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IDENTIFICATION OF CHARACTERISTICS AND TYPOLOGY OF COASTAL AREAS AND SMALL ISLANDS OF KOLAKA REGENCY, SOUTHEAST SULAWESI PROVINCE

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Abstract

Both the characteristic and the typology distinct the coastal areas dan small island landforms of Kolaka Regency. This paper aims to identify the characteristics and typology of coastal areas and small islands in Kolaka Regency, Southeast Sulawesi Province. The research originates with a literature study and conducts a remote sensing analysis to obtain a tentative map. Furthermore, the terrestrial land survey was carried out using a purposive sampling technique to collect abiotic and biotic data. Semi-structured interviews were conducted to collect the components of cultural data. This study used quantitative and qualitative descriptive. A spatial analysis was also employed to obtain spatial variations that occurred in the study location. Seven measurement stations spread over three districts: Pomalaa, Samaturu, and Wundulako. Pomalaa District consists of two stations: Sweedy Beach and Pelangi Island of coastal genesis in the Marine Deposition Coast. Samaturu District has two stations, Indah Kapu Beach of coastal genesis in the form of Marine Deposition Coast and Konaweha coastal village in Subaerial Deposition Coast. Wundulako District is divided into three stations: Padamarang Island of coastal genesis in the form of Coast Built by Organisms, Lambasina Besar Island with Marine Deposition Coast genesis, and Towua I identified as Coast Built by Organisms. Data on the characteristics and typology of coastal areas and small islands is a preliminary study regarding to analyzing Coastal Vulnerability Index (CVI).

***Keywords**: Typology; Coastal; Small Islands; Kolaka*

Introduction

Coastal areas are known as vulnerable areas and need distinct attention to preserve the ecosystem and human activities that inhabit the area (Anfuso, Postacchini, Di Luccio, & Benassai, 2021). Based on physical perspective, the coast is a narrow area as a consequence the transitional area between land and the sea (Sumardi, Fatimah, & Nizamuddin, 2019). Coastal zone widely known has diverse of natural resources, minerals, and tourism potential. On the other hand, this zone is being constantly attacked by various natural disasters such as cyclones, Sea Level Rise (SLR), and storm surge that caused severe impact on this zone (Ahmad, 2019). Currently, ± 45% of the total world population inhabits coastal areas, which is directly proportional to the density and economic activity which has implications for the magnitude of pressure on coastal areas (Finkl & Makowski, 2019). Indonesia is an archipelago (archipelagic estate) with a coastline of 108,000 km and the Indonesian sea has a very large wealth of marine, coastal, and biodiversity resources (Susmoro, 2019).

By genesis, coastal areas are divided into two main types, namely primary and secondary coasts. The primary coasts are divided into four coastal typologies, namely: Land Erosion Coasts, Sub Aerial Deposition Coasts, Volcanic Coasts, and Structurally Shaped Coast. Meanwhile, secondary coasts are grouped into three typologies: Marine Deposition Coasts, Wave Erosion Coasts, and Coasts Built by Organisms (Benassai, 2006; Shepard, 1973). Sea Level Rise (SLR) at a rate of about 0.6 – 0.8 cm/year, can have implications for residential areas, infrastructure, and ecosystems in coastal areas and small islands. Furthermore, coastal

erosion is more dangerous due to the small size of the land, the retreat of the coastline until the sinking of the entire mainland of these small islands (Sari & Muslimah, 2014; Sofian, Supangat, Fitriyanto, & Kurniawan, 2011). The existence of coastal area management is expected to be able to provide benefits as well as improve welfare for the community based on the study of typology, dynamics, and potential for disasters on the coast (Marfai, Cahyadi, & Anggraini, 2013). In order to determine the right strategy for managing coastal areas and small islands, it is better to be accompanied by the identification stage in the realm of resource potential and disaster potential.

Based on the Disaster Event Data in Indonesia released by National Disaster Mitigation Agency throughout 2019, there were 18 tidal wave and abrasion disasters and in 2020, the intensity doubled, namely 36 events. Kolaka Regency is categorized as a coastal regency, this is supported by data in the form of a total of 12 Districts in Kolaka Regency, there are 11 Districts that are directly adjacent to the sea (Badan Pusat Statistik Kabupaten Kolaka, 2021). Based on the Southeast Sulawesi Province Climate Risk and Vulnerability Study Report (2018), this province has many islands and coasts, so the risk from extreme waves is quite large.

In Kolaka Regency, the impact of climate change also affects an average temperature increase of ± 0.804-0.866 °C along with the threat of flooding that hit the coast which is categorized as moderate (DAI, 2018). The study of the characteristics and typology of coastal areas and small islands in the Kolaka Regency has its own urgency due to the dominant number of districts in the coastal area is associated with the large number of people who inhabit the area. The study of identifying the characteristics and typology of coastal areas and small islands is considered necessary as the initial effort to assess the vulnerability of coastal areas and small islands (Coastal Vulnerability Index).

Methods

Administratively, the research was conducted in coastal areas and small islands in Kolaka Regency, Southeast Sulawesi Province. The west side of the research location is directly adjacent to Bone Gulf, shown spatially in Figure 1. Astronomically, Kolaka Regency is located between 02˚00' and 05˚00' South Latitude and 120˚45' and 124˚06' East Longitude. Kolaka Regency has an area of ± 3.283,59 km^2. Kolaka Regency consists of 12 districts with 135 villages/ sub-districts. The number of villages/ sub-districts consists of 100 villages and 35 sub-districts (Badan Pusat Statistik Kabupaten Kolaka, 2020d).

Kolaka Regency is directly opposite Bone Gulf on the west side. Bone Gulf is located between the South and Southeast sides of the Sulawesi Island arm which has an area of ± 50,000 km^2 and in the middle of the bay it reaches a depth of 1800 m (Camplin & Hall, 2014). In this study, the unit of analysis that will be used is the sub-districts. Overall, there are seven observation stations spread over three districts in the coastal area and small islands of Kolaka Regency including Pomalaa District, Samaturu District, and Wundulako District.

In this research, data collecting was carried out from April to July 2021. Data collection techniques were used:

a) Literature study was carried out at the stages before and after data collection, the scope of which was related to the abiotic, biotic, and cultural components of coastal areas and small islands of Kolaka Regency;
b) Remote Sensing, namely with Sentinel-2 Imagery (2021) and Indonesia Topographic Map (RBI);
c) Field measurements were carried out using a modified Rapid Integrated Survey (Gunawan, Santosa, Muta'ali, & Santosa, 2007). The location selection will be carried out by purposive sampling technique, the determination of the sample is based on the objectives of the study on the diversity of coastal zone on the north, middle and south of Kolaka Regency. The field measurements aimed to collect the abiotic and biotic data. The abiotic data encompasses geomorphological, oceanographic, and hydrological data, especially groundwater (geohydrology). The geomorphological data is observed in three parameters: coastal morphology (beach shape, slope, topography, and coastal relief), constituent materials, geomorphological processes (types of processes and processes). erosion), and coastal genesis. The oceanographic aspects were observed into four parameters including wind direction and speed, wave height, and tidal type. The geohydrological aspects were observed in seven parameters: water level, Salinity, pH, Color, and Odor of Water, and seasonal freshwater availability. Meanwhile, the biotic components were observed: the local flora and fauna.

d) Interviews to obtain a description of the data on geographical conditions and accessibility, economic conditions, infrastructure conditions, institutional conditions. The targeted respondents include stakeholders and local communities in study area.

Result And Discussion

Result

a. Coastal Geomorphology Aspect

The results of geomorphological aspects in coastal areas and small islands in Kolaka Regency show variations, as shown in Table 1.

Table 1. Coastal Geomorphology Aspect

No.	Station	Location	District	Coastal Geomorphology Aspect							
				Coastal Morphology					Geomorphology Process		Coastal Genesis
				Shape	Slope (%)	Topography	Relief	Material	Process	Type of Erosion	
1.	Station 1	Swedy *Beach*	Pomalaa	Irregular	0-2	Flat	0-4	Clastic Sediment	Abration	Splash	MDC
2.	Station 2	Pelangi Island	Pomalaa	Curvature	0-2	Flat	0-4	Reef Flat	Abration	Splash	MDC
3.	Station 3	Indah Kapu Beach	Samaturu	Curvature	0-2	Flat	0-4	Alluvium	Sedimentation	Splash	MDC
4.	Station 4	Coastal Village of Konaweha	Samaturu	Curvature	0-2	Flat	0-4	Alluvium	Abration	Splash	SDC
5.	Station 5	Sub-district Padamarang Island	Wundulako	Curvature	0-2	Flat	0-4	Ultramafic	Sedimentation	Splash	CBO
6.	Station 6	Lambasina Besar Island	Wundulako	Curvature	0-2	Flat	0-4	Ultramafic	Abration	Splash	MDC
7.	Station 7	Towua I	Wundulako	Curvature	0,2	Flat	0-4	Alluvium	Sedimentation	Splash	CBO

Note: MDC: Marine Deposition Coasts; SDC: Subaerial Deposition Coasts; CBO: Coast Built by Organisms

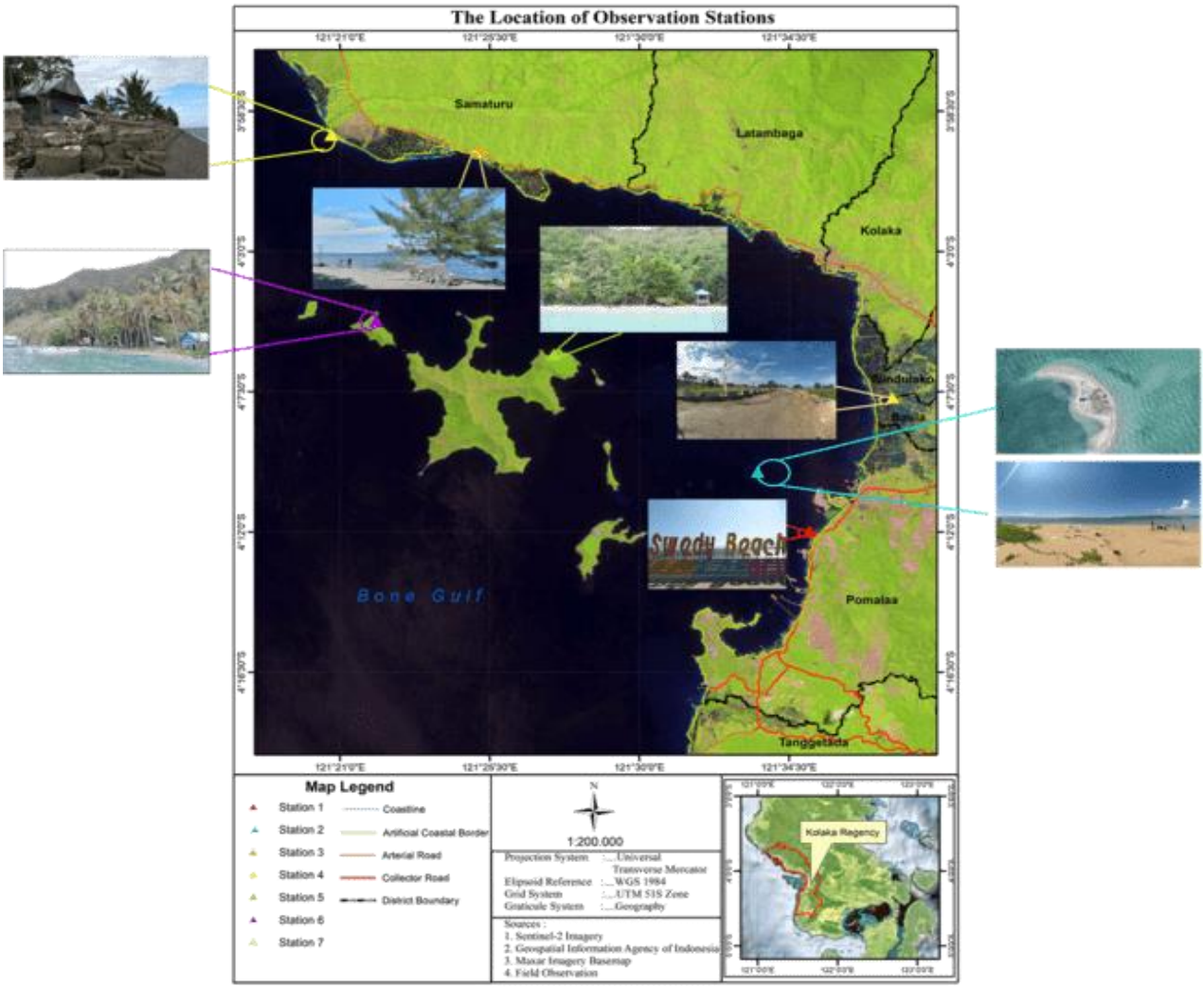

Figure 1. Research Location Map

b. Oceanographic aspect

The oceanographic aspects of coastal areas and small islands in Kolaka Regency show varied results in aspects divided into four parameters (Table 2).

Tabel 2. Oceanographic Aspect

No.	Station	Location	District	Oceanography Aspect			
				Wind Direction	Wind Velocity (Beaufort Scale)	Wave Height (m)	Tides Type
1.	Station 1	Swedy *Beach*	Pomalaa	E	3	0,1-0,2	Diurnal
2.	Station 2	Pelangi Island	Pomalaa	E	2	0,1-0,2	Diurnal
3.	Station 3	Indah Kapu Beach	Samaturu	E	3	0,1-0,2	Diurnal
4.	Station 4	Coastal Village of Konaweha Subdistict	Samaturu	E	4	0,3-0,5	Diurnal
5.	Station 5	Padamarang Island	Wundulako	SE	2	0,1-0,2	Diurnal
6.	Station 6	Lambasina Besar Island	Wundulako	SE	4	0,3-0,5	Diurnal
7.	Station 7	Towua I	Wundulako	E	1	0,1-0,2	Diurnal

Note: E: East; SE: Southeast

c. Geohydrological Aspect

The parameters of geohydrological aspects in coastal areas and small islands in Kolaka Regency are arranged out in Table 3.

Table 3. Geohydrology Aspect

No.	Station	Location	District	Geohydrology Aspect					
				Water level (m)	Salinity	pH	Colour	Odor	Seasonal Condition
1.	Station 1	Swedy *Beach*	Pomalaa	0,48	0	7	-	-	2 seasons
2.	Station 2	Pelangi Island	Pomalaa	*	*	*	*	*	*
3.	Station 3	Indah Kapu Beach	Samaturu	-	0	6	-	-	2 seasons
4.	Station 4	Coastal Village of Konaweha Subdistict	Samaturu	0,96	0	6	-	-	2 seasons
5.	Station 5	Padamarang Island	Wundulako	*	*	*	*	*	*
6.	Station 6	Lambasina Besar Island	Wundulako	0,70	0	8	-	-	2 seasons
7.	Station 7	Towua I	Wundulako	0,36	0	6	-	-	2 seasons

Note: *: Data cannot be measured; -: No data available

Discussion

a. Pomalaa District

Pomalaa District covers an area of 337, 82 km^2 and in 2019 consists of 12 sub-districts/ village areas. This district is bordered by Baula District on the north side, on the south side by Tanggetada District, on the east side by East Kolaka Regency, and the west side by South Sulawesi Province in Bone Gulf. Based on data of Central Bureau of Statistics (2019), there is one sub-district/ village affected by the tidal wave disaster namely, Hakatutobu Village. However, there are no natural disaster mitigation facilities or natural disaster early warning systems, special tsunami early warning systems, safety equipment, as well as signs and disaster evacuation routes (Badan Pusat Statistik Kabupaten Kolaka, 2020a). In this District, there are two measurement stations: Sweedy Beach and Pelangi Island.

Swedy Beach

At this station, in general, the type of land use is in the form of beaches, and on the majority side, it is used as residential land. The morphological aspect of the beach is in the form of an irregular shoreline pattern with a slope of 0-2%, characterized by flat topography and a coastal relief range of 0-4 m. This location, regarding to the Geological Map of Sheet Kolaka (2111-2211), this location is in the Alangga Formation (Qpa), with the constituent materials in the form of conglomerate and sandstone (Simandjuntak & Surono, 1994). The additional parameter used is the soil pH of 6.4. The existing geomorphological process is in the form of abrasion on the revetment walls with the type of erosion process on the mainland in the form of splash erosion. Coastal typology classification is known as Marine Deposition Coast. This typology was characterized by the accumulation of sedimentary material originating from the sea and deposited towards the land (Giovani, Damayanti, & Susiloningtyas, 2018). This typology on the northeast side of this location, there is a mangrove ecosystem. The results of the image analysis show that in its development, Sweedy Beach was dominated by human activities which were marked by the construction and utilization of the location as a pier for the community before 2009. Human intervention in the development of coastal areas is also known as the development of the Anthropogenic Coast. Meanwhile, human intervention regarding human activities occupying certain new areas begins with land reclamation with various uses, such as constructing a harbor. Generally, the land shortage is overcome by running coastal reclamation projects (Ulfa, Jia, Yaziz, Irawan, & Puradimaja, 2021). Anthropogenic Coast, known as man-made coastal typologies can be found for example in Sadeng Harbor, Gunungkidul Regency (Marfai et al., 2013) (Marfai et al., 2013).

The results of the analysis on the oceanographic aspect, based on observations when the wind direction measurement shows the direction of the East (E), with a wind speed of 3 on the Beaufort Scale, the wave height is based on local station data of Meteorological, Climatological, and Geophysical Agency ranging from 0.1-0.2 m with the type of tide ebb as a diurnal. Regarding to the geohydrological aspect, the water level is measured at 0.48 m. Water samples were taken from local well, which generally used well water for domestic purposes. The results of the analysis of water samples showed a measured salinity value of 0‰, pH 7, Total Dissolve Solid (TDS) 212 mg/L. In the water sample, there was no color and odor in the water. In terms of

availability, the groundwater available in both the dry and rainy seasons.

Pelangi Island

The type of land use at this station is the beach, from the morphological aspect of the curved beach shape with a slope of 0-2%, flat topography with a coastal relief range of 0-4 m. Based on its morphogenesis, Pelangi Island consists of gravel and sand materials produced by coral reef-forming organisms. The additional parameter used is the soil pH of 6. When viewed from the formation process, Pelangi Island classified as marine deposition coast typology. The topography of the island changes depending on dry and rainy seasons. The height of the island is vulnerable due to global warming. The process of forming this island is strongly controlled by the supply of sediment carried by waves. Naturally, sediment transport is influenced by tidal currents (Von Lieberman & Albers, 2008). Moreover, the process is commonly found concerning marine deposition coasts topology. Characteristics of Pelangi Island in the form of sand, commonly found in several areas in Indonesia.

Based on the results of the analysis on satellite imagery via Google Earth, in 2018 the area of the island reached 4,900 m^2, and the results of the recording in 2019 changed its area to 3,300 m^2. The island is exposed above high tide in the middle of the reef flat (Figure 2), and changes in area and shape are thought to be influenced by stressors from hydro-oceanographic factors. Based on observations on the oceanographic aspect, the wind direction is from the East, with a wind speed of 2 on the Beaufort Scale. The wave height is based on local station data Of Meteorological, Climatological, And Geophysical Agency ranging from 0.1-0.2 m with a diurnal tidal type. Geohydrological aspect measurements cannot be carried out due to the unavailability of groundwater to be sampled.

Figure 2. Pelangi Island
(Source: Observations, 2021)

b. Samaturu District

Samaturu District has an area of 285.91 km^2. Administratively, Samaturu District consists of 19 sub-districts/ villages. Samaturu District in the north is bordered by Wolo District, in the south by Latambaga District, on the east side by East Kolaka Regency, and in the west by South Sulawesi Province in Bone Gulf. Central Bureau of Statistics data (2019), there are three sub-districts / villages that were affected by the tidal wave disaster: Sani-sani, Konaweha, Ulaweng. However, there are no natural disaster mitigation facilities, both natural disaster early warning systems, special tsunami early warning systems, safety equipment, as well as signs and disaster evacuation routes (Badan Pusat Statistik Kabupaten Kolaka, 2020b). Based on data on the number of natural disasters in Kolaka Regency by District throughout 2020, Samaturu District experienced one tidal wave event, and all victims were recorded in the affected and evacuated category (Badan Pusat Statistik Kabupaten Kolaka, 2021). In this District, there are two measurement stations, namely: Indah Kapu Beach and the Coastal Village of Konaweha.

Indah Kapu Beach

Indah Kapu Beach has a type of coastal land use. The morphology of the beach is in the form of a curved beach with a slope of 0-2%, flat topography with a coastal relief of 0-4 m. The genesis of this beach was interpreted from Geological Map of the Kolaka Sheet (2111-2211), it is classified as being in the Alluvium Formation (Qa) (Simandjuntak & Surono, 1994). The existing geomorphological process is in the form of sedimentation with the type of erosion

process that occurs is splash erosion. The condition of the soil pH is 6. The color of the beach material is light gray, there is a river on the side. The coastal genesis category is thought to be marine deposition coasts. Based on the results of the analysis on satellite imagery of Google Earth, was ± 42 m width (2019) and changes in scale width insignificant results ± 42.5 m (2021). On the West-Northwest side of this location, there are spit landform units with a distance of ± 3 km.

When viewed from the oceanographic aspect, based on observations when measuring the east wind direction (East/E), with a wind speed of 3 on the Beaufort Scale, the wave height is based on local station data Of Meteorological, Climatological, And Geophysical Agency ranging from 0.1-0.2 m with the tidal type in the form of diurnal. Furthermore, geohydrological aspects, water sources from local springs from the hills, measured salinity of water samples 0‰, pH 6, TDS 82 mg/L. In the water samples there was no color and odor in the water. For availability, two seasons are available (dry and rainy season).

Konaweha Coastal Village

This station is categorized as a type of coastal land use which is used for settlements (Northeast to Southeast) and ponds (southeast side). The morphology of the beach is in the form of a curved beach with a slope of 0-2%, flat topography with a coastal relief range of 0-4 m. The additional parameter used is soil pH of 6.6. On the Geological Map of Sheet Kolaka (2111-2211), this station is categorized the Alluvium Formation (Qa) (Simandjuntak & Surono, 1994). Regarding to the geomorphological processes, the type of process is in the form of abrasion as can be seen in Figure 3. Meanwhile, the existing type of erosion is splash erosion on the ground. This coast is identified as the subaerial deposition coasts because the material supplied from the river in the North-Northwest with a distance of ± 0.7 km. In the use of pond-type land, mangrove vegetation with the type of *Rhizophora mucronata Lmk.* was also found. This type of mangrove can be used as fuel, charcoal, and barrier protection in pond areas (Noor, Khazali, & Suryadiputra, 2006).

Figure 3. Abrasion on the Coast of Konaweha Village
(Source: Observations, 2021)

Based on observations during measurements (oceanographic aspects) the wind is blowing from the east (E), with a wind speed of 4 on the Beaufort Scale, the wave height is based on local local station data of Meteorological, Climatological, And Geophysical Agency ranging from 0.3-0.5 m with tidal types in the form of a daily single. The geohydrological aspects observed include water level 0.96 m, where the water source is used by local people for domestic water use, measured salinity 0‰, pH 6, TDS 125 mg/L, and there is no color and odor in the water. In addition, for availability, there are dry seasons and rainy seasons.

c. Wundulako District

Wundulako District has an area of 157.97 km^2. Administratively, the district consists of 11 sub-districts/ villages areas. Wundulako District in the north is bordered by Mowewe District, in the south by Baula District, in the east by Ladongi District, and in the west by Bone Gulf. There are no natural disaster mitigation facilities, both natural disaster early warning systems, special tsunami early warning systems, safety equipment, as well as signs and disaster evacuation routes (Badan Pusat Statistik Kabupaten Kolaka, 2020c). Based on data on the number of natural disasters in Kolaka Regency by District throughout 2020, Samaturu District experienced one tidal wave event, and all victims were recorded in the affected and evacuated category (Badan Pusat Statistik Kabupaten Kolaka, 2021). There are three observation stations

including: Padamarang Island, Lambasina Besar Island, and Towua 1.

Padamarang Island

The type of land use at this station is the beach, with a flat morphology and a curved beach shape with a slope of 0-2%, a flat topography with a coastal relief range of 0-4 m. The existing geomorphological process is in the form of sedimentation, with the type of erosion process that occurs is splash erosion. The additional parameter used is soil pH of 6.2. The origin of its formation, Padamarang Island is included in the classification of organic-related to controlled by organism activities, with the coastal typology of Coasts built by Organisms. Furthermore, based on the results of the analysis on satellite imagery via Google Earth, the recording year 2013 was ± 16 m wide, and changes in the beach's width showed significant results (2016) ± 27 m. Meanwhile, based on the observation, the beach's width is 28 m.

Figure 4. Vegetation on Padamarang Island, Wundulako District
(Source: Observations, 2021)

In the oceanographic aspects, the wind direction came from the Southeast (SE) direction, with a wind speed of 2 (Beaufort Scale), the wave height recorded in the local station data of Meteorological, Climatological, and Geophysical Agency ranged from 0.1-0.2 m. The tidal type at the observation location is diurnal. Based on the results of field observations, the vegetation in this location consists of Sea Hibiscus (*Hibiscus tiliaceus*), Whistling Pine Tree (*Casuarina equisetifolia*), Sea Poison Tree (*Baringtonia asiatica*), Cantigi (*Vaccinium Sp.*), Fig Tree (*Ficus Sp.*), Beach Callophyllum (*Callophyllum inophyllum*), as shown in Figure 4. This observation station is also designated as part of the Padamarang Islands Marine Nature Tourism Park as mandated in the Decree of the Minister of Forestry No. 94/Kpts-II/2003 covering an area of 36,000 Ha of 16 species of coral reefs and 13 species of reef fish. Based on the classification by the International Union for Conservation of Nature (IUCN), this location is categorized into Protected Landscape (category V).

The genesis of Padamarang Island was interpreted from the Geological Map of the Kolaka Sheet (2111-2211). This island is categorized the Ultramafic Complex (Ku) with the constituent material in igneous rock (Simandjuntak & Surono, 1994). Ultramafic rocks are dominantly found in the earth's crust. Therefore, the rocks found in surface outcrops have been tectonically implanted from the mantle throughout the orogenesis (Bucher & Frey, 2002). Furthermore, under the sea on the southwest side of Padamarang Island, there are Maniang High and Padamarang Sub-basins units. Meanwhile, on the Northwest side of the island, there is a Kolaka High unit. Kolaka High is thought to be part of the Kolaka Fault connection on the mainland and across the north side of the Padamarang sub-basins in Bone Gulf (Camplin & Hall, 2014).

In terms of geohydrology, measurements cannot be carried out due to the unavailability of groundwater that can be sampled. On the other hand, this island is used for tourist purposes, for example beach tourism, hiking, and diving. The utilization of a destination for various tourist destinations requires the availability of freshwater as a supporting element. Freshwater availability is one of the parameters used in determining the Tourism Suitability Index (Chasanah, Purnomo, & Haeruddin, 2017; Yulianda, 2007). Efforts to inject rainwater into shallow aquifer layers are categorized as a wise effort to keep excess rainwater stored safely and not spilling into the sea and to strengthen the existence of small island freshwater lenses (Hantoro, 2020).

Lambasina Besar Island

Geographically, Lambasina Besar Island is on the Northwest side of Padamarang Island. The land use at this station is in the form of a beach which has a coastal morphology in the form of an arch, with a slope of 0-2%, flat topography with a coastal relief range of 0-4 m. The additional parameter used is the soil pH of 6.4. The genesis of this island was considered from The Geological Map of Kolaka Sheet (2111-2211). This island are classified as Ultramafic Complex (Ku) as well as Padamarang Island with the type of material in the form of gabbro, basalt, metamafic, and so on (Simandjuntak & Surono, 1994). The existing geomorphological process is in the form of abrasion with the type of erosion process that occurs is splash erosion. The coastal genesis is marine deposition coasts. The results of the analysis on satellite imagery of Google Earth, the width of the scales reached ± 14 m (2013), and the change in the width of the scales was reduced to ± 8 m.

The oceanographic aspect, the wind direction: southeast (SE), with a wind speed on the Beaufort Scale of 4, the wave height based on local station data of Meteorological, Climatological, And Geophysical Agency ranging from 0.3-0.5 m with the tidal type in the form of diurnal. In terms of geohydrology, this island only has one source of freshwater which is used for various purposes, not only by residents who inhabit Lambasina Island but also by tourists visiting Padamarang Island because the island does not have a freshwater source. The results of the measurement of the water level are 0.70 m, the measured salinity level is 0‰, pH 8, there is no color and odor identified. The measurement of an additional parameter, namely TDS, is 574 mg/L. Based on the Regulation of the Minister of Health of the Republic of Indonesia Number 32 of 2017, for sanitation hygiene, water that can be used for drinking water raw water has a maximum TDS parameter of 1000 mg/L, which means water on this island can be consumed. Meanwhile, in terms of availability, this water is available in dry and rainy seasons.

Towua I

The type of land use at this station is residential, from the morphological aspect of the coast in the form of an irregular beach with a slope of 0-2%, flat topography with a coastal relief range of 0-4 m. The additional parameter used is the soil pH of 6.8. The result of interpretation on the Geological Map of the Kolaka Sheet (2111-2211), this location is classified into the Alluvium Formation (Qa) (Simandjuntak & Surono, 1994). The existing geomorphological process is in the form of sedimentation, with the type of erosion process that occurs is splash erosion. This coastal genesis category is coasts built by organisms.

The measurement results on the oceanographic dimensions show the wind direction from the East, wind speed 1 on the Beaufort Scale, wave height based on local station data of Meteorological, Climatological, and Geophysical Agency station data ranging from 0.1-0.2 m with a diurnal tidal type. Geohydrological aspects, water level 0.36 m using raw water sources, measured salinity 0‰, pH 6, TDS 70 mg/L. In the water sample, there was no color and odor. Regarding to the availability of water, the freshwater available for dry seasons and rainy seasons.

Overall, seven stations provided an overview of the characteristics and typology of coastal areas and small islands in some areas of Kolaka Regency showing diversified results. In addition, to better understand the characteristics and typology of coastal areas and small islands in Kolaka Regency, previous studies can be used as references by considering associations in the field, including 1) The existence of mangrove ecosystems in Latambaga District with high-density conditions, but several areas have been converted into ponds (Ibrahim et al., 2021); and 2) Mollusks (Bivalves and Gastropods) found in mangrove ecosystems of Kolaka Regency in villages: Induha, Mangolo, Tahoa, and Towua with a low diversity index in bivalves while the gastropods diversity index was categorized as medium (Hasidu et al., 2020). The existence of bivalves and gastropods in these locations (Latambaga District, Kolaka District, and Wundulako District) can be used as the basis for the spatial distribution of the existence of the mangrove ecosystem which is associated with the typology of coasts built by organisms that can be identified in the form of salt marshes, mangroves or mudflats. The existence of mudflats and salt marshes mangroves is the main feature of the typology of coasts built by organisms (Benassai, 2006; Shepard, 1973).

The results of the study on coastal areas and small islands of Kolaka Regency, especially in this case geomorphological characteristics are the first step in conducting a Coastal Vulnerability Index (CVI) study in the context of sustainable development in

coastal areas and small islands of this district. Regarding the CVI study, there was previous research on this subject in the Mataram Coast study area. Results showed that the moderate to high-risk vulnerability level was found on the Mataram coast, whereas geomorphology and shoreline change factors (Rudiastuti, Rahadiati, Dewi, Soetrisno, & Maulana, 2020). Variations in the ranking of coastal vulnerability on geomorphological variables are in the low to very high range in the form of sand and rock composites (low), sand (moderate), clay and rock or sand composites (high), and mudflats (very high) (Mohamad, Lee, & Samion, 2014). On the other hand, the sustainable development of coastal areas requires the management of economic development in harmony with environmental protection and restoration, as well as social benefits that imply control and protection in the area (Anton, Panaitescu, Panaitescu, & Ghiță, 2019).

Conclusion

This paper had discussed the characteristics and typology of coastal areas and small islands in Kolaka Regency showed heterogeneous results. The obtained results presented seven measurement stations encompassed three districts: Pomalaa, Samaturu, and Wundulako. Pomalaa District consists of two stations: Sweedy Beach and Pelangi Island of coastal genesis in the Marine Deposition Coast. Samaturu District has two stations, Indah Kapu Beach of coastal genesis in the form of Marine Deposition Coast and Konaweha coastal village in Subaerial Deposition Coast. Wundulako District is divided into three stations: Padamarang Island of coastal genesis in the form of Coast built by Organisms, Lambasina Besar Island with Marine Deposition Coast genesis, and Towua I identified as Coast built by Organisms. In addition, previous studies also support the findings of coastal typology by analyzing the association of coastal characteristics, for example in the form of a mangrove ecosystem which is categorized as coasts built by organisms.

There is a need for further studies to identify Coastal Vulnerability in coastal areas and small islands in the Kolaka Regency to conceive the determination of the management strategy of the coastal regions and small islands. The assessment of the vulnerability index is very dependent on the additional unit stations and the matrix composition. Future research findings regarding the suitable countermeasures of Coastal Vulnerability in coastal areas and small islands in this particular area.

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References

Ahmad, H. (2019). Coastal Zone Management Bangladesh Coastal Zone Management Status and Future Trends. *J Coast Zone Manag*, *22*(1), 466. https://doi.org/10.4172/2473-3350.1000466

Anfuso, G., Postacchini, M., Di Luccio, D., & Benassai, G. (2021). Coastal sensitivity/vulnerability characterization and adaptation strategies: A review. *Journal of Marine Science and Engineering*, *9*(1), 1–29. https://doi.org/10.3390/jmse9010072

Anton, I. A., Panaitescu, M., Panaitescu, F. V., & Ghiță, S. (2019). Impact of coastal protection systems on marine ecosystems. *E3S Web of Conferences*, *85*, 1–7. https://doi.org/10.1051/e3sconf/20198507011

Badan Pusat Statistik Kabupaten Kolaka. (2020a). *Kecamatan Pomalaa Dalam Angka 2020*.

Badan Pusat Statistik Kabupaten Kolaka. (2020b). *Kecamatan Samaturu Dalam Angka 2020*.

Badan Pusat Statistik Kabupaten Kolaka. (2020c). *Kecamatan Wundulako Dalam Angka 2020*.

Badan Pusat Statistik Kabupaten Kolaka. (2020d). *Statistik Daerah Kabupaten Kolaka Tahun 2020*.

Badan Pusat Statistik Kabupaten Kolaka. (2021). *Kabupaten Kolaka dalam Angka 2021*.

Benassai, G. (2006). Introduction to Coastal Dynamics and Shoreline Protection. In *WIT Press* (Vol. 1).

Bucher, K., & Frey, M. (2002). Metamorphism of Ultramafic Rocks. *Petrogenesis of Metamorphic Rocks*, 171–195.

https://doi.org/10.1007/978-3-662-04914-3_5

Camplin, D. J., & Hall, R. (2014). Neogene history of Bone Gulf, Sulawesi, Indonesia. *Marine and Petroleum Geology*, *57*, 88–108. https://doi.org/10.1016/j.marpetgeo.2014.04.014

Chasanah, I., Purnomo, P. W., & Haeruddin, H. (2017). Analisis Kesesuaian Wisata Pantai Jodo Desa Sidorejo Kecamatan Gringsing Kabupaten Batang. *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management)*, *7*(3), 235–243. https://doi.org/10.29244/jpsl.7.3.235-243

DAI. (2018). *Laporan Kajian Kerentanan dan Risiko Iklim Provinsi Sulawesi Tenggara*.

Finkl, C. W., & Makowski, C. (2019). *Encyclopedia of Coastal Science*. Springer International Publishing.

Giovani, C., Damayanti, A., & Susiloningtyas, D. (2018). Coastal Typology of Landform in Pelabuhan Ratu Bay, Sukabumi Regency, Jawa Barat Province. *E3S Web of Conferences*, *73*, 0–4. https://doi.org/10.1051/e3sconf/20187304012

Gunawan, T., Santosa, L. W., Muta'ali, L., & Santosa, S. H. M. B. (2007). *Pedoman survei cepat terintegrasi wilayah kepesisiran*. Badan Penerbit dan Percetakan Fakultas Geografi.

Hantoro, W. S. (2020). Kerentanan-Ketahanan Kawasan Landai Pesisir dan Pulau Kecil: Mitigasi dan Adaptasinya. *Kerentanan-Ketahanan Kawasan Landai Pesisir Dan Pulau Kecil: Mitigasi Dan Adaptasinya*. https://doi.org/10.14203/press.144

Hasidu, L. O. A. F., Jamili, Kharisma, G. N., Prasetya, A., Maharani, Riska, … Anzani, L. (2020). Diversity of mollusks (Bivalves and gastropods) in degraded mangrove ecosystems of Kolaka district, Southeast Sulawesi, Indonesia. *Biodiversitas*, *21*(12), 5884–5892. https://doi.org/10.13057/biodiv/d211253

Ibrahim, A. F., Prasetya, A., Maharani, M., Asni, A., Agusriyadin, A., Mubarak, A. A., … Kharisma, G. N. (2021). Analisis Vegetasi, Estimasi Biomassa dan Stok Karbon EkosistemMangrove Pesisir Kecamatan Latambaga, Kabupaten Kolaka. *JSIPi (Jurnal Sains Dan Inovasi Perikanan)(Journal of Fishery Science and Innovation)*, *5*(2), 60–71.

Marfai, M. A., Cahyadi, A., & Anggraini, D. F. (2013). Typology, Dynamics, and Potential Disaster in The Coastal Area District Karst Gunungkidul. *Forum Geografi*, *27*(2), 147. https://doi.org/10.23917/forgeo.v27i2.2373

Mohamad, M. F., Lee, L. H., & Samion, M. K. H. (2014). Coastal vulnerability assessment towards sustainable management of Peninsular Malaysia coastline. *International Journal of Environmental Science and Development*, *5*(6), 533.

Noor, Y. R., Khazali, M., & Suryadiputra, I. N. N. (2006). *Panduan Pengenalan Mangrove di Indonesia*. Bogor: PHKA/WI-IP.

Rudiastuti, A. W., Rahadiati, A., Dewi, R. S., Soetrisno, D., & Maulana, E. (2020). Assessing coastal vulnerability index of tourism site: The case of Mataram Coast. *E3S Web of Conferences*, *153*. https://doi.org/10.1051/e3sconf/202015303002

Sari, D. A. A., & Muslimah, S. (2014). Kebijakan Pengelolaan Pulau - Pulau Kecil Terluar Indonesia Dalam Menghadapi Perubahan Iklim Global. *Yustisia*, *90*, 57–73.

Shepard, F. P. (1973). *Submarine geology*. Harper & Row.

Simandjuntak, T. O., & Surono, S. (1994). *Geological Map of the Kolaka Sheet, Sulawesi*. Geological Research and Development Center, Bandung.

Sofian, I., Supangat, A., Fitriyanto, M. S., & Kurniawan, R. (2011). Memahami Dan Mengantisipasi Dampak Perubahan Iklim Pada Pesisir Dan Laut Di Indonesia Bagian Timur. *Jurnal Meteorologi Dan Geofisika*, *12*(1), 53–64. https://doi.org/10.31172/jmg.v12i1.86

Sumardi, A., Fatimah, E., & Nizamuddin, N. (2019). Study of Physical Vulnerability Mapping of the Coastal Areas of North - East Aceh. *International Journal of Multicultural and Multireligious Understanding*, *6*(4), 107. https://doi.org/10.18415/ijmmu.v6i4.944

Susmoro, H. (2019). *Valuasi Dan Kontribusi Hidrografi Sebagai Faktor Pengungkit Perekonomian Nasional*. Retrieved from www.pushidrosal.id

Ulfa, Y., Jia, T. Y., Yaziz, A. M. C., Irawan, D. E., & Puradimaja, D. J. (2021). Between natural and anthropogenic coastal landforms: Insights from ground

penetrating radar and sediment analysis. *Applied Sciences (Switzerland)*, *11*(8). https://doi.org/10.3390/app11083449

Von Lieberman, N., & Albers, T. (2008). Morphodynamics of wadden sea areas - measurements and modeling. *Chinese-German Joint Symposium on Hydraulic and Ocean Engineering, JOINT 2008*, *1*(3), 209–214.

Yulianda, F. (2007). Ekowisata Bahari Sebagai Alternatif Pemanfaatan Sumberdaya Pesisir Berbasis Konservasi.[Makalah] Departemen Manajemen Sumberdaya Perairan. *Institut Pertanian Bogor*.