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Abrasion and Accretion Analysis in Demak, Indonesia Coastal for Mitigation and Environmental Adaptation

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ABSTRACT

The purpose of this study was to analyze abrasion at the border of Sayung, Demak, Indonesia. Coastal abrasion data were obtained from high-resolution images from 2005-to 2017 by using ArcGIS 10.3, while data on environmental factors that affected abrasion, including tides from 2013-to 2017, was obtained from *BMKG*. Based on the analysis and calculations, the area of abrasion at the coast of Sayung, Demak was 262.74 hectares spread over four villages, namely Sri Wulan, Bedono, Timbulsloko, and Surodadi. Avifauna in the mangroves will be severely harmed by abrasion. As a result, abrasion prevention and evaluation, as well as the factors that cause abrasion, are required to reduce the impact of abrasion on the specified shore.

INTRODUCTION

Natural processes such as erosion and natural disasters place a high priority on sustainable management in coastal areas (Ghosh et al. 2015). However, as a result of global climate change, the threat to coastal areas has increased. The incidence of large waves and rising sea levels can pose a concern. Because the shore is directly near to the ocean, this circumstance will result in environmental issues such as flooding and abrasion along the coast.

Coastal abrasion is the erosion of coastal areas due to waves that continue to hit the coast. This abrasion will usually befall the coastal area due to the absence of a protective beach (Irsadi et al. 2019a). This will cause floods in the coastal areas and erosion. Coastal abrasion can generally be caused by two things, first naturally and second by human activities (Akbar et al. 2017).

Coastal abrasion occurs everywhere. In the UK, around 17% of the coastline changes were estimated by coastal erosion, while in Ireland, shoreline changes are estimated at 20% due to coastal erosion (Masselink & Russel 2013). Coastal abrasion also occurred on the northern coast of Central Java, Indonesia. Abrasion was felt throughout the coast of Central Java, Indonesia, including near the boundary of Semarang and Demak, among other places (Irsadi et al. 2019b). For example, abrasion caused coastal damage in Tugu Subdistrict, Semarang, Indonesia (Prihatanto et al. 2013), while abrasion occurred in Sayung District, Demak Regency, Indonesia (Prihatanto et al. 2013, Marfai 2012). With flooding and coastal erosion in the Sayung area, Demak urges around 221 houses in Bedono village (one of the villages in Sayung Sub-district, Demak) to move to other areas (Asiyah et al. 2015). This condition was triggered by high waves from the ocean. Abrasion might disrupt the coastal ecosystem. One of the ecosystems on the beach is the mangrove. Disruption to the mangrove ecosystem will ultimately disrupt the organism that depends on mangroves. Avifauna uses mangroves to live and get food, therefore the abrasion that occurs on the coast of Sayung, Demak, Indonesia, will affect the avifauna's livelihood.

As a result, it is required to carry out abrasion mitigation and adaptation activities. Mitigation efforts are linked to environmental consequences and determine the trigger, allowing adaptation efforts to be determined, which can be done through the community's active participation. It is possible to adapt to abrasion so that detrimental effects are reduced both now and in the future.

This paper aimed to analyze the impacts of abrasion at the border of Sayung, Demak, Indonesia beaches, and the initiative and active participation of the community to overcome abrasion.

MATERIALS AND METHODS

Abrasion Data Collection

Quickbird high-resolution pictures from 2005 to 2017 were used to collect abrasion data. Between 2005 and 2017, considerable abrasion and accretion were recorded in Sayung District, Demak, Indonesia. ArcGIS 10.3 was used to perform extensive abrasion and accretion calculations. Computers running ArcGIS 10.3 software were used to determine the degree of abrasion and accretion. Materials used to determine the degree of abrasion and accretion in Sayung Subdistrict, Demak, Indonesia included an Indonesian Earth map, time-series image data from 2005 to 2017 on the shore of Sayung, Demak, Indonesia, and Landsat pictures from 2005 to 2017.

Fauna Data Collection

The fauna observed in this study was birds. Bird observation was carried out directly in the study area by exploration. Observation of birds was done by using binoculars. The bird species observed were identified by the MacKinnon Field Guidebook (1998). The bird observation technique was carried out by making a list of bird species observed throughout the study location during the observation time. Recorded bird species should not be recorded twice in one list (MacKinnon et al. 1994). Identification of bird species was made in two ways: first identification directly in the field based on its morphological form (Howes et al. 2003), including (i) body shape and size, beak, and leg, (ii) color of feathers, and feet, (iii) distinctive features, and (iv) sound produced. The second identification was done in a laboratory-based on field documentation results in the form of photographs. Observations were conducted from June 2018 to March 2019.

Analysis of Abrasion And Accretion Data

The first phase involved gathering satellite image data in Sayung Subdistrict, Demak, in 2005, 2010, and 2017 in four villages/districts damaged by abrasion: Sri Wulan, Bedono, Timbulsloko, and Surodadi. The information extraction stage was followed by a radiometric correction. The radiometric adjustment was used to reorder the reflected values recorded by sensors that approach or have a pattern that fits the recording wavelength, such as the reflection of an object. The third step used Landsat geometric adjustment, which resulted in consistent coordinates and scale, as well as the image's north-south direction matching that of the map, allowing it to be positioned between the two (Parman 2010, Arief et al. 2011). Digital digitization was the fourth stage. The fifth stage involved analysis and calculation, which involved combining the digitization findings to determine the area affected by abrasion or accretion.

RESULTS

According to satellite imagery, the coastal area of Sayung, Demak, Indonesia, is an open area, making it a connecting connection between land and sea, making it easier for fishermen to reach the sea. On the other side, open regions render Sayung, Demak, Indonesia's coastline areas vulnerable to abrasion from big waves.

Abrasion in Sayung, Demak, Indonesia areas occurred in Sri Wulan, Bedono, Timbulsloko, and Surodadi. The results of digitizing ArcGIS on the area of abrasion and accretion that occurred in Sayung, Demak, Indonesia Districts are shown in Table 1.

Birds Found in Sayung Coastline

We discovered 61 bird species based on identification, as shown in Fig. 1 and reported in Table 2. The Environment and Forestry Ministerial Decree (Permen LHK) No. 20 the Year 2018 protects eighteen species recognized**.**

DISCUSSION

Based on Table 1, It can be seen that the abrasion that occurred in Sayung Subdistrict, Demak, Indonesia was so vast. In contrast, the accretion that occurred was not proportional to the abrasion process. Field data show that from June 2018 to March 2019 in the Sisenik area (Bedono, Sayung, Demak), there has been 3-5 meters of abrasion. This causes a reduction in land directly adjacent to the ocean. The abrasion was caused, among other things, by the presence of ocean waves, which have been more common in recent years (Irsadi et al. 2019a, 2019b). Furthermore, the temperature of the environment has risen (Fig. 3 and 4).

Fig. 3 shows that the wave height in the Demak area at each stage tends to increase. This makes alertness and efforts to deal with abrasion in the Sayung, Demak area. It should also be noted that the trend of increasing temperatures in the Sayung, Demak, Indonesia regions.

The average temperature in the Demak area has increased between particular months, as seen in Fig. 4. The fact that the state of abrasion, wave height, and temperature have all

Table 1: Area of abrasion and accretion in Sayung, Demak in 2005-2017.

No.	Site	Abrasion is [ha]	Accretion area [ha]
1	Sriwulan	14.58	-
2	Bedono	109.91	4.75
3	Timbulsloko	96.76	-
4	Surodadi	41.49	1.12
	Total area	262.74	5.87

Table 2: Birds in Semarang-Demak coastline and its conservation status.

No.	Local name	Species	Location		Conservation status	
			TS	B	IUCN	Permen LHK No. P.20/2018
1	Pecuk-ular asia	*Anhinga melanogaster*	v	v	NT	Protected
2	Pecuk padi hitam	*Phalacrocorax sulcirostris*	v		LC	Not Protected
3	Cikalang Christmas	Fregata andrewsi	v		CR	Protected
4	Cangak abu	*Ardea cinerea*	v	v	LC	Not Protected
5	Cangak merah	*Ardea purpurea*	v	v	LC	Not Protected
6	Cangak besar	*Ardea alba*	v	v	LC	Protected
7	Kuntul kerbau	*Bubulcus ibis*		v	LC	Not Protected
8	Kuntul karang	*Egretta sacra*		v	LC	Not Protected
9	Kuntul cina	*Egretta eulophotes*		v	VU	Protected
10	Kuntul perak	*Ardea intermedia*	v	v	LC	Not Protected
11	Kuntul kecil	*Egretta garzetta*	v	v	LC	Not Protected
12	Kokokan laut	*Butorides striata*	v	v	LC	Not Protected
13	Blekok sawah	*Ardeola speciosa*	v	v	LC	Not Protected
14	Kowak-malam abu	*Nycticorax nycticorax*	v	v	LC	Not Protected
15	Bangau bluwok	*Mycteria cinerea*	v	v	EN	Protected
16	Ibis rokoroko	*Plegadis falcinellus*		v	LC	Protected
17	Elang bondol	*Haliastur indus*	v	v	LC	Protected
18	Sikep-madu Asia	*Pernis ptilorhynchus*	v		LC	Protected
19	Kareo padi	*Amaurornis phoenicurus*			LC	Not Protected
20	Cerek kernyut	*Pluvialis fulva*	v		LC	Not Protected
21	Cerek besar	*Pluvialis squatarola*	v		LC	Not Protected
22	Cerek Melayu	*Charadrius peronii*	v		NT	Not Protected
23	Cerek tilil	*Charadrius alexandrinus*	v		LC	Protected
24	Cerek Jawa	*Charadrius javanicus*	v		NT	Protected
25	Cerek-pasir Mongolia	*Charadrius mongolus*	v		LC	Not Protected
26	Gajahan penggala	*Numenius arquata*	v		NT	Protected
27	Trinil pantai	*Actitis hypoleucos*	v	v	LC	Not Protected
28	Trinil kaki-hijau	*Tringa nebularia*	v		LC	Not Protected
29	Trinil bedaran	*Xenus cinereus*	v		LC	Not Protected
30	Terik asia	*Glareola maldivarum*	v	v	LC	Protected
31	Dara-laut sayap putih	*Chlidonias leucopterus*	v		LC	Protected
32	Dara-laut biasa	*Sterna hirundo*	v	v	LC	Protected
33	Dara-laut jambul	*Sterna bergii*	v		LC	Protected
34	Dederuk Jawa	*Streptopelia biorquata*	v	v	LC	Not Protected
35	Tekukur biasa	*Streptopelia chinensis*	v	v	LC	Not Protected
36	Perkutut Jawa	*Geopelia striata*	v		LC	Not Protected

Table cont...

No.	Local name	Species	Location		Conservation status	
			TS	B	IUCN	Permen LHK No. P.20/2018
37	Wiwik Lurik	*Cacomantis sonneratii*	v	v	LC	Not Protected
38	Wiwik uncuing	*Cacomantis sepulcralis*	v	v	LC	Not Protected
39	Bubut jawa	*Centropus nigrorufus*	v		VU	Protected
40	Cabak kota	*Caprimulgus affinis*	v	v	LC	Not Protected
41	Walet linchi	*Collocalia linchi*	v	v	LC	Not Protected
42	Kapinis rumah	*Apus affinis*	v		LC	Not Protected
43	Raja-udang biru	*Alcedo coerulescens*	v	v	LC	Not Protected
44	Cekakak australia	*Todiramphus sanctus*	v	v	LC	Not Protected
45	Cekakak sungai	*Todiramphus chloris*	v	v	LC	Not Protected
46	Kirik-kirik laut	*Merops philippinus*	v	v	LC	Not Protected
47	Caladi ulam	*Dendrocopos macei*	v		LC	Not Protected
48	Layang-layang batu	*Hirundo tahitica*	v	v	LC	Not Protected
49	Cucak kutilang	*Pycnonotus aurigaster*	v	v	LC	Not Protected
50	Remetuk laut	*Gerygone sulphurea*	v	v	LC	Not Protected
51	Cici padi	*Cisticola juncidis*		v	LC	Not Protected
52	Perenjak padi	*Prinia inornata*		v	LC	Not Protected
53	Kipasan belang	*Riphidura javanica*	v	v	LC	Protected
54	Kekep babi	*Artamus leucorynchus*	v	v	LC	Not Protected
55	Burung-madu sriganti	*Nectarinia jugularis*	v	v	LC	Not Protected
56	Cabai Jawa	*Dicaeum trochileum*			LC	Not Protected
57	Kacamata Jawa	*Zosterops flavus*	v		VU	Protected
58	Bondol Jawa	*Lonchura leucogastroides*	v	v	LC	Not Protected
59	Bondol Peking	*Lonchura punctulata*	v	v	LC	Not Protected
60	Bondol Haji	*Lonchura maja*	v	v	LC	Not Protected
61	Burung-gereja Erasia	*Passer montanus*	v	v	LC	Not Protected

increased implies that there is a link between the variables. High waves would be triggered by an increase in ambient temperature on the continent and the ocean. The increasing waves may cause abrasion along the coastline of Sayung, Demak, Indonesia. In the Sayung and Demak, Indonesia regions, significant rainfall influences temperatures in addition to waves and abrasion.

Abrasion occurred and the mentioned environmental aspects also determine the soil structure. Soil conditions in the form of mud and sand will be more prone to erosion than rocky areas (Masselink & Russel 2013). Based on an analysis of the soil's texture on the coast of Sayung, Demak, Indonesia, it is known that the composition of the soil consists of sand between 1-43%, dust between 8-85%, and clay between 2-86%. The composition of the land on the coast of Sayung, Demak, Indonesia in the form of sand, dust, and clay also makes it a factor that makes the area susceptible to abrasion.

The continuous abrasion will break the coast of Sayung, Demak, Indonesia since the ocean strongly influences the coastal ecosystem. As part of it, Mangroves will be damaged and crashed due to abrasion, as shown in Fig. 5 (Gilman et al. 2006).

Fig. 5 shows visible damage on the coast of Sayung, Demak due to wave stroke. This episode is one of the factors contributing to the destruction of mangroves in Sayung, Demak, Indonesia. Damage to mangroves disrupts mangrove inhabitants, such as birds that live in or forage in mangrove forests. Birds are disturbed by a variety of natural activities

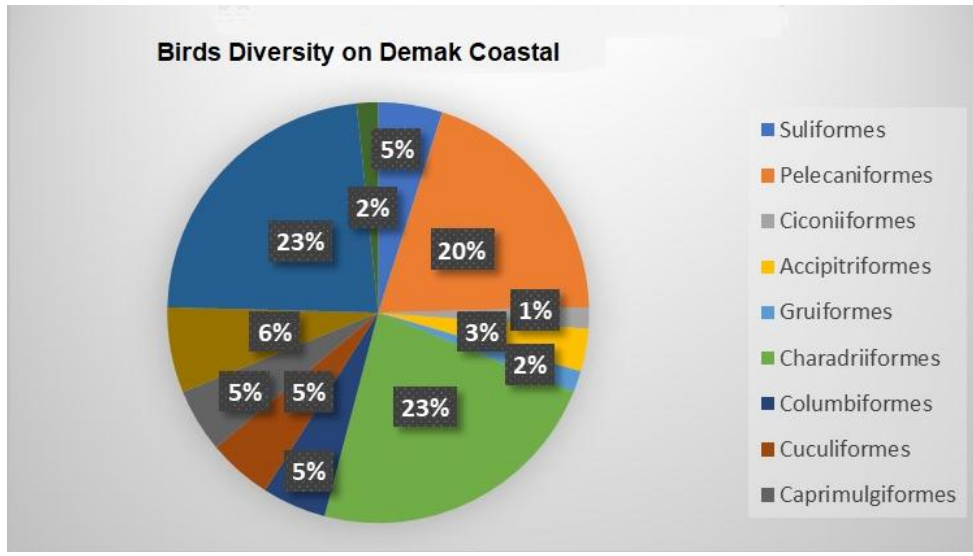

Fig. 1: Birds diversity at Demak coastal based on its ordo.

Fig. 2: Protected birds species at Demak coastal.

carried out by humans, including the sound of motorboats, kayaking, and even observation activities (Mayo et al. 2015).

According to Table 2, the study location has two types of bird species: unprotected bird species and protected bird groups. Both of these groupings can be found in the Bedono and Timbulsloko Villages' mangrove ecosystems. It demonstrates that the two research sites are appropriate habitats for these creatures. The two research locations are compatible in terms of foraging for fruit or other creatures such as invertebrates, as well as providing a home for these bird species. If one area changes (as an example of continued abrasion, without improvement) so that mangrove forests are collapsed or damaged, then the species of birds found in the two study sites are mainly protected species (*Anhinga melanogaster,*

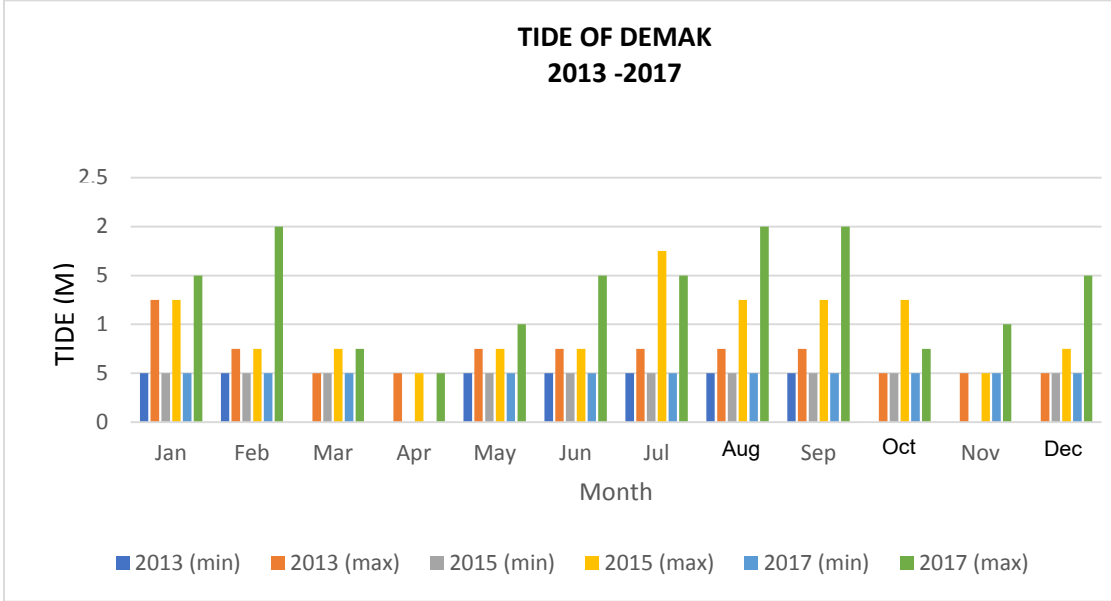

Fig. 3: The tide in Semarang and Demak in 2013-2017.

Ardea alba, Haliastur indus, Glareola maldivarum, Sterna hirundo, and *Riphidura javanica*) will experience disruption. Still, because the birds are in two research locations, it is possible to migrate from one place to another because the two research sites have mangrove species that are not much different (Elfidasari & Junardi 2006, Suripto & Hamidy 2006). However, if the protected species is only found in one of the research locations (*Fregata andrewsi, Egretta eulophotes, Plegadis falcinellus, Ptilorhynchus varnish, Charadrius alexandrinus, Charadrius javanicus, Chlidonias leucopterus, Sterna bergii, Centropus nigrorufus, Zosterops flavus*), there will be interference in the group this second bird so that further research is needed regarding the suitability of the area to support this type of life.

Mangroves have other land recovery functions in addition to being a life-sustaining avifauna (Muharam 2014). Furthermore, the presence of mangroves can reduce the impact of disasters on the shore (Karminarsih 2007), as well as prevent erosion and seawater infiltration (Salim et al. 2016). As a result, abrasion must be avoided by constructing coastal

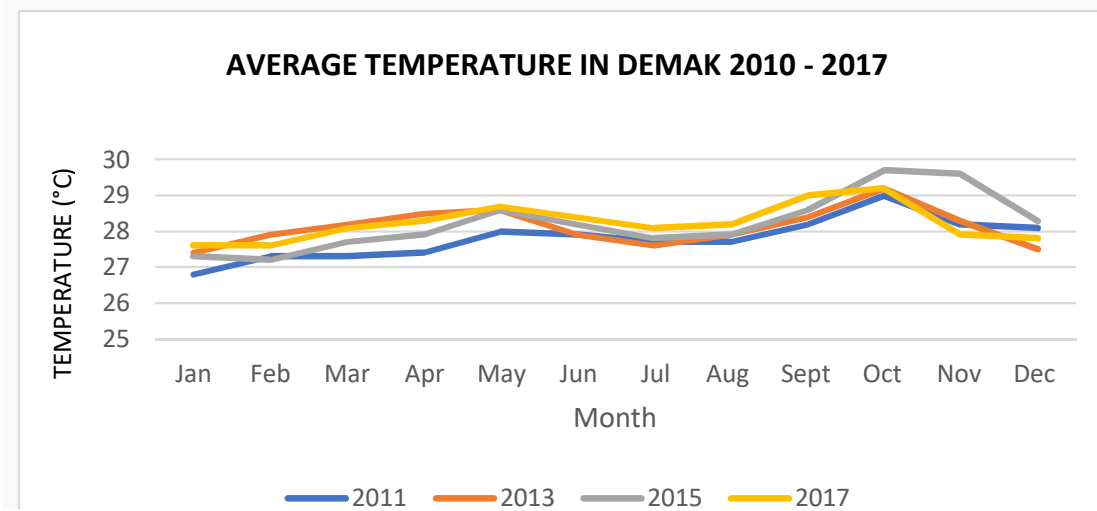

Fig. 4: The average temperature in Demak 2010-2017.

Fig. 5: Mangrove damage in Sayung coastline, Demak, due to tide.

protective equipment such as breakers or planting coastal protective plants.

Abrasion mitigation has been actively carried out by people in abrasion-prone areas and government or private organizations that offer abrasion avoidance incentives. Planting mangroves on the shore of Sayung, Demak, Indonesia, is one example of active community participation in mitigation in Sayung Subdistrict, Demak. With evidence of increased mangrove acreage, active community participation in planting mangroves demonstrates success (Chafid et al. 2012, Irsadi et al. 2019b).

According to the residents of Sayung, Demak, Indonesia, mangrove planting provides immediate benefits in the form of young Avicennia leaves that can be converted into chips and the fruit can be eaten, as well as indirect benefits such as protection from strong winds and high waves. Mangroves can operate as natural coastal boundary defenders against erosion and tsunamis (Alongi 2008, Blankespoor et al. 2016). Demak, Indonesia, can profit as a tourism destination in addition to being a coast defender by planting mangroves in the Sayung area. Due to abrasion, tourism has risen in the Sayung, Demak, Indonesia area as a means of adapting to the community. The tourism industry has grown in Sayung and Demak. For example, Sayung, Demak, in the Bedono area, mixes catastrophe tourism, religious tourism, and conservation.

Disaster tourism due to abrasion is one of the tours in Bedono Village (areas affected by abrasion so that the area is flooded with seawater and cannot be re-occupied). This tour is the location of introspection for residents who always try to protect the coastal areas from the dangers of abrasion and flooding (Fig. 6).

Religious tourism may be found in Kyai Mudzakir's tomb, one of the tombs in Bedono Village located in the middle of the sea. This trip is one of the community's local pearls of wisdom that has developed. The presence of the tomb protects this tourist destination from abrasion by forming waves breakers and tomb defenders. This protects the area surrounding the tomb from abrasion. Conservation tourism is a type of tourism that recognizes the significance of coastline preservation. This movement was carried out and traveled with observations of the different sorts of birds that could be seen along the shore of Sayung, Demak, as well as the planting of mangroves in the impacted areas.

In addition to integrated tourism activities, institutional strengthening is also carried out to protect existing mangroves. The form of protection carried out is in the form of village rules (PERDES) issued by the Bedono and Timbulsloko Village Heads with the main goal of protecting mangroves. In addition to protecting mangroves, this village regulation also regulates mangrove management and the community's financial protection. This regulation protects

Fig. 6: Abandoned mosque submerged by flood.

the environment and makes the community more empowered (Purnaweni et al. 2018). In addition, this regulation contains the form of sanctions applied to people who commit violations in the form of illegal logging or environmental destruction with the sanction of logging one mangrove tree, which should be replaced by 300 mangrove trees or a fine of 500 thousand-1 million rupiahs, besides sanctions for fishers who use poisons or explosives. The bird shooters also will be fined and seized their tools.

However, because not all villages impacted by abrasion can adapt well, the implementation of mitigation and adaptation (Fig. 7) must be monitored and evaluated on an ongoing basis. As a result, continued efforts at sustainable development as mitigation and adaptation to

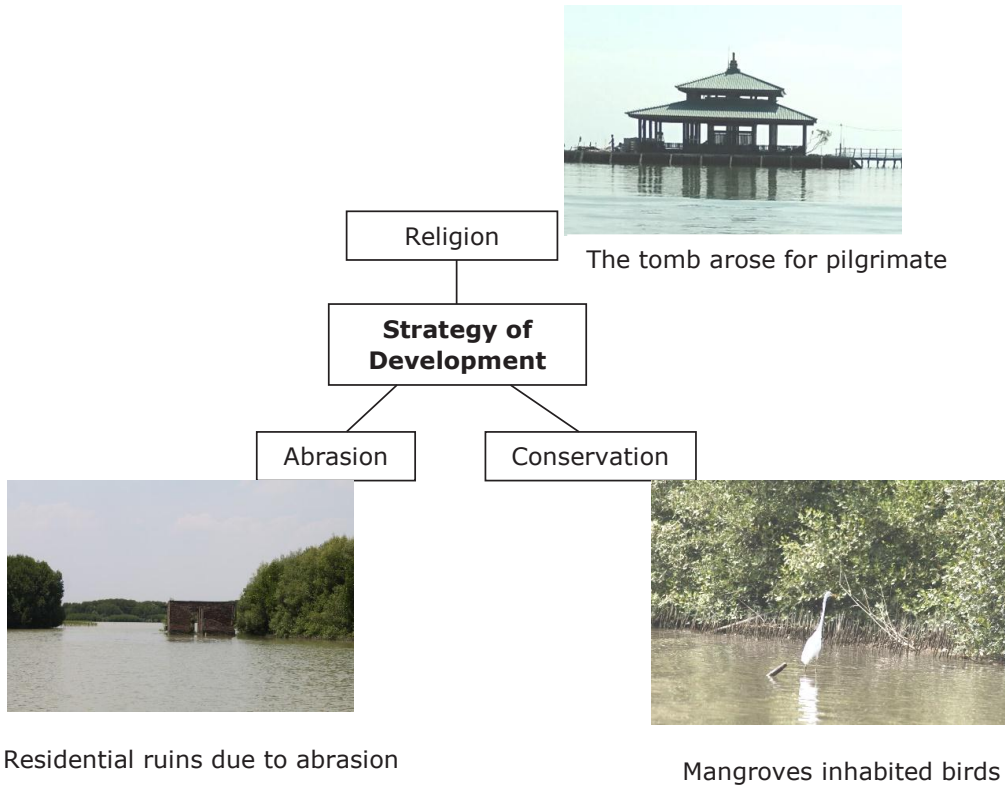

Fig. 7: Developmental scheme of mitigation and adaptation.

abrasion are required to ensure that the coastal regions of Sayung, Demak, Indonesia do not become more lost due to abrasion.

CONCLUSION

There has been a beach abrasion on the coast of Sayung, Demak, covering 262.74 hectares and an accretion of 5.87 hectares spread across four villages, namely Sri Wulan and Bedono Timbulsloko, and Surodadi. Prevention and evaluation are needed to be related to abrasion and the factors triggered so that abrasion on the coast of Sayung, Demak can be shrunk.

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