

Analysis of the quality of the coastal substrate of Awarange Beach, Barru Regency, Indonesia

ABSTRACT

The study aims to determine the quality of the coastal substrate of Awarange Beach, Barru Regency, Indonesia. The research was conducted from July to August 2024 on the coast of Awarange Beach, SoppengRiaja District, Barru Regency, Indonesia. Soil sample analysis was carried out in the Chemistry and Water Laboratory of the Pangkep State Agricultural Polytechnic. This study uses a substrate quality survey method on the Awarange coast of Barru Regency. Determination of substrate quality refers to the chemical and physical properties of each location. Data analysis used in this study to see pH, nitrite concentration (NO_2), ammonia, total nitrogen and substrate texture. After obtaining the measurement results, the next step is descriptive analysis. The results of the study by measuring the quality of the substrate at three research locations, namely ST 1, La Sonrai recreation beach, Barru Regency; ST 2, which is the location around the Awarange shipyard, Barru Regency; and ST 3, which is the location near the Barru Regency Port, showed that the pH value, nitrogen, organic matter, ammonia (NH_3), and nitrite (NO_3) were all in good condition and were not classified as polluted. Furthermore, all research locations had a sandy substrate texture.

Key words: coastal substrate, Beach, Sediment, Substrate quality

1. INTRODUCTION

Coastal areas are transitional areas between land and sea, with parts of the sea still influenced by land activities such as sedimentation and freshwater currents and parts of the sea influenced by marine activities such as tides, sea breezes, and salinity (Akbar & Pratiwi, 2023). These conditions cause coastal areas to experience pressure from various activities and phenomena on land and at sea (Pinto, 2015). Phenomena that occur on land include abrasion, flooding, and activities carried out by the community, namely the construction of settlements, deforestation for rice fields, construction of ponds, and so on, which ultimately have an impact on the coastal ecosystem. Likewise, phenomena at sea, such as sea tides, storm waves, and so on (Hastuti, 2012).

In general, coastal community activities include economic activities in the form of fisheries that utilize land, water, and open sea; tourism and recreation activities that utilize land, water, and underwater objects; marine transportation activities that utilize

land and space allocation in the sea for shipping lanes, port pools and others; industrial activities that utilize land; mining activities that utilize land and sea; energy generation activities that use land and sea; maritime industry activities that utilize land and sea, settlements that utilize land for housing and public service facilities; and agricultural and forestry activities that utilize land (Pinto, 2015). Coastal damage is more influenced by natural and human factors (Gumilar, 2012).

The potential of natural resources in coastal areas must be supported by the management of the utilization of natural resources and environmental services in coastal areas, by conducting a comprehensive assessment of coastal areas and the natural resources and environmental services contained therein, determining the objectives and targets of utilization, and then planning and managing all utilization activities, in order to achieve optimal and sustainable development in a comprehensive and integrated manner (Lubis, 2014). In addition, coastal and marine areas are also used for aquaculture

(marine cultivation), recreation and tourism, agro-industry, transportation and ports, industrial development, settlements, and also as waste disposal sites (Lubis, 2014). Basically, the existence of industry can have positive and negative impacts on the development of the surrounding area (Rahayuningsih, 2017). Lack of coastal area management, inappropriate use of resources, lack of environmental standards, and lack of balance between tourism activities and physical space cause coastal damage due to tourism activities to worsen (Shafei & Mohamed, 2012).

Problems that threaten the sustainability of water resources are activities in the upstream areas of rivers, such as agriculture, plantations, industry, and settlements, that continuously have a significant impact on river ecosystems. Pollutants produced by each activity will be carried by river currents to the downstream areas, then accumulate in the estuary area so that the area around the estuary often contains quite high levels of pollutants (Prianto et al., 2010). Due to the pressure on water in coastal areas, it is possible that it will also have an impact on the substrate in coastal areas. Various efforts that are considered to be able to reduce the risk with various activities on the coast are planting mangroves. However, the utilization of mangroves that has occurred without paying attention to the composition of the vegetation must be restored through appropriate management methods, including selecting the right types of mangrove vegetation for the substrate, planting, conservation, and so on (Masruroh&Insafitri, 2020). According to Arief (2003), one of the supporting factors for maintaining high mangrove vegetation composition is mangrove substrate. Substrate is a place where mangrove roots can grow. Substrate is the main limiting factor for mangrove growth and distribution (Budiman, 1991).

Specifically for the Awarange coast, various activities have been carried out to support the community's economy, including coastal tourism, where there are tourism activities around the coast that also contains mangrove trees. According to Pinto (2015), tourism activities in coastal areas have the potential to be developed both in relation to natural and artificial tourism. Tourism and environmental activities are interrelated because they involve many tourism activities that will have an impact on the environment, economy, and physical and social aspects (Shafei & Mohamed, 2012). However, the coastal area is an area that is vulnerable to damage due to tourism activities. In addition, around it there is also a port called Awarange port where many ships sail and anchor. Although at this time there is no data showing that there has been a decline in fish production, however, looking at the activities at the research location, it is very possible that there has been a decline in water and substrate quality, which will directly or indirectly result in a decline in fish production in the future.

According to Lubis (2014), a port is a network system that is interconnected between one variable and another; increasing port activity will cause major changes in the port system, resulting in the need for port effectiveness and efficiency becoming increasingly urgent to be met immediately. Even around the harbor there has been a shipyard. These three factors are the basis for the need to conduct research on the condition of the basic substrate of the waters around the Awarange coast.

This research is very important to do because at the research location, namely location 1, which is a tourist spot of Lasonrai, has the potential for environmental pollution, especially by tourists if not handled properly. At location 2, which is a shipyard, it is very dangerous for environmental pollution because of the

loading and unloading activities of goods and ship repairs, so that research needs to be done. Location 3, which is a port where there are many ships leaving and entering the port, and this can be a source of

environmental pollution. Based on this description, it is necessary to analyze the substrate at the research location to detect the possibility of environmental pollution.

2. METHODOLOGY

2.1 Research Location

The research was conducted from July to August 2024 on the coast of Awarange Beach, Soppeng Riaja District, Barru Regency, Indonesia. The sediment sampling process was carried out at 3 different locations. Location 1 (ST 1.) is the La Sonrai tourist spot, where there are also several mangrove trees around it; location 2 (ST 2) is a location located around the Awarange shipyard, and location 3 (ST 3.) is a location located around the Awarange Port, where there are many ship loading and unloading activities, both government ships (Pelni) and private ships and fishermen. Analysis of soil samples was conducted in the Chemistry and Water laboratory of the Pangkep State Agricultural Polytechnic. This study used a substrate quality survey method on the Awarange coast of Barru Regency. Determination of substrate quality refers to the chemical and physical properties of each location. The research location is as shown in Figure 1.

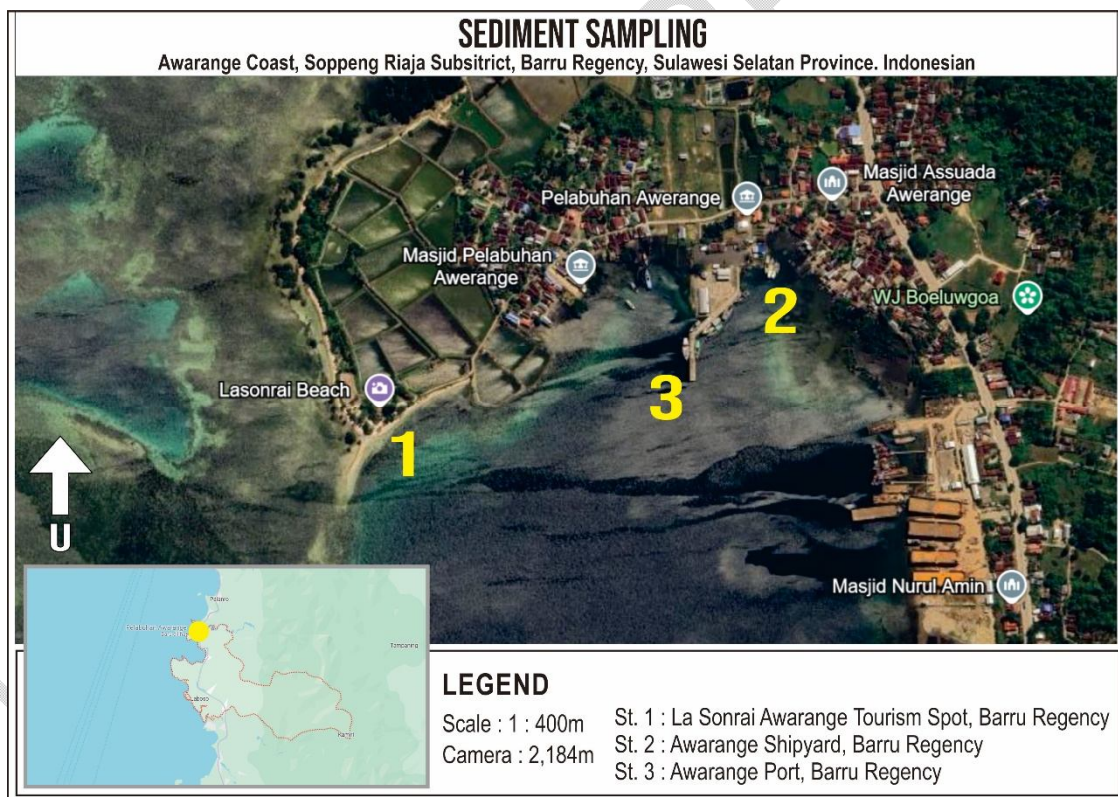


Figure 1. Research Location

2.2 Data Collection Methods

Soil sampling was conducted using systematic sampling techniques because the topography of the research location is flat (Suganda, 2006). Substrate sample analysis in the laboratory was conducted to determine pH, nitrogen, organic matter, NH_3 , NO_2 , and soil texture.

2.2.1. pH

Soil pH measurement was carried out by weighing 10 grams of soil sample, which was put into a shaker bottle. Then 50 ml of ion-free water was added to the bottle and then shaken with a shaker for 30 minutes, and then the soil suspension was measured with a pH meter that had been calibrated using a pH buffer solution of 7.0 and 4.0, and then the pH value was reported in 1 decimal (Prayitno et al., 2016).

2.2.2. Nitrogen

Total nitrogen content was measured using the indophenol method by titration (SNI 4146-2013). A sample of 10 g of pond bottom substrate, ± 10 g of catalyst, and 35 ml of concentrated H_2SO_4 from each were put into a Kjeldahl flask. Then the heating process was carried out at a temperature of $400^\circ C$ for 30 minutes. The solution was then cooled, and then 300 ml of distilled water was added. The cooling process was collected into 50 ml of H_3BO_3 solution and put into a 250 ml Erlenmeyer flask. After that, the distillate was titrated with 0.1 N H_2SO_4 solution using a mixture indicator until it turned violet. Furthermore, the total nitrogen content was calculated using the formula (Nadapdapa et al., 2020):

$$\text{Kadar nitrogen (\%)} = \frac{((a1 - a2) \times n \times 14)}{c} \times 100\%$$

Where :

- a1 : is the average 0.1 N H_2SO_4 standard used in the sample titration (ml)
- a2 : is the average 0.1 N H_2SO_4 standard used in the blank titration (ml)
- n : is the normality of H_2SO_4 (g/L)
- 14 : is the atomic weight of Nitrogen

2.2.3. Total Organic Matter (TOM)

Total organic matter in water in this study was measured using the titrimetric method (SNI 06-6989.22-2004). A 100 ml water sample was put into a 250 ml Erlenmeyer flask, and then a few drops of $KMnO_4$ were added until it turned slightly bluish. After that, 10 ml of 4N H_2SO_4 solution was added. Furthermore, the mixed solution was then heated using a hotplate until boiling, and then 10 ml of 0.01 N $KMnO_4$ solution was added. The solution was then boiled for 10 minutes at a temperature of $105^\circ C$, then 10 ml of 0.01 N oxalic acid solution $H_2C_2O_4$ was added and boiled again until the red color disappeared. The solution was then titrated with 0.01 N $KMnO_4$ solution in a hot state until a pink color was formed (Rahman et al., 2022).

2.2.4. Ammonia (NH_3)

Ammonia measurement begins with the process of extracting ammonia from

sediment samples. This process is carried out by taking a sediment sample of 2.5 grams, which is then added with 7.5 ml of 1M KCL solution. After that, the mixture is agitated using a vortex until homogeneous. Take 2 ml of the vortex results into a tube for centrifuge. Furthermore, the ammonia measurement process will be carried out on the suspension of the agitation results. The suspension (1 ml) was mixed with the reagent solution from the Salifert Ammonia Test Kit and waited for 2 minutes. Then, the absorbance value will be measured using a spectrophotometer using a light wavelength of 400 nm (Tinambunan et al., 2022).

2.2.5. Nitrate (NO_3)

Determination of nitrite levels was carried out using the spectrophotometer method (SNI 06-6989.9-2004). In an acidic environment (pH 2.5), nitrite will react with sulfanilamide (SA) and N-(1-naphthyl) ethylene diamine dihydrochloride (NED

dihydrochloride) to form a purplish red azo compound that can be measured at a wavelength of 543 nm (Putri et al., 2019).

2.2.6. Substrate Texture

The method used to see the soil fraction is to provide a 100 mL beaker; soil samples are taken with a depth of 30 cm as needed, soil samples are put into the beaker, given enough water until it approaches the mouth of the bottle, and then homogenized. Placed on a flat place, after 1 minute, observations and measurements are made on the first layer (sand layer), and then the results of the observations are recorded. The sample is left for another 2 hours; after 2 hours, observations and measurements are made on the second layer (mud layer) and the third layer (clay layer). The results of the observations are then recorded, and the percentage of sand, mud, and clay fractions is calculated (Chrisyariati et al., 2014).

Data analysis was used in this study to see pH, nitrite concentration (NO_2), ammonia, total nitrogen, and substrate texture. After obtaining the measurement results, this analysis was carried out using Microsoft Excel 2013, and the data obtained were presented descriptively in the form of graphs, which were then analyzed as a basis for drawing conclusions.

3. RESULTS AND DISCUSSION

3.1. pH

Figure 2 shows that the lowest average substrate pH value is at location 3 (ST 3), which is the location around Awarange port

with an average substrate pH value of 8.34, followed by location 2 (ST 2), which is the location around the shipyard, which is the average substrate pH value of 8.39, and the highest average substrate pH value is at location 1 (ST 1), which is the location that is the La Sonrai tourism recreation area with an average value of 8.61. All locations have an average substrate pH value between 8.34-8.61, which means that the substrate pH is in the basic category. The high pH value of the substrate at ST 1 compared to other stations is thought to be due to the presence of many organisms, animal, plant, and bacterial activities in the waters. According to Wantasen (2013), the pH tolerance range is around 6.0-9.0, and the optimal pH is around 7.0-8.5 (Wantasen, 2013).

The high pH value of the substrate around the research location is thought to be caused by all locations having a substrate base in the form of coral. According to Chrisyariati et al. (2014), the degree of acidity (pH) of waters is greatly influenced by the decomposition of soil and the bottom of the waters as well as the condition of the surrounding environment. High pH levels can cause an increase in the concentration of toxic ammonia (Tinambunan et al., 2022). Furthermore, alkaline pH will reduce the solubility of micronutrients. P nutrients cannot be available to plants because of precipitation in solid carbonate. To reduce soil pH, sulfur can be used (Setyobudi, 1993).

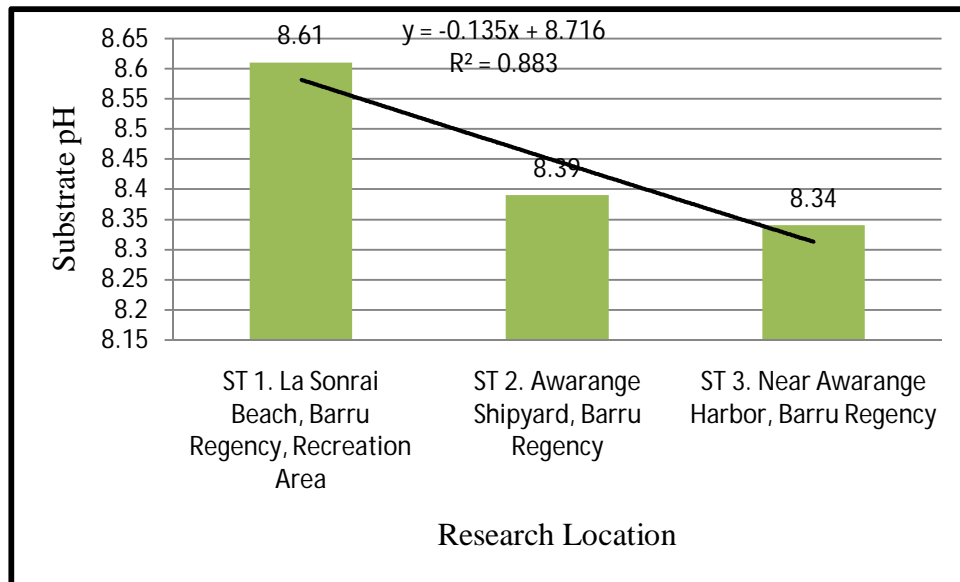


Figure 2. Substrate pH at the research location

3.2. Nitrogen (%)

Figure 3 shows that the nitrogen value in the substrate at the research location is in the range of 0.108-0.129, and the highest substrate nitrogen is at ST 2, namely 0.129, namely the substrate located around the Awarange shipyard, and the location with the lowest substrate nitrogen content is ST 3,

namely the substrate located around the Awarange port in Barru Regency. According to Suharno et al. (2007), the existence of nitrogen elements is also very important, especially in relation to the formation of chlorophyll in plant leaves. In waters, the plants in question are mainly plankton which are the basis of life for biota in waters.

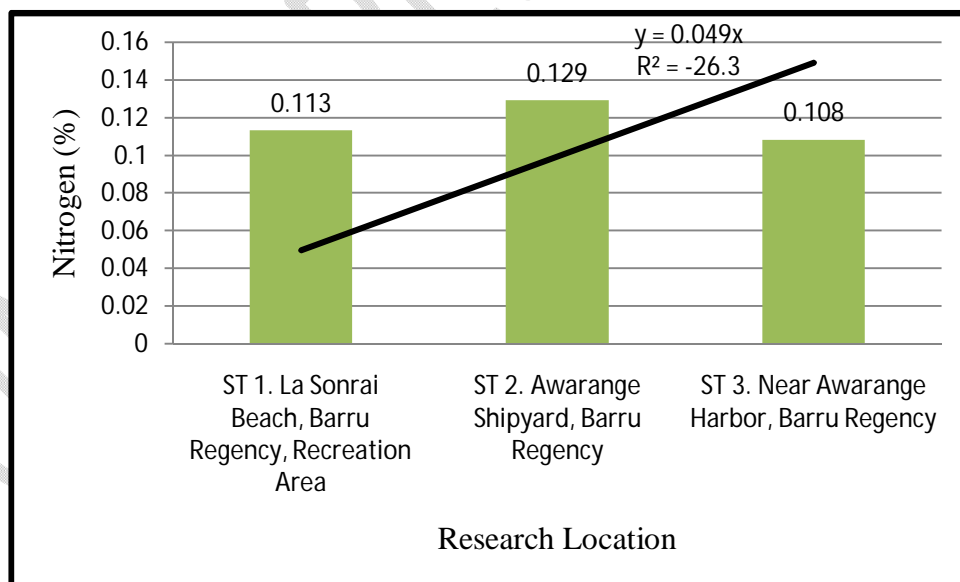


Figure 3. Nitrogen (%) Substrate at the research location

Another factor that causes low nitrogen content in the soil is the presence of excessive water in the soil so that nitrogen will undergo a denitrification process

(Prayiko et al., 2016). Denitrification is the process of changing nitrate and nitrite into N_2 and N_2O gas, which will return to the atmosphere (Poerwowidodo, 1993). The low

total N value in the soil, apart from the above factors, is also influenced by leaching that occurs in the soil. Bacteria play an active role in the process of breaking down organic materials such as carbon and nitrogen because these elements are a source of energy and nutrients that are very much needed by bacteria in the formation of enzymes to carry out metabolism (Suprpto et al., 2017).

3.3. Organic Materials (%)

Organic matter is a material that stabilizes soil aggregates and is a source of plant nutrients, as well as a source of energy and food for soil microorganisms (Patti et al.,

2013). Figure 4 shows that the organic matter content of the substrate at the research location is in the range of 0.39-1.04%, with the lowest organic matter content of the substrate at ST 2, namely the location around the Awarange shipyard, Barru Regency, namely 0.39, followed by ST 2, namely the location around the Awarange port, Barru Regency, namely 0.63, and the location with the highest organic matter content of the substrate is ST 1, namely the location on the beach of the La Sonrai recreation area, Barru Regency, namely 1.04%.

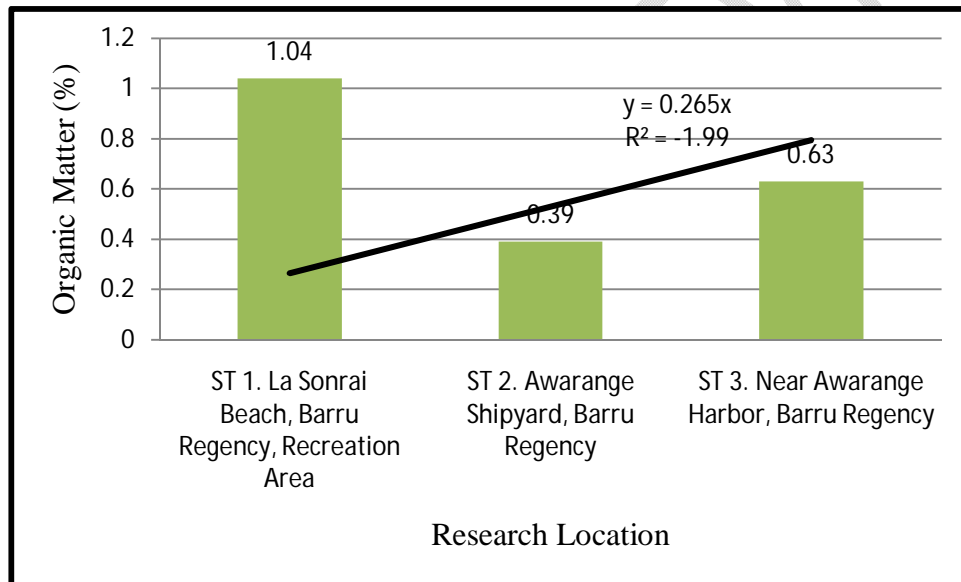


Figure 4. Organic Matter (%) of Substrate at the research location

Organic matter is a collection of various complex organic compounds that are undergoing or have undergone a decomposition process, either in the form of humus resulting from humification or inorganic compounds resulting from mineralization, including heterotrophic and autotrophic microbes that are involved and present in it (Hardjowigeno, 2003). Organic matter in sediment is composed of sedimentation results influenced by conditions during the sedimentation process. Conditions with the presence of oxygen will reduce the amount of organic compounds

that precipitate due to further degradation of organic matter in the water column. The amount of organic matter that will be deposited is also closely related to primary productivity, waves, currents, and the presence of predators and decomposers (Killops and Killops, 1993). Organic matter is one indicator of the fertility of the aquatic environment. Organic matter in certain amounts is needed by waters, related to its function as a provider of nutrients for bacteria and phytoplankton in the waters (Marwan et al., 2015). The largest source of organic matter in the sea comes from land

(Nybakken, 1992). The speed of bacteria in decomposing organic matter depends on the increase in organic matter levels in the substrate; the higher the organic matter available, the more the decomposition process will also increase (Nadapdapa et al.,

3.4. Ammonia (ppm)

Ammonia (NH_3) is one of the inorganic nitrogens that is soluble in water (Connell and Miller, 1995). This compound comes from nitrogen, which becomes NH_4 at low pH and is called ammonium. Ammonia in water comes from urine and feces, microbiological oxidation of organic substances, and from industrial wastewater and community activities (Putri et al., 2029). Ammonification is the process of forming ammonia from organic matter, which will then be converted into nitrate or nitrite through the nitrification process (Hastuti, 2011). Figure 5 shows that the ammonia (NH_3) content of the substrate at the research location is in the range of 0.0287-0.1005 ppm, with the lowest ammonia substrate content at ST 2, namely the location around the Awarange shipyard, Barru Regency, which is 0.0287 ppm, followed by ST 1, namely the location

2020). Hanafiah& Kemas (2005) stated that increasing organic matter in the soil will also increase N in the soil. The low organic matter in ST 2 is thought to be due to the topography and the relatively small sand content compared to the mud. around the La Sonrai recreation beach, Barru Regency, which is 0.0329 ppm, and the location with the highest ammonia substrate content is ST 3, namely the location around the Awarange port, Barru Regency, which is 0.1005 ppm. Husnah (2010) found higher ammonia concentrations along the downstream Musi River, ranging from 0.63 to 3.09 ppm. It was further explained that the increase in ammonia concentration was caused by agricultural, plantation, industrial and residential activities around the area. The results of the study by Larasati et al. (2015) found that the concentration of ammonia in the Rupert Strait ranged from 0.092 to 0.724 ppm. According to Zhang et al. (2012), high concentrations of ammonia in waters can cause a decrease in dissolved oxygen, which can cause disruption of physiological and metabolic functions such as respiration.

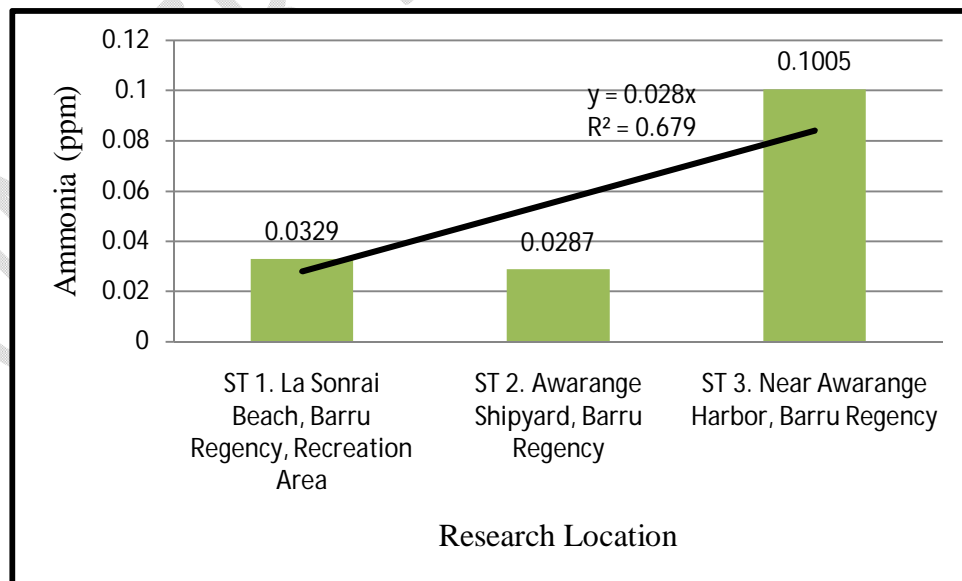


Figure 5. Ammonia (ppm) Substrate at the research location

When dissolved oxygen in the aquatic environment is low, ammonification will also slow down (Zhao et al., 2015). The ammonia content in mangrove sediments in Tahura Ngurah Rai is known to be higher than the ammonia content in mangrove sediments in Perancak Bali (Susiana, 2015). The ammonia content in mangrove sediments in Tahura Ngurah Rai is known to be higher than the ammonia content in mangrove sediments in Perancak Bali (Susiana, 2015). The increasing levels of ammonia in the sea are related to the entry of organic matter that can be easily decomposed, both containing nitrogen and non-nitrogen elements (Tinambunan et al., 2022). In this ammonification process, organic matter will be converted into ammonia by a group of ammonifying bacteria (Iswantari et al., 2014). **The ammonium condition is inversely proportional to the organic material content, due to the decomposition process by decomposing bacteria so that ammonia changes into ammonium.**

3.5. Nitrite(ppm)

Nitrite (NO_2) is an oxidized form of nitrogen with an oxidation number of +3 and is often found in wastewater treatment plants, river water, and drainage (Putri et al., 2019). Figure 6 shows that the nitrite (NO_3) content at the research location is in the range of 0.0024-0.0029 ppm, with the lowest nitrite content at ST 1, namely the location around the La Sonrai recreation beach in Barru Regency, namely 0.0024 ppm, followed by location ST 3, namely the location around or near the Awarange port in Barru Regency, namely 0.0027, and the location with the highest nitrite content, namely ST 2, namely the location around the Awarange shipyard in Barru Regency, namely 0.0029 ppm. The Canadian Council of Ministers of the Environment (2008) states that natural waters generally contain nitrite of 0.001 ppm and should not exceed 0.06 ppm. Furthermore, Effendi (2003) states that in natural waters, nitrite is generally found in very small amounts due to its unstable nature due to the presence of oxygen.

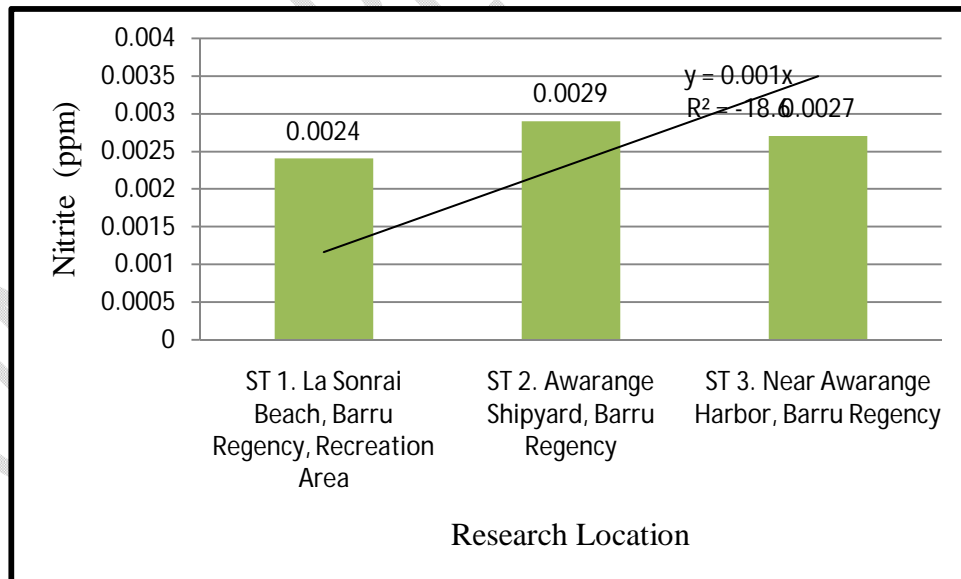


Figure 6. Nitrite (ppm) Substrate at the research location

As we know, nitrite is generally a transitional form between ammonia and nitrate and immediately changes into a more stable form, namely nitrate (Putri et al.,

2019). However, nitrite is one of the key parameters in determining water quality because it is toxic when it reacts with hemoglobin in the blood, causing the blood

to be unable to transport oxygen (Effendi, 2003). In the nitrification process and the ammonification process, it is very dependent on the presence of oxygen in the aquatic environment, because ammonification bacteria are aerobic bacteria that require oxygen to carry out their metabolic processes (Meirinawati, 2017). When oxygen in the environment is abundant, the ammonification and nitrification processes will also run smoothly (Iswantari et al., 2014). Because the high total bacteria indicate that there is a sufficient supply of food (energy) and oxygen in the sediment (Tinambunan et al., 2022).

3.6. Substrate Texture

Table 1 shows that at the research locations, namely ST 1, La Sonrai recreation beach, Table 1. Substrate texture at the research location

| Substrate Sample | Substrate Texture |
|---|-------------------|
| ST 1. La Sonrai Beach, Barru Regency, Recreation Area | Sandy |
| ST 2. Awarange Shipyard, Barru Regency | Sandy |
| ST 3. Near Awarange Harbor, Barru Regency | Sandy |

The type of substrate on a beach greatly affects the growth of mangroves. The type of soil, silt (dust) and clay, is a supporting factor for the regeneration process where clay particles in the form of mud will catch the fruit of mangrove plants that fall when they are ripe. This regeneration process greatly affects the density of mangroves in an area. On the other hand, on beaches with sandy substrates or sand mixed with coral fragments, the mangrove density will be low because the type of substrate is unable to catch/hold the fallen mangrove fruit so that the regeneration process does not occur (Kordi, 2012). Barru Regency and ST 3. Near the Port of Barru Regency showed a substrate pH value between 8.34-8.61; nitrogen in the substrate at the research location was in the range of 0.108-0.129; the organic matter content of the substrate at the research location was in the range of 0.39-1.04%; the ammonia (NH₃) content of the substrate at

Barru Regency; ST 2, Awarange shipyard, Barru Regency; and ST 3, near the Barru Regency Port, all locations have a sandy substrate texture. Sari et al. (2017) reported that the type of substrate found in river estuaries and rehabilitated mangroves was sandy substrate, while in natural mangroves it was muddy substrate. The three locations have a sandy texture, presumably because all locations face the open sea and are far from river mouths. According to Nybakken (1982), at river mouths with weak currents, the substrate type is mud and clay; if the current is strong, you will find a lot of sandy substrate because only large particles settle more quickly than smaller particles.

the research location was in the range of 0.0287-0.1005 ppm; the nitrite (NO₃) content at the research location was in the range of 0.0024-0.0029 ppm; all research locations had a sandy substrate texture. Based on the results of measuring the quality of the substrate at the research location, it can be stated that the condition of the substrate quality is still good and has not been in a polluted substrate condition.

4. CONCLUSION

Based on the results of the study by measuring the quality of the substrate at three research locations, namely ST 1, La Sonrai recreation beach, Barru Regency; ST 2, Awarange shipyard, Barru Regency; and ST 3. Near the Barru Regency Port, the substrate pH value shows between 8.34-8.61; nitrogen in the substrate at the research location is in the range of 0.108-0.129; the organic matter content of the substrate at the research location is in the range of 0.39-1.04%; the ammonia (NH₃) content of the

substrate at the research location is in the range of 0.0287-0.1005 ppm; the nitrite (NO₂) content at the research location is in the range of 0.0024-0.0029 ppm; all research locations have a sandy substrate texture. Based on the results of measuring the quality of the substrate at the research location, it can be stated that the condition of the substrate quality is still good and has not been in a polluted substrate condition.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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