined in the National Medium-Term Development Plan (RPJMN) for 2020-2024. In addition, Demak is adjacent to the large city Semarang. On the other hand, in recent years, Demak has been suffering from serious flood damage due to land subsidence and urgent measures are required in Indonesia. Considering this background, BAPPENAS strongly requested the JICA study team to conduct a survey in the Sayung area in Demak. After JICA study team discussed with JICA, it was decided to review the existing survey conducted in the Demak Sayung area.

21.2 Present Condition

21.2.1 Outlook of Present Condition

Sayung district is located in the west of Demak regency, adjacent to Semarang city and the Java Sea.

There are three tourist resources in Sayung district, including Morosari Beach, mangrove forests, and the tomb of Sheikh Mudzakir (Sheikh Mudzakir).



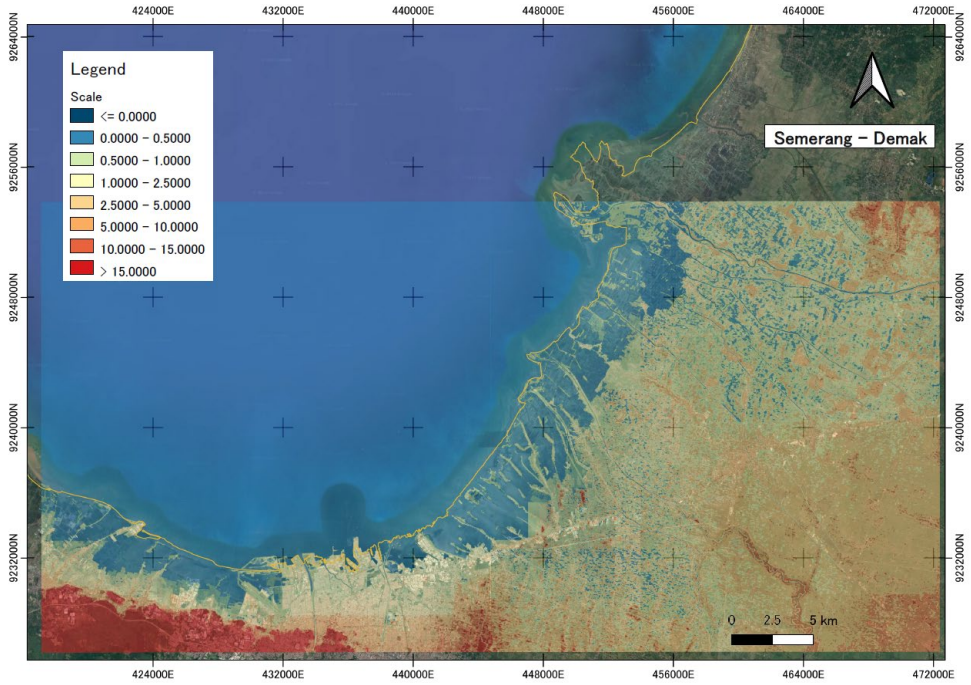
Source: Demak Regency with some additions by JICA Study Team

Figure 1 Location Map of Sayung District

21.2.2 Natural Characteristic

(1) Terrain

The ground elevation distribution map is shown in Figure 2, created from DEMNAS data from the BIG (Geospatial Information Agency). The ground elevation is based on MSL.The area seaward from the national road Route 1 in Sayung district is widely distributed with elevations of less than 0.5 m above sea level.

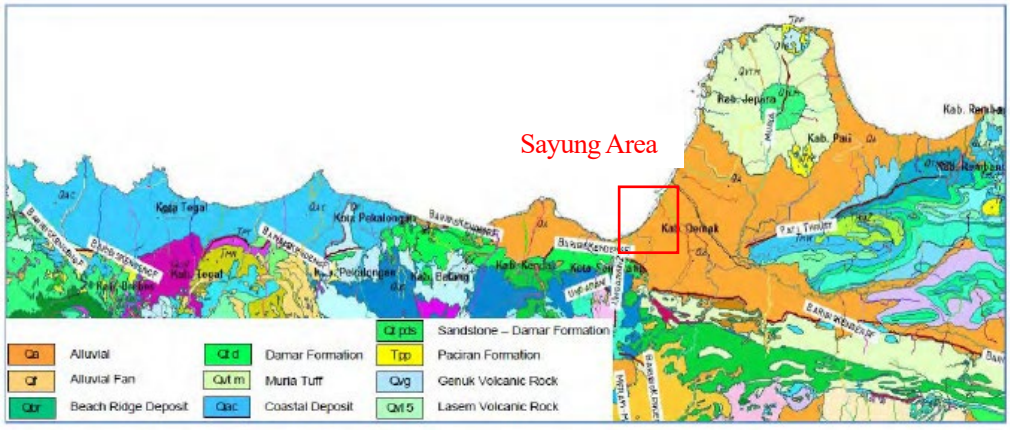


Source: JICA Study Team based on DEMNAS data.

Figure 2 Ground Elevation Distribution Map

(2) Geological Features

Geological map of central Java is shown in Figure 3. The Sayung district is formed by alluvial deposits (Qa). The component materials of the coastal alluvial plain consist of river sediments and coastal deposits.

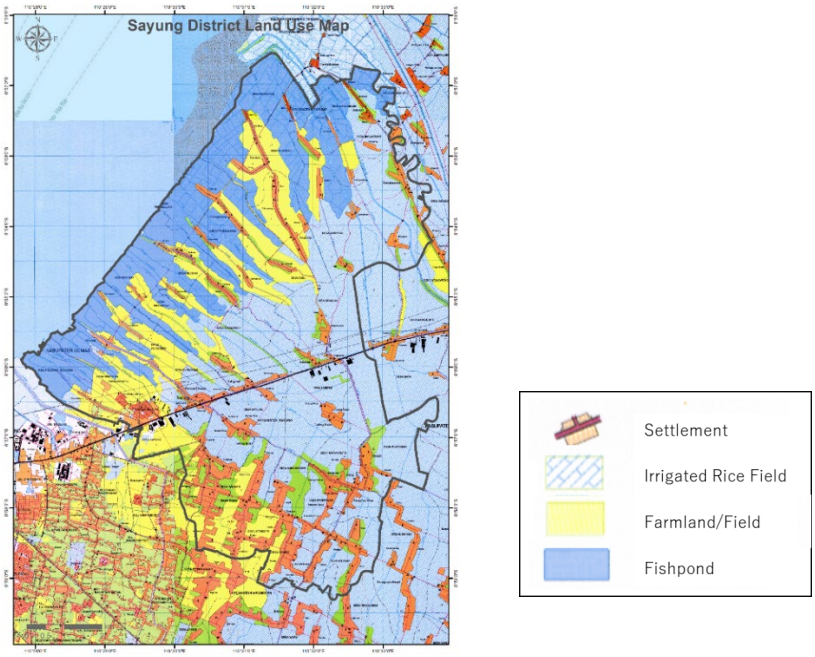


Source: MEMR, 2012 with some additions.

Figure 3 Geological Map of Central Java

(3) Land use

1:25,000 topographic map is shown in Figure 4. The land use in Sayung district is mainly fishponds, paddy fields, and residential areas.

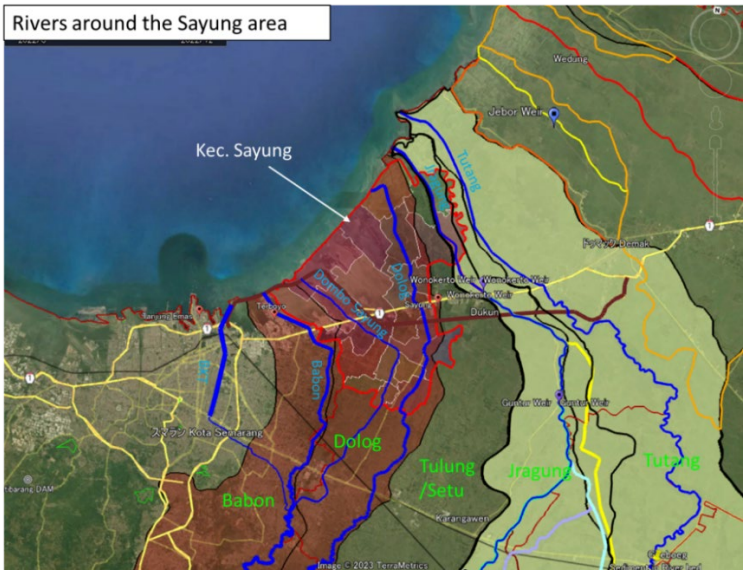


Source: Prepared by JICA Study Team based on BIG data.

Figure 4 Topographic Maps (1: 25,000, Semarang: 1996, Sayung, Wedung: 1999)

(4) Inflow River

Four rivers (Babon River, Dombo Sayung River, Dolog River, and Jragung River) flow into and around the Sayung district.

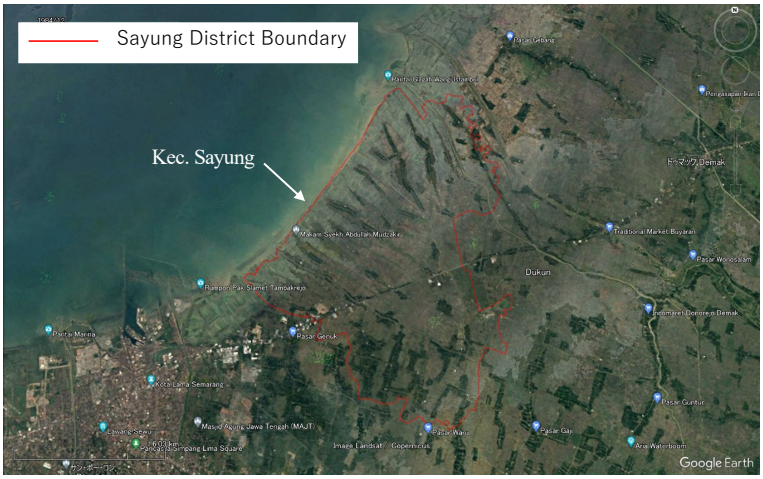
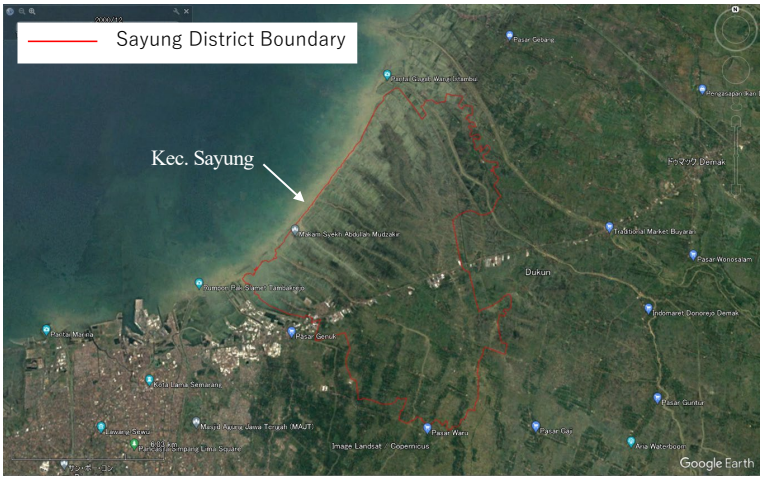
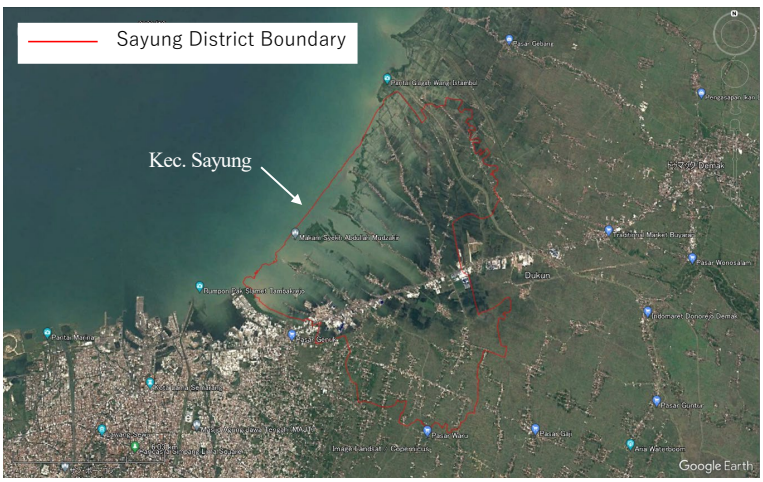


Source: Edited by JICA Study Team based on BIG and Google Earth.

Figure 5 Rivers flowing into and around Sayung District

(5) Shoreline change

Satellite images of the area around Sayung district in 1984, 2000, and 2020 are shown in Figure 6, extracted from Google Earth. The red circled line in the figure indicates the boundary of the Sayung district, it can be confirmed that the sea area extended to the western part of the Sayung area between 2000 and 2020.

December 1984	
December 2000	
December 2020	

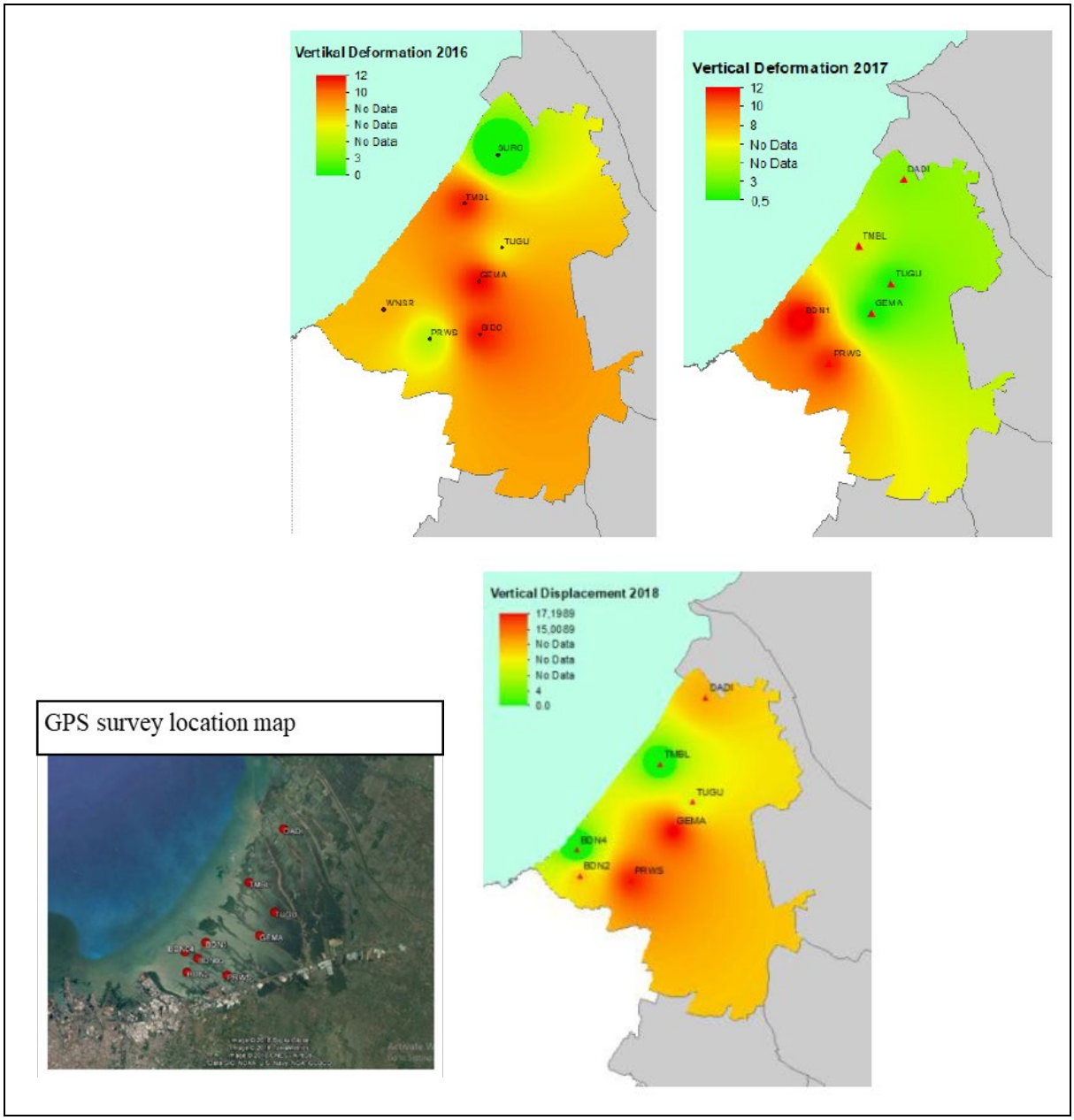
Source: Edited by JICA Study Team based on Google Earth

Figure 6 Satellite Image of the Sayung District

(6) Land subsidence

Land subsidence in Demak has been organized by B. D. Yuwono et.al. (2019) and is summarized below.

The GPS surveys conducted by the Geodetic Research Group of Diponegoro University between 2015 and 2018 provides land subsidence distribution shown in Figure 7. According to this distribution, the subsidence rate in Demak ranges from 0.8 cm/year to 17.9 cm/year with spatial variability; the central part of Sayung district is reported to have a higher subsidence rate compared to the northern and southern parts.

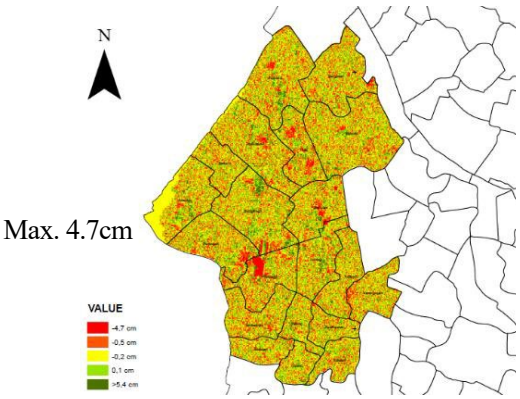
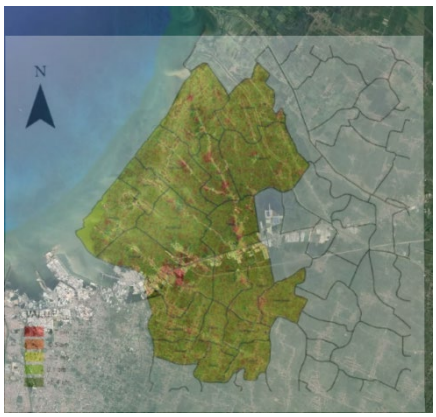
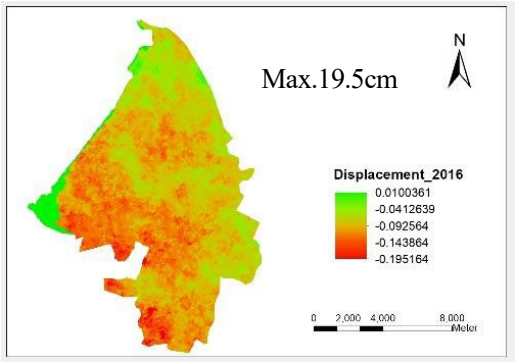
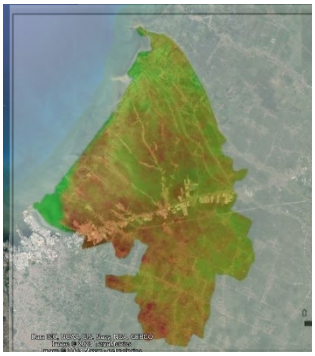
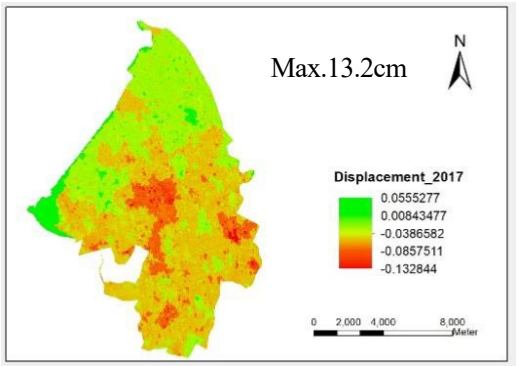


Source: b. d. Yuwono et.al. (2019).

Figure 7 Land Subsidence (cm/year) by GPS Survey (2015-2018)

The Geodetic Research Group of Diponegoro University has analyzed the amount of land subsidence by satellite image analysis (DInSAR : Differential Interferometry) from 2015 to 2017.

- Land subsidence was estimated to be up to 4.7 cm in 2015, 19.5 cm in 2016, and 13.5 cm in 2017.
- Large areas of land subsidence are found in the central part of the Sayung area.

Land Subsidence Analysis Results by DInSAR	Overlaid View on Satellite Image
Year 2015 	
Year 2016 	
Year 2017 	

Source : addition to B. D. Yuwono et.al. (2019)

Figure 8 Land Subsidence Analysis Results by DInSAR (cm/year)(Year 2015 to 2018)

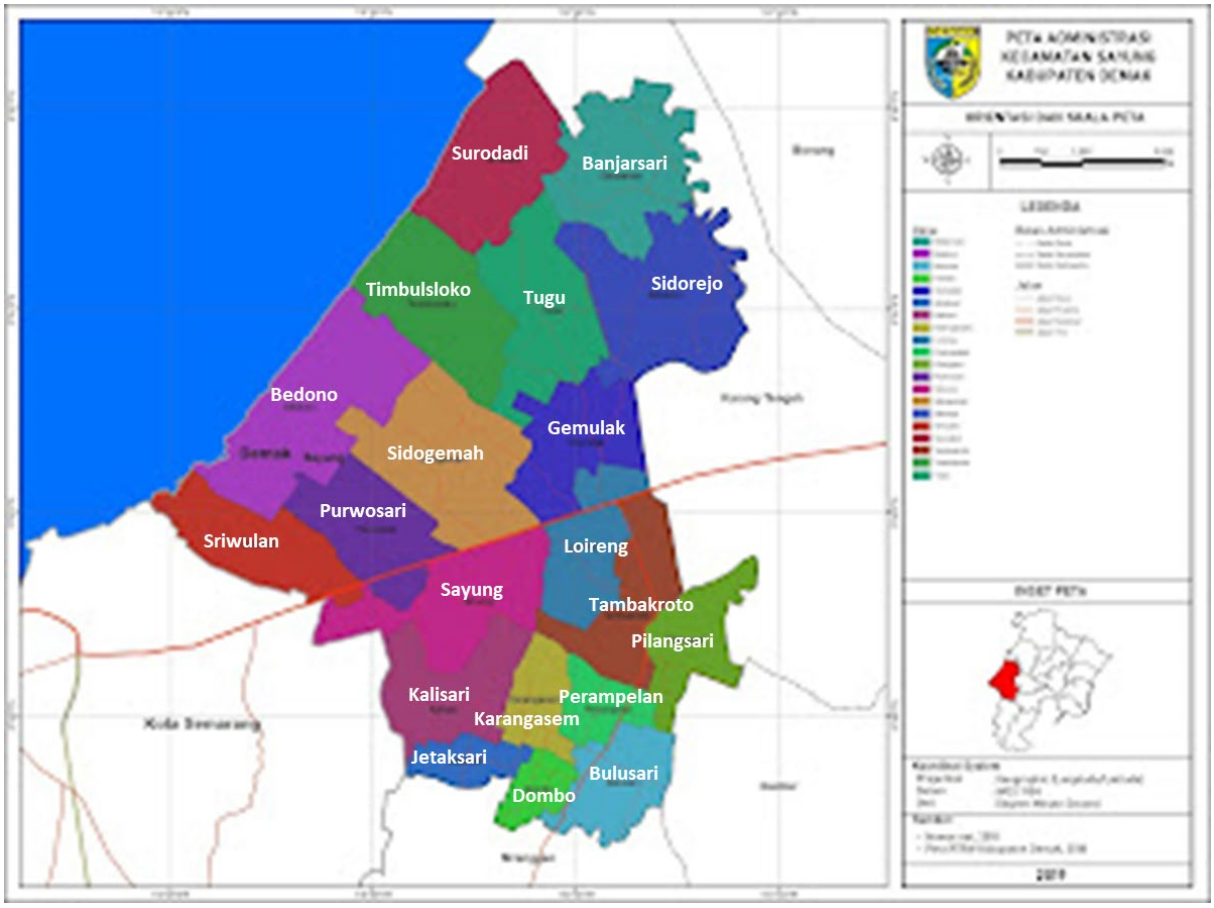
21.2.3 Social Environment Characteristics

(1) Administrative Divisions and Population

Figure 9 shows the administrative divisions of the Sayung district. There are 20 desa (villages) in Sayung district.

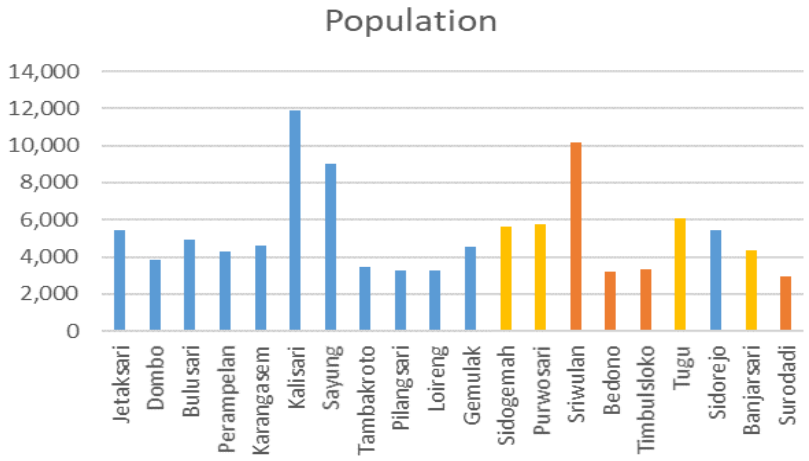
The population of Sayung district is 106,005 in 2021, which corresponds to about 10 % of the total population of Demak regency.

The population by village in Sayung district is shown in Figure 10. The population of the 10 villages (Sriwulan, Bedono, Timbulsloko, Surodadi, Purwosari, Sidogemah, Tugu, Banjarsari, Gemulak, and Sidorejo) located on the sea side from national road Route 1 is about 51,491. This population is about 49 % of the total population of Demak.



Source: Demak Regency with some additions by JICA Study Team

Figure 9 Administrative Division map of Sayung District



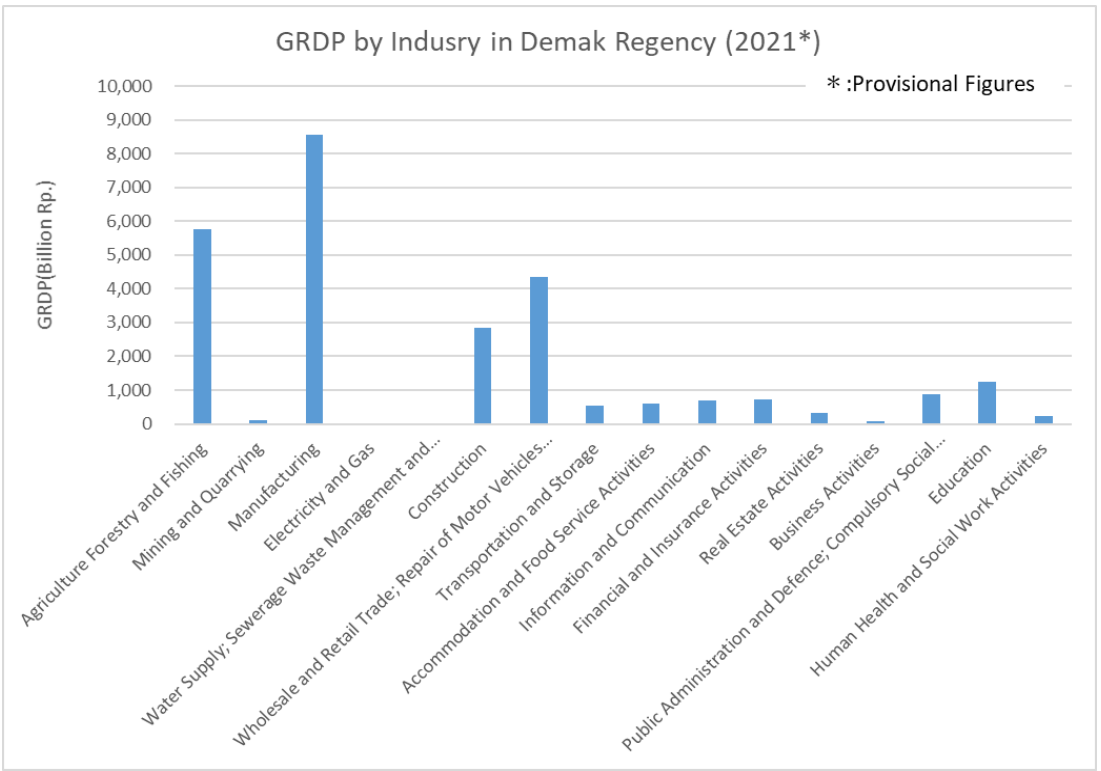
Source: JICA Study Team based on Demak Statistics Centre, 2021

Figure 10 Population by Desa (Village) in Sayung District, 2021

(2) Major Industries

Figure 11 shows the GRDP (Gross Regional Domestic Product) by industry in Demak regency in 2021.

Manufacturing, agriculture forestry and fishing, and wholesale and retail and trade repair of motor vehicle are a large percentage of the GRDP in Demak regency.



Source: JICA Study Team based on BPS-STATISTIC OF DEMAK REGENCY

Figure 11 GRDP by Industry (Gross Regional Domestic Product, 2021)

(3) Cultural heritage

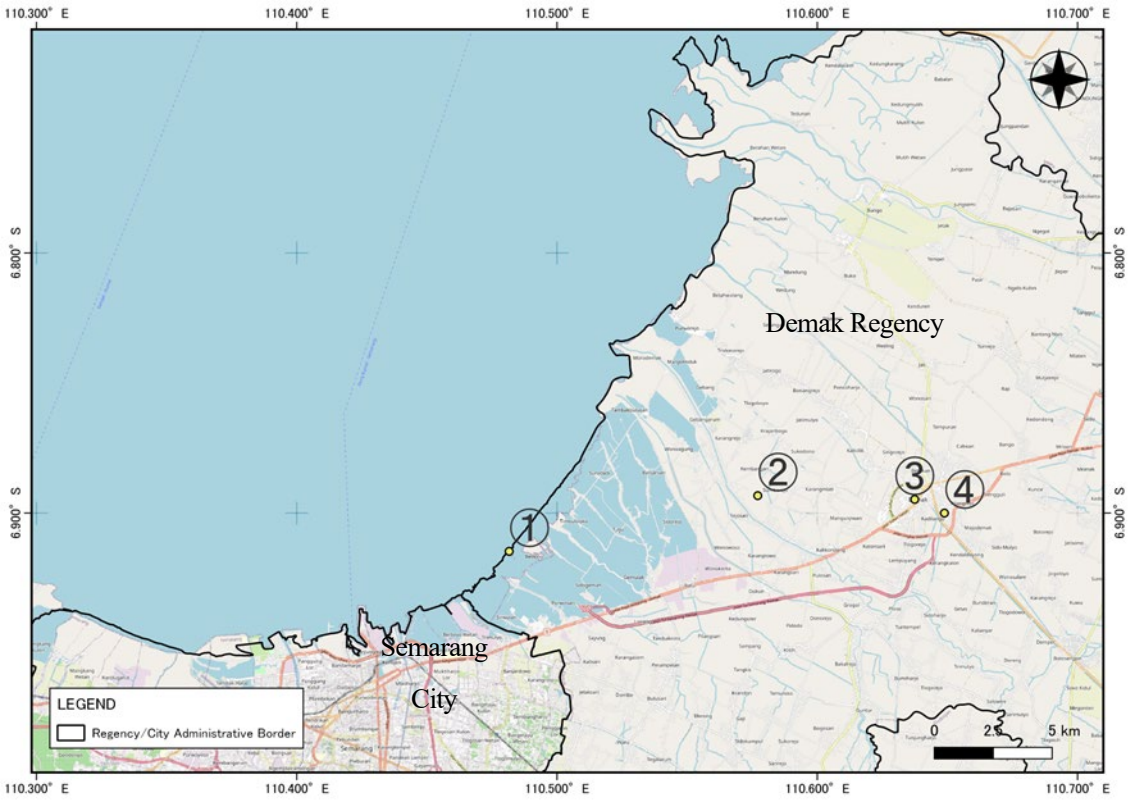
The cultural heritage of the Demak regency is shown in Table 1 and Figure 12.

In the Sayung district, Tomb of Syekh Mudzakir exists as a cultural heritage site.

Table 1 Cultural Heritage of Demak Regency

Level	Location	Name of Heritage	Category	Approx. Distance from Coastline (km)
N/A	Demak	Tomb of Syekh Mudzakir	Building	0.0
National		Astana Gedhong Kenep Tomb Complex, Glagah Wangi	Site	7.7
		Demak Great Mosque (Masjid Agung Demak)	Building	13.5
		Notobratan Kadilangu Hall (Pendopo Notobratan Kadilangu)	Building	15.0

Source: https://referensi.data.kemdikbud.go.id/kebudayaan/cagarbudaya/



Source: JICA Study Team

Figure 12 Location Map of Cultural Heritage Sites

(4) Tourist resources

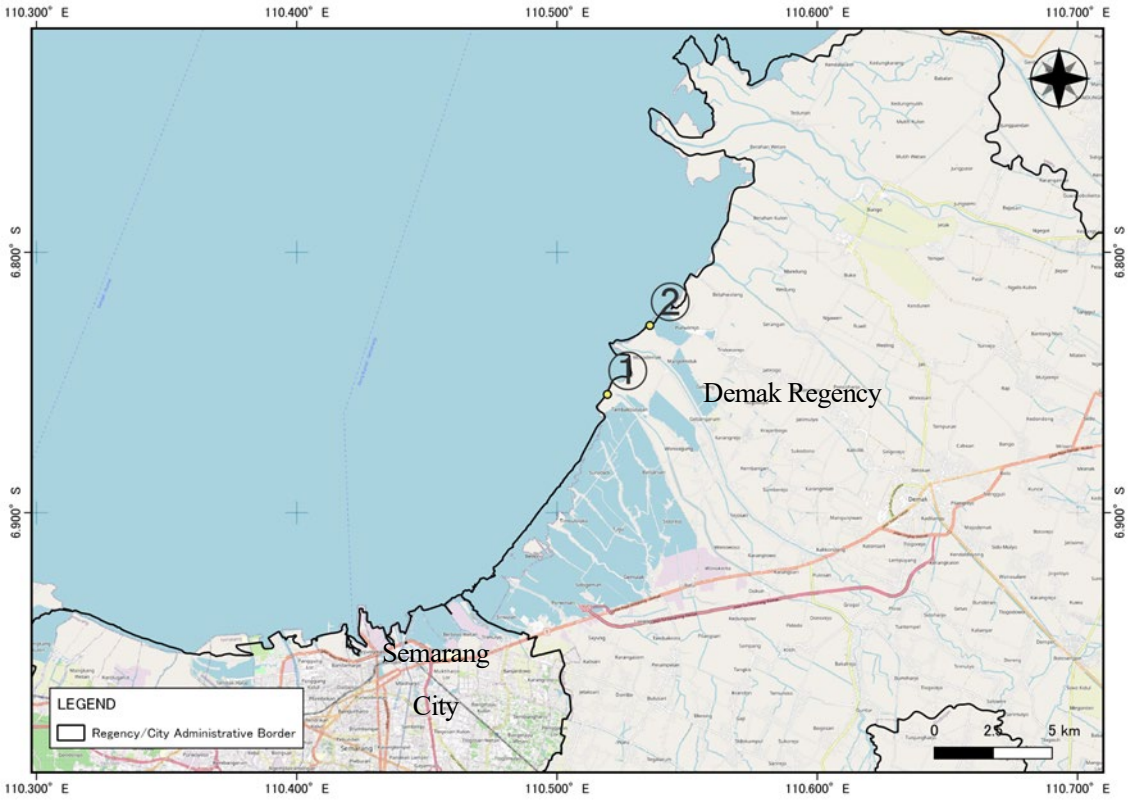
Tourism resources in and around Demak are shown in Table 2 and Figure 13.

There are tourism resources such as sandy beaches and eco-tourism sites using mangrove forests around Sayung district.

Table 2 Tourism Resources in Demak Regency

Area	Tourist Attractions	Classification.
Demak	Istanbul Glagah Wangi Beach	Tourism Beach
	Mangrove Park, Moro Demak	Mangrove Park

Source: JICA Study Team



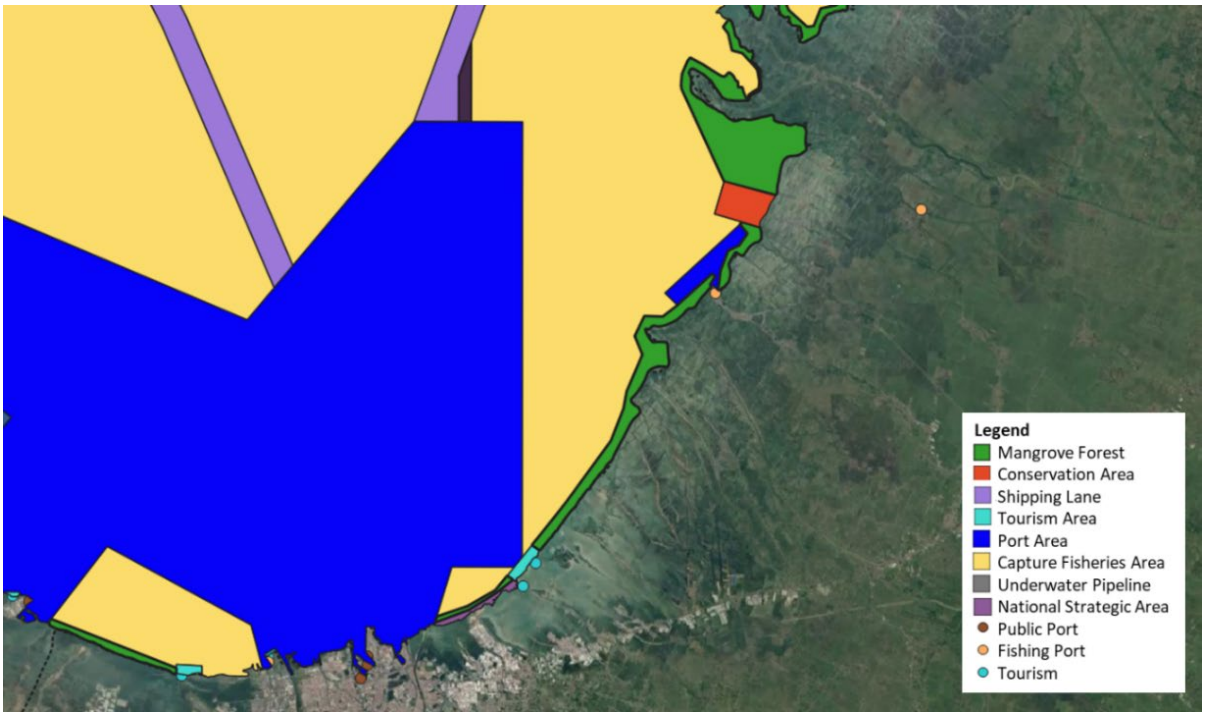
Source: JICA Study Team

Figure 13 Location Map of Tourist Resource

(5) Marine spatial planning

Marine spatial planning around Demak is shown in Figure 14, and the regulations for marine spatial planning shown in Table 3.

In the marine spatial planning, the coast of Sayung district falls under Tourism area and Mangrove forest in the coastal area, and Capture fishery area and Port area in the offshore area.



Source: DKP of Central Java

Figure 14 Marine Spatial Planning (Demak)

Table 3 Regulations for Marine Spatial Planning

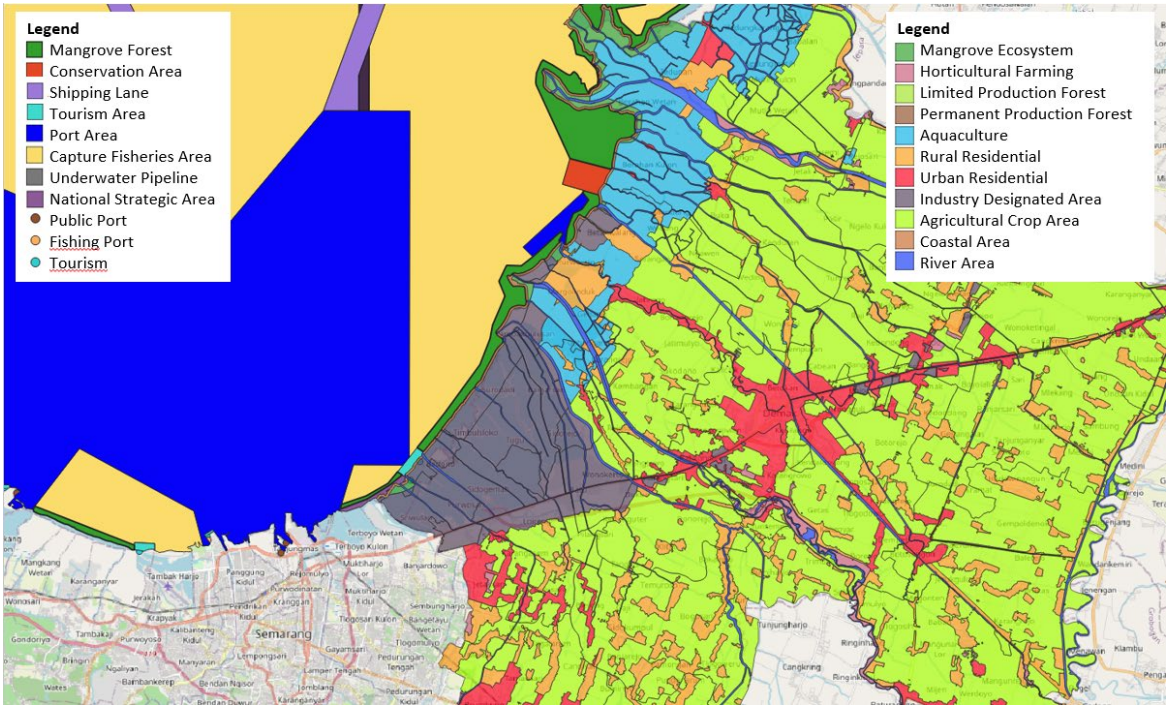
Zone	Allowed Activities	Not Allowed Activities	Allowed activities with permission
Tourism Area	a. provision of tourist attractions in accordance with the tourism master plan; and/or b. provision of tourism facilities and infrastructure.	a. removal and destruction of coral reefs; b. catching fish using explosives, toxic materials, and using fishing gear that is destructive to ecosystems in coastal areas and small islands; c. installation of fishing aids such as FADs; d. mining of metallic, non-metallic and rock minerals; e. other activities that reduce the value and/or function of the tourism zone; and/or f. other activities that do not support tourism	a. aquaculture; b. catching fish with fishing gear in accordance with statutory regulations; c. construction of public facilities; d. construction of coastal protection buildings; and/or e. research and education.
Port Area	a. construction of basic facilities, functional facilities, and supporting facilities in accordance with the port master plan and fishing port master plan and WKOPP; b. shipping lane activities, berths, places for loading and unloading between ships, port pools for the needs of berthing and ship maneuvering, scouting activities, ship repair places, and other activities in accordance with the provisions of the legislation; and/or c. the need for emergency situations, dead ships, sailing placements, ship piloting trials, ship facilities and construction, and maintenance of long-term port development and other activities in accordance with statutory provisions.	a. all types of fishing activities; b. all types of aquaculture activities; c. coral reef extraction; d. installation of fishing aids such as FADs; e. construction of buildings whose plans are not listed on the port master plan or WKOPP; f. mining of metallic, non-metallic and rock minerals; and/or g. other activities that value and/or reduce the function of the port zone.	a. dredging of harbor channel; b. laying/installing submarine cables/pipes; c. construction of public facilities; d. construction of coastal protection buildings; e. use or utilization of sea water; f. research and education; and/or g. tourism and recreation.
Capture Fisheries Area	a. fishing activities using equipment environmentally friendly; b. fishing activities that take into account the protection of habitats and fish populations; c. the size of fishing vessels, fishing gear (API) and fishing aids (ABPI) used in fishing activities in accordance with the regulations stipulated by the applicable laws and regulations; and/or d. installation of fish houses and fishing aids such as licensed FADs and artificial coral reefs.	a. fishing using explosives, toxic materials, electricity, and using fishing gear destructive to ecosystems in coastal areas and islands small island; b. coral reef extraction; c. the use of fishing gear (API) that disturbs and destroys the sustainability of fish resources; d. the use of Fishing Aids (ABPI) which not in accordance with the applicable laws and regulations; and/or e. other activities that reduce the value and/or function of the capture fisheries zone.	a. research and education; b. construction of public facilities; c. construction of coastal protection buildings; d. tourism and recreation; e. mining in potential reserves of metal, non-metal and rock minerals that have been designated as mining business permit areas in accordance with the provisions of the law outside of 2 nautical miles from the coastline permanently in areas which, if technically, ecologically, socially, and/or culturally, do not cause environmental damage and/or environmental pollution and/or harm to the community surroundings; and/or f. all types of aquaculture activities in accordance with water and sediment quality standards to ensure food safety for all aquaculture products that do not interfere with fishing activities.
Mangrove Forest	a. rehabilitation of mangrove ecosystems; b. tourism and recreation; c. small-scale fishing (<=5 GT) with environmentally friendly fishing gear (API) in accordance with laws and regulations; and/or d. education and research.	a. fishing that uses explosives, toxic materials, as well as using fishing gear that is destroying the mangrove ecosystem; b. all activities that use destructive methods and methods and perform function transfers and cut down coastal vegetation for activities that damage ecosystems; c. campfire with campfire; d. mining of metallic, non-metallic and rock minerals; and/or e. other activities that reduce the value and/or function of the mangrove forest zone.	a. provision of tourism facilities and infrastructure; b. construction of public facilities; and/or c. construction of coastal protection structures.

Source: Perda_No 13 Tahun 2018_RZWP3K (Central Java)

(6) Spatial planning

Spatial planning around Demak is shown in Figure 15 and spatial planning regulations is shown in Table 4.

Sayung area is classified as Industry designated area, River area, Aquaculture, and Rural residential in the spatial planning. Industry designated areas occupy most of the Sayung area.



Source: Marin Spatial Plan from DKP of Central Java, Land Spatial Plan from Bappeda Demak

Figure 15 Spatial Plan in Demak

Table 4 Regulations for Spatial Planning

Area	Law Reference	Zone	Allowed Activities	Allowed Activities With Conditions	Prohibited Activities	Allowed Activities with Limited Permit
Demak	Regional Law 1 of 2020	Mangrove Ecosystem	mangrove planting	-	- mangrove illegal logging - disposal of industrial waste that can damage coastal areas	tourism activities and its supporting activities
		Aquaculture	-	- fish product processing buildings, technical training centers, fishery product development facilities and - development of fishery and salt industry business	aquaculture activities that can disrupt rivers water quality and reservoirs for inland fisheries	commercial buildings and/or fishery tourism
		Rural Residential Area	- green open space - construction of infrastructure, facilities and utilities - tourism development	- business development and creative industries considering the scale of activities and environmental impacts - storage facilities and agricultural processing business	medium and large scale industrial activities	-
		Urban Residential Area	- green open space - construction of infrastructure, facilities and utilities - tourism development	business development and creative industries considering the scale of activities and environmental impacts	medium and large scale industrial activities	-
		Industry Designated Area	- space utilization for warehousing, service industry, fueling stations and industrial supporting activities - construction of energy generation facilities - development of industrial supporting infrastructure and facilities - small industries and medium industries located outside industrial areas or industrial designated areas that do not have the potential to cause environmental pollution with broad impacts and/or industries that use special materials and/or production processes require a special location	- development of residential area and its supporting facilities - development of public infrastructure and facilities by considering the impact of conflicts with industrial activities - installation of electricity networks, telecommunications towers, telephone networks, drinking water pipes and other utility networks	- utilizing groundwater for the purposes of industrial activities and its supporting activities located in water catchment areas - contaminate water, air and soil beyond the required threshold	-
		Coastal Area	- activities that protect or strengthen the protection of the coastal border area from abrasion, seawater intrusion and seawater infiltration - green open space	development of transportation infrastructure and facilities, fish auctions, water control buildings, tourism, energy facilities, shipping navigation aids, safety guard towers and/or other activities on the coastal	activities that reduce the ecological and aesthetic functions of the area by changing and/or damaging the landscape, and river preservation	existing settlement activities that has legal land ownership
		River Area	green open space	- development of transportation infrastructure and facilities, water control buildings, tourism, energy facilities, and/or other activities on the river banks - installation of billboards, counseling and warning boards, security signs - installation of electricity networks, telecommunications towers, telephone networks, and drinking water pipes and other utility networks - constructing buildings to support the functions of river management, water utilization, nature tourism, docks, energy facilities and other functions on the river banks	activities that reduce the ecological and aesthetic functions of the area by changing and/or damaging the landscape, and river preservation	existing settlement which at the time this Regional Regulation was enacted already existed, until the Regional Government or institution authorized to relocate

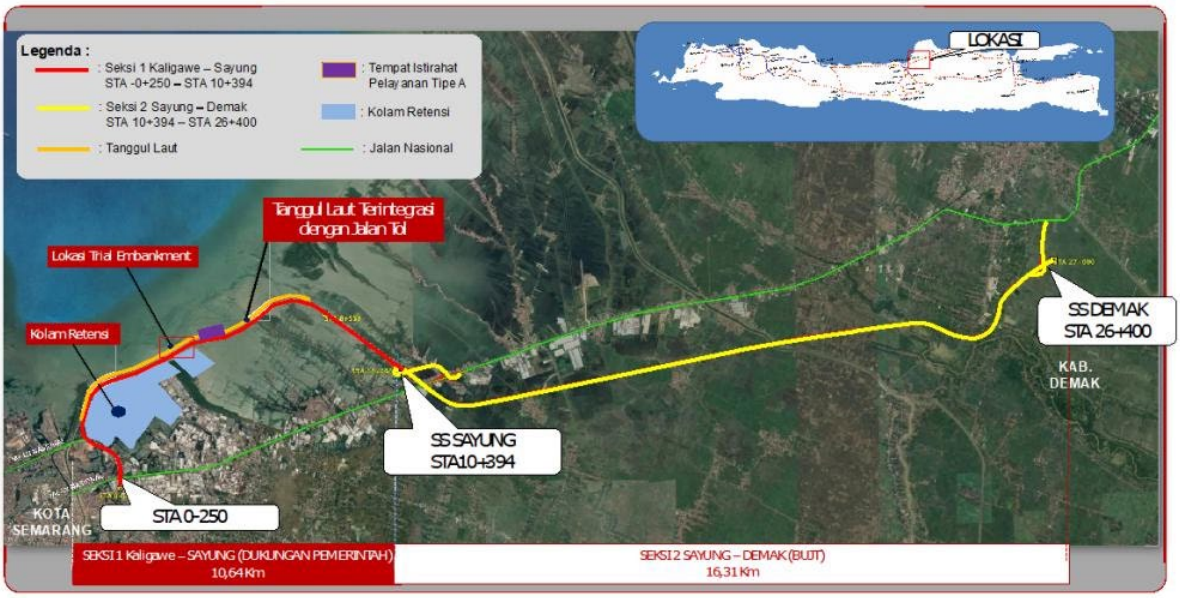
Source: Regional Law 1 of 2020, Demak Regency

21.2.4 Existing Measures and Related Plans

(1) Semarang-Demak Toll Road Project

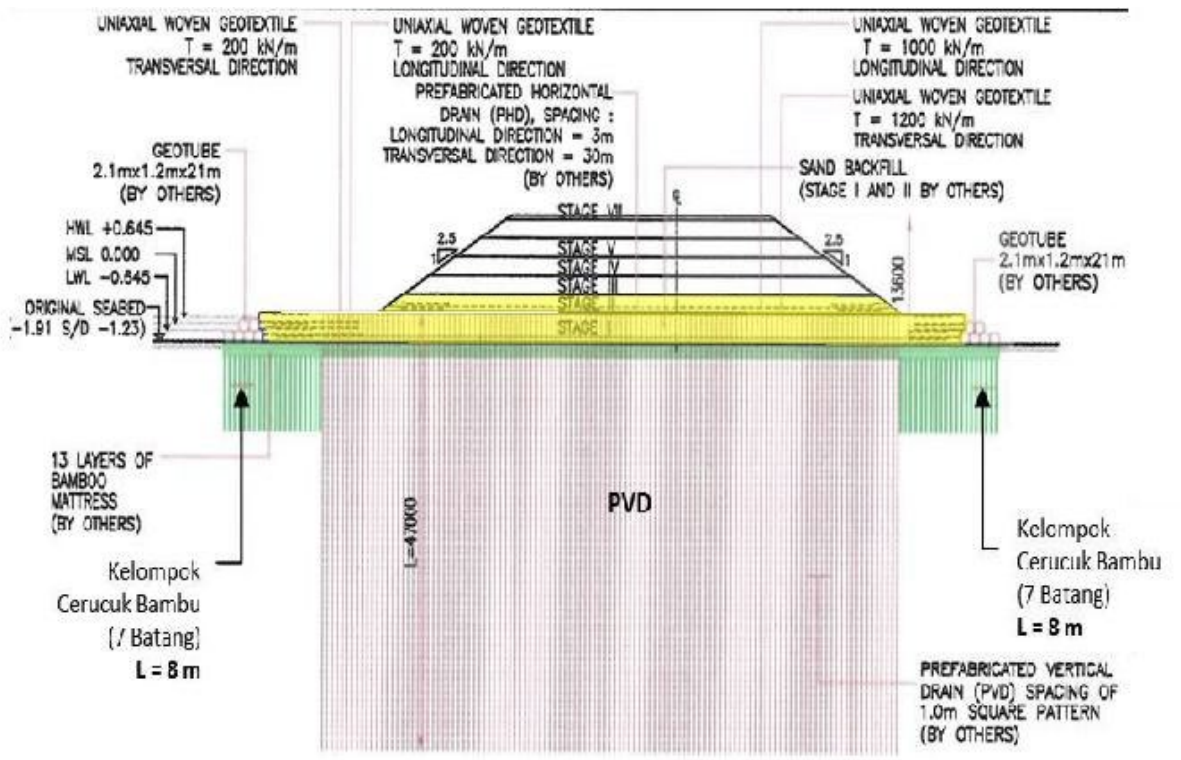
The Semarang-Demak Toll Road is being constructed integrated with preventing tidal inundation in the Sayung district, with the construction of the first section (section: Kaligawe Sayung, about 10 km in length, including a 6 km coastal dike) scheduled for completion in February 2025.

The cross section of the coastal dike consists of ground improvement using the paper drain method + bamboo mats + geotextile + soil layer. The top height of the coastal dike is set considering MSL + Highest Tide + subsidence (5 cm x 10 years = 50 cm) + sea level rise. The design tide levels are H.W.L + 0.645 m, M.S.L. + 0.0 m, and L.W.L. - 0.645 m (tidal range is about 1.3 m).



Source: PUPR, 2022

Figure 16 Toll Road Planning Route Map



Source: PUPR, 2022

Figure 17 Standard cross section of coastal dike

Source: JICA Study Team

Figure 18 Toll Road construction in progress (June 2022)

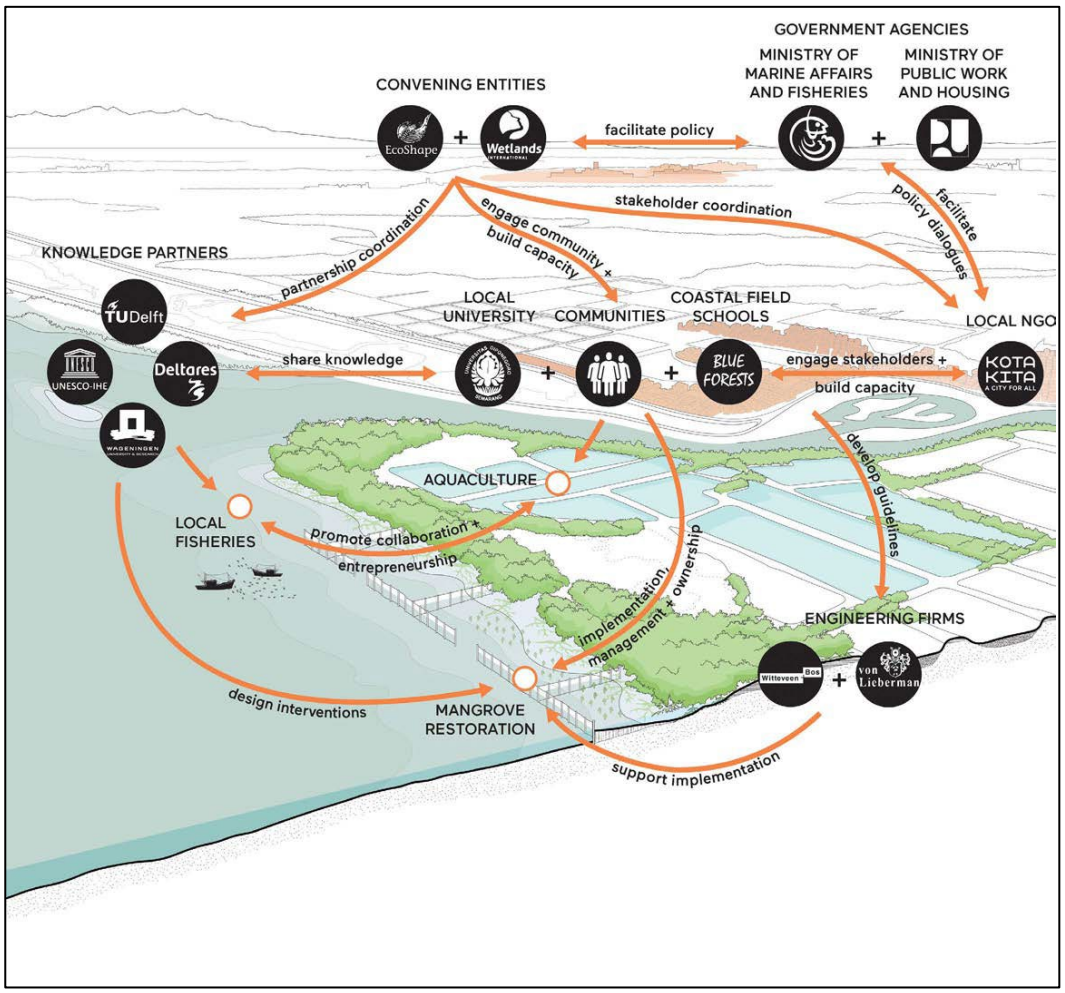
In the Sayung district of Demak, the following three types of projects are being implemented against coastal erosion

1. Hybrid Engineering (HE)
2. APO (seawall)
3. Mangrove reforestation program

(2) Building with Nature Business (Hybrid Engineering)

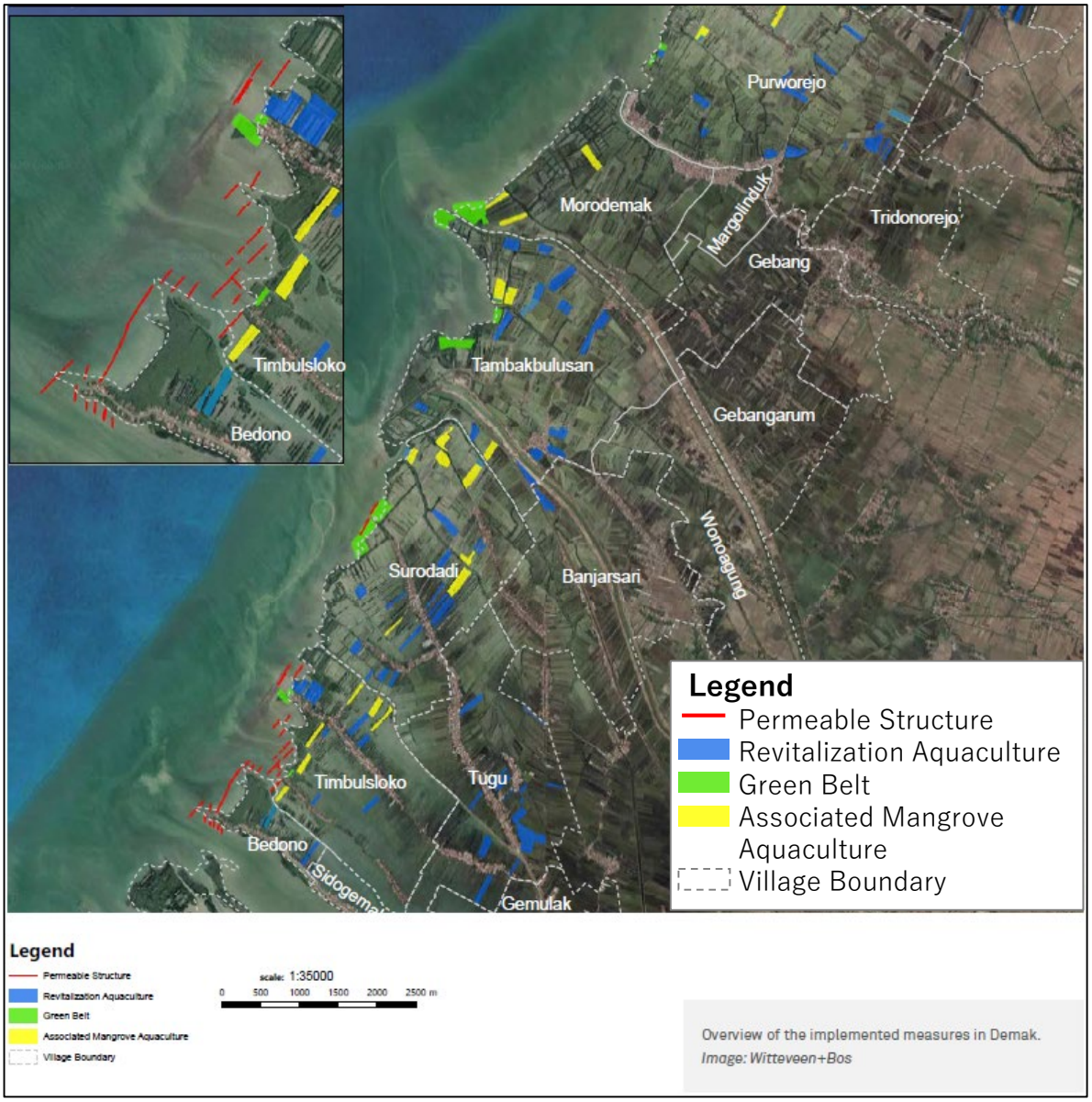
The Building with Nature project is a coastal erosion control approach implemented by an environmental organization called Eco Shape (https://www.ecoshape.org/en/about/) through collaboration with various local C/Ps across multiple regions.

In Demak, the measures such as construction of permeable structures on the hard side and creation of learning opportunities for fishermen through the Bio-rights system, afforestation, and use of aquaculture ponds on the soft side are being implemented between 2015 and 2021. The correlation chart of project implementing agencies in Demak is shown in Figure 19. Figure 20 shows the location of the Building with Nature project in Sayung district of Demak.



Source: BwN, p84

Figure 19 Correlation Diagram of Implementing Organizations on Building with Nature Project

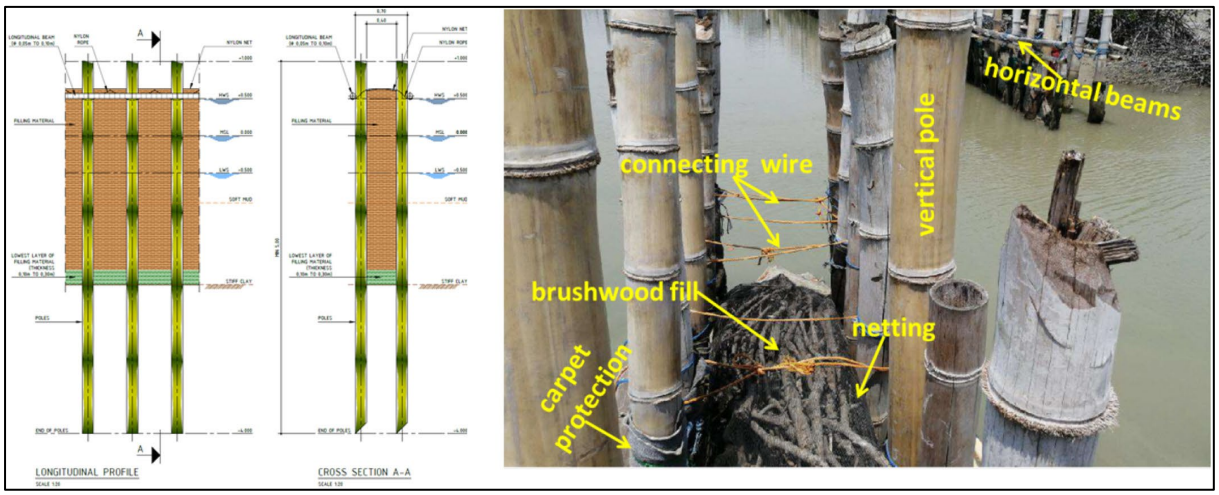


Source: BwN, p39

Figure 20 Building with Nature Project Sites in Demak and Sayung Regions

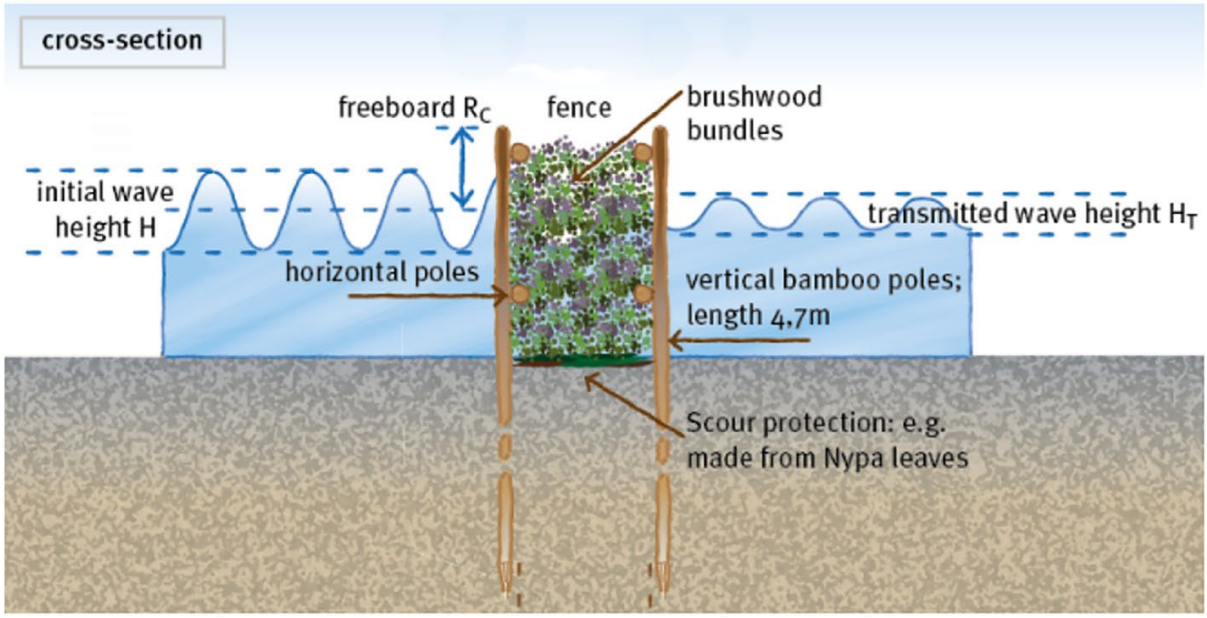
1) Permeable structures (Hybrid Engineering (HE))

Permeable structures are structures made of brushwood, bamboo, etc., tied to wooden poles (Figure 21). The purpose is to reduce coastal erosion damage by restoring both mangrove forests and beaches through the structures' ability to trap sediment (here mainly mud) and mangrove seeds. (See Figure 22)



Source: J.C. Winterwerp, et al. 2020

Figure 21 Overview of Permeable Structures



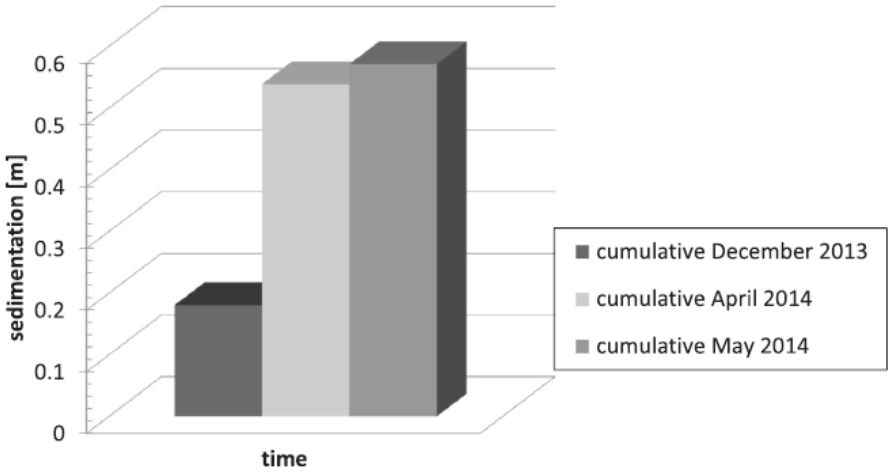
Source: J.C. Winterwerp, et al. 2020

Figure 22 Overview of Permeable Structures and Damping of Wave

In Demak, the first permeable structure was built in 2013 as a pilot project in the Timbul Sloko area. The construction location is shown in Figure 23. The structure was subsequently followed by the deposition of approximately 0.5 m of sediment behind the structure over a period of up to 4 months (See Figure 24).

Source: J.C. Winterwerp, et al. 2020

Figure 23 Location of Permeable Structure Construction in Timbul Sloko



Source: J.C. Winterwerp, et al. 2020

Figure 24 Sedimentation Volume behind Permeable Structures Constructed in Timbul Sloko [m]

According to Building with Nature's technical guidelines1), 9 km of permeable structures are being constructed in Demak between 2015 and 2019 as a result of this pilot project. Of this, 4.4 km are by the Ministry of Marine Fisheries (KKP). (See Table 5 (red box).

Table 5 Construction of Permeable Structures

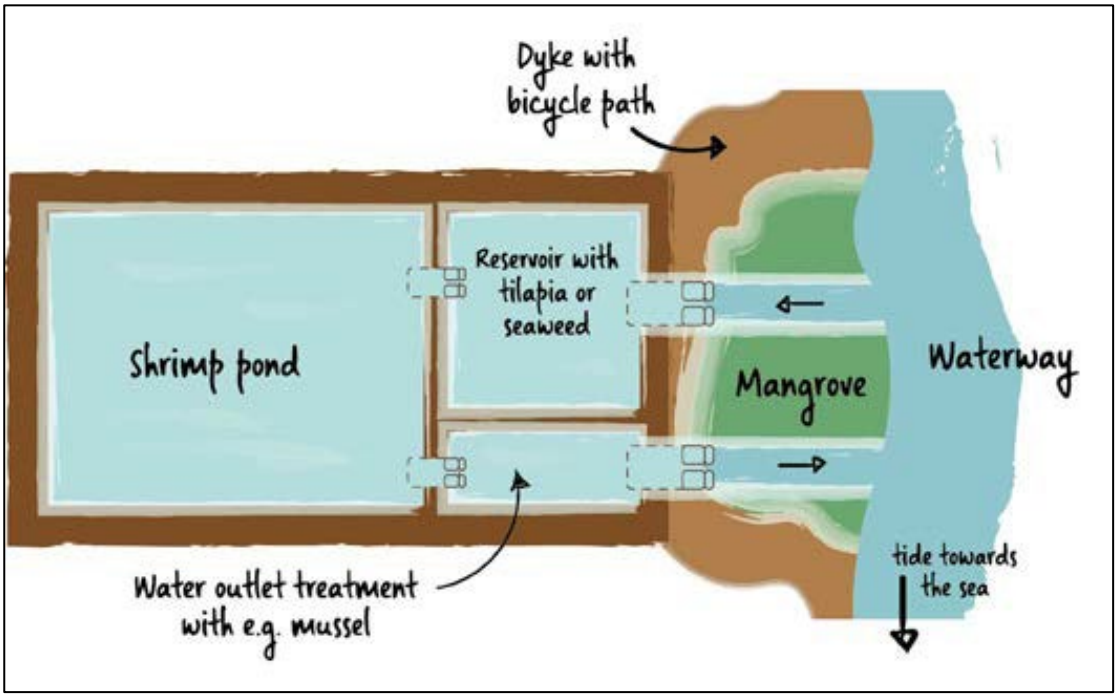
NO.	DISTRICT/CITY	PROVINCE	LENGTH (METRE)
	YEAR 2015		14.160
1	Cirebon District	West Java Province	2.910
2	Brebes District	Central Java Province	910
3	Semarang City	Central Java Province	3.145
4	Demak District	Central Java Province	915
5	Jepara District	Central Java Province	3.140
6	Pati District	Central Java Province	3.140
	YEAR 2017		7.450
1	Cirebon District	West Java Province	1.850
2	Demak District	Central Java Province	3.300
3	Rembang District	Central Java Province	1.100
4	Gresik District	East Java Province	1.200
	YEAR 2019		1.900
1	East Lombok District	Nusa Tenggara Barat Province	200
2	Bombana District	Southeast Sulawesi Province	1.100
3	Bone District	South Sulawesi Province	600
		TOTAL	23.510

Source: BwN, p23

2) Bio-rights

Bio-rights is a system that provides financial and technical assistance to fishermen for sustainable livelihoods. In addition to financial assistance, fishermen are given the opportunity to learn about mangrove forest ecosystems and sustainable aquaculture methods of natural origin.

With these aids, fishermen will be obliged to make decisions that lead to the restoration of mangrove forests (transfer of dilapidated aquaculture ponds or implementation of aquaculture coexisting with mangrove forests), construction and maintenance of permeable structures, monitoring, etc. Figure. Figure 25 shows an image of aquaculture coexisting with mangrove forests. Here, a buffer zone is established between the aquaculture ponds and the mangrove forest vegetation, making the two compatible. It is expected that the mangrove forest will prevent the mangrove forest from adversely affecting the aquaculture and that the mangrove forest will purify the inflow/outflow water.



Source: BwN, p34

Figure 25 Diagram of Aquaculture Coexisting with Mangrove Forests

(3) Example of Countermeasures by APO (Seawall)

In the Timbul Sloko area of Demak, a seawall made of stacked concrete columns, called an APO, had been constructed before the pilot project described in Section 10.1.4 (2) was implemented. (See Figure 26)

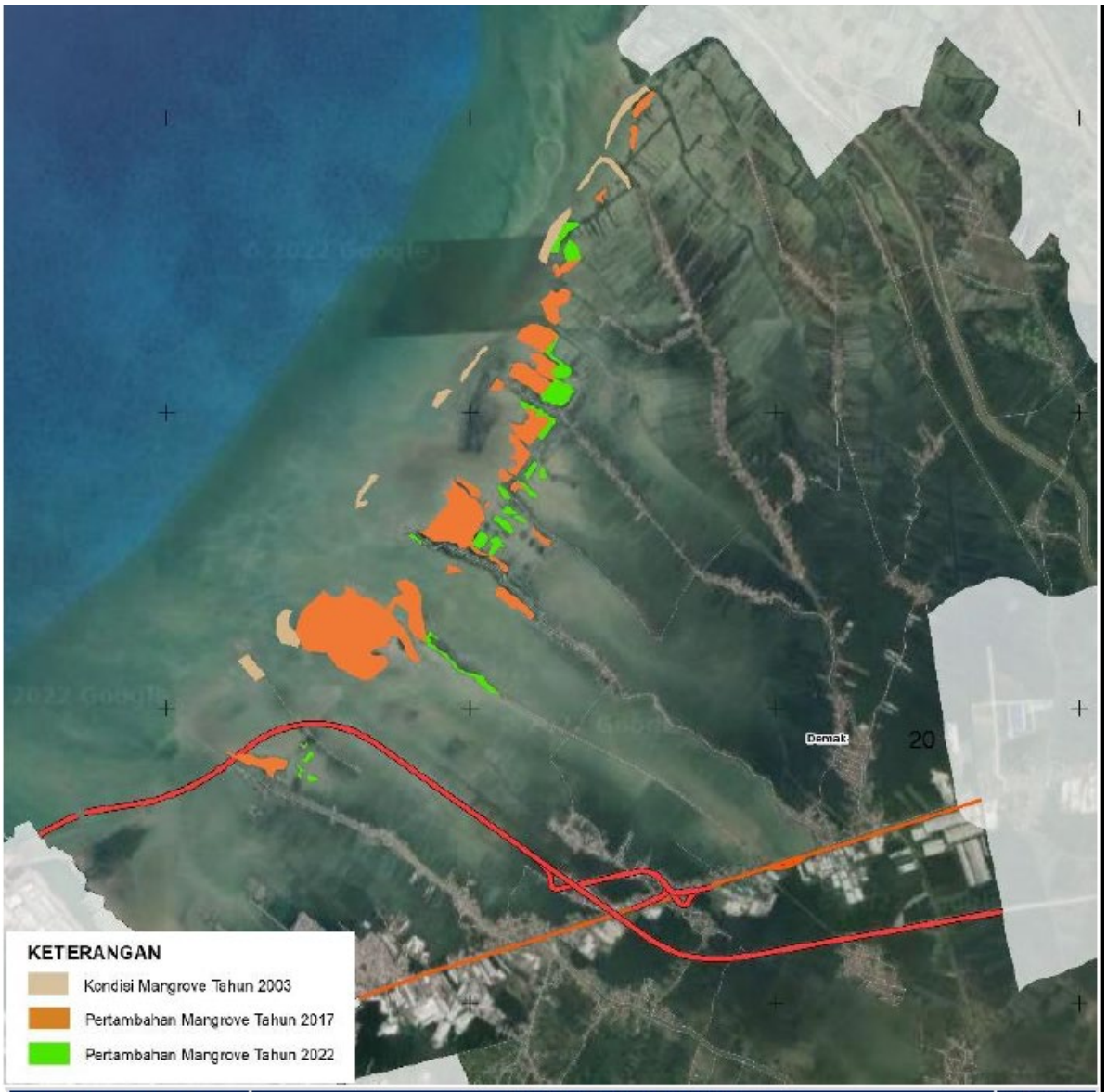
Over the years, vegetation has formed behind the structure, but due to the low permeability of the structure, it is unlikely that the vegetation will extend beyond the structure to the offshore side. The structure's foundation has also been subject to collapse from year to year, but the debris may provide continuous protection to the mangrove forest behind it by attenuating the waves. In the future, temporary structural measures may be considered for areas with large water depths where it is difficult to construct permeable structures, taking post-collapse effects into consideration.

Source: J.C. Winterwerp, et al. 2020

Figure 26 APO (Seawall) Overview

(4) Mangrove Planting

According to data from Demak regency, 17.15 ha (which has been already lost) in 2003, 158.77 ha in 2017, and 32.68 ha in 2022 of mangroves have been planted. As of 2022, about 191 ha of mangroves have been planted.



KONDISI MANGROVE	LUAS TIAP DESA (HA)					TOTAL (HA)
	BEDONO	PURWOSARI	SIDOGEMAH	SURODADI	TIMBULSLOKO	
TAHUN 2003	11,05	-	-	2,50	3,60	17,15
TAHUN 2017	111,92	-	0,99	12,26	33,61	158,77
TAHUN 2022	7,24	0,58	1,30	5,42	18,15	32,68

Source: Dinas Pekerjaan Umum dan Penataan Ruang, Kabpaten Demak

Figure 27 Status of Mangrove Plantations in the Coastal Area of Sayung District

(5) Countermeasures in Demak regency

A presentation material is introduced on the efforts of Sayung district in the Department of Public Works and Spatial Planning of Demak regency (Dinas Pekerjaan Umum dan Penataan Ruang).

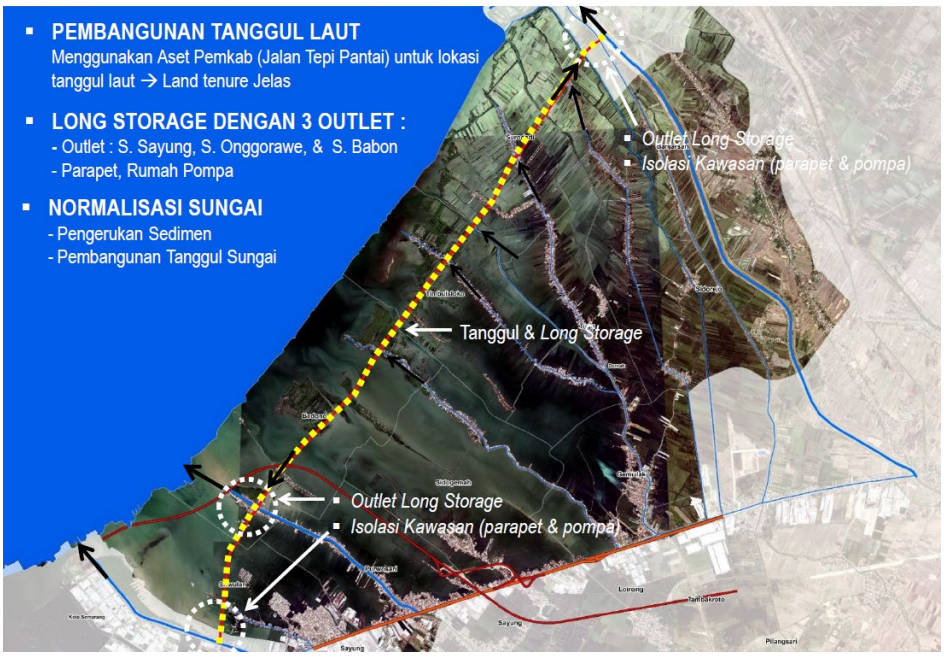
The presentation material consists of 1) urgency of response in the Sayung area, 2) assessment of natural conditions, 3) impact of Tidal Flood, 4) response scenarios for the Sayung area, and 5) infrastructure development items to deal with Tidal Flood.

In this material, as a response scenario for the Sayung area, the seven scenarios and measures for each scenario are shown in Table 6. Scenario 1 involves the construction of a seawall, and the image of the facility layout is shown in Figure 28. The policy is to construct a sea wall in line with the location of the coastal road (local government property).

Table 6 Response Scenarios for Sayung District

Scenario	Policy
1 Construction of seawalls	Construction of seawalls, long storage, normalization of rivers
2 Fishermen's Village Placement	1. Development of a marine products culinary center 2. Riverside riparian improvement
3 Development of a new commercial center district (CDB)	New business center at toll road exit, Sayung District Civic Center West gate of Demak
4 Improved functionality of boundary areas	1. River normalization and beautification (blue corridor) 2. Development of vertical gardens along the riverbank 3. CSR industry and private companies 4. Construction of pedestrian streets
5 Piloti style housing ('Mumbul' house)	1. non-transfer (in situ) , 2. Conversion of houses to pilotis 3. Road raising , 4. Panel-type house (RUSPIN MODEL (Rumah Unggul Sistem Panel Instan))
6 Resettlement	New housing development (for residents of affected communities)
7 Mangrove park development	-

Source: Prepared by JICA Study Team based on Dinas Pekerjaan Umum dan Penataan Ruang, Kabpaten Demak



Source: Dinas Pekerjaan Umum dan Penataan Ruang, Kabpaten Demak

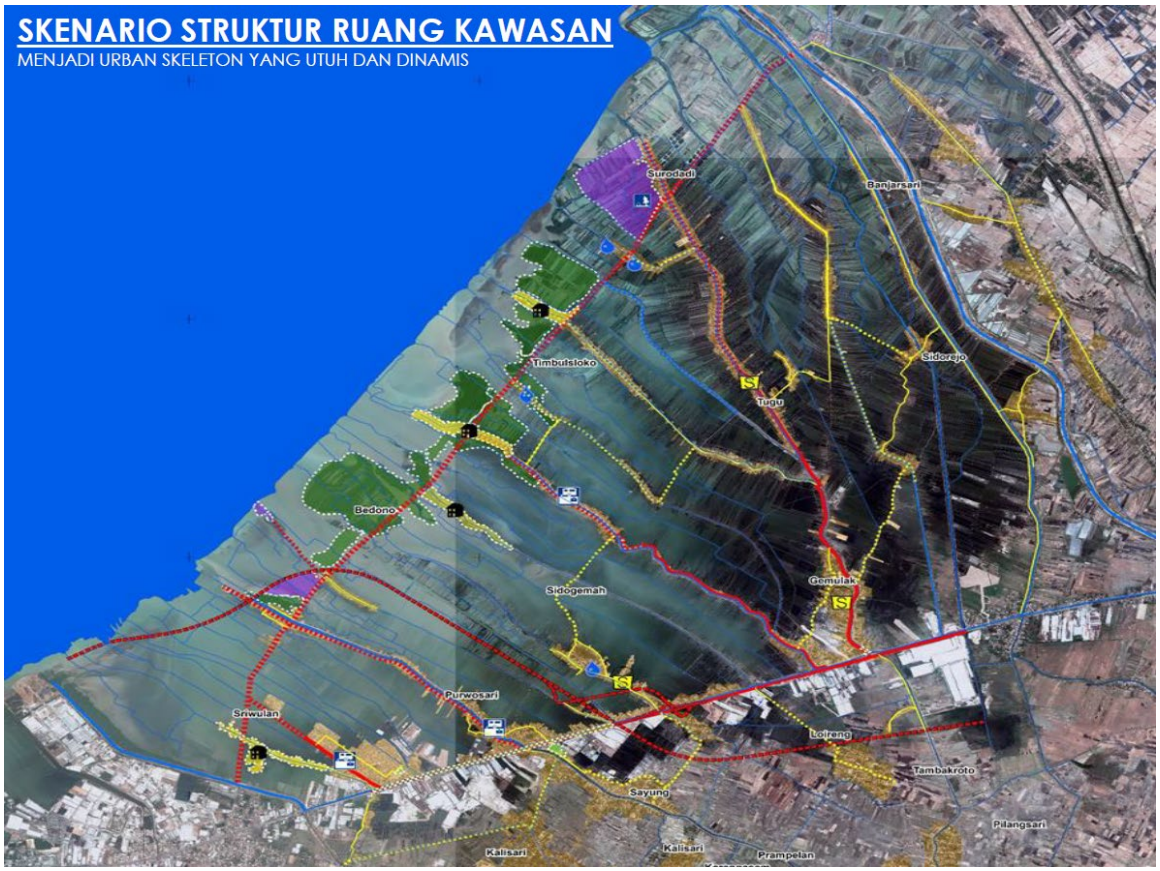
Figure 28 Diagram of Seawall Layout

In addition, Infrastructure maintenance menu for 2022 - 2024 to deal with tidal floods is listed by scale and sector in Figure 29 shows the facility layout plan.

Table 7 Infrastructure Menu for Tidal Flood Response

Development Scale	Maintenance Menu by Sector
Regional Scale	Roads Sector: 7 projects (Semarang-Demak highway, coastal road, etc.) Rivers Sector: 2 projects (river normalization)
Community Or Regional Development	Commercial sector: 2 businesses Environment sector: 2 projects (mangrove plantation) Tourism sector: 3 businesses Fishery sector : 3 businesses
Neighborhood Scale	Roads sector : 24 projects Water supply sector : 9 projects Housing sector : 17 projects

Source: Prepared by JICA Study Team based on Dinas Pekerjaan Umum dan Penataan Ruang, Kabpaten Demak



Source: Dinas Pekerjaan Umum dan Penataan Ruang, Kabpaten Demak

Figure 29 Facility Layout Plan

21.2.5 Field Survey Results

The following two sites were surveyed in Demak which is adjacent to the east of Semarang.

Source: JICA Study Team

Figure 30 Field Survey Locations in Demak

(1) Location ①

There is a waterway in the center, with residential roads and houses on both sides, extending out to sea. Fish Pond are located around the waterway (Figure 31). The amount of land subsidence in the surrounding area is 10-12 cm/year, and a restaurant at the tip of the study site had to be closed three years ago due to subsidence and flooding (Figure 32, based on field interviews). Due to the progressive subsidence, reinforcement of seawall (approximately 1 m) were also remained. (Figure 33).

Source: JICA Study Team

Figure 31 Situation Around the Survey Point

Source: JICA Study Team

Figure 32 Restaurant and Surrounding Seawalls near the Survey Site

Source: JICA Study Team

Figure 33 Seawall Condition (Left) and Heightening of Seawall (Right)

(2) Location ②

The land subsidence at point ② is also serious, having sunk approximately 1.5 m since 1965 to the present (1.5 m/57 years = 0.03 m/year) according to field interviews. This is evidenced by the fact that a number of small bridges over the channel have lost all clearance (see Figure 35).

Source: JICA Study Team

Figure 34 Status of Fish Pond in Roads, Dwellings, and Surrounding Areas across the Waterway

Source: JICA Study Team

Figure 35 Bridge and Dwelling with No Clearance over Waterway (Left) and Dwelling about to be submerged (Right)

21.3 Review of Existing Studies and Reports

21.3.1 Summary of Existing Studies

Table 8 provides a summary of the existing studies conducted to date in and around the Sayung area of Demak. A detailed description of each survey is provided in Appendix.

Table 8 Summary of Existing Studies

No.	Title	Summary
1	Impact of Coastal inundation on ecology and agricultural land use case study in central Java, Indonesia (Muh Aris Marfai, 2011)	A study of the impact on the coastal environment and ecosystems due to coastal inundation, and an assessment of the impact on agricultural land use. Approximately 16,687.31 ha are affected in a 150 cm inundation scenario, with fishponds, dry farm land, and paddy fields being mainly affected areas.
2	Genangan Banjir Pasang Pada Kawasan Pemukiman di Kecamatan Sayung, Kabupaten Demak-Provinsi Jawa Tengah (Petrus Subardjo, et al., 2015)	Tidal flood inundation map of Sayung District is created to identify the residential areas affected. The area inundated by tidal floods in Sayung District in 2013 is 1,938.42 ha, of which 140.05 ha (7% of the total inundated area) is residential area.
3	MODELLING OF SUSPENDED SEDIMENT TRANSPORT IN COASTAL DEMAK INDONESIA BY USING CURRENTS ANALYZING (Denny Nugroho Sugianto, et al., 2017)	Observation of ocean currents and case studies of the effects on coastal erosion by structures. Maximum current velocities of 0.098 to 0.126 m/s on the east side and 0.114 to 0.149 m/s on the north side were recorded at a depth of 6 m. The dominant direction of the current moved to the northeast.
4	Shoreline Change Analysis in Demak, Indonesia (Komariah Ervita, 2017)	Shoreline changes over a 25-year period were determined by satellite image analysis. The factors contributing to these changes were identified. Shoreline changes have resulted in erosion in the Sayung area and sedimentation in the Wedung area. The factors include wind, waves, currents and tides.
5	PENGENDALIAN BANJIR SUNGAI WULAN, DEMAK, JAWA TENGAH/ FLOOD CONTROL OF WULAN RIVER, DEMAK, CENTRAL JAVA (Rasyid Kanza, et al., 2017)	A study of a river improvement plan for the WULAN River. -1/50 year design flood discharge: approx. 1759 m^3 /s -Development policy: Dredging and embankment construction to secure the cross sectional area. -Design cross-section: river bottom width 70 m, slope gradient 1 : 3
6	Coastal protection by means of natural mangrove recovery: experiences from Demak (Pieter van Eijk, et al., 2018)	Results and findings from coastal protection efforts through natural restoration of mangroves in the BwN project are presented. Implementation of a combination of infrastructure improvements, environmental restoration, and sustainable land use measures will lead to coastal resiliency, economic

No.	Title	Summary
		development, and nature conservation. Multi-sectoral stakeholder collaboration and a common understanding of coastal systems are needed.
7	Time Series of Land subsidence rate on Coastal Demak Using GNSS CORS UDIP and DINSAR(B. D. Yuwono , et al. ,2018)	The study was conducted by applying DInSAR and GNSS technology to predict the land subsidence rates in the coastal areas of Demak regency. Based on GPS survey land subsidence rates for Demak range from 0.8 cm/year to 17.9 cm/year.
8	Kajian Risiko Bencana Pesisir,. (Wetland International Indonesia 2018)	Conducted coastal disaster risk assessments and recommendations for integrated disaster risk management (IRM) approaches in four villages. Disaster risks (flooding, tidal flooding, coastal erosion, and access to clean water) are in descending order: tidal flooding > coastal erosion > access to clean water > flooding. The IRM approach was recommended as a response to disaster risk.
9	Alternative Designs for Semarang-Demak Coastal Dike and Toll Road (Rasyid Kanza, et al., 2019)	Structural and geotechnical analyses were performed on three alternative structures for the Semarang - Demak Toll Road, and the most effective and efficient alternative was proposed. -Alternative Design 3: Seawall (piles + embankment [NCICD method]) + deck-on-pile type [Sedyatmo Toll Road method] is the most promising design alternative.
10	Managing erosion of mangrove-mud coasts with permeable dams -lessons learned (Winterwerp, J.C., et al., 2020)	The report surveys the use and examples of permeable structures, and summarizes the applications and lessons learned in Indonesia and four other countries. Function of permeable structures require the following. (1) understanding and analysis of biophysical coastal systems, (2) maintenance of mangrove forest restoration on a multi-decade scale, and (3) active participation of stakeholders.
11	PENILAIAN RISIKO BENCANA KAWASAN PARIWISATA PANTAI SAYUNG, KABUPATEN DEMAK (Achmad Andi Rif'an, et al., 2020)	A disaster risk assessment of a tourism area in Sayung was conducted and directions for tourism development were proposed. Sayung coastal tourism area is at high risk of disasters and the direction of regional development is mitigation and adaptation measures against Tidal Flood and coastal erosion.
12	Economic assessment of subsidence in Semarang and Demak ,Indonesia (Deltares, 2021)	The economic impact under multiple land subsidence scenarios is evaluated. Demak's damage over 20 years under BAU (business as usual scenario) is 39 trillion IDR (equivalent to about 7% of Demak's GRDP). Measures to reduce land subsidence rate by 50% avoid economic losses of 10 trillion IDR. Measures to reduce land subsidence rate by 75% avoid economic losses of IDR 14 trillion.
13	Analisis Multibahaya di Wilayah Pesisir Kabupaten Demak	Predicted trends in subsidence and increasing tides for subsidence and tidal multi-hazards in the coastal area of

No.	Title	Summary
	(Ni Md. Widya A. Suryanti, et al.)	Demak, and examined the Tidal Flood area in 2025. The tide in 2025 is expected to reach 1.63 m, and the inundated area by tidal floods account for 57 % of the study area.
14	Competition in Sayung District (Bappeda, Central Jawa, 2022)	Spatial planning competition in Sayung district (refer 10.2.2) 3 prize-winning teams (40 teams applied) First Place: Abhi Kurniawan Team (TIM URBANESHA) 1st Prize:The Resilient Sayung "A Water Adaptive Eco Industrial Town".

Source: JICA Study Team

21.3.2 Competition on Spatial Arrangement of Sayung Coastal Area

Materials on competition winners in Sayung coastal area were collected from the Regional Development Planning Agency (Bappeda) of Central Java.

A summary of the competition is shown in Table 9

According to Bappeda of Central Java, as of early March 2023, the competition ideas have been proposed to BAPPENAS, and the next step will be to incorporate the competition results into the master plan and basic design. A summary of each of the top three winning competition proposals is shown on the next page and followings.

Table 9 Summary of Competition on Sayung Coastal Area

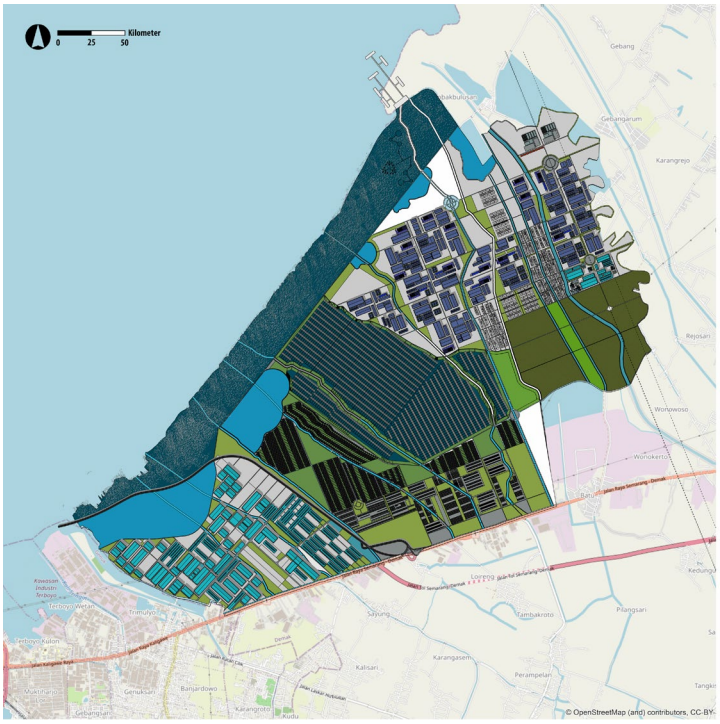
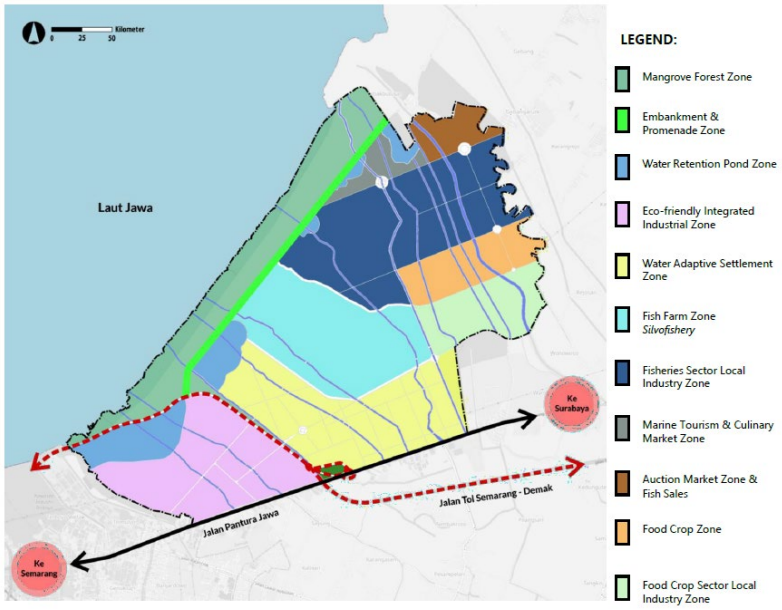
Name Of Competition	The Competition on Spatial Arrangement of Sayung Coastal Area for Integrated Environmentally Friendly and Sustainable
Application Period	September 19th, 2022 - December 3, 2022
Results Of Examination	December 9th: The 15 best teams that passed the first round were announced. (40 teams applied) December 19th: After a second round of document screening, the 10 teams advancing to the final round were announced. December 27th: After the final judging (presentations and interviews), the top three winning teams were announced.
Prize-Winner	First Place: Abhi Kurniawan Team (TIM URBANESHA) Second Place: Fahlevi Ermaula Aseseang Team (TIM Ermaula) Third Place: Muhammad Retas Aqabah Team (TIM SHIRVANO)
Selection Committee	Committee on administration processes Committee on technical matters The technical committee consisted of academics (lecturers from Diponegoro University and Dutch universities) and officials from Bappeda, Dinas PU, Dinas KP, Dinas LHK, and others.

Source: JICA Study Team

Source: https://disperakim.jatengprov.go.id/

Figure 36 Publicity for the Sayung District Competition

(1) 1st place in competition

Team	URBANESHA Team :7 members (urban planning, civil engineering, GIS, architecture and urban design)
Title.	The Resilient Sayung "A Water Adaptive Eco Industrial Town".
Summary	A master plan with two missions and five strategies is being developed. -Two missions: 1) adaptation to water, 2) eco-industrial and local economies -Five strategies: 1) disaster management, 2) resilient places, 3) sustainable communities, 4) eco-industries, and 5) local economies. Master plan  Land Use Framework 

Strategies and their programs

4.1 Vision and Mission

Resilient sayung

" Water Adaptive Eco-Industrial Town "

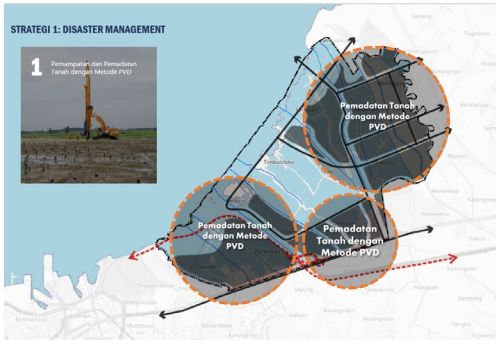
Adaptation to water	Toward a resilient city that coexists with water and nature
Eco-Industrial & Local Economy	Become an environmentally friendly and sustainable industrial and regional economic development city

4.2 Strategies and Programs

Water Adaptation Mission	Strategy 1 : Disaster Management	Improve and restore the quality of the community to increase its resilience to water hazards.	1. Soil compaction and solidification by PVD method 2. Reclamation in specific land functions 3. Construction of a seawall integrated with the promenade
	Strategy 2: Resilient Place	Anticipate that the region will become more responsive and in harmony with water in the future and work to prevent this from happening.	1. Mangrove planting 2. Reservoir construction 3. Installation of pumps and sluice gates 4. River optimization 5. Construction of area drainage 6. Greening of riverbeds
	Strategy 3: Sustainable community	Develop viable and sustainable residential neighborhoods	1 Construction of a water-adaptive stage house 2 Relocation of residence 3 Establishment of a clean water network 4 Construction of a communal WWTP 5 Improvement of the electric power grid 6 Construction of waste network facilities 7 Construction of water-adapted educational, worship, and health facilities 8 Development of public parks adapted to water 9 Establishment of environmentally friendly community associations
Eco-Industry & Local Economy Mission	Strategy 4: eco-industry	Development of a comprehensive, environmentally friendly, water-friendly industrial park	1. Water infiltration development in industrial areas 2. Construction of WTPs and WWTPs using legumes as filters 3. Road network development for health access to toll roads, Pantura trunk roads, and ports
	Strategy 5: Local economy	Develop a local economy that utilizes the surrounding natural resources for the welfare of the community.	1 Pier construction 2 Development of a people's industrial complex in the fish processing industry 3 Markets and Fish for Sale 4 Market and Sea Sightseeing 5. Preservation of inundated areas for aquaculture and fisheries activities 6 Development of tourist areas using mangroves 7 Development of food crop regions 8 Development of People's Industrial Park in the food crop processing sector 9 Establishment of local cooperatives 10 Financial Aid and Training

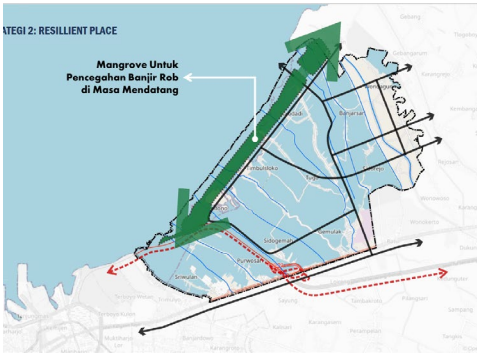
Strategy 1: Disaster Management Menu

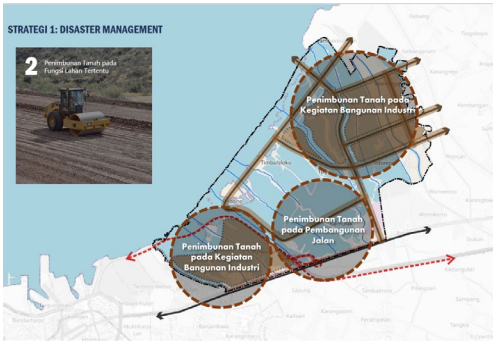
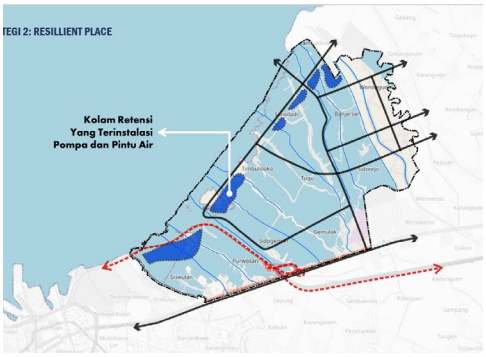
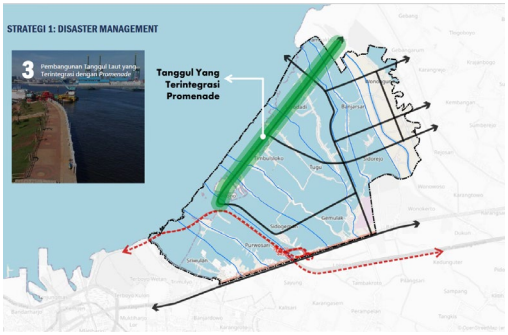
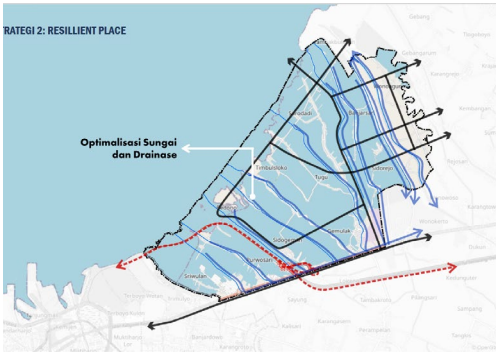
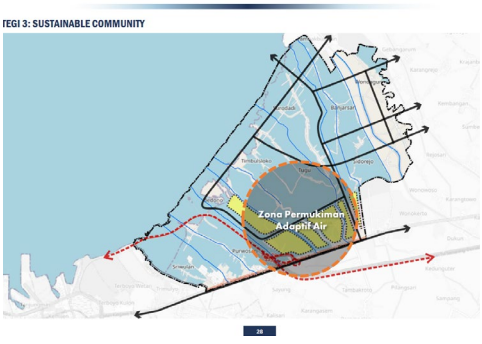
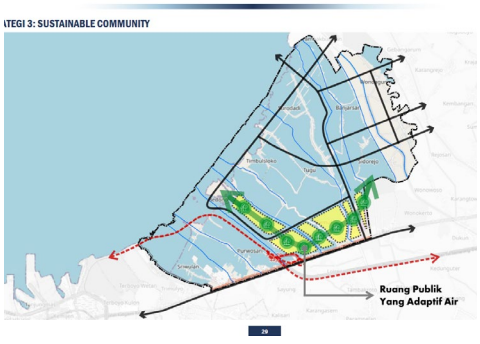
1. Soil improvement of specific land



Strategy 2: Menu of Resilient Place

1. Mangrove Planting



<table>
<tr><td></td><td>
<table>
<tr><td>2. Reclamation of specific land
 
</td><td>2. Maintenance of regulating pond
 
</td></tr>
<tr><td>3. Seawall development integrated with the promenade
 
</td><td>3. Normalization of rivers and drainage channels
 
</td></tr>
</table>
Strategy 3: Sustainable Communities
<table>
<tr><td>Water adaptive residence area
 
</td><td>Water-adapted public space
 
</td></tr>
</table>
</td></tr>
<tr><td>Evaluation</td><td>Strategy 1: Disaster Management" includes projects to improve the ground and reclaim land using the PVD method and to construct seawalls in specific areas. The structural specifications of each of these measures have not yet been determined technically, and will need to be studied in detail in the future.
Strategy 2: Resilient Places" includes proposals for 1) mangrove planting, 2) construction of reservoirs, 3) installation of pumps and sluice gates, 4) river optimization, 5) construction of area drainage, and 6) creation of green areas along riverbanks. Specific basic specifications for each measure have not yet been determined and will need to be discussed in the future.
The following nine measures are proposed for "Strategy 3: Sustainable Communities," but more work needs to be done to make them concrete.
1 Construction of water-adapted stage houses; 2 Relocation of settlements; 3 Establishment of a clean water network, 4 Construction of a communal WWTP, 5 Development of an power network, 6 Construction of a waste network facility, 7 Construction of water-adapted educational, worship, and health facilities; 8 Development of water-adapted public parks , 9 Establishment of environmentally friendly community associations</td></tr>
</table>

(2) 2nd place in competition

<table>
<tr><td>Team</td><td>Ermaula Team(8 members)</td></tr>
<tr><td>Title.</td><td>Sayung Eco Industrial District
Livable and Integrated Sayung Eco Industrial District to Catalyze Sustainable Growth of Central Java</td></tr>
<tr><td>Summary</td><td>Four Policies
<table>
<tr><td>Land Reclamation</td><td>Soil reclamation to restore submerged soils. A combination of backfilling and sedimentation.</td></tr>
<tr><td>Shoreline Protection</td><td>Shoreline protection structures (bamboo trunks) can block waves and minimize the effects of erosion.</td></tr>
<tr><td>Mangrove Restoration</td><td>Restore mangroves by connecting fragmented mangrove habitats and expanding the area of mangroves.</td></tr>
<tr><td>Regulating pond</td><td>Regulating ponds prevent flooding and provide a source of fresh water, effectively reducing groundwater use.</td></tr>
</table>
Master Plan
 

A. Entrance Area, B. City Center, C. Industrial Center, D. Residential Center, E. West Industry
F. West Settlement, G. East Industry, H. East Settlement, I. Food Estate, J. Retention pond, K. Tourism Area
L. Tourist Jetty, M. Research Center, N. Fisherman's Jetty, O. Upper Middle Settlement
P. Mangrove Conservation and Eco-Tourism</td></tr>
<tr><td>Evaluation</td><td>• For coastal protection measures, a green infrastructure made of bamboo has been proposed, but the basic specifications are not yet available, so further study is needed.
• The proposed improvement and reclamation of the land requires an engineering study to determine the basic specifications, as there are no basic specifications available.
• The concrete idea of regulating ponds need to be proposed based on hydrologic and hydraulic analysis.</td></tr>
</table>

(3) 3rd place in competition

<table>
<tr><td>Team</td><td>TIM SHIRVANO</td></tr>
<tr><td>Title.</td><td>Sayung anchored, Empowered, Aligned, Growing</td></tr>
<tr><td>Summary</td><td>
<u>Design approach</u>
<table>
<tr><td>Double protection</td><td>Combined with grey-green infrastructure, Sayung will be protected from tidal flooding.</td></tr>
<tr><td>Multifunctional Blue Green Scape</td><td>Multifunctional green and blue areas with social and ecological benefits</td></tr>
<tr><td>Economy Generator</td><td>Leverage the region's potential to promote economic growth.</td></tr>
<tr><td>Living projection</td><td>Provide a growth area to accommodate additional population in Sayung.</td></tr>
</table>
<u>Master Plan Outline</u>
Road network development: road infrastructure development to support the mobility of Sayung area residents.
Secure space for water: Provide space for water movement to reduce the impact of tidal runoff.
Protection allocation: Two types of protection methods are prepared to reduce flooding damage caused by tides.
Land Use: Various functions with consideration of environmental capacity
<u>Master plan</u>


<table>
<tr><td>A. Mangrove Barrier,.
B. Mangrove Biodiversity
C. Wetland</td><td>D. Morosari Beach
E. Tomb of Sheikh Abdullah Mudzakir
F. Industrial Area</td><td>G. Residential
H. Residential with Ponds
J. Residential with Agricultural Area</td><td>K Growth Area
L Agricultural Area
M Commercial Area</td></tr>
</table>
</td></tr>
<tr><td>Evaluation</td><td>
• Hybrid engineering and mangrove wave shielding have been proposed as coastal protection measures, but the facility layout and basic specifications have not yet been finalized. The facility layout and basic specifications should be established in the future.
• Using piles for the foundation of the structure is considered and need to conduct a study of the foundation.
• In considering foundations, it is considered necessary to consider the impact of land subsidence.
</td></tr>
</table>

21.3.3 Results and Issues

Table 10 summarizes the results and issues of the existing studies conducted in the Sayung District, Demak. Individual details of existing studies are shown in Table 11.

Although the impact assessment of land subsidence has been conducted, some issues still need to be solved. The issues include the lack of continuous land subsidence monitoring and inadequate accuracy in predicting land subsidence. In addition, surveys to identify the causes of land subsidence have not been sufficiently conducted.

Table 10 Summary of Results and Issues of Previous Studies

Results	Issue	No.
(1) Understanding of oceanographic phenomena and natural characteristics		
Understanding ocean currents with ADCP	Data Accumulation	No.3
Understanding Sediment Movement with 3D Models	Model refinement and data updating	No.3
Erosion and sedimentation trends due to shoreline change	Proof of association between shoreline change factors, update data	No.4
Rate of Land Subsidence	Building a BM network	No. 7
	Continuous Monitoring	No. 7
(2) Disaster risk assessment		
Identification of Tidal Flood inundation area (current and future)	Development into disaster risk assessment and damage estimation	No. 1
	Update external force conditions through data accumulation	No.1, No.2
	Consideration of the impact of land subsidence and sea level rise	No.1, No.2
	Improved land subsidence prediction accuracy	No. 13
Disaster Risk Assessment	Evaluation by hydrologic and hydraulic analysis and land subsidence analysis	No. 8,
	Consideration of the effects due to land subsidence and climate change	No.8, No.11
Economic damage according to land subsidence scenario	Reflecting unassessed items of economic damage	No.12
	Improvement of accuracy in predicting land subsidence	No.12
(3) Proposed countermeasures		
Practicing an Integrated Approach	Cooperation with Related Organizations	No.6
Maintenance and effectiveness of permeable structures and how to maintain their function	Continuous Monitoring	No.6, No.10
Proposed mitigation and adaptation measures	Concretization of proposed countermeasures, technical studies	No.11
Seawall/road structure type	Update soil survey data, modeling of embankment aging	No. 9
	Comparative study of each proposal including economic analysis	No. 9
Draft River Improvement Plan	Validity assessment by comparison of alternatives	No. 5
(4) M/P		
Proposed Spatial Arrangement Plan	Establishment of basic specifications based on technical studies of each countermeasure proposal	No.14

Source: JICA Study Team

Table 11 Results and issues of previous studies

No.	Title.	Summary	Results	Issue
1	Impact of Coastal inundation on ecology and agricultural land use case study in central Java, Indonesia (Muh Aris Marfai, 2011)	A study of the impact on the coastal environment and ecosystems due to coastal inundation, and an assessment of the impact on agricultural land use.	Based on the 100 cm and 150 cm inundation scenarios, the damaged area would be approximately 15, 207.6 ha and 16,687.31 ha, respectively. Fishponds, dry farm land, and paddy fields are mainly affected agricultural areas by coastal inundation.	Integration of microtopography and land use as a geoecological approach based on the number of survey cross-sections, distances and routes, and field observations. Assessing the risk of inundation and flood damage of agricultural land.
2	Genangan Banjir Pasang Pada Kawasan Pemukiman di Kecamatan Sayung, Kabupaten Demak-Provinsi Jawa Tengah (Petrus Subardjo, et al., 2015)	Tidal flood inundation map of Sayung District is created to identify the extent of impact on residential areas.	The area inundated by tidal flood in Sayung District, Demak regency in 2013 is 1,938.42 ha, of which 140.05 ha is residential area. The highest water level (HHWL) increase from 2004 to 2013 is found to be 13.63 and the highest HWL value used for tidal flood inundation in this study is 235.09 cm in December 2013.	The area inundated is estimated using the highest tide level data from 2004 to 2013. Updated tidal level data from 2013 onward and consideration of the effects of future land subsidence and sea level rise are needed.
3	MODELLING OF SUSPENDED SEDIMENT TRANSPORT IN COASTAL DEMAK INDONESIA BY USING CURRENTS ANALYZING (Denny Nugroho Sugianto, et al., 2017)	Observation of ocean currents and case studies of the effects on coastal erosion by structures.	Maximum current velocities of 0.098 to 0.126 m/s on the east side and 0.114 to 0.149 m/s on the north side were recorded at a depth of 6 m. The dominant direction of the current moved to the northeast.	This is an assessment of the dominant currents as of 2016, and it is necessary to accumulate data on a regular basis.
4	Shoreline Change Analysis in Demak, Indonesia (Komariah Ervita, 2017)	Shoreline changes over a 25-year period were determined by satellite image analysis. The factors contributing to these changes were identified.	The most significant shoreline changes have occurred in the Sayung and Wedung districts, with erosion in the Sayung area and sedimentation in the Wedung area. The physical factors that have had the greatest	Factors contributing to shoreline change; wind, waves, currents, and tides were discussed. However, further research is needed to prove the relevance of each factor in the future.

No.	Title.	Summary	Results	Issue
			impact on these changes are wind, waves, currents, and tides.	
5	PENGENDALIAN BANJIR SUNGAI WULAN, DEMAK, JAWA TENGAH/ FLOOD CONTROL OF WULAN RIVER, DEMAK, CENTRAL JAVA (Rasyid Kanza, et al., 2017)	A study of a river improvement plan for the WULAN River.	The design flood discharge for the 1/50 year is approximately 1759 m^3 /s. For river improvement, design cross-section with a river bottom width of 70 m and slope gradient of 1 : 3 is proposed by dredging and embankment construction.	In order to evaluate the adequacy of the river improvement plan, a comparative study of alternatives should be conducted in terms of their economic efficiency and social and environmental impacts.
6	Coastal protection by means of natural mangrove recovery: experiences from Demak (Pieter van Eijk, et al., 2018)	Results and findings from coastal protection efforts through natural restoration of mangroves in the BwN project are presented.	Implementation of a combination of infrastructure improvements, environmental restoration, and sustainable land use measures will lead to coastal resiliency, economic development, and nature conservation. It requires cooperation and a common understanding of coastal systems by stakeholders from multiple sectors. Incorporating this approach into policy, governance, and budget allocation will ensure long-term sustainability and promote "BwN" throughout the region.	The "BwN" is a tailor-made approach, and it is important to adapt project activities as the understanding of the coastal system evolves. This will require a periodic, phased implementation model and thorough monitoring. The development of appropriate legislation and proper enforcement is essential to sustain the measures over the long term.
7	Time Series of Land subsidence rate on Coastal Demak Using GNSS CORS UDIP and DINSAR(B. D. Yuwono , et al. ,2018)	The study was conducted by applying DinSAR and GNSS technology to predict the land subsidence rates in the coastal areas of Demak regency.	Based on GPS survey land subsidence rates for Demak range from 0.8 cm/year to 17.9 cm/year. The central part of Sayung district shows a higher land subsidence rate than the northern and southern parts.	DInSAR techniques need to improve accuracy using PS InSAR techniques because of the low coherence present due to temporal, atmospheric, and noise noncoherence. In order to obtain a good correlation

No.	Title.	Summary	Results	Issue
				between the methods, a stable BM should be installed for a long period of time and the results of DInSAR and GNSS analysis should be verified by level surveying.
8	Kajian Risiko Bencana Pesisir,. (Wetland International Indonesia 2018)	Conducted coastal disaster risk assessments and recommendations for integrated disaster risk management (IRM) approaches in four villages (Purworejo, Morodemak, Surodadi, and Timbulsloko).	Disaster risks (flooding, tidal flooding, coastal erosion, and access to clean water) in descending order: tidal flooding > coastal erosion > access to clean water > flooding. The IRM approach was recommended as a response to disaster risk. Based on the coastal disaster risk assessment, an IRM approach is recommended along the themes of (1) disaster risk reduction, (2) adaptation to climate change, and (3) ecosystem management and restoration.	Demak needs technical recommendations based on more multifaceted evaluations, such as hydrologic and hydraulic analyses and analyses related to land subsidence.
9	Alternative Designs for Semarang-Demak Coastal Dike and Toll Road (Rasyid Kanza, et al., 2019)	Structural and geotechnical analyses were performed on three alternative structures for the Semarang - Demak Toll Road, and the most effective and efficient alternative was proposed. Alternative Design 1: Seawall (revetment + embankment) + bank type [Afsluitdijk dike-causeway method]. Alternative Design 2: Seawall (piles + embankment [NCICD method]) + Embankment type	Alternative Design 3 is preferred over the other two proposals because it has the least amount of ground settlement. In the long run, maintenance costs, such as the need for soil re-filling due to ground settlement and road cracking due to uneven settlement, may outweigh the higher investment costs.	Improved analytical results from borehole data, proper modeling of the settlement of the embankment over time, a comparative study of the benefits and concerns of each proposal using economic analysis is needed.

No.	Title.	Summary	Results	Issue
		Alternative Design 3: Seawall (piles + embankment [NCICD method]) + deck-on-pile type [Sedyatmo Toll Road method])		
10	Managing erosion of mangrove-mud coasts with permeable dams - lessons learned (Winterwerp, J.C., et al., 2020)	The report surveys the use and examples of permeable structures, and summarizes the applications and lessons learned in Indonesia and four other countries.	For a permeable structure/dam to function, it is necessary to (1) understand and analyze the biophysical coastal system, (2) maintain the mangrove forest on a multi-decade scale as it recovers, and (3) actively involve all stakeholders.	Since the functionality of the Permeable Structure depends on the characteristics of the area, the factors presented in the conclusions of this study are only qualitative.
11	PENILAIAN RISIKO BENCANA KAWASAN PARIWISATA PANTAI SAYUNG, KABUPATEN DEMAK (Achmad Andi Rif'an, et al., 2020)	A disaster risk assessment of a tourism area in Sayung was conducted and directions for tourism development were proposed.	The Sayung coastal tourist area is at high risk of disasters, and the direction of regional development is the implementation of mitigation measures and adaptation measures against tidal flood and coastal erosion.	The risk assessment is based on the current situation. It is necessary to update the risk assessment with the accumulation of future data, as well as to consider future land subsidence and sea level rise. Specific consideration of mitigation and adaptation measures is also needed.
12	Economic assessment of subsidence in Semarang and Demak ,Indonesia (Deltares, 2021)	The economic impact in 2040 under three land subsidence scenarios is evaluated. Land subsidence scenario Business as Usual (BAU) and two alternative scenarios estimated damages between 2020 and 2040. Scenario A) After 10 years, the rate of settlement is halved compared to BAU Scenario B) After 10 years, the rate of settlement is 25 % compared to the BAU.	Under BAU (business as usual scenario), Demak's damage over 20 years is 39 trillion IDR (equivalent to about 7% of Demak's GRDP). If the rate of land subsidence is halved (Scenario A), the amount of damage is 29 trillion IDR. This avoids economic losses of 10 trillion IDR. If the subsidence rate is kept at 25 % of BAU (scenario B), the economic damage due to land subsidence in Demak is IDR 25	Economic damage to non-road infrastructure (water management, transportation, communications and energy), is not considered and is underestimated. Other potential impacts include flood risk and a less attractive business environment. A method of prioritizing adaptation and mitigation measures for Demak subsidence needs to be developed. Refinement of subsidence scenarios

No.	Title.	Summary	Results	Issue
			trillion. This measures have high investment costs, but the reduction in economic losses makes the investment worthwhile, avoiding economic losses of 14 trillion IDR in Demak (equivalent to $1.02 billion).	Accurate assessment of impacts that could not be quantified. Creating awareness of subsidence and its countermeasures among specific stakeholders
13	Analisis Multibahaya di Wilayah Pesisir Kabupaten Demak (Ni Md. Widya A. Suryanti, et al.)	Predicted trends in subsidence and increasing tides for subsidence and tidal multi-hazards in the coastal area of Demak, and examined the extent of Tidal Flood in 2025.	In the coastal area of Demak, land subsidence of 0.06 to 1.15 m per year occurs and the elevation in 2025 expect to be significantly lowered. The tidal in 2025 is projected to reach 1.63 m, thus areas with low elevation could be inundated. 57 % of the study area is projected to be inundated by tidal flood in 2025.	Since the prediction of land subsidence is based on four years of topographic data differences between 2004 and 2008, the prediction must be based on geological knowledge and engineering studies. Since the increasing trend in tides is estimated by regression analysis based on data from 2002-2012, the data needs to be updated and the regression equation needs to be updated.
14	Competition for spatial planning in Sayung district (refer 10.2.2) (Bappeda, Central Jawa, 2022)	A competition was held for the spatial arrangement of the Sayung area, with three teams winning prizes.	Three proposals won awards. The themes of each are as follows 1st Prize:The Resilient Sayung "A Water Adaptive Eco Industrial Town". 2nd Prize:Sayung Eco Industrial District, Livable and Integrated Sayung Eco Industrial District to Catalyze Sustainable Growth of Central Java 3rd Prize:Sayung anchored, Empowered, Aligned, Growing	It is necessary to set basic parameters based on engineering studies for each proposed countermeasure. To determine these parameters, surveying and soil investigation are necessary.

Source: JICA Study Team

21.4 Items to be investigated and studied in the future

Based on the current status of the Sayung area and the results of the review of existing studies and reports, this section summarizes the items to be investigated and studied in the future in order to examine measures to reduce or eliminate flooding damage due to land subsidence in the Sayung area.

In the existing survey, although the Sayung area is seriously affected by flooding due to land subsidence, observation records on land subsidence are limited, the current status of land subsidence is not fully understood, and the main causes of land subsidence are not clear.

Therefore, in considering measures (mitigation and adaptation measures) to deal with land subsidence in the Sayung area, the first step to be undertaken is a survey to "identify the main causes of land subsidence". Based on this main cause, it is important to consider mitigation and adaptation measures for land subsidence.

(1) Identification of the main causes of land subsidence

In Idonesia, there are generally four possible causes of land subsidence: (a) building loading, (b) consolidation settlement, (c) excessive groundwater pumping, and (d) plate tectonics.

It is important to identify which factor is the most significant cause of subsidence in the Sayung area and to implement countermeasures against that factor.

For reference, Table 12 lists possible countermeasures (mitigation and adaptation measures) for each cause of land subsidence. The menu of land subsidence mitigation measures will vary depending on the cause of land subsidence.

Table 12 Causes of land subsidence and possible countermeasures (reference)

Cause	Mitigation Measure	Adaptation Measure
Building Loading	Building regulations + ground improvement, etc.	Seawall construction, resettlement, etc.
Consolidation Settlement	Development regulations + ground improvement, etc.	Seawall construction, resettlement, etc.
Excessive groundwater pumping	Regulation of groundwater pumping + securing alternative water sources	Seawall construction, resettlement, etc.
Plate Tectonics	－	Resettlement, etc.

Mitigation measures： Measures to reduce the causes of land subsidence

Adaptation measures：Measures to avoid or reduce damage caused by land subsidence

Source: JICA Study Team

(2) Schedule for Investigation and Study

To identify the causes of land subsidence, necessary investigation and study items and their schedule are summarized in Table 13.

In order to understand the current status of land subsidence and identify the main causes, it is considered necessary to conduct a basic investigation to understand the current status of land subsidence, clarify the land subsidence mechanism and identify the causes, establish a land subsidence monitoring system, and make a land subsidence prediction.

Table 13 Draft Schedule for Investigation and Study

Item	Short-Term (1～3 year)	Midium-Term (4～5 year)	Long-Term (6～10 year)
1.Understanding the Current Situation of Land Subsidence, Identifying the Main Causes, and Predicting the Future	→		
1） Basic Survey	→		
・Understanding of the current situation of land subsidence (Topographical survey, Satellite image analysis (InSAR analysis))	→		
・Understanding of the current situation of groundwater level	→		
・Understanding of groundwater pumping rate	→		
・Understanding of geological structure (Boring survey, AMT* measurement, etc.)	→		
2） Clarification of land subsidence mechanism and identification of factors	→		
3） Monitoring of land subsidence and groundwater level (Establishment of monitoring system, Development of observation network/wells)	→	Monitoring ----	----→
4） Land Subsidence Prediction (one-dimensional subsidence prediction model, groundwater analysis model, etc.)	→		

Source: JICA Study Team

21.5 Consideration of Options for the Direction of Countermeasures

Based on the existing conditions and the results of the review of existing studies, the following five options were assumed for the direction of adaptation measures to avoid or eliminate tidal floods due to land subsidence.

Option 1: Offshore protection by large sea dike on the first line (Offshore large sea dike similar to toll road project in Semarang)

Option 2: Offshore protection by large-scale green infrastructure (hybrid engineering) on the first line

Option 3: Heightening of existing settlements land along the river + Secondary Levee along Route 1

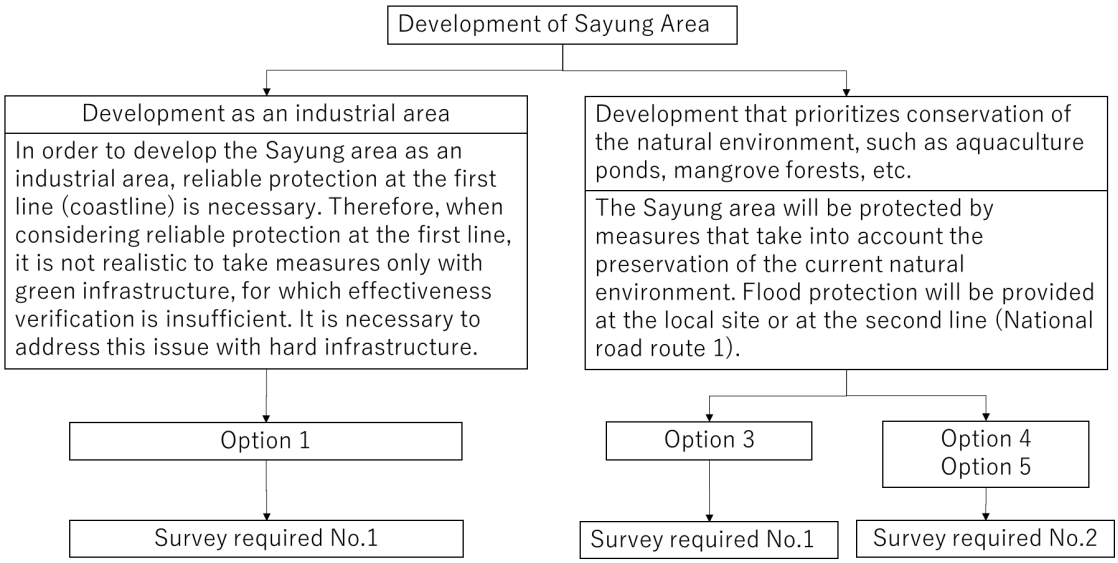
Option 4: Construction of satellite islands and relocation of existing residents along the river (+ Secondary Levee along Route 1 if necessary)

Option 5: Settlement relocation (+ Secondary Levee along Route 1 if necessary)

A qualitative preliminary evaluation of the above options with respect to the following evaluation items: outline image, safety, cost, feasibility, sustainability, flexibility, social impact, and environmental impact, was summarized in Table 14.

At this point, it is difficult to select one recommendation option due to issues such as the lack of a basic survey to identify the primary cause of subsidence and the fact that the area is designated as an industrial area in the spatial plan despite the

fact that it is severely flood-prone. For this reason, options and necessary studies are organized depending on if this area is to be developed as an industrial area or not.



Source: JICA Study Team

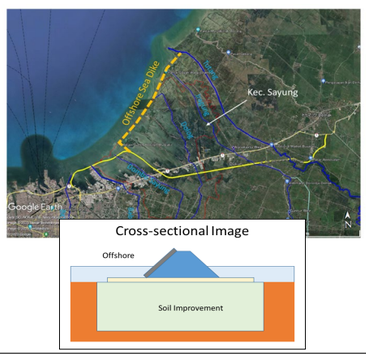
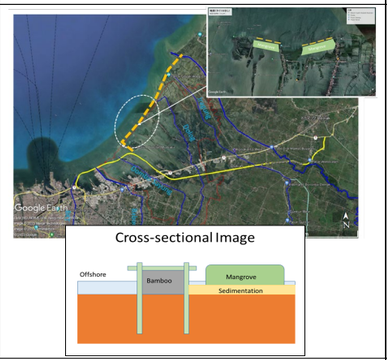
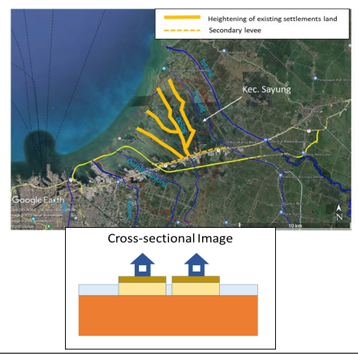
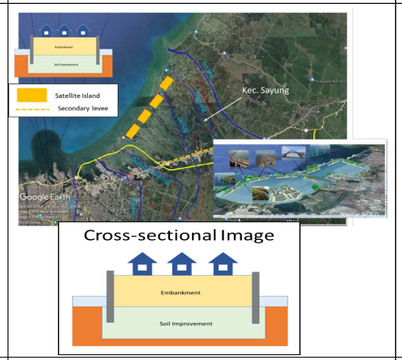
Figure 37 Future study policy for Sayung Area

Table 14 Draft schedule for investigation of necessary adaptation measures

Item	Short-Term (1～3 year)	Midium-Term (4～5 year)	Long-Term (6～10 year)
1.Understanding the Current Situation of Land Subsidence, Identifying the Main Causes, and Predicting the Future	→		
1） Basic Survey	→		
・Understanding of the current situation of land subsidence (Topographical survey, Satellite image analysis (InSAR analysis))	→		
・Understanding of the current situation of groundwater level	→		
・Understanding of groundwater pumping rate	→		
・Understanding of geological structure (Boring survey, AMT* measurement, etc.)	→		
2） Clarification of land subsidence mechanism and identification of factors	→		
3） Monitoring of land subsidence and groundwater level (Establishment of monitoring system, Development of observation network/wells)	→	Monitoring →	
4） Land Subsidence Prediction (one-dimensional subsidence prediction model, groundwater analysis model, etc.)	→		
2. Study of menu of measures to adapt to ground subsidence		→	
・Study of countermeasure method		→	
・Basic design		→	
・Estimated construction cost calculation **Survey 1**		→	
・Environmental and social considerations		→	
・Evaluation of economic feasibility		→	
3. Resettlement Planning		→	
・Basic survey		→	
・Resettlement Plan **Survey 2**		→	
・Livelihood reconstruction plan		→	

Source: JICA Study Team

Table 15 List of options for adaptation measures

	Option 1	Option 2	Option 3	Option 4	Option 5
	Protection by Hard measures in the 1st line (large offshore breakwater similar to Semarang)	Protection by Green infrastructure (hybrid engineering) in the 1st ine	Raise existing settlements along the tiver + Hard measures on the 2nd line (Route 1)	Construction of satelite islands and relocation of existing residents along the fiver (+ hard measures on the 2nd line, if necessary)	Residential migration plan (+ if necessary, Hard measures on the 2nd line (Route 1))
Image					
Outline	Protect against high tide levels by hard countermeasures at the 1st line. - Offshore sea dike* & revetment development (1st line) *The sea dike is expected to be of the same scale as the Semarang-Demak road, which is currently under construction in a road-integrated	Protect against high tide levels with green infrastructure (hybrid engineering) on the 1st line - Development of permeable structures (1st line) - Mangrove Plantation	Protect against high tide levels by raising existing settlements along rivers/drainage channels, and by hard countermeasures at the 2nd line (National Road). - Raising of residential area - Seawalls and Ernbankments development (2nd line)	Protect against high tide levels by building satellite islands and relocating existing residents along the river, in addition to hard countermeasures at the 2nd line (national road), - Satelite islands development - Seawalls and Embankments development (2nd line)	Protect against high tide levets by migrating to residential areas and by hard countermeasures at the 2nd line (national road), - Resettlement - Seawalls and Embankments development (2nd line)
Safety(Goals & Effectiveness))	Elimination of Tidal Floods	Elimination of Tidal Floods (No prescribed effect is expected during mangrove growth)	Elimination of Tidal Floods(Longer maintenance and more time required for the effects to appear)	Elimination of Tidal Floods	Elimination of Tidal Floods
Cost	Middle	Small	Huge (Compensation for temporary relocation of residence)	Huge (Compensation for relocation houses)	Huge (Compensation for relocation houses)
Feasibility	Can be handled with existing technology. Can be constructed independently without land acquisition or relocation of residents.	Traditional construction method. Effectiveness verification through demonstration testing required. Monitoring required. Can be constructed independently without land acquisition or relocation of residents.	Can be handled with existing technology. Temporary relocation af residence is required during construction.	Can be handled with existing technology. Time is needed to reach a consensus with relocated residents. Can be constructed independently without land acquisition.	Time is needed to reach a consensus with relocated residents. Appropriate relocation sites are needed
Durability	Yes (monitoring and maintenance required)	Yes (monitoring and maintenance required)	Yes (monitoring and maintenance required)	Yes (monitoring and maintenance required)	Yes (monitoring and maintenance required)
Flexibility	Yes (can be handled by Heightening)	Yes (can be handled by Heightening)	Yes (can be handled by Heightening)	Yes (can be handled by Heightening)	Yes (can be handled by Heightening)
Socail Impact	Some navigation restrictions for fishermen. Subsidence of residential areas needs to be handled separately	Some navigation restrictions for fishermen. Subsidence of residential areas needs to be handled separately	Temporary relocation of residence during construction required. No impact on fishermen.	Some navigation restrictions for fishermen.	No Impact for fishermen.
Environmental Impact	Loss of previous landscape. Consideration for mangrove forest habitat is required.	Loss of previous landscape. Possible growth of mangrove forests	Loss of previous landscape. Possible growth of mangrove forests	Loss of previous landscape. Consideration for mangrove forest habitat is required.	No impact on landscape. Mangroves can grow well
Isuues	- Soil survey for basic design is required. - Estimation of future land subsidence is necessary for setting the height of the embankment. - The problem of land subsidence in residential areas will not be solved, thus mitigation measures will be required - Appropriate maintenance is necessary.	- Soil survey for basic design is required. - Estimation of future land subsidence is necessary for setting the height of the embankment. - The problem of land subsidence in residential areas will not be solved, thus mitigation measures will be required - Appropriate maintenance is necessary.	- Soil survey for basic design is required. - Estimation of future land subsidence is necessary for setting the height of the embankment. - Regular monitoring of subsidence in residential areas is needed. - Appropriate maintenance is necessary.	- The access to the artificial islands needs to be considered - Soil survey for basic design is required. - Estimation of future land subsidence is necessary for setting the height of the embankment. - Appropriate maintenance is necessary.	- Necessary to build consensus with residents to be relocated and to secure appropriate relocation sites. - Appropriate maintenance is necessary.

Source: JICA Study Team

<Reference>

TECHNIACAL GUIDELINES #3 PERMEABLE STRUCTURES:
https://www.ecoshape.org/app/uploads/sites/2/2017/08/Technical-Guidelines-Permeable- Structures_Building-with-Nature-Indonesia-LR.pdf

Lampiran-21_Annex1
Review Study of Existing Study on Sayung District

Table 1 Case Study on the Effects of Coastal Inundation on Ecosystems and Agricultural Land Use in Central Java, Indonesia

Title: Impact of Coastal inundation on ecology and agricultural land use case study in central Java, Indonesia
Author: Muh Aris Marfai (Gadjah Mada University)

Key Word: coastal inundation, impact on ecosystems and agriculture

(1) Outline

This study provides information on ecological problems caused by coastal inundation in the northern coastal region of Central Java, Indonesia, focusing on a regional scale. The objectives are to map coastal inundation, investigate the impacts of coastal inundation on the coastal environment and ecosystems, and assess the effects of inundation on agricultural land use. Neighbor method, iterative computation, and superposition methods are integrated and applied to create digital maps and analyze the effects of inundation. Cross-profiling field observations were conducted to observe the impact of inundation on coastal ecosystems.

(2) Results

Based on the 100 cm and 150 cm inundation scenarios, the damaged area would be approximately 15,207.6 ha and 16,687.31 ha, respectively. Fishponds, dry farming, and rice paddies are the agricultural areas most affected by coastal inundation.

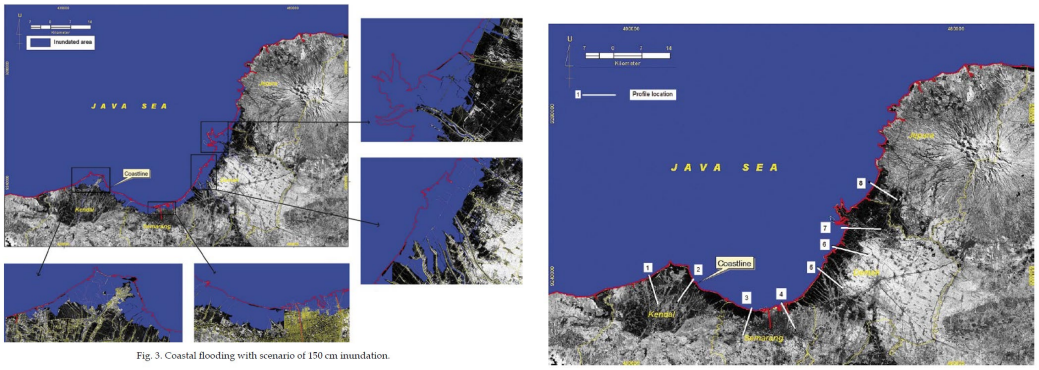


Fig. 3. Coastal flooding with scenario of 150 cm inundation.

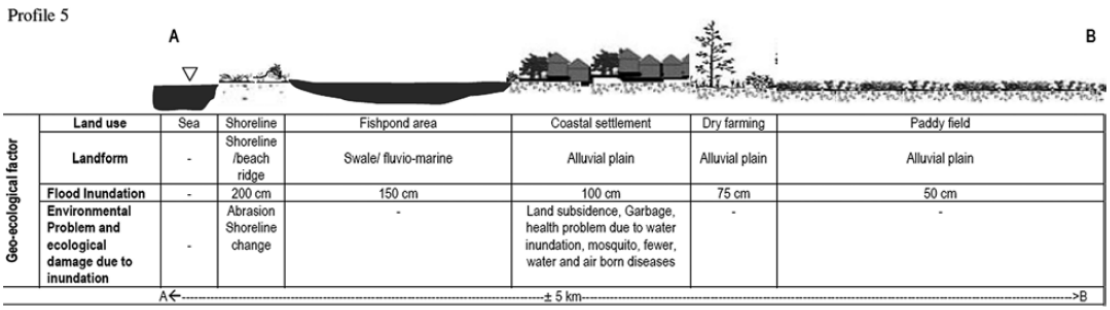


Fig. 15. 5th cross profile.

(3) Issues

Given the importance of natural resources and economic assets in the coastal zone, challenges can be seen regarding the technical modeling of coastal inundation maps for different inundation depth scenarios using GIS.

The cross-sectional profile measurement conducted in this study was evaluated to be an effective given the time and technical constraints. However, some factors remain to be considered in future studies, such as the number of cross sections, distances and routes of cross sections, and the integration of microtopographic units and land use units as a geoecological approach based on field observations.

By determining the impact of inundation on each agricultural unit, it would be possible to assess risk and calculate the amount of damage. Therefore, it was suggested that future studies also consider the productivity of each agricultural unit and the recent market value of each productivity.

Table 2 Effects of storm surge inundation events on residential areas in Sayung District, Demak Province, Central Java

Title: Genangan Banjir Pasang Pada Kawasan Pemukiman di Kecamatan Sayung, Kabupaten Demak - Provinsi Jawa Tengah

Author: Petrus Subardjo dan Raden Ario (Universitas Diponegoro)

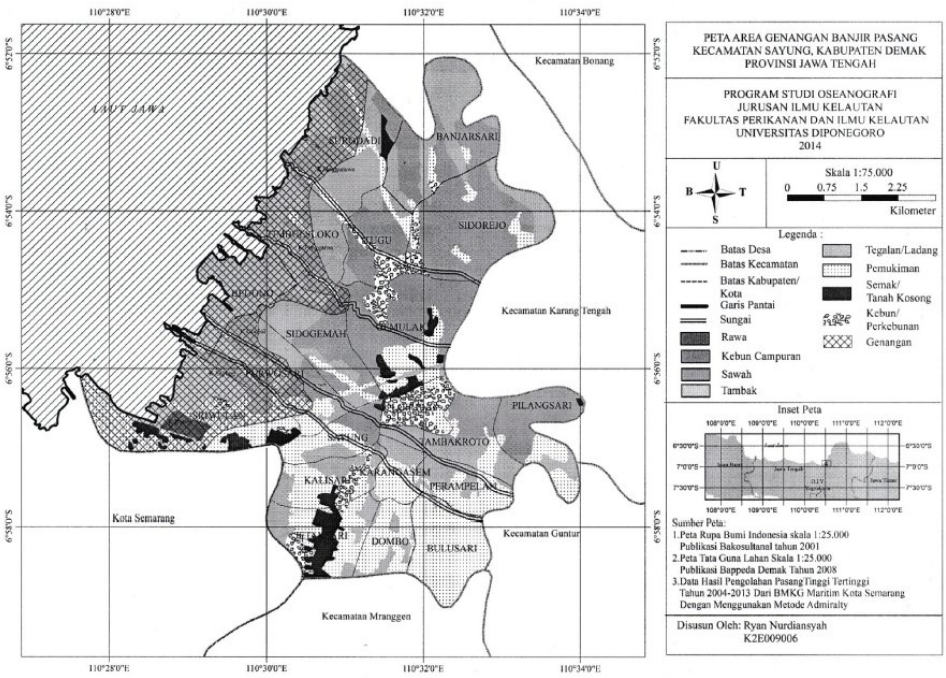
Key Word: Tidal Flood inundation map, residential area

(1) Outline

The objective of this study is to determine the highest tidal rise for each year from monthly highest water level (HHWL) data for one year. The inundation area of Tidal Flood and residential areas in Sayung District, Demak Province were mapped, based on the tidal harmonic analysis of tidal data from 2004 to 2013, analysis of the highest tidal elevation from field observations, spatial analysis of tidal inundation, and DEM (2008),.

(2) Results

The area inundated by Tidal Flood in Sayung district, Demak province in 2013 was found to be 1,938.42 ha and the area of residential land within the inundated area was 140.05 ha. The increase rate of HHWL from 2004 to 2013 was 13.63 and the highest HHWL value of Tidal Flood in this study was the HHWLvalue used for inundation which is 235.09 cm in December 2013.



Tidal Flood Range

(3) Issues

The results provide an overview of the current situation and the effects of subsidence or future projections wasn't considerd.

Table 3 Floating sediment transport modeling using tidal current analysis for the Demak coast of Indonesia.

Title: MODELLING OF SUSPENDED SEDIMENT TRANSPORT IN COASTAL DEMAK INDONESIA BY USING CURRENTS ANALYZING

Author：Denny Nugroho Sugianto,et al (Diponegoro University)

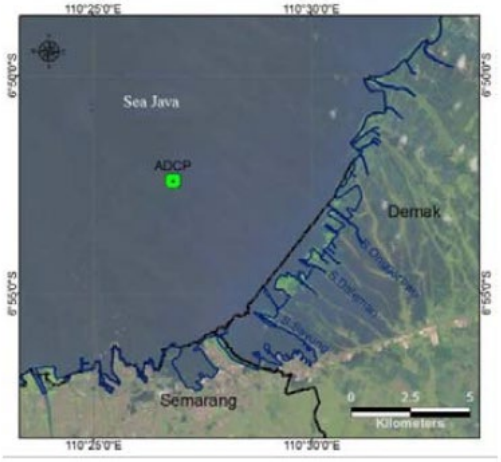
Key Word: sediment, transport

(1) Outline

This study is a case study of the effects of ocean currents and soil structures on erosion at Demak. Current measurements were made by ADCP for 7 x 24 hours during the study period of June 3-10, 2016.

(2) Results

The difference in velocity dispersion of opposing ADCP beams was used to estimate the shear stress of the flow over the bottom-mounted ADCP. The RMSE was verified by flow dynamics and velocity measurements from Sontek Argonaut observations. The highest flow velocities were found at a depth of 6 m, ranging from 0.098 to 0.126 m/s on the east side and from 0.114 to 0.149 m/s on the north side. The scatter plots show that the dominant direction of the flow is shifting to the northeast.



Location of ADCPs

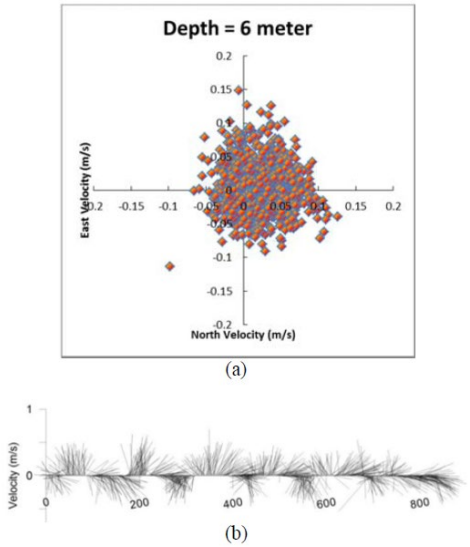


Figure-6. The pattern of ocean currents a) a scatter plot, b) stick diagram depth of 6 meters.

(3) Issues

This is an assessment of the current dominant currents as of 2016, and it is considered necessary to accumulate data on a regular basis.

Table 4 Shoreline Change Analysis in Demak, Indonesia

Title: Shoreline Change Analysis in Demak, Indonesia
Author: Komariah Ervita et al. (Universitas Gadjah Mada)

Key Word:

(1) Outline

This study was conducted to determine the shoreline changes in Demak County over a 25-year period and to identify the main factors of these changes. Shoreline change analysis was conducted in the study based on Landsat satellite imagery from multiple time periods (1990, 1994, 1999, 2002, 2008, 2011, and 2015).

Shoreline identification was performed using the band ratio, histogram threshold, and composite band 457 methods. Erosion and sedimentation analysis was performed using Wind Rose Plot (WRPLOT) for wind data, Sverdrup Munk Bretschneider (SMB) for wave prediction, mean high water level (MHWL), mean sea level (MSL), mean low water level (MLWL), minimum low water level (LLWL), and an erosion and sedimentation analysis was conducted using tidal current data processing.

(2) Results

The most significant shoreline changes occurred in the Sayung and Wedung districts, with erosion observed in Sayung and sedimentation in Wedung. The physical factors that have significantly influenced these changes include wind, waves, currents, and tides; between 1990 and 2015, the shoreline of Demak District has been significantly changed mainly by erosion and sedimentation processes.

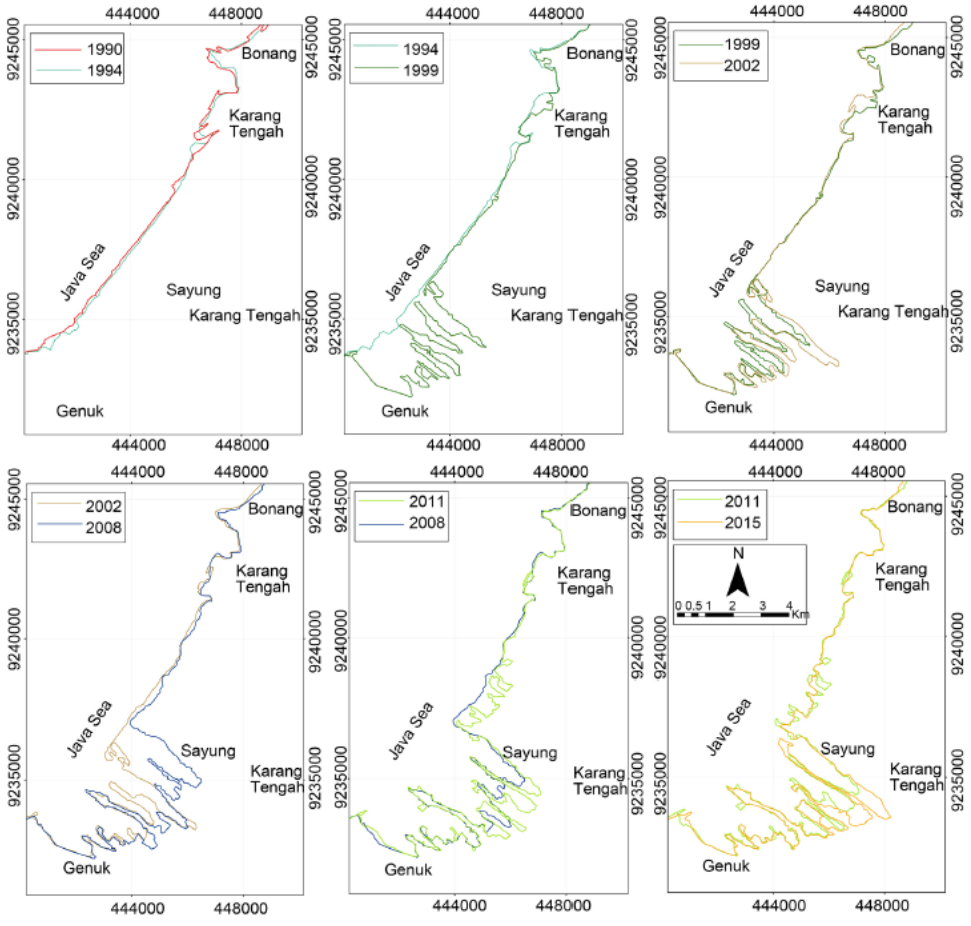


Figure 4. The shoreline change in Sayung District and Karangtengah District in 1990, 1994, 1999, 2002, 2008, 2011, and 2015.

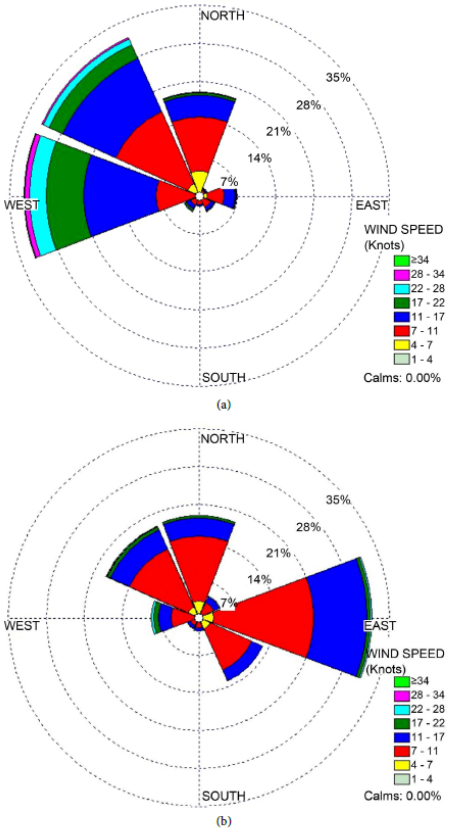


Figure 6. The Windrose diagram of the winds blowing during the west (a) and the first transitional (b) seasons of 2002-2012 in the coastal areas of Demak Regency, Indonesia.

Wind distribution on the coast of Demak province during the west monsoon and the first transitional period, 2002-2012.

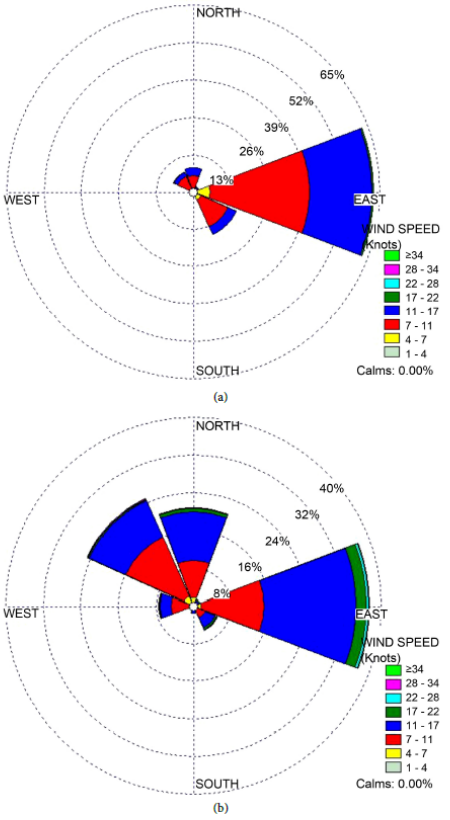


Figure 7. The Windrose diagram of the winds blowing during the east (a) and the second transitional (b) seasons of 2002-2012 in the coastal areas of Demak Regency, Indonesia.

Wind distribution on the coast of Demak province during the east monsoon and the second transitional period, 2002-2012.

(3) Issues

A unique feature of this study is the combination of satellite image data analysis methods to map shoreline changes. This study is significant, especially in the context of monitoring the coastal environment in Demak Province, where data is difficult to obtain. This shoreline change is considered to be closely related to wind, wave, current, and tidal factors. Therefore, these factors are discussed in greater depth in this study. However, as a recommendation of this study, further research is needed in the next step to prove the relevance of each factor.

Table 5 Flood Control of the Wulan River in Demak, Central Java

Title: PENGENDALIAN BANJIR SUNGAI WULAN, DEMAK, JAWA TENGAH/ FLOOD CONTROL OF WULAN RIVER, DEMAK, CENTRAL JAVA

Authors: Rasyid Kanza, Alvin Ahmada, Suseno Darsono , Pranoto Samto Atmodjo (Universitas Diponegoro)

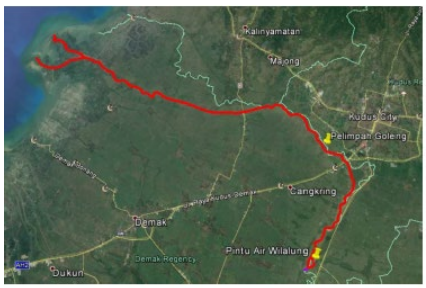
Key Word:

(1) Outline

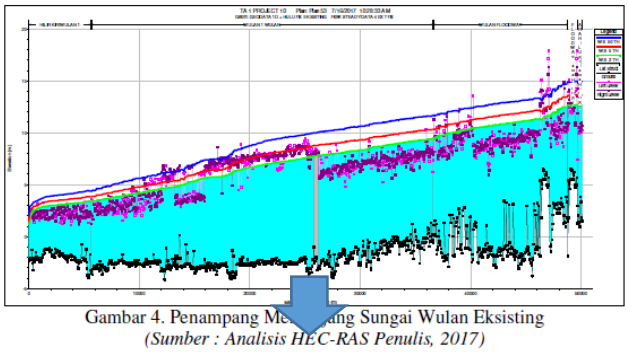
Demak is one of the flood-prone areas affected by the Wulan River; the Wulan River is a tributary of the Lusi and Serang Rivers, both of which flow into Bendung Klambu (Grobogan Province) The main problem in Demak is the long lasting waterlogging damage. Improving the river cross section of the Wulan River watershed is an alternative to address the problem of subsidence due to sea level rise.

(2) Results

Based on runoff analysis using HEC-HMS 4.0, the 50-year planned flood discharge is 1754.9 m3/sec Improvements of the Wulan River cross-section includs dredging of the riverbed and planning for a river bank. For the river improvement plan, the cross-section is trapezoidal, the bottom width is 70 m, and the gradient is 1:3. No additional cost will be required for the purchase of backfill soil, since part of the excavated soil will be used as backfill material for the river embankment. The cost of this project is Rp. 1,533,642,964,000.



Gambar 1. Lokasi Sungai Wulan
(Sumber: Google Earth,2017)

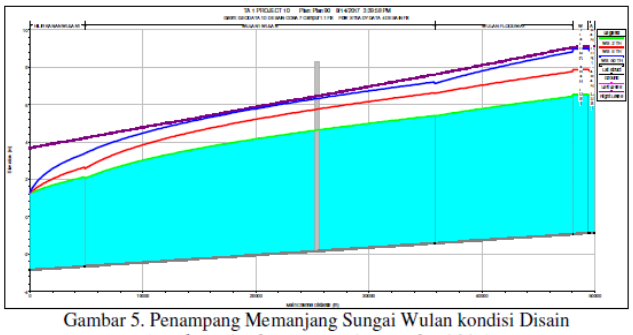


Gambar 4. Penampang Me...ng Sungai Wulan Eksisting
(Sumber : Analisis HEC-RAS Penulis, 2017)

Tabel 4. Hasil *Output* HEC-HMS

Periode Ulang (tahun)	Hasil Debit HEC-HMS (m^3/s)
2	868
5	1226,5
10	1321,2
20	1488,3
50	1754,9

(Sumber : Analisis HEC-HMS Penulis, 2017)



Gambar 5. Penampang Memanjang Sungai Wulan kondisi Disain
(Sumber : Analisis HEC-RAS Penulis, 2017)

(3) Issues

Since no impact assessment on economic evaluation and environmental and social considerations has been conducted, it is necessary to evaluate the appropriateness of the project and other aspects of the project through FS.

Table 6 Coastal protection through natural mangrove restoration: the case of Demak

Title: Coastal protection by means of natural mangrove recovery: experiences from Demak
Author(s): Pieter van Eijk, et al., 2018

Key Word:

(1) Outline

It presents the results and findings from the first mangrove nature restoration coastal protection effort of the "Building with Nature" program on the severely eroding mangrove coast of the northern coast of Java Island.

(2) Results

A combination of infrastructure development, environmental restoration, and sustainable land use measures will lead to coastal resiliency, economic development, and nature conservation. This requires cooperation and a common understanding of coastal systems by stakeholders from multiple sectors.

Incorporating this approach into policy, governance, and budget allocation will ensure long-term sustainability and promote "BwN" throughout the region.

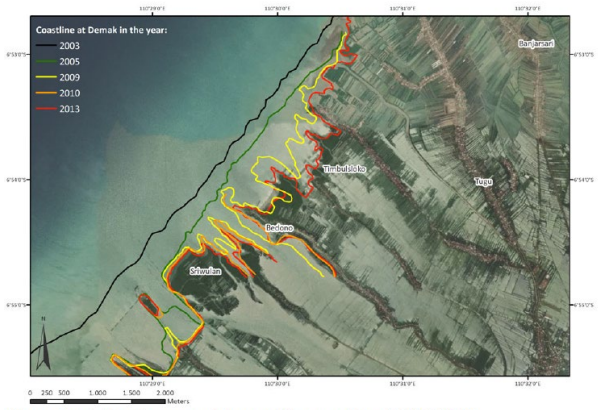


Illustration 1. Development of the coastline near Demak 2003-2013

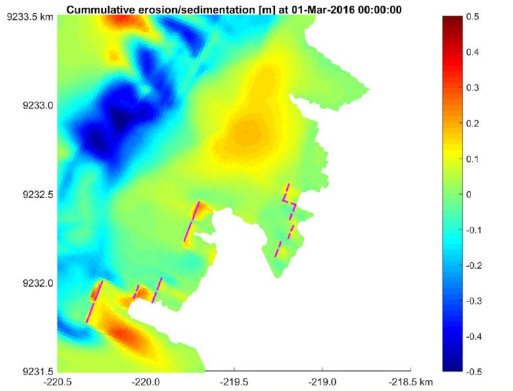


Illustration 2. Coastline near Demak, with the permeable dams (coloured) in the sea. The cumulative erosion (negative) and sedimentation (positive) can be seen during the rainy season, modelled with the aid of D-Flow Flexible Mesh (Smit, 2016).

(3) Issues

The "BwN" is a tailor-made approach, and it is important to adapt project activities as the understanding of the coastal system evolves. This will require a periodic, phased implementation model and thorough monitoring. The development of appropriate legislation and proper enforcement is essential to sustain the measures over the long term.

Table 7 Coastal Hazard Risk Analysis by Wetland International Indonesia (2018)

Title: Kajian Risiko Bencana Pesisir, (Coastal Disaster Risk Assessment)
Author: Wetland International Indonesia 2018)

Key Word:

(1) Outline

Integrated Disaster Risk Management (IRM)

IRM is a risk management approach (recommendation) that aims to increase local resilience to disasters.IRM is done along three themes: 1) disaster risk reduction, 2) climate change adaptation, and 3) sustainable ecosystem management and restoration.In Demak, a coastal disaster risk assessment is being conducted for 10 days during August 2017, led by Wetland International Indonesia, with the goal of conducting this IRM in four villages in the province (Purworejo, Morodemak, Surodadi, and Timbulsloko villages).

In each region, three indicators were quantified: a-Threat, b-Vulnerability, and c- Regional disaster preparedness, and a disaster risk score was calculated based on these indicators. The a-Threat was calculated by identifying the type of threat through interviews with informants and field observations, and then according to the duration and degree of impact. Vulnerability was calculated based on the results of interviews and literature review. In addition, c-Regional Disaster Preparedness was calculated based on the literature review.

(2) Results

The disaster risk score for each area was calculated based on four items (flooding, tidal flooding, coastal erosion, and access to clean water) (Table 1). Table 2 also shows that the four villages in Demak have the same disaster risk degree with respect to each of the four items. A comparison of each of the four categories in each area is shown in Figure 1, where the trend remains the same across the four villages, with "tidal flooding" risk being the highest, followed by "coastal erosion" and "access to clean water" risk. Flood risk is the smallest.

Table 1: Disaster Risk Score Summary for Each Region

No.	Type of threat	Scoring value			Disaster Risk Score
		Threat	vulnerability	Capacity	
Purworejo Village					
1	Flood	5	1,34	14	0,48
2	Rob	13	1,63	14	1,52
3	Coastal erosion	12	1,63	14	1,40
4	Lack of Clean Water Source	10	0,96	14	0,68
Morodemak village					
1	Flood	5	1,35	14	0,48
2	Rob	13	1,76	14	1,63
3	Coastal erosion	12	1,76	14	1,51
4	Lack of Clean Water Source	10	0,99	14	0,71
Surodadi Village					
1	Flood	5	1,34	14	0,48
2	Rob	13	1,70	14	1,58
3	Coastal erosion	12	1,70	14	1,46
4	Lack of Clean Water Source	10	0,98	14	0,70
Timbulsloko Village					
1	Flood	5	1,42	14	0,51
2	Rob	13	1,85	14	1,72
3	Coastal erosion	12	1,85	14	1,59
4	Lack of Clean Water Source	10	0,98	14	0,70

Notes: Field data results (2017), Low risk: $x \leq 0.56$, Medium Risk: $0.56 < x \leq 1.11$, High Risk: $x > 1,11$

Table 2: Disaster Risk Situation in Each Region

Risk	Purwerejo Village	Morodemak Village	Surodadi Village	Timbulsloko Villange
Flood	Low	Low	Low	Low
Rob	High	High	High	High
Coastal Erosion	High	High	High	High
Lack of Clean Water Source	Medium	Medium	Medium	Medium

Source: ICA research team based on Kajian Risiko Bencana Pesisir,J

Figure 1 Comparison of each item value in each region

Based on the coastal disaster risk assessment, the IRM approach was recommended along the following three themes

(1) Disaster risk reduction

- Provide accurate information to understand the causes of disasters
- Reflecting ecological, landscape, and climate perspectives on disaster risk and policy
- Integration of disaster risk into regional spatial planning and regional/village development planning

(2) Adaptation to climate change

- Adaptation using local resources and knowledge
- Assistance to communities for new living arrangements if relocation is necessary

(3) Ecosystem management and restoration

- Regulatory policies related to the environment (protection of coastal and wetland ecosystems, implementation of strategic environmental assessments, capacity building and restoration of buffer zone ecosystems, etc.)

(3) Issues

Demak needs technical recommendations based on more multifaceted evaluations, such as hydraulic analyses and analyses related to land subsidence.

Table 8 Alternative Designs for Semarang-Demak Coastal Dike and Highway

Title: Alternative Designs for Semarang-Demak Coastal Dike and Toll Road

Authors: Andojo Wurjanto*, Julfikhsan Ahmad Mukhti & Shinta Ayuningtyas (Coastal Engineering Research Group,)

Key Word:

(1) Outline

Alternative designs supporting the proposed construction of the Semarang-Demak section of the North Java Coastal Toll Road planned in the PUPR were presented and recommendations based on design analysis and past experience were provided. Detailed engineering calculations of the dimensions of each alternative structure were also performed from available secondary data. The structural and geotechnical analyses were used to find the most effective and efficient alternative, taking into account concerns based on past design experience.

(2) Results

Reasonably detailed structural and geotechnical analyses were performed for the three alternatives. Design alternative 3 is preferred over the other two alternatives because it is least affected by subsidence, which is a concern with the large embankments presented in design alternatives 1 and 2. However, in the long term, there are concerns about maintenance costs, such as the need to refill the soil due to subsidence and cracking of the roadway due to uneven subsidence.

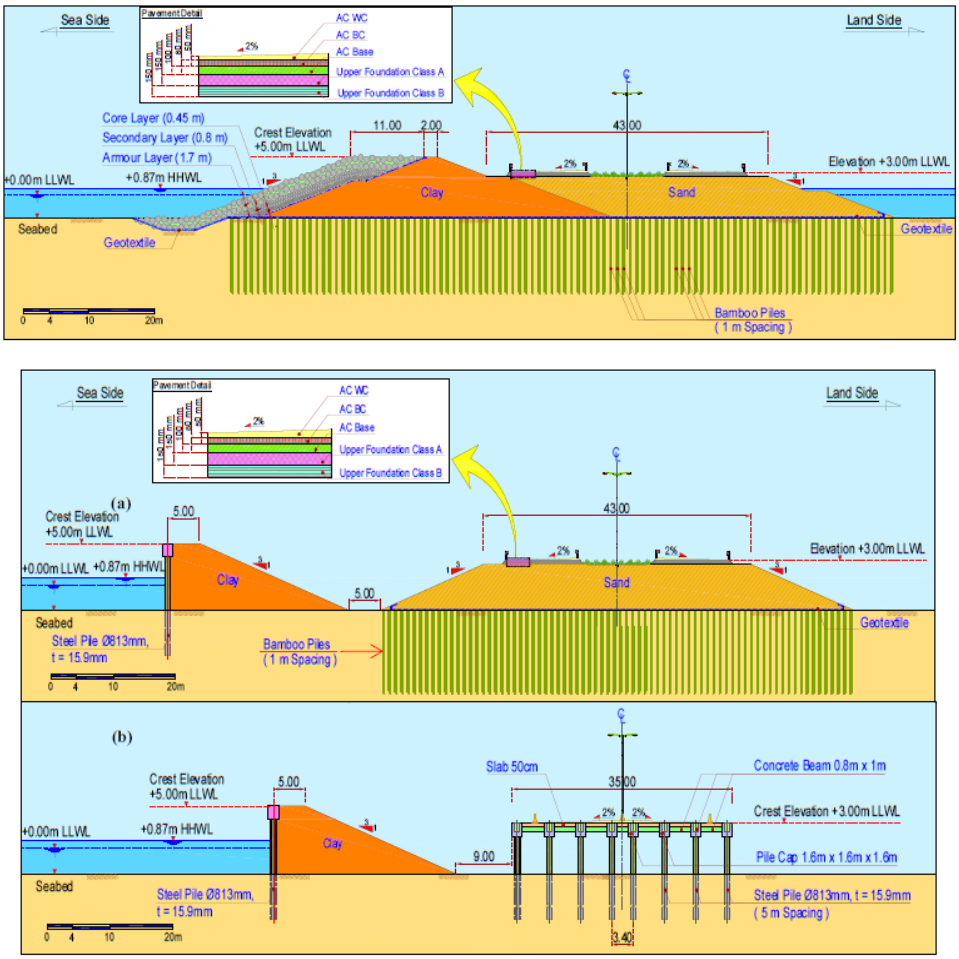


Figure 1: Seawall + road structure alternatives (design alternatives 1, 2, and 3 from above)

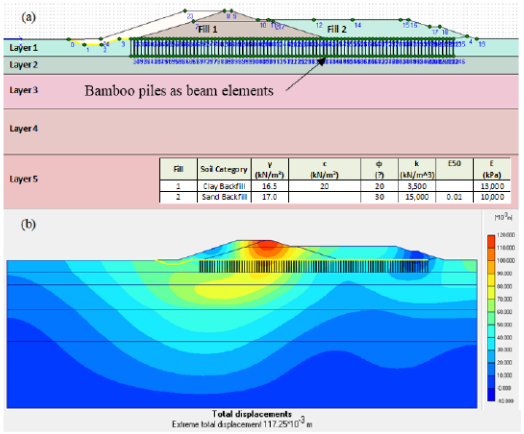


Figure 7 Geotechnical software (a) model for Design Alternative 1 and its (b) displacement analysis result.

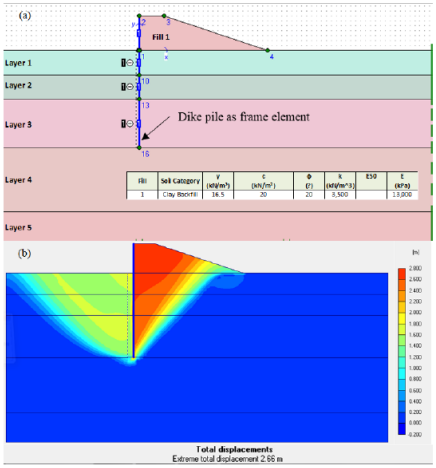


Figure 8 Geotechnical software (a) model for Design Alternative 2 and 3 and their (b) displacement analysis result.

Figure 2: Geotechnical analysis results

(3) Issues

A more accurate geotechnical boring log is expected to improve with respect to soil bearing capacity. Better geotechnical data will also allow for proper modeling of the settlement over time of the embankments presented in Design Alternatives 1 and 2. Finally, a more comprehensive comparison of the benefits and concerns of each proposal can be made using economic analysis.

Table 9 Erosion control of mangrove mudbanks by permeable structures and dams

Title.	Managing erosion of mangrove-mud coasts with permeable dams -lessons learned (Winterwerp, J.C., et al., 2020)
Outline	A survey of 15 years of applications and successes of permeable structures/ dams was conducted. Specific examples of adaptations and lessons learned in Guyana, Suriname, Indonesia, Thailand, and Vietnam were summarized. The relationship between the structures and the biophysical coastal system was analyzed and an associated cost summary was also presented. The principles for using this structure were referred to the Building with Nature project.
Conclusion.	For a permeable structure/dam to function, it is necessary to (1) understand and analyze the biophysical coastal system, (2) maintain the mangrove forest on a multi-decade scale as it recovers, and (3) actively involve all stakeholders.
Issue	The functionality of the Permeable Structure when adapted depends largely on the characteristics of the region. Therefore, the elements presented in the conclusions of this study are only qualitative.

Table 10 Disaster Risk Assessment of Sayung Tourist Site, Demak Province

Title: PENILAIAN RISIKO BENCANA KAWASAN PARIWISATA PANTAI SAYUNG, KABUPATEN DEMAK

Author : Achmad Andi Rif'an, Agatia Wenan Tyawati, (Sekolah Tinggi Pariwisata Ambarrukmo, Yogyakarta, Indonesia)

Key Word:

(1) Outline

Sayung tourist area is located in the coastal region of Sayung District and consists of three tourist attractions (Morosari Beach, Mangrove Forest, and Tomb of Sheikh Mudazakir) and has been experiencing Tidal Flood and coastal erosion for several years. In this study, disaster hazard, vulnerability and community disaster response capacity were identified and risk assessment of Tidal Flood and coastal erosion in Sayung tourist area was conducted. Directions for tourism development based on disaster risk were proposed. Development directions for the area indicate the implementation of adaptation and mitigation measures against Tidal Flood and coastal erosion.

(2) Outputs

1) Results

Villages at medium disaster risk are Purworejo Village, Betahwalang, Morodemak, and Margolinduk (Bonang Subdistrict) on the north coast, and Tambakbulusan (Karangtengah Subdistrict) and Surodadi. Villages with high disaster risk are Sidogemah, Timbulsloko, Bedono, and Sriwulan.

Mitigation measures against tidal flood and coastal erosion are mangrove planting, establishment of APOs. Adaptation measures are preparation of SAR (search and rescue) teams, provision of evacuation buildings, raising the land around tourist sites (backfilling), and conversion of facilities around tourist sites to pilotis and stilts.

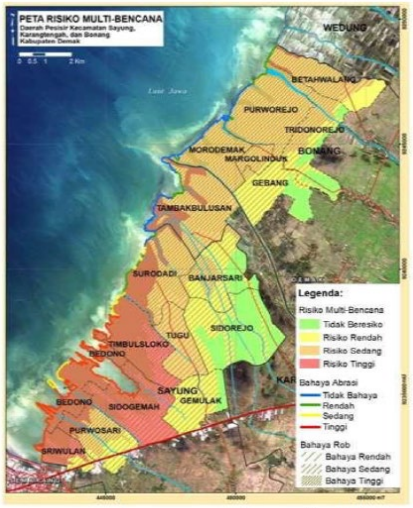


Figure 9: Map of Sayung Coastal Area Risk of Disasters

2) Advice

Based on the results of mapping, observations, and consultations with stakeholders and communities at the study sites, the following recommendations can be made.

1. Integrated planning disaster management efforts are urgently needed for erosion and tidal floods in the coastal areas of Demak Province.

2. A place (forum) is needed to accommodate people from all kinds of life-style to coordinate and work on disaster risk reduction.

3. Collaboration among stakeholders, including government, tourism managers, communities, and academia, is needed for better weather and tourism management.

(3) Issues

Conditions for hazard identification are unclear, and risk assessment is made based on only current conditions. It is necessary to update the risk assessment after data accumulation and to consider future risk assessment that takes into account future land subsidence and sea level rise. Specific consideration of mitigation and adaptation measures is also necessary.

Table 11 Economic Evaluation of Subsidence in Semarang and Demak

Title: Economic assessment of subsidence in Semarang and Demak ,Indonesia
Author: Deltares, 2021

Key Word:

(1) Outline

1) Purpose of the survey

This study evaluated the economic impacts under different subsidence scenarios.

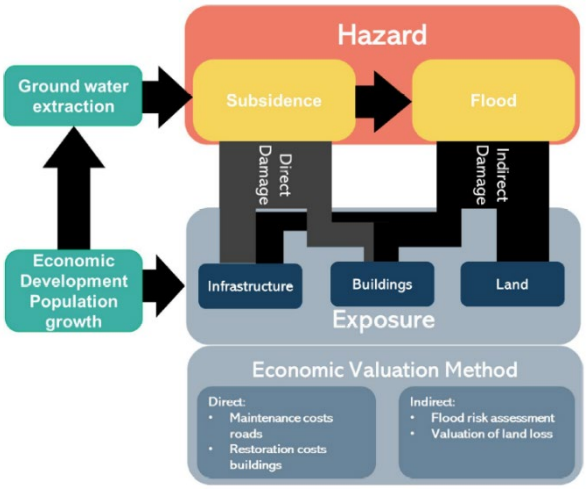
An economic impact assessment provides an economic rationale for implementing mitigation measures and can assist in decision-making. It can also identify and quantify the benefits of taking action by comparing the economic impacts of subsidence as usual (without additional measures) with those of alternative scenarios (with additional measures).

2) Damage to surveyed objects

The study quantifies direct damage to roads and buildings and indirect damage from land loss due to increased flood risk and reduced area below mean sea level. Indirect economic damage, such as damage to other infrastructure (drainage, sewage, railroads, etc.), transportation disruptions, and production losses, were not quantified.

3) Subsidence scenario

Damage between 2020 and 2040 was estimated for Business as Usual (BAU) and two alternative scenarios. Under Scenario A, the rate of subsidence was estimated to be half that of the BAU after 10 years, and under Scenario B, the rate of subsidence was estimated to be 25% of that of the BAU after 10 years.



Schematic diagram of the relationship between land subsidence factors (green), hazard (red), exposure (gray-blue), and economic valuation methods used

(2) Outputs

1) Results

Under BAU (business as usual scenario), Demak's damage over 20 years could be 39 trillion IDR (equivalent to about 7% of Demak's GRDP).

If the rate of subsidence is reduced by half (Scenario A), the economic damage due to subsidence is estimated to be 29 trillion IDR. 10 trillion IDR of damage could be prevented in this case.

If the subsidence rate is controlled to 25 % of BAU (scenario B), the economic damage due to land subsidence in Demak would be 25 trillion IDR. The measures to control the land subsidence rate to 25 % have higher investment costs, but the reduction in economic losses indicates that the investment is worthwhile. In this case, economic losses of 14 trillion IDR could be avoided in Demak (equivalent to $1.02 billion).

Table 1: Economic losses due to land subsidence (2020-2040)

Effect	Damage in Semarang (billion IDR)			Damage in Demak (billion IDR)		
	A	B	BAU	A	B	BAU
Direct						
Increased road maintenance	1,350	1,200	1,700	800	700	1,000
Increased arterial road maintenance	750	670	950	550	480	680
Damage to buildings	50	50	70	5	4	70
Damage to other infrastructure	PM	PM	PM	PM	PM	PM
Indirect						
Land Loss	56,000	14,000	76,000	27,000	23,000	37,000
Increased Coastal Flood risk	300	350	250	150	180	140
Increased pluvial and fluvial flood risk	PM	PM	PM	PM	PM	PM
Reduced attractiveness of business climate; lower agricultural yields	PM	PM	PM	PM	PM	PM
Lower quality of life population	PM	PM	PM	PM	PM	PM
Total (present value in billion IDR)	58,500	16,300	79,000	28,500	24,300	39,000

PM: Pro Memorie : to be remembered when reviewing results from this study. All cells marked with PM were not included in the analysis.

(3) Issues

This result is an underestimate as it represents only a portion (estimated at 60-80 %) of the total economic damage caused by subsidence in Demak. Subsidence impacts on non-road infrastructure, such as water management infrastructure (water and sewer pipes, drains, pumping stations, and levees), transportation infrastructure (railroads, ports, and airports), and communication and energy infrastructure (oil and gas pipes and cables) are also likely to be significant. Other significant impacts could include increased flood risk and a less attractive business environment.

It is recommended that a method be developed to prioritize adaptation and mitigation measures for land subsidence in Demak. This will require a more refined assessment of impacts that could not be quantified in this study, more interviews with local stakeholders, quantification of the effects of the proposed measures on reducing damage from subsidence, and a more refined scenario evaluation under BAU (degree of economic development, climate change). It is also recommended that an exercise be conducted to raise awareness about subsidence and its countermeasures.