Environmental Geology of Semujur Island, Bangka Belitung Archipelago Province

Irvani*, Mardiah, and Guskarnali

Department of Mining Engineering, Faculty of Engineering, Universitas Bangka Belitung, Indonesia

*E-mail: bujangbabel@yahoo.co.id

Abstract. Semujur Island is an inhabit small island with an area around 145,000 m². The island position is on the east side of Bangka Island with high marine potential. The study conducted using a geological survey for getting information on land, groundwater, seawater, and marine sediments. The analysis types are petrologic of soil or sediments, the geochemical analysis of dark well water, seawater, and marine sediments. The results of the study, Semujur Island is formed by sand dun of loose bioclastic material of carbonate pieces with grain-sized sand and gravel resulting from the marine organisms decomposition like reefs, mollusk, and foraminifera shells. The unconfined shallow groundwater system flows in bioclastic to be able to fulfill all populations. The composition of Pb is <0.0250 mg/l in all dark well water under the threshold. Abrasion and seawater intrusion also occur on Semujur Island.

1. Introduction
Semujur Island is a beautiful small island on the east side of Central Bangka Regency. As a sailor homes, the island has a strategic position with very kind of marine resources, including tourism potential. Every holiday time there is a fair number of domestic tourists came. According to Badaruddin et al. [1], tourism is part of the non-living potential of coastal areas and small islands. Marine tourism development requires the availability of information, coordination, and natural resources [2].

According to the Law of the Republic of Indonesia [3], the understanding of small islands is a smaller area or is equal to 2,000 km² with their ecosystem unity. The coastal resources and small islands can include biological, nonbiological, artificial, and environmental services. Furthermore, Asriningrum [4] classifying small island types built on morphogenesis, where geomorphological-based groupings of small islands, arrange-small islands, and some island.

Semujur Island is a narrow land surrounded by shallow seas. The environmental geology conditions of the island are closely related to Bangka island located at Sunda exposure [5]. Written down by Katili [6], Bangka is the Peneplainized island, has relatively stable geologically [5-8]. Using Van Zuidam classification [9], the geomorphological unit mostly flat until very steep hill locally [10],[11]. Bangka island buildings and smaller islands around it is possible to be closely associated with the Sunda shelf emergent at the Pleistocene time [12], transgression-regression took place [13]. These events continue to Holocene time [7], where is the sea-level rise occurs on the most Sundaland [14].

Metasediment rock of Bangka Island is the oldest rock, and a loose deposit of Alluvial as the younger [15],[16]. The older rock has weathered strongly, including shallowing and high-rate sedimentation on
streams [17],[18]. The chemical weathering run intensively [19] because the island on the Sundashelf has a wet tropical climate [5].

As a small island, the environmental condition of all islands has its susceptibility. The factors of small island environmental vulnerability like remoteness, geographical, natural disasters, ecological, economic, and natural resources [20]. The uncontrolled land conversion into built-up areas would contribute to the higher vulnerability of small islands [21]. The coastal elevation significantly affects coastal vulnerability [22]. Morphology or bathymetry will affect the tides high on the coastal area [23]. Furthermore, mining activities around the islands are possible to put environmental health under stress.

Freshwater on the small islands is closely related to the vast catchment area, aquifers type, climate, and human activities [24]. The freshwater source only from the meteoric water as lenses. The groundwater thick-lenses are affected by seasons, water use, and sea tides [25]. Rainy numbers are associated with water availability, especially for small islands with a dry climate [26]. Overpumping of groundwater leads to an intrusion of seawater [27]. The mangrove tree was able to prevent the intrusion of the seawater [28]. Groundwater vulnerability is susceptible to contaminants introduced at the land surface [29].

As the rising sea levels by global climate change, Semujur Island is susceptible to abrasion. The abrasion is influence by decreased sediment supply, wave, tidal and cyclonic, sea-level rise and land subsidence, and also human activities [30]. Abrasion occurs on the blocked coastal area, without sediment supply [31]. The loose sediments of biogenic fragments fine-medium sand-sized, easily fabricated in the coastal areas [23]. Sea waves can transport large amounts of sediment material [1].

2. Methods
The environmental geology survey-purpose is for getting geological information all over Semujur Island. The geological data is a marine sediment, soil, seawater, groundwater, geo-disaster potential. Using global positioning system (GPS) units is for getting coordinates of sample and measuring data. The petrology analysis of soil and marine sediments. Simple spatial analysis to obtain extensive coverage of land, also geo-disaster potential as abrasion and sedimentation.

The water-geochemistry analysis purpose is to determine the heavy metal concentration of Pb by using the Atomic Absorption Spectrophotometry. Groundwater salinity detects using the Electrometric Method, as well as Pb metals contents in marine sediments by using XRF (X-Ray Fluorescence). The maximum permissible level of heavy metal Pb for drinking water is determined based on Indonesian government regulation [32]. The final stage is geologic reconstruction to understand the potential of environmental geology comprehensively.

3. Results and discussion
Semujur Island covers one neighborhood association, part of Kebintik Village, Pangkalan Baru subdistrict, Central Bangka Regency. The island is home to 63 families. Generally, they are fishermen of Bubu fishing and Cumi Maban. Almost half of them are settlers from the Sulawesi Island. In the holiday season, the domestic tourist came visiting for one to three days long (Figure 1). At the peak of the holidays, there were a total of about 200 people staying on Semujur Island. As for the energy needs for lights at night using a generator.

The land existing in Semujur Island are gardens mostly, shrubs with rare trees, and residential. The residential area has approximately 20,620 m², with supporting facilities such as narrow roads and a fishing port. The daily freshwater use fulfill from the dark wells, but for drinking water, use refill water from Bangka generally. The edge of the beachside, the corals and white sand color is easy to see. They become the seafloor. In the western, there are residential areas along with tourism facilities such as villas with dock facilities that are used as places to stay for guests who travel to Semujur Island. The people's homes entirely are stilts type (Figure 2).
3.1 Geology of Semujur Island

Semujur Island has an east-west elongated shape, with the bright white sand on land. The beach slope is flatly about 2-5°, contour line 0-3.5 m above sea level based on terrestrial measurement. This island is formed by the accumulation of sand bars and compose of the loose bioclastic material, as generally. The material is mostly carbonate pieces, has grain-sized of sand to gravel. They are resulting from the marine organisms decomposition of coral reefs break, mollusk shells break, and foraminifera shells around the study area.

The bedrock unexposed on the Semujur Island. All over the land covering by a loose bioclastic. We classify this loose material of coastal deposits, named alluvium if we refer to Mangga & Djamal, and Margono et al. [15, 16], as regionally. Based on morphometry, morphography, and morphogenesis parameters, unformal-classified as a Flaty Coastal Geomorphology Unit. It's geomorphology unit generally forms Bangka Island [6], called Peneplain. The elongation shape of Semujur Island and the surrounding islands have a relatively east-west trending. This shape also relatively perpendicular to the direction of the sea surface current model from the Wyrtki current model [33], which occurs in the West Monsoon and the East Monsoon.

3.2 Hydrogeology of Semujur Island

In the dry season, all the Wells are not dry. But especially for drinking water, some people buy bottled refill water from Bangka Island. There are four dark wells all over the Semujur Island, and one of them illustrate in Figure 3. The freshwater useful to fulfill the domestic fishermen and tourists visited needs. The dark well-depth is about 2.6-3.85 m, with a water column 0.5-0.66 meters in thick. All freshwater of dark wells have good clarity, but in particular, for one dark well closest to a settlement area is more salty or brackish. Based on the water test of three dark wells showed brackish water with a salinity content of 0.5-0.7 gr/kg. The dark well nearest the settlement has the highest salinity, while the dark well farthest has the lowest salinity. Suggest, groundwater over-pumping caused this seawater intrusion. An uncontrolled groundwater pumping would result in the intrusion of seawater into underground freshwater [27]. The Semujur island groundwater aquifer can be assumed to be a lenses as usual small island. Freshwater aquifers in a small island form lenses, shallows, and recharge depends on rain [25].

Heavy metal-analysis of Pb in groundwater from three dark wells has composition under 0.0250 mg/l, below the threshold of 0.03 mg/l [32]. On the other hand, Pb's content in seawater is 0.16 mg/l. The high contents of Pb metals in seawater are estimated associated with tin-mining activities around the island. The natural process remediation of heavy metal Pb has worked well through sediment that built the
island, so the Pb content in all groundwater samples are still below the threshold. The tin mining activity had no effect groundwater quality based on heavy metal of Pb content.

3.3 Geodisaster Potential of Semujur Island

Geodisasters' potential of Semujur Island is coastal abrasion, seawater intrusion, sedimentation, high tides, storms, and etcetera. The beach abrasion traces on the northern side of the island opposite the Natuna Sea (Figure 4). The morphology change that form natural signs of abrasion reaches an average height is 0.5 m. The tidal wave and sea current with the north to east direction [33] at West Monsoon is estimated as the cause it. They are hitting the open northern Semujur Island directly.

The seawater intrusion observes in the all of the existing dark wells. The nearest dark well to settlement saltier than the others. Groundwater pumping overcapacity causes the intrusion [27]. On the Semujur Island, there are no mangroves to prevent seawater intrusion, as Salim et al. [28]. The groundwater pump has exceeded the maximum aquifer yield.

Sedimentation runs very dynamic around the island all year long. The sedimentation patterns are contrasting between East and West Monsoon, as illustrated in Figure 6. At the West Monsoon, sediment is plentiful on the south of the east and west of Semujur Island. However, these sediments are disturbed during the eastern monsoon, and then deposition occurs on the north side of the island. The sea wave transported sediments to another side [1]. Apart from the potential disasters above, there are also other potential disasters, high tidal waves, and storms. However, not yet found records of casualties that occurred on Semujur Island.

3.4 Developments of Semujur Island

Semujur Island is a bioclastic sand dun that has natural beauty. The southern of the island is more protected, more shallowing bathymetry, having a small wave, and becomes a favorite tourist site for play, snorkeling, relaxing, and gathering. As for the northern and eastern of the island, it has reefs and
snorkeling area. Groundwater is well available for domestic use but slightly salty cause influenced by seawater intrusion.

The future development of Semujur island as to follow the population grows requires adequate housing, the sufficient freshwater, and medical infrastructure. The local wisdom existing settlement of the stilts provides the solution to keep the catchment area goods. Northern island susceptible to abrasion, so needs to build natural abrasion resistance infrastructure. Planting mangrove trees is better if possible. As for seawater intrusion, it can be overcome by build infiltration holes, increasing the volume of rainwater charging the ground.

4. Conclusions
The results of the study are as follows: Semujur Island is formed by sand bars and composed by loose bioclastic material of carbonate pieces with grain-sized sand and gravel resulting from the marine organisms decomposition. The unconfined shallowing groundwater system flows in bioclastic as lenses and influences by seawater intrusion. The composition of Pb metal in groundwater is under the threshold. Tin mining suggested it did not affect the groundwater quality of Semujur Island. The abrasion sign on the northern of Semujur Island, facing the Natuna Sea, estimated caused by tidal-wave at the West Monsoon.

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