Water quality of Sempu Strait to support the ecosystem resilience

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Abstract. Sempu Island is one of the marine conservation areas, which has an important function in the conservation stage, namely preservation, preservation itself means the preservation of biodiversity and protected areas in biotic and abiotic life support systems [1]. Many problems arise on Sempu Island as a protected area due to lack of access which triggers a conflict of interest in the management of the area between policy makers and the community [2].

Sempu Island is a unique natural resource area, where Sempu Island is formed from uplifted reefs or commonly known as Atolls [3]. Sempu Island consists of various ecosystems, namely, tropical rain ecosystems, coastal forests, coral reef ecosystems, mangrove ecosystems, and seagrass ecosystems. Ecosystem diversity can be evidence that the quality of the waters on Sempu Island are in optimal conditions and suitable to support a diversity of species and ecosystems. Coral reefs are an indicator when an area can be used as a conservation area which will be seen from the condition of its coral reefs, a good coral reef condition will be used as the core zone of an area, although not absolutely [4].

1. Introduction

Sempu Island is a marine conservation area which has an important function in the conservation stage, namely preservation, preservation itself is the preservation of biodiversity and a protected area in biotic and abiotic life support systems [1]. Many problems arise on Sempu Island as a protected area due to lack of access which triggers a conflict of interest in the management of the area between policy stakeholders and the community [2].

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The coral reef ecosystem is an ecosystem that has a big impact on the marine ecosystem, because the coral reef ecosystem is a home for various types of fish, a place to find food, and a place for spawning. Therefore, the damage to the coral reef ecosystem will disturb the sea ecologically [5]. Coral reef ecosystems undergo dynamic changes from time to time, due to environmental conditions and human activities. The condition of the coral reef ecosystem must always be monitored, because coral reefs take a long time to return, and there are even some types of coral reefs that take ± 1 year to reach a length of 1 cm [6].

Water quality is an important parameter for assessing water conditions and productivity associated with other biotic parameters, such as plankton and zooxanthellae. Water quality also plays a role in facilitating coral reefs to live, grow, and develop properly, as well as the various flora and fauna that live in them [7]. The importance of information regarding the quality of waters in the waters of Sempu Island can be used as an integrated coastal area management. The level of water fertility can be viewed from its biological and chemical characteristics, especially the availability of essential nutrients [8]. The purpose of this study was to determine the quality of Sempu Island waters based on water parameters to be used as initial data in measuring the resilience of the Sempu Island aquatic ecosystem.

2. Materials and Method
The research was conducted in the waters of Sempu Island, at locations 112° 41'46" E and 8° 26’40" S. Sempu Island has an area of 877 ha. This research was conducted on August 26, 2020. Retrieval of water quality data using in situ methods or direct data collection. Data taken in the form of depth, temperature, DO, salinity, turbidity, and pH. Water quality parameter data collection is carried out at a depth of 0 m to 4 m. The instrument used to make measurements is the Aqua Quality Sensor model series AAQ Rinko 1183. Water quality data collection was at 15 station points. The map of the data collection location can be seen in Figure 1.

![Research location map](image-url)

**Figure 1.** Research location
3. Result and Discussion

Sempu Island is administratively located in Tambakrejo Village, Sumbermanjing Wetan District, Malang Regency, East Java. Sempu Island has high biodiversity, for example, it has a bottom substrate in the form of corals which can be found in the western and eastern regions of the Sempu Strait waters [9]. Sempu Island has high biodiversity, the ecosystem on Sempu Island consists of coral reef ecosystems, mangrove ecosystems, seagrass ecosystems, and protected forest ecosystems. Sempu Island has the potential to be overgrown by invading species that can thrive in Java. In general, the impact of biological invasion on small island ecosystems will have a greater impact than the ecosystems on large islands [10]. The forest ecosystem in the Sempu Island area produces a variety of flora and fauna diversity that can be used as life support, such as a source of food, medicine and other uses (3). Small islands usually have quite large coastal resources, where fisheries and marine potential are supported by coral reef ecosystems, seagrass ecosystems, mangrove ecosystems, and seaweed [11].

Monitoring of water quality is very necessary in coastal waters, because coastal areas are very vulnerable to pollution. Monitoring of water quality aims to determine the value of water quality based on physical, chemical and biological parameters by comparing the results of water quality measurements with the appropriate quality standards in assessing the feasibility of a water [12].

3.1. Temperature quality

Based on temperature data at 15 stations on the island of Sempu, various results were taken. The highest temperature value is at station 3 with a value of 26.45 °C while the lowest data is at station 15 with a value of 25.95 °C (Figure 2). The results of the data obtained can be concluded that the temperature in Sempu waters is in the good enough category because the temperature is relatively lower than the quality standard of marine waters. Where the optimal quality standard of marine waters according to the Minister of Environment Decree Num.51 of 2004 for the growth of organisms is valued at 28-30 °C. In addition, according to [13] the normal temperature of Indonesian marine waters ranges from 28 °C -31 °C. According to [14], in his research on SST in the South Java Sea, the temperature has increased over the last 32 years.

![Figure 2. Temperature quality parameters](image)

Temperature is a mandatory parameter that must be measured when discussing water quality. For example, a temperature change of 2-3 °C an increase can affect the "coral bleaching" phenomenon,
where most of the zooxanthellae will be damaged which causes the pigment in the zooxanthellae body to come out and cause the color of the coral to become transparent and look like a chalk framework so that it looks white [15].

3.2. Turbidity quality
The turbidity data obtained from measurements of 15 stations in sempu waters has a very variable value. The lowest turbidity value is at station 6, which is 0.34 ftu, while the highest is at station 15 worth 0.55 ftu (Figure 3). Turbidity in these waters can be concluded to have good water quality because it is in accordance with the quality standards of marine waters that are suitable for biota. The quality standard for marine waters suitable for marine life is <5 ftu.

![Turbidity Quality Parameters](image)

**Figure 3.** Turbidity quality parameters

The level of turbidity in the waters or commonly called turbidity can affect the growth of macro algae, it is because turbidity affects the penetration of light entering the waters. The entry of light is impeded by suspended substances to enter the waters, this will prevent the photosynthesis process from running completely. In addition, insufficient penetration of turbid water can affect the growth of aquatic plant habitats which can lead to death [16].

3.3. Salinity quality
The salinity values obtained from measurements in Sempu waters with 15 stations have varied results. The salinity with the highest value is obtained at the 6th station with a value of 34.6 ppt while the lowest value is at the 14th station with a value of 34.55 ppt (Figure 4). Judging from the value of these 15 stations, sempu waters have good water quality because they are in accordance with the water quality standard values according to the regulation of the Minister of Environment Decree Num. 51. The optimal salinity value in marine waters for biota is 33-34 ppt.

In previous studies, measurements of the distribution of salinity from the surface to a depth of 5 meters and the results obtained in August the salinity ranged from 34.087 - 34.317 PSU, and in October ranged from 31.910 - 35.520 PSU [8]. There is no difference between the previous research and the current measurement. Therefore, it can be concluded that the waters of the Sempu Strait do not have a significant difference and the quality of the waters is still good.
3.4. pH quality

The pH value obtained in measurements in the sempu strait with 15 stations has varying values. The highest pH value was obtained at station 10 with a water pH value of 8.67, while the lowest was at station 2 valued at 8.47 (Figure 5). The results of these measurements can be concluded that the sempu strait has good water quality because it has a value in accordance with the quality standards of marine waters according to the regulation of the Minister of Environment Decree Num. 51. The pH standard for optimal marine waters for marine biota is 7 - 8.5.
High and low pH levels are influenced by fluctuations in \( O_2 \) content and \( CO_2 \) levels. A drastic change in pH value can affect the survival of biota and living things in the waters. Therefore, when the pH value is less than 4.8 and greater than 9.2, it can be said that the waters are polluted. When the concentration of \( CO_2 \) is more than the threshold, it can affect other water quality parameters that can lead to acidification \cite{17}.

3.5. DO quality

DO is dissolved oxygen in the water. In measuring DO in sempu waters, various results are obtained. This measurement is done by collecting data at 15 stations (Figure 6).

![DO Quality Parameters (mg / L) in Sempu Island Waters](image)

**Figure 6.** DO quality parameters

The highest Do value was at station 15, namely 6.95 mg / L, while the lowest value was at station 7 with a value of 6.49 mg / L. From this measurement it can be concluded that Do in sempu waters is included in the indicators of good water quality because it is in accordance with the quality standards according to the regulation of the Minister of Environment Decree Num. 51. The DO quality standard in marine waters is optimal for marine life, namely \( > 5 \) mg / L.

In previous studies, it was found that the pH value of the Sempu Strait waters tended to be evenly distributed and there were no significant changes. In October it was 6.46 - 6.55, while in November it was 11.43 - 11.6. then in December as much as 8.99 - 9.24 \cite{8}. Comparison of the results of previous and current studies does not have a very significant difference. So it can be concluded that in Sempu waters there is no difference in water quality.

3.6. Chlorophyll quality

The results of the measurement of chlorophyll distribution in the waters of Sempu Island with 15 stations as sampling points have varied results. The highest chlorophyll value was at station 15 with a value of 1.45 mg / m\(^3\), while the lowest was at station 6 with a value of 1.05 mg / m\(^3\) (Figure 7). From the data obtained, it can be concluded that the waters of the Sempu island on the Chlorophyll indicator fall into the good category because there is no algae blooming in accordance with the quality standards set by regulation of the Minister of Environment Decree Num. 51.
Figure 7. Chlorophyll quality parameters

The higher the intensity of sunlight that enters the waters, the higher the chlorophyll content in plants. There are two types of chlorophyll, namely chlorophyll a and chlorophyll b which play a role in the photosynthetic process of plants. Chlorophyll b has a function to collect light which will be transferred to a reaction center composed of chlorophyll a. Light energy will be converted into chemical energy which can be used in the reduction process in photosynthesis [18].

4. Conclusion
Except for temperature, which is relatively lower than the quality standard of marine waters, all water quality of Sempu Strait is in good quality and fulfill standards set by regulation of the Minister of Environment Decree Num. 51 to support the ecosystem resilience.

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References
[1] Purnomo H, Sulistyantara B, and Gunawan A 2013 Ecotourism Business Opportunities in Sempu Island Nature Reserve Area, East Java. J For Soc Econ Res 10(4):247–63
[2] Wiratno I D, Syarifudin A, and Kartikasari A 2004 Berkaca di Cermin Retak : Refleksi Konservasi dan Implikasi Bagi Pengelolaan Taman Nasional. Edisi Kedua. Jakarta: Forest Press, The Gibbon Foundation Indonesia, Departemen Kehutanan, PILI-NGO Movement
[3] Sulistyowati H 2008 Status Analysis of Flora from "Cagar Alam – Pulau Sempu", Malang. J Basic Sci 9(1):78–81.
[4] Nurhidayat I, Rustam, and Rauf A 2019 Condition Of Coral Reef In The Likuang Tangaya Water, Pangkajene District And Islands. J Agric Technol Educ 5(1):41–8
[5] Riansyah A, Hartono D, and Kusuma A B 2018 Ikan Kepe - kepe (Chaetodontidae) sebagai
Bioindikator Kerusakan Perairan Ekosistem Terumbu Karang Pulau Tikus. Maj Ilm Biol Biosf A Sci J [Internet]. 35(2):103–10. Available from: https://journal.bio.unsoed.ac.id/index.php/biosfera/article/view/480/pdf

[6] Rachmawati D N, Sasmito B, and Sukmono A 2018 Studi Perkembangan Terumbu Karang di Perairan Pulau Panjang Jepara Menggunakan Citra Satelit Sentinel-2 dengan Metode Algoritma Lyzenga. J Geod UNDIP 7(4): 233–43

[7] Souhoka J, and Patty S I 2013 Monitoring of Hydrological Conditions in Relation to the Condition of Coral Reefs in the Waters of Talise Island, North Sulawesi J Ilm Platax 1(3): 138–47.

[8] Wibawa I G N A, and Luthfi O M 2017 Water Quality Of Coral Reef Ecosystem At Sempu Strait, Sendang Biru Malang. J Segara 13(1):25–35

[9] Luthfi O M, Akbar D, Ramadhan M G, Rohman M, and Wahib N K 2019 Studi Komparatif Tutupan Living dan Non Living Substrat Dasar Perairan Pulau Sempu Kabupaten Malang Menggunakan Metode Reef Check. JFMR-Journal Fish Mar Res 3(2) :1–8.

[10] Abywijaya I K, Hikma A, and Widyatmoko D 2014 Diversity and Distribution Patterns of Invasive Foreign Plant Species in Sempu Island Nature Reserve, East Java. J Biol Indones 10(2): 221–35

[11] Yusuf M 2007 Sustainable Management of Coastal and Marine Resources in Karimunjawa National Park. (Bogor: IPB)

[12] Saraswati N L G R A, Arthana I W, and Hendrawan I G. Analysis of Water Quality in Island Waters Northern Attack Based on Sea Water Quality Standards. J Mar Aquat Sci 3(2): 163.

[13] Nontji A 2007 Laut Nusantara. (Jakarta: Djambatan)

[14] Syaifullah M D 2015 Sea Surface Temperature Analysis Over Indonesian Waters And It’s Relation To Global Warming. Segara 3:11

[15] Luthfi O M, and Jauhari A 2013 Assessment on Physical-Chemical Condition at Sempu Island’s Waters as a Coral Garden Purpose. In: Proceeding PIT X ISOI p 27–34.

[16] Maturbongs M R 2015 The Effect Of Aquatic Contacts Level On The Composition Of Macro Algae Species With The Upwelling Proc 2014 The Effect of Acidic Level of Media on Calcium Concentration and Growth of Halimeda sp. J Mar Fish Sci [Internet] 24(1) :28–34. Available from: https://www.scribd.com/document/363166182/ph-derajat-air-laut-pdf

[18] Budiono R, Sugarti D, Nurzaman M, Setiawati T, Spriatun T, and Mutaqien A Z 2016 Stomata density and chlorophyll content of Clausena excavata plants based on differences in light intensity. Natl Semin Educ Sci [Internet] 61–5. Available from: https://publikasiilmiuh.ums.ac.id/xmlui/handle/11617/7556