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Analysis of Seawater Quality in the Villa Ombak Gili Terawangan Area, Pemenang District

Nurhidayah[1], Hijriati Sholehah[1*], Nurhidayatullah[2], Mulhidin[1], Azwaruddin[1]

[1]Environmental Engineering Study Program, Mataram College of Environmental Engineering, Mataram, Indonesia
[2]Environmental Health Study Program, Mataram College of Environmental Engineering, Mataram, Indonesia
[*]e-mail: hijriati.chemist@gmail.com

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Abstract: Tourism is one of the most rapidly growing sectors globally and plays a vital role in regional development by contributing to foreign exchange earnings, job creation, and poverty alleviation. Gili Trawangan, a small island in West Lombok, is a popular marine tourism destination experiencing rapid growth in tourist visits and supporting infrastructure, such as hotels and restaurants. This growth has led to increased population density and higher environmental pressures, particularly in the form of liquid waste and pollutants entering coastal waters. If not properly managed, these pollutants can degrade water quality and marine ecosystems. This study aims to assess the quality of seawater in the Villa Ombak area of Gili Trawangan, located in Pemenang District. A quantitative research method was applied, with seawater samples collected from six stations using the Niskin bottle method at a depth of one meter. Parameters analyzed included physical (temperature, total suspended solids/TSS), chemical (pH, salinity, dissolved oxygen/DO, ammonia-N/NH_3-N, nitrate-N/NO_3-N, phosphate/PO_4, oil and fat), and biological (total and faecal coliform) characteristics. Laboratory analysis was conducted at the Mataram PUPR Laboratory, and results were compared to the Indonesian Government Regulation (PP) No. 22 of 2021 on seawater quality standards. The findings showed that all measured parameters met the required quality standards for marine tourism and biota. Recorded values included a temperature of 29°C, TSS 2.5 mg/L, pH 8.2, salinity 33 PSU, DO 6.9 mg/L, NH_3-N 0.019 mg/L, NO_3-N 0.0017 mg/L, oil and fat <0.03 mg/L, total coliform 185 MPN/100 mL, and faecal coliform 0 MPN/100 mL. Although still within safe limits, ongoing monitoring and environmental management are essential to prevent ecological degradation and to ensure the sustainability of marine tourism in the area.

Keywords: Gili Terawangan; Seawater; Standard Quality; Villa Ombak; Water quality.

Introduction

Tourism is one of the sectors that is considered to have an important role in the development of a country, where tourism can directly contribute more to regional income, where the tourist attraction is foreign exchange earnings, job creation and poverty alleviation [1].

The tourism industry is one of the largest industries and service sectors with the fastest growth rate in the world today. The rapid number of tourist visits is a very profitable condition. The development of tourism in turn encourages the development of various business fields that support the tourism sector, such as accommodation, transportation, culinary and the surrounding seawater.

Gili Trawangan is an island located west of Lombok with a length of 3 km, a width of 2 km, and an area of 2,954 square meters. In Gili Trawangan, the population is now quite dense, ranging from local residents and people who work in hotels, restaurants, and tourists who come every day. The more residents on a small island, the more liquid waste is inevitable and can pollute the environment around the island. If this liquid waste is not handled properly or processed properly, environmental pollution will be very bad. Natural tourism, which is a favourite, is beach tourism, which is centered on the Three Gilis in Pemenang District. One of the barometers of tourism development in North Lombok Regency is the number of hotels and restaurants. One of them is the Vila Ombak Hotel, which is one of the hotel barometers in Gili Trawangan. This is directly proportional to the number of tourists visiting North Lombok Regency, both domestic and foreign tourists continue to increase [2].

Figure 1. Location map of Hotel Vila Ombak activities

The population of Gili Terawanga has increased with the number of immigrants from outside who have entered with the intention of making the area a place to earn a living to support their daily lives. In line with this, the economy in coastal areas has also increased. The consequences of a high population on coastal areas have resulted in environmental damage, with the entry of various pollutants that can cause

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environmental degradation in coastal areas and the surrounding ecosystem. Pollutants that enter coastal and marine areas can come from various sources with different compositions, so that the impacts on the environment also vary. This affects the status of water quality, namely the level of water quality conditions that indicate polluted conditions or good conditions within a certain time compared to the established quality standards [3].

The most obvious problem in coastal areas is the existence of development activities in coastal areas that are more dominant, which results in a decline in the quality of the coastal and marine environment, namely in the form of pollution and environmental damage. Every pollutant that enters the waters has the potential to cause a decline in the quality of the waters which will reduce the biological and ecological functions of the ecosystem within it [4] Every pollutant that enters aquatic ecosystems has the potential to degrade water quality, leading to the disruption of biological processes and the impairment of ecological functions. Numerous studies have demonstrated that contaminants such as heavy metals, nutrients, pesticides, pharmaceuticals, and microplastics can significantly alter aquatic biodiversity, reduce primary productivity, and disrupt food web dynamics [5]. For example, eutrophication driven by excessive nutrient loading has been linked to hypoxic zones and fish kills [6] while trace metals have been shown to bioaccumulate in aquatic organisms, affecting their survival and reproduction. Furthermore, emerging contaminants like endocrine-disrupting chemicals can interfere with hormonal systems in fish and amphibians, compromising reproductive success[7].

Coastal conditions are closely related to rivers, estuaries, and seas in the area; changes in river properties that occur due to human activities will affect the quality of coastal waters. Changes in the coastal environment occur not only due to natural phenomena but are greatly influenced by human activities in the surrounding area, which can affect the coastal ecosystem, resulting in a decrease in the quality of coastal and marine areas. This means that a quite high population growth affects the quality of coastal waters. The high level of community activity in Gili Terawangan is feared to have a negative impact on water quality conditions [8].

Water quality monitoring is a critical activity, particularly in coastal waters that are vulnerable to pollution from both land-based and marine sources. The primary objective of water quality monitoring is to assess the status of water quality through the measurement of physical and chemical parameters, and to compare these measurements with established environmental quality standards. In this study, the results of water quality measurements were compared with the Seawater Quality Standards stipulated in Government Regulation of the Republic of Indonesia Number 22 of 2021 (PP RI No. 22/2021). These standards categorize seawater quality based on its designated uses, such as for marine biota protection, marine tourism, port and marine industry activities, and other uses. In particular, physical and chemical parameters were evaluated against standards for marine biota, while biological parameters were assessed with reference to the standards for marine tourism activities [9].

Any pollutant that enters the water body in the waters of Gili Terawangan has the potential to cause a decrease in water quality which will reduce the biological and ecological functions of the ecosystem in it. Therefore, management of the quality and control of seawater pollution needs to be carried out to maintain the potential of this area and provide benefits to the community. This study aims to determine the quality of seawater in Gili Terawangan from several parameters, both physical-chemical and biological.

Research Methods

The method used in this study is a quantitative research method. Data collection was carried out by taking and measuring the quality of seawater samples at the research location. The method for determining the quality status of seawater in the Villa Ombak Gili Terawangan Area, Pemenang District, uses the basis for determining seawater quality standards based on PP RI Number 22 of 2021 [10] concerning Seawater Quality Standards.

Water sampling was carried out using the Niskin bottle method at a depth of 1 meter. Sampling was carried out at 6 (six) stations with 2 repetitions per station for in-situ water quality measurements [11]. Meanwhile, seawater sampling that requires laboratory analysis is carried out by inserting seawater samples into Niskin bottles and storing them in a coolbox for analysis at the Mataram PUPR Laboratory.

The water quality parameters observed are physical, chemical and biological parameters. Physical parameters consist of temperature and brightness. While chemical parameters consist of pH, sulfide (H_2S), Nitrate (NO_3N), Phosphate (PO_4), and faecal coliform. Temperature and pH measurements are carried out using a water quality meter. Meanwhile, the analysis of chemical parameters of sulfide, nitrate, phosphate, faecal coliform and coliform is carried out by laboratory analysis. Data analysis is carried out on data from measurements and tests on water quality parameters. Analysis of seawater quality data is basically by comparing the results of primary laboratory analysis data with seawater quality standards based on PP RI Number 22 of 2021.

Data Analysis Methods

Data analysis was carried out using a descriptive comparative approach. The physical, chemical, and biological parameters of seawater—measured both in situ and through laboratory analysis—were compared to the Seawater Quality Standards as stated in Government Regulation of the Republic of Indonesia Number 22 of 2021 (PP RI No. 22/2021). Specifically, physical and chemical parameters were assessed against the standards for marine biota, while biological parameters were compared with the standards for marine tourism. All analytical methods used for parameter testing followed the Standard Methods for the Examination of Water and Wastewater, ensuring accuracy and comparability with national and international standards. Parameters were also checked for outliers and potential measurement errors before analysis.

The results were presented in tabular and graphical form, and were interpreted by examining whether observed values complied with the regulatory limits. Where exceedances were detected, possible causes were discussed based on supporting literature and site-specific observations.

Results and Discussion

The quality of seawater used for marine biota and other activities, such as tourism areas, should ideally meet standards, both physically, chemically, and biologically. The value of seawater quality that exceeds the maximum threshold for its use will be classified as polluted waters. The results of laboratory analysis of seawater quality are:

Table 1. Sea Water Test Results In The Ombak Villa Area

No	Parameter	Unit	Result	Quality Standard **
A	Physical parameters			
1	TSS	mg/L	2.5	20
2	Suhu	˚C	29	28 - 30
B	Chemical parameters			
1	pH	-	8.2	7 – 8.5
2	Salinitas	0/oo	33	33 - 34
3	Oksigen terlarut (DO)	mg/L	6.9	>5
4	Total amonia (NH_3-N)	mg/L	0.019	0.03
5	Nitrat (NO_3-N)	mg/L	0.0017	0.06
6	Fosfat (PO_4)	mg/L	<0.05	0.015
7	Minyak dan lemak	mg/L	<0.03	1
C	Microbiology			
1	Total Coliform*	Jml/100mL	185	1000
2	Fecal Coliform *	Jml/100mL	0	-

Physical Parameters

Temperature: Water temperature is one of the most important factors for the life of organisms in water. An increase in temperature can cause stratification or water layering. This water stratification can affect water agitation and is needed for the distribution of oxygen, so that with the presence of water layering in the bottom layer, it does not become anaerobic, and organisms can live well [12]. High temperatures cause the covalent bonds of water compounds to loosen, which allows oxygen to be released into the air, so that dissolved oxygen will decrease [13]. The results of temperature measurements obtained 29˚C, which is in line with temperature data in the waters in Bolaang Mongondow, ranging from 28.6-29.3˚C [9]. The temperature range of the research results is still within the optimal limit of sea water temperature, namely 28-30˚C, so it is still categorized as suitable for the survival of marine biota [14].

Total Suspendet Solid: Based on laboratory tests, the TSS level is 2.5 mg/L. These results meet the PPRI standard No. 22 of 2021, but it is important to observe so as not to exceed the quality standards, such as in the waters of Bontang City, which range from 156 - 175 mg/L. High TSS values that exceed the quality standard threshold will indirectly affect the life of organisms because they will increase the turbidity of the waters, thus affecting the photosynthesis process. This will have an impact on disrupting the life and development of biota and can cause death of biota because it can close the gills and respiratory tract [15].

Chemical Parameters

Acidity (pH) indicates the amount of hydrogen ions in seawater expressed in hydrogen activity. This acidity plays an important role in biological and chemical processes in water [16]. The measured pH value of the sea is 8.2. These results meet the PPRI quality standards No. 22 of 2021, Appendix VIII, namely 7 - 8.5. Based on the measurement results, the seawater around the Ombak villa is alkaline, so it is categorized as good if the acidity level is (pH>7) or alkaline [17]. pH greatly affects the biota in waters, fish will tend to secrete mucus on the skin and inside the gills to adjust the pH value. pH greatly affects the biota in waters, fish will tend to secrete mucus on the skin and inside the gills to adjust the pH value. The acidity level of seawater affects the deposition of metals in sediments; the higher the pH value, the easier it is for metal accumulation to occur [18].

Salinity is the concentration of all salt solutions obtained in seawater, where the salinity of the water affects the osmotic pressure of the water; the higher the salinity, the greater the osmotic pressure [19]. The results of the salinity measurement were as high as 33 ‰. This salinity value is not much different from the salinity value of Indonesian waters, where, in general, the average surface salinity of Indonesian waters ranges between 32 - 34 ‰ and meets the standard quality standards of PPRI No. 22 of 2021, Appendix VIII, namely 33 – 34%.

Dissolved oxygen (DO); This dissolved oxygen is used as a sign of the degree or level of waste pollution. The results of the DO analysis of seawater in Table 1 are 6.9 mg/L. These results meet the ideal oxygen content in water, which is 3-7 mg/L. The DO content in waters is closely related to the level of pollution, type of waste and the amount of organic material in waters [20]. DO values that exceed the quality standards at observation stations can be associated with the sea surface temperature in these waters, thereby increasing the solubility of oxygen gas in seawater [21].

Ammonia in seawater can come from domestic waste, ship activities, or the decomposition process of organic matter in seawater [22]. Villa Pmbak is a tourist area, so visitors are quite dense, but the results of other water ammonia laboratory tests meet the PPRI quality standards No. 22 of 2021, which is 0.019 mg/L. Ammonia is important to analyze because it can be toxic, which causes a decrease in oxygen supply because the compound interferes with the binding of oxygen in the blood, changes blood pH, and affects enzymatic reactions and membrane stability in marine biota [23]. Ammonia in waters will result in a decrease in the utility, efficiency, productivity, carrying capacity and capacity of aquatic resources, so that it will ultimately reduce the wealth of natural resources.

The phosphate levels in this study were the same as other levels, namely meeting the standards of PP Number 22 of 2021, which is <0.05 mg/L. Phosphate is thought to originate from the activities of people around the island, such as laundry whose waste is disposed of into the drainage, leftover washing of plates, glasses and other eating utensils from food vendors along the beach which is directly absorbed into the sand, also from stalls, restaurants, and hotels, whose liquid waste storage does not match the

capacity of the waste produced. In seawater, phosphate is in the form of dissolved inorganic and organic as well as particulate phosphate [24]. Dissolved Phosphate in Gili Air waters comes from demineralization from the bottom of the waters in the form of coral [25].

Oil and grease; The tested oil and grease levels showed results that met the quality standards for marine tourism and marine biota set by PP Number 22 of 2021, which is <0.03 mg/L, although the oil and grease levels are below the threshold, the presence of these substances indicates the potential for pollution due to maritime activities around the villa. High concentrations of oil and grease interfere with the photosynthesis process because oil and grease cover the intensity of sunlight entering the water; besides that, it will be dangerous for marine biota, because oxygen diffusion is reduced, so that oxygen in the water will decrease [26].

Microbiology: Total coliform; Coliform bacteria are a group of bacteria that live in the digestive tract. The presence of coliform bacteria in water indicates that the water is contaminated by pathogenic faeces in the intestines, so that it is not suitable for consumption. The greater the number of coliforms, the worse the quality of the water, but the results of this study meet the quality standards for marine tourism and marine biota stipulated in PP Number 22 of 2021, namely 185, as in Table 1. The sea water temperature reaches 29ºC, this temperature is relatively high but still relatively stable for the category of marine waters. This can occur due to direct exposure to sunlight radiation, so it is assumed that this condition is still a good condition for the growth of Coliform bacteria. Coliform is a microorganism that grows well at temperatures ranging from 25-37ºC, or is called a mesophilic microorganism, so the results of this study are in line with the results of Latifah's 2019 study, namely mesophilic 25ºC [27].

Faecal coli; The results of the E. coli test in this study met the quality standards for marine tourism and marine biota set by PP Number 22 of 2021, which is 0. However, the main source of E. coli comes from faecal waste from humans and warm-blooded animals. E. coli enters the sea waters through river flows and rainwater runoff, so that the abundance of bacteria will increase during the rainy season. This condition is caused by the concentration of organic matter (N and P), changes in salinity and temperature, and increased light intensity [28].

Conclusion

The environmental quality of the waters of the Villa Ombak area based on the results of laboratory measurements or analysis for physical parameters (temperature, TSS), chemical (pH, salinity, DO, NH3-N, NO3-N, PO4, oil and fat) and biological (Total and fecal Coliform) obtained that all parameters meet the quality standards for marine tourism and marine biota stipulated in PP Number 22 of 2021, but it is still important to monitor even though it does not exceed the quality standards, because it has an impact on disrupting the ecological function of the ecosystem in the waters and a decrease in the quality of sea water both physically, chemically and biologically which results in a decrease in the utility, efficiency, productivity, carrying capacity and capacity of aquatic resources so that in the end it will reduce the wealth of natural resources.

Author's Contribution

Nurhidayah: Manage Permits and Collect Data. Hijriati Sholehah: Searching for supporting literature for compiling research results and compiling research results. Nurhidayatullah: Compiling research results. Mulhidin: Publication in scientific journals

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