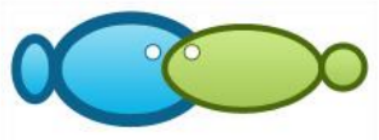
2023.1156-1165.pdf

by 2 1

Submission date: 02-Jun-2023 06:00AM (UTC+0700)
Submission ID: 2107022497
File name: 2023.1156-1165.pdf (336.09K)
Word count: 5692
Character count: 29695



Water quality for grouper farming in Mandeh Bay waters, Pesisir Selatan, Indonesia

[1]Suparno Suparno, [2]Deswati Deswati, [3]Hilfi Pardi

[1] Study Program of Fisheries Resources Utilization, Faculty of Fisheries and Marine Sciences, Bung Hatta University, Kampus Ulak Karang, Padang, Indonesia; [2] Department of Chemistry, Faculty of Mathematics and Natural Sciences, Andalas University, Padang, Indonesia; [3] Department of Chemistry Education, Faculty of Teacher Training and Education, Raja Ali Haji Maritime University, Senggarang, Tanjungpinang, Indonesia. Corresponding author: Suparno Suparno, suparnopranoto@bunghatta.ac.id

Abstract. In the rapid development of marine fish farming in Mandeh Bay, water quality in the aquatic environment is considered a major limiting factor. Floating net cage (FNC) cultivation activities are highly dependent on water quality. The waters of Mandeh Bay have the potential to develop FNC cultivation activities. Therefore, we analyzed the water quality physically, chemically, and biologically, analyzed the sources of water pollution, and analyzed the status of water quality in the waters of Mandeh Bay. This study aims to examine the status of water quality in grouper culture in FNC. Water quality data collection is carried out by purposive sampling. Water quality data was then analyzed using the STORET method. The results of the STORET calculation show that the water quality in the waters of Mandeh Bay is classified as class D, in the bad category, or has been heavily polluted. Chemical parameters (nitrate and orthophosphate) contribute the most to the pollution level. In the future, to make Mandeh Bay a grouper cultivation area, special regulations are needed to minimize pollutant sources.
Key Words: FNC, marine fish farming, purposive sampling, STORET.

Introduction. To meet the ever-increasing demand for fishery products due to declining capture fishery production, increasing population, and changes in people's consumption of healthier animal protein, the primary choice is the development of marine aquaculture. The contribution of the marine aquaculture business is expected to increase the volume and value of marine product exports and provide animal protein for the community to achieve a balanced diet (animal and vegetable protein). Types of groupers widely cultivated include batik grouper (*Epinephelus polyphekadion* syn. *E. microdon*), kertang grouper (*Epinephelus lanceolatus*), sunuk grouper (*Plectropomus leopardus*), mud grouper (*Epinephelus bleekeri*), tiger grouper (*Epinephelus fuscoguttatus*), duck grouper (*Cromileptes altivelis*), cantang grouper (*Epinephelus lanceolatus* × *Epinephelus fuscoguttatus*), pretty grouper (*Epinephelus fuscoguttatus* × *Epinephelus microdon*). In Indonesia, grouper cultivation has been widely developed, especially in floating net cages. In addition to the vast potential for developing marine aquaculture, the growth of grouper is fast, the market price tends to be stable, and the demand for grouper exports is increasing yearly.

Decreasing water quality can cause instability in the ecosystem, and the high content of high organic waste will affect the phosphorus content in the sea. One of the effects that can be caused by elevated phosphorus in the waters is the increased growth of aquatic plants (Mylaparavu 2008). The water pollution problem is of particular concern because if the content in waste exceeds the quality standard, it can cause chronic poisoning (Napiórkowska-Krzebietke 2015; Napiórkowska-Krzebietke & Dunalska 2015). Water quality standards consist of physical and chemical parameters such as biochemical oxygen demand (BOD), temperature, electrical conductivity, nitrate, phosphorus, potassium, dissolved oxygen, and heavy metals such as lead, chromium, iron, mercury etc.

This study aims to analyse the water quality physically, chemically, and biologically, to analyse the sources of water pollution, and to analyse the status of water quality in the waters of Mandeh Bay.

Material and Method

Study site description. Teluk Mandeh (00059'00" - 01011'05" SL and 100019'00" - 100026'55" EL) is a very strategic area for life and economic development in Pesisir Selatan Regency. The coastal area of Mandeh Bay is used as a source of nutritious food (capture fisheries and aquaculture), dock activities, sea transportation routes, conservation areas, and residential areas. This condition will continue, and it is feared that one day it will have an impact on decreasing water quality. Population growth continues to increase, accompanied by clearing of land for settlements and agricultural businesses that are not well managed resulting in high sedimentation in several marine aquaculture areas in Mandeh Bay, especially during the rainy season. Floods can carry various kinds of household waste and sediments, generally in the form of solids that will immediately settle on the bottom of the water, while other forms, such as colloids, are present in the water column and they can cause a decrease in water quality.

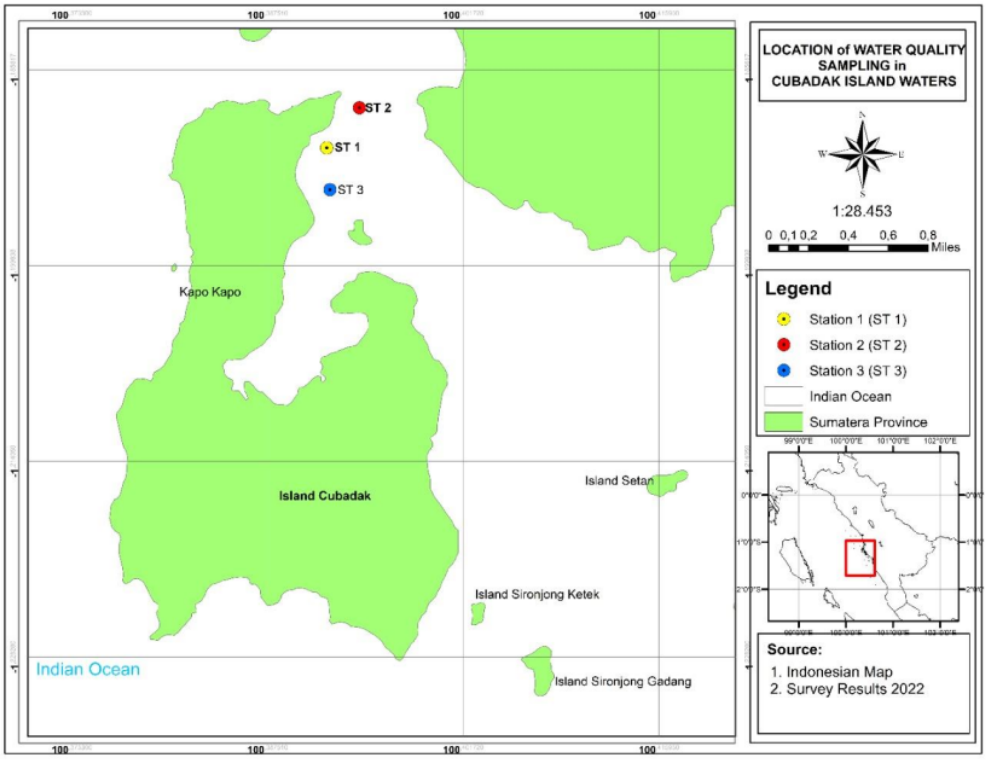


Figure 1. Sampling station in Floating Net Cages (FNC) (map source: Indonesia Geospatial Portal 2022).

In Mandeh Bay, most of the fish farming is done by the community using the floating net cages (FNC) method. Every organism needs food to live, but organisms that are in a closed system need not only food but also optimal water quality to promote growth. Fish in FNC need not only food but also optimal water quality to promote growth. The problem that always arises in the floating net cage cultivation system is environmental pollution caused by various activities around the waters and the cultivation business itself. This pollution can be in the form of physical-chemical and biological pollution. Although these physico-

chemical and biological aspects have been studied, experts and water managers always recommend that research on water pollution needs to be carried out on an ongoing basis considering that environmental changes can occur at any time.

The study was conducted for 3 months, from January to March 2022 in the Marine Fish Farming Waters of Mandeh Bay. Sampling was carried out at 3 (three) stations: Station 1 (100023'30.5"E; 1011'28.6"S), Station 2 (100°23'38.545"E; 1°11'18.834"S) and Station 3 (100°23'31.788"E; 1°11'39.502"S) (Figure 1).

Data collection. This research includes field and secondary data collection, processing, analysis, and interpretation of data. The research station consisted of 3 (three) stations which were determined based on purposive sampling. A sampling of water in the waters of Mandeh Bay was carried out using a Nansen bottle. Analyzes were carried out in site and in the laboratory. This research station is determined based on the location that is considered to represent the general condition of the research location and refers to the standard criteria for living conditions of marine fish commodities such as *Epinephelus* sp. Water quality parameters measured at each research station consisted of physical parameters (temperature, brightness, turbidity, total suspended solids), chemical (salinity, pH, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, ammonia, nitrate, orthophosphate), and biology (bacteria). Field observations were carried out to identify sources of pollution, and to identify community activities around the bay that have the potential to cause pollution.

Data analysis. The data that has been obtained, was analyzed and presented descriptively. To find out the status of water quality at several locations that will be determined for the cultivation of Floating Net Cages (FNC) in Mandeh Bay, the parameter data obtained are compared with the quality standards designated for marine biota and are presented in Table 1 (Government Regulation of the Republic of Indonesia Number 22 of 2021).

Table 1

Water quality parameters required for fish farming in FNC

No	*Parameter*	*Unit*	*Quality standards**
1	Temperature	°C	28-31
2	Brightness	m	>5
3	Turbidity	NTU	<5
4	TSS	mg L^{-1}	<20
5	Salinity	‰	28-34
6	pH	-	7-8,5
7	DO	mg L^{-1}	>5
8	BOD	mg L^{-1}	20
9	COD	mg L^{-1}	20
10	Ammonia	mg L^{-1}	0.3
11	Nitrate	mg L^{-1}	0.006
12	Orthophosphate	mg L^{-1}	0.015
13	Hydrogen sulfide	mg L^{-1}	0.01
14	Fecal coliform	CFU/100 mL	-

Note: *Government Regulation of the Republic of Indonesia Number 22 of 2021, concerning the implementation of environmental protection and management which is intended for marine biota.

The principle of the STORET method is to compare water quality data with water quality standards adapted to its designation to determine the status of water quality (Ministry of Environment Decree 115 of 2003). To determine the status of water quality the value system of the USEPA (1978) is used, by classifying water quality into four classes (Table 2).

Table 2

Pollution score and status with STORET Index based on scoring system by USEPA (1978)

Class	*Criteria*	*Score*
A	Very good condition	0
B	Good condition	-1≤score≤-10
C	Moderately good condition	-11≤score≤-30
D	Bad condition	≥-31

If the measurement results meet the water quality standard value, then it is given a score of 0. If the measurement result does not meet the water quality standard value (measurement result > quality standard), then the table score is given according to Table 3. The negative sum of all parameters is calculated, and the quality status is determined from the number of scores obtained using the value system.

Table 3

Water quality scoring status by STORET Index (Canter 1977)

Number of samples	*Score*	*Parameter*		
		Physical	*Chemical*	*Biological*
< 10	Maximum	-1	-2	-3
	Minimum	-1	-2	-3
	Mean	-3	-6	-9
≥ 10	Maximum	-2	-4	-6
	Minimum	-2	-4	-6
	Mean	-6	-12	-18

Results and Discussion. The waters of Mandeh Bay have a strategic location for marine aquaculture activities due to its location, which is protected from big waves. So, it is suitable to be developed as a floating net cage cultivation location. In grouper cultivation activities, water quality is one of the most important parameters because it is a factor that affects the availability of natural food, namely plankton. For this reason, water quality monitoring is necessary to support fishery activities (Table 4). Grouper fish (*Epinephelus* sp.) need a comfortable environment to live healthy, grow optimally, and reproduce. If the environment does not meet the requirements, fish can experience stress and be susceptible to disease, which will lead to death.

Table 4

Water quality in grouper culture using floating net cages in the waters of Mandeh Bay

No	*Parameter*	*Units*	*Measurement results*		*Quality standards**
			Maximum	*Minimum*	
1	Temperature	°C	30.9	28.4	28-31
2	Brightness	m	17.8	16.3	>3
3	Turbidity	NTU	3.8	3.2	5
4	TSS	mg L^{-1}	7.81	6.99	20
5	Salinity	‰	33.5	32.9	28-34
6	pH	-	7.94	7.46	7-8.5
7	DO	mg L^{-1}	7.5	7.3	>5
8	BOD	mg L^{-1}	12.38	11.23	<20
9	COD	mg L^{-1}	14.1	12.3	<20
10	Ammonia	mg L^{-1}	0.024	0.021	<0.3
11	Nitrate	mg L^{-1}	0.027	0.025	0.015
12	Orthophosphate	mg L^{-1}	0.395	0.105	0.3
13	Hydrogen sulfide	mg L^{-1}	0.009	0.006	0.006
14	Fecal coliform	CFU/100 mL	200	108	0.01

Note: *Government Regulation of the Republic of Indonesia Number 22 of (2021), concerning the implementation of environmental protection and management which is intended for marine biota.

Water quality analysis

Temperature. Grouper fish are poikilothermic aquatic animals, so their body temperature will adjust to water temperature. This will affect behavior and metabolism. If the temperature is low, it will result in low appetite, relatively slow metabolism, and slow growth. Appetite, metabolism, and change will increase with the increase in water temperature. However, if the temperature is too high, it will stress the fish, make them sick, or susceptible to pathogens (diseases) and even death. For this reason, it is necessary to have an optimum temperature for optimal fish life and maximum growth speed.

Based on Table 4, the water temperature range recorded for grouper culture sites (28.4 - 30.9°C) is favorable and can support fisheries and aquatic life. The results of this study are similar to the previous findings by Ofori-Danson and Ntow (2005) (29.3 –31.0 °C) and Karikari et al (2013) (27.9–29.7°C). Temperature is very influential on chemical and biological processes. The general rules of chemical and physical reactions increase 2-3 times for every 10°C increase. This means that fish can use twice as much or more DO at 30°C than at 20°C. Therefore, the fish's need for oxygen will be more critical in higher temperature water than in colder water.

Brightness and cloudiness. Brightness is one of the supporting factors in grouper cultivation. Brightness is inversely related to cloudiness and depth. From Table 4, the results of measurements of water brightness at all sampling locations varied between 16.3 -17.8 m. This value indicates that the waters of Mandeh Bay are quite feasible to be used as a location for FNC because the water brightness required for FNC is around 3-5 m. Effendi (2003) states that the value of the brightness of water is influenced by weather conditions, measurement time, turbidity, and suspended solids, as well as the accuracy of the person taking the measurement. The intensity of light will decrease as the depth increases (Effendi 2003), and according to Buitrago et al (2005), the optimal condition of the brightness of water for aquaculture is >3 m.

Brightness is closely related to turbidity (presence of sediment particles in the water column). The higher the number of dissolved particles, the cloudier the water. From Table 4, the measurements of water turbidity at all sampling locations varied between 3.2 – 3.8 NTU. This value indicates that the waters of Mandeh Bay are suitable for grouper cultivation in FNC.

Total Suspended Solid (TSS). Suspended solids in water significantly affect the brightness of the water. The higher the number of suspended solids in water, the lower the value of the brightness. The high value of suspended solids causes natural waters to become more turbid and even form organic deposit at the bottom of the seas. This organic matter deposition can reduce the oxygen content of waters through natural oxidation processes, including microbial respiration and aerobic decomposition, which can harm aquaculture biota. According to Effendi (2003), TSS consists of mud, fine sand, and micro-organisms, mainly caused by soil erosion or soil erosion carried into water bodies. Clearing top land for settlements results in soil erosion when it rains. It is evident in the color of the waters in the coastal area, which turns brown due to the high soil particles entering the seas.

From Table 4, the TSS value in the waters of Mandeh Bay is 6.99 – 7.81 mg L^{-1}. Based on Government Regulation of the Republic of Indonesia Number 22 of (2021), the TSS value intended for seagrass and coral reef communities is 20 mg L^{-1}, while for mangroves, it is 80 mg L^{-1}. In this study, the TSS value is still below the established quality standard, so it can be said that it is feasible for grouper cultivation sites.

Salinity. Salinity is closely related to the osmotic pressure of water. The higher the salinity, the higher the osmotic pressure of the water. The level of osmotic pressure required by fish varies according to species, so salinity tolerance also varies. Fish that live in water with a certain level of salinity should not be suddenly transferred to ponds with different levels of water salinity, either higher or lower.

The salinity tolerance range suitable for grouper culture is between 31 – 34 ‰. Inappropriate salinity will result in grouper production not being optimal because it will disrupt fish growth. Aditya et al (2001) said that large salinity fluctuations caused the kidneys and gills to be unable to regulate the osmosis of bodily fluids. The salinity value in the waters of the Bay of Mandeh is still within the tolerance limit for grouper culture, being 32.9-33.5 ‰.

pH. The degree of acidity (pH) is influenced by multiple variables. The temperature at a certain pH determines the availability or absorption of nutrients. Marine offshore and coastal waters generally have a relatively more stable pH (7.7-8.4) due to buffer capacity (Syamsuddin 2014). The buffer capacity of water that exceeds the input discharge, the pH of the water will change (Selanno 2009), where most of the waste material comes from household waste and other organic materials. In Table 3, the pH value ranges between 7.46 - 7.94. and is still in the optimal pH range of 7-8.5 (Government Regulation of the Republic of Indonesia Number 22 of 2021), thus allowing grouper to live in an aquatic environment that is appropriate.

Dissolved oxygen (DO). All organisms require oxygen, including fish, but not all waters provide optimal amounts of oxygen. DO is one of the chemical parameters needed by all aerobic organisms. Based on natural phenomena, water entering the waters of Mandeh Bay at high tide can cause agitation of the water mass so that DO levels increase. Dissolved oxygen in water comes from the diffusion of oxygen in the atmosphere, currents or water flow through rainwater, and photosynthetic activity by aquatic plants and phytoplankton (Novonty & Olem 1994). According to Table 4, DO levels range from 7.3 – 7.5 mg L^{-1} indicating that the DO value is at the quality standard that is set, which is > 5 mg L^{-1} (Government Regulation of the Republic of Indonesia Number 22 of 2021). The waters of the Mandeh Bay are proper for grouper cultivation.

The DO value obtained at a depth of 5 m is higher than at a depth of 20 m. Photosynthesis is suspected to occur in the upper layer so that the DO level will be higher than in the lower layer. With increasing depth, there will be a decrease in dissolved oxygen levels because the photosynthesis process is decreasing, and the oxygen content is widely used for respiration and oxidation of organic and inorganic materials.

BOD and COD. Biochemical oxygen demand (BOD) is the oxygen required for biochemical reactions during the decomposition of organic matter by bacteria (Connell & Miller 1984). High BOD levels are related to organic matter. Conversely, if the BOD level is low, in that case, a slight overhaul of organic matter, shown in Table 4, BOD levels are quite high in the waters of Mandeh Bay (12.38 - 11.23 mg L^{-1}), indicating that there has been a buildup of organic matter originating from unutilized feed residues and water input from land to the sea, bringing excess organic matter that increase BOD levels. Different from DO, high BOD levels harm aerobic organisms, such as fish and other benthic fauna that use primary substrates as a habitat. However, BOD levels in the waters of the Mandeh Bay are still meet the quality standard.

The chemical oxygen demand (COD) analysis is used to determine the amount of polluting organic matter in the water, so it is essential to decide on the water quality in mg L^{-1} organic solution, which is related to the input of sewage into the waters of Mandeh Bay and affects the amount of oxygen consumption per liter of wastewater. The research data shows that the COD (12.3 – 14.1 mg L^{-1}) in the waters of the Mandeh Bay still meets the quality standard that has been set so that the water quality can be suitable for the location of floating net cages. According to Effendi (2003), waters that have a COD value < 20 mg L^{-1} are said to be unpolluted.

Ammonia and nitrate. Table 4 shows that the ammonia value is 0.021-0.024 mg L^{-1} and meets the established quality standard, which is <0.3 mg L^{-1}. The presence of ammonia is thought to be due to the entry of domestic waste and runoff of agricultural fertilizers (Effendi 2003).

Nitrate is one of the essential nutrients in synthesizing animal and plant protein. High nitrate concentrations in water can stimulate the growth and development of aquatic organisms. Nitrate content is a determining factor in determining an aquaculture location's feasibility. Nitrate content that can support fish cultivation recommended nitrate levels of < 0.008 mg L^{-1} (Akbar et al 2001). Landau (1995) stated that the required nitrate level is between 0.02-0.4 mg L^{-1} for cultivation purposes. In Table 4, the nitrate content in the waters of Mandeh Bay is 0.025-0.027 mg L^{-1}, and this value exceeds the quality standard for grouper cultivation. It is caused by activities from the mainland, considering this location is close to residential areas. Cloern (2001) suggests that almost all nitrate in marine waters comes from river flows produced by agricultural, industrial activities, and household or resident waste.

In general, high levels of nitrate are often found in marine waters. Normal nitrate levels in marine waters range from 0.001 to 0.007 mg L^{-1} (Brotowidjoyo et al 1995). Nitrate levels are also still good for coral growth. Nitrate levels in the waters of coral reef ecosystems whose coral conditions are in the excellent category range from 0.003-0.071 mg L^{-1} (Sutarna 1987).

Orthophosphate (PO_4-P). Orthophosphate is an essential element as a nutrient for aquatic organisms. Orthophosphate content is one indicator that describes the fertility of water. The presence of orthophosphates in the seas is significant. However, orthophosphate levels in marine waters are not needed in too much quantity. Increased levels of orthophosphate in the oceans will cause eutrophication which triggers plankton blooms resulting in a decrease in dissolved oxygen levels, followed by the emergence of aerobic conditions that produce various toxic compounds such as nitrite, which causes the death of aquatic organisms (Akbar et al 2001). In Table 4, the content of Orthophosphate ranges from 0.105 to 0.395 mg L^{-1}, and this value has exceeded the threshold. It is presumably due to activities originating from the mainland, such as household and agricultural waste.

Hydrogen sulfide (H_2S). H_2S is a gas found in water from urban waste and agricultural and industrial activities. Sulfate compounds from organic waste containing sulfur are degraded anaerobically to form H_2S. Furthermore, H_2S is oxidized to sulfate, which comes from the photosynthetic activity of bacteria. Sulfate compounds can also come from industrial waste. Besides, it also comes from the results of the decomposition process of organic substances by microorganisms. The toxicity of H_2S depends on the pH of the seawater. The lower the pH of the seawater, the higher the toxicity of H_2S. Leftover feed not consumed by cultured organisms is also a source of H_2S due to the anaerobic atmosphere that allows the oxidation of H_2S. Efforts to prevent and control the impact of hydrogen sulfide poisoning in aquaculture waters can be done by increasing the pH of the water through liming and increasing the oxygen content of the seas by oxygenation.

The relationship between hydrogen sulfide and aquaculture is very closely related, where increasing the concentration of non-ionized H_2S above the threshold of 1 mg L^{-1} can result in mass death of cultured organisms.

The maximum limit of H_2S concentration that can be tolerated for cultivation activities is only 0.002 mg L^{-1}. From Table 4, the measurement results of the main water quality parameters show that the pH of the water tends to be alkaline (7.46-7.94), and the H_2S value (0.006-0.009 mg L^{-1}) is within the optimal limit interval. It is shown by the absence of unpleasant odors. Delicious taste that comes from H2S gas produced from the decomposition process of organic matter (Muchlisin 2009).

Fecal coliform. From Table 4, the waters of Mandeh Bay contain E-Coli bacteria in varying amounts within 108 – 200 CFU/100 m. Total coliform bacteria, fecal coliform bacteria, and *Escherichia coli* are water quality indicators. Generally, *E. coli* bacteria are considered very dangerous because their presence is directly related to fecal contamination (feces), which causes diarrheal disease (Rice et al 1991). The people of Mandeh Bay prefer Mandeh Bay as a marine cultivation area and tend to choose other recreation locations.

Source of pollution. Some environmental factors strongly influence water quality in the form of research data. Pollution is thought to be the leading cause, which in this study was not measured, but considered an essential factor that has affected the water quality in Mandeh Bay. These pollutant materials come from various sources. Based on the activity, the origins of pollution estimated to occur at the location include household waste, reclamation sedimentation, agricultural waste, and microorganism waste.

Household waste is one source of pollution associated with household activities. The high population increase results in higher household waste generated. The action of disposing waste originating from households is carried out every day so that if it is not managed correctly, it will disrupt the ecological stability of the waters. Based on the research results, it is estimated that all locations indicate household waste originating from settlements, by utilization of water as a place for household disposal in the form of liquid and solid waste. It is characterized by a high BOD value because many activities in settlements increase the volume of liquid waste containing high organic matter to increase the BOD value. Indeed, not all households dispose of their waste directly into the waters. It is assumed that only homes located near the riverbank, which drains into the sea, the beach, and the flow of rainwater are considered.

Clearing new land to expand residential areas or agricultural land can cause siltation. If it is carried out in coastal areas, it is called reclamation, and affects the volume of waste. Sedimentation occurs because, from time to time, a lot of sediment (particles of sand, soil, and rock) is carried by rainwater from land to sea and settles on the bottom of the water (Droppo et al 1997).

Pollution status. Table 5 shows the water quality in Mandeh Bay is classified as class D, in the bad category, or has been badly polluted because the score is greater than 40. Under these conditions, marine aquaculture activities, especially grouper cultivation, are hazardous. The high intensity of utilization of Mandeh Bay waters as it is today indicates that there is pollution in the seas of Mandeh Bay. The reality of this condition has spurred all parties to take serious measures to deal with it. Therefore, the instrument for dealing with this pollution problem must be described clearly. One of the steps to deal with it is comprehensive marine spatial planning so that the proposed policy measures will greatly assist efforts to restore water conditions.

Table 5

Status of water quality for grouper cultivation activities in the waters of Mandeh Bay according to the STORET index method

No	*Parameter*	*Unit*	*Quality standards*	*Measurement results*			*Total score*
				Max	*Min*	*Mean*	
1	Temperature	°C	Experience	30.9	28.4	30.15	0
2	Brightness	m	>5	17.8	16.3	17.05	0
3	Turbidity	NTU	<5	3.8	3.2	3.5	0
4	TSS	mg L^{-1}	<20	7.81	6.99	7.4	0
5	Salinity	‰	Experience	33.5	32.9	33.2	0
6	pH	-	7-8,5	7.94	7.46	7.7	0
7	DO	mg L^{-1}	>5	7.5	7.3	7.4	0
8	BOD	mg L^{-1}	<20	12.38	11.23	11.805	0
9	COD	mg L^{-1}	<20	14.1	12.3	13.2	0
10	Ammonia	mg L^{-1}	0,3	0.024	0.021	0.345	0
11	Nitrate	mg L^{-1}	0.006	0.027	0.025	0.026	-20
12	Orthophosphate	mg L^{-1}	0.015	0.395	0.105	0.25	-20
13	Hydrogen sulfide	mg L^{-1}	0.01	0.009	0.006	0.0075	0
14	Fecal coliform	CFU/100 mL	-	108	200	154	-

Conclusions. It can be concluded that the results of a feasibility study on water quality for grouper culture using floating net cages (FNC) in Mandeh Bay indicate that Mandeh Bay is quite suitable as a location for fish cultivation in floating net cages. This is based on the results of the analysis of several water quality parameters: temperature, brightness,

turbidity, total suspended solids, salinity, pH, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, ammonia, and bacteria, which are still below the standard threshold. However, the value of nitrate and orthophosphate has exceeded the specified quality standard. Several sources of pollution that affect the value of water quality parameters identified come from household waste, reclamation, agricultural waste, and microorganism waste. The STORET method shows that the water quality in the waters of Mandeh Bay is classified as class D, in poor condition, or has been heavily polluted. Currently, the utilization of Mandeh Bay is not only a cultivation area but has also been used massively for other purposes such as ship traffic, ship mooring and repair locations, and various other activities that are feared to interfere with cultivation activities. Based on this analysis, further research, such as analysis of heavy metals and microplastics is required. This is important because fish is as a source of protein that can serve as a temporary medium which in turn transfers heavy metals to consumers. In the future, to make Mandeh Bay a marine fish cultivation area with high economic value, special regulations are needed that can minimize pollution sources and it is necessary to monitor water quality regularly.

Conflict of Interest. The authors declare that there is no conflict of interest.

References

Aditya, Evalawati M., Meiyana, 2001 [Grouper biology, rearing of duck grouper and tiger grouper in the sea]. Direktorat Jenderal Balai Budidaya Laut, Lampung [in Indonesian].

Akbar M., 1995 [Grouper hatchery at the Lampung Marine Cultivation Center]. Direktorat Jenderal Perikanan [in Indonesian].

Brotowidjoyo D. M., Tribowo D., Eko M., 1995 [Introduction to the aquatic environment and aquaculture]. Liberti, Yogyakarta [in Indonesian].

Buitrago J., Rada M., Hernandez H., Buitrago E, 2005 A single-use site selection technique, using GIS, for aquaculture planning: choosing locations for mangrove oyster raft culture in Margarita Island, Venezuela. Environmental Management 35(5):544–556.

Canter L. W., 1977 Environmental impact assessment. University of Oklahoma. New York: McGraw-Hill Book Company.

Cloern J. E., 2001 Our evolving conceptual model of the coastal eutrophication problem. Marine Ecology Progress Series. 210:223–253.

Connell D. W, Miller G. J., 1984 Chemistry and ecotoxicology of pollution. John Wiley & Sons.

Droppo I. G., Leppard G. G., Flannigan D. T., Liss S. N., 1997 The freshwater floc: A functional relationship of water and organic and inorganic floc constituents affecting suspended sediment properties. Wat. Air Soil Pollut. 99:43-53.

Effendi H., 2003 Study of water quality for resource management and aquatic environment. Kanisius Publisher, Yogyakarta.

Karikari A. Y., Akpabey F., Abban E. K., 2013 Assessment of water quality and primary productivity characteristics of Volta Lake in Ghana. Academia Journal of Environmental Sciences. 1:88–103.

Landau M., 1995 Introduction to aquaculture. John Willey & Sons, Inc. New York. 464 pp.

Muchlisin Z. A., 2009 [Preliminary study of water quality for the development of aquaculture in Sampolnit Aceh Jaya District after the tsunami]. Biospecies. 2(1):10-16 [in Indonesian].

Mylaparavu R., 2008 Impact of phosphorus on water quality. University of Florida. Florida. Publication #SL 275.

Napiórkowska-Krzebietke A., 2015 Cyanobacterial bloom intensity in the ecologically relevant state of lakes – an approach to Water Framework Directive implementation. Oceanological and Hydrobiological Studies. 44(1):97–108.

Napiórkowska-Krzebietke A., Dunalska J., 2015 Phytoplankton-based recovery requirement for urban lakes in the implementation of the water framework

directive's ecological targets. Oceanological and Hydrobiological Studies. 44(1):109–119.
Novonty V., Olem H., 1994 Water quality, prevention, identification and management of diffuse pollution. New York: Van Nostrans Reinhold. 1054 pp.
Ofori-Danson P. K., Ntow W. J., 2005 Studies on the current state of the limno-chemistry and potential yield of Lake Volta (Yeji Sector) after three decades of impoundment. Ghana Journal of Agricultural Science 35:65–72.
Rice E. W., Allen M. J., Brenner D. J., Edberg S. C., 1991 Assay for b-glucuronidase in species of the genus *Escherichia coli* and its application for drinking-water analysis. Applied and Environmental Microbiology 57:592–593.
Selanno D. A. J., 2009 [Analysis of the relationship between pollution load and waste concentration as the basis for managing the environmental quality of Ambon Bay waters]. Disertasi. Sekolah Pascasarjana IPB. Bogor [in Indonesian].
Sutarna I. N., 1987 [Diversity and richness of coral reef species in the outer Ambon Bay, Ambon Island, Ambon Bay Book (Biology, Fisheries, Oceanography and Geology)]. BSDL Lembaga Ilmu Pengetahuan Indonesia, Ambon [in Indonesian].
Syamsuddin R., 2014 Management of water quality. Theory and application in the fisheries sector. Pijar Press, Makassar. 340 pp.
*** Government Regulation of the Republic of Indonesia Number 22, 2021 Concerning the Implementation of Environmental Protection and Management.
*** Indonesia Geospatial Portal, 2022 www.tanahair.indonesia.go.id.
*** Ministry of Environment Republic of Indonesia, 2003 Ministry of Environment Decree number 115/2003 about the guidelines for determination of water quality status. Jakarta (ID).
*** United States Environmental Protection Agency (USEPA), 1978 Standard method for the examination of water and wastewater (11th edn). Washington: USEPA.

Received: 10 October 2022. Accepted: 02 November 2022. Published online: 24 April 2023.
Authors:
Suparno Suparno, Study Program of Fisheries Resources Utilization, Faculty of Fisheries and Marine Sciences, Bung Hatta University, Kampus Ulak Karang, Padang, Indonesia, e-mail: suparnopranoto@bunghatta.ac.id
Deswati Deswati, Department of Chemistry, Faculty of Mathematics and Natural Sciences, Andalas University, Padang, Indonesia, e-mail: deswati@sci.unand.ac.id
Hilfi Pardi, Department of Chemistry Education, Faculty of Teacher Training and Education, Raja Ali Haji Maritime University, Senggarang, Tanjungpinang, Indonesia, e-mail: hilfipardi@umrah.ac.id

How to cite this article:
Suparno S., Deswati D., Pardi H., 2023 Water quality for grouper farming in Mandeh Bay waters, Pesisir Selatan, Indonesia. AACL Bioflux 16(2):1156-1165.

2023.1156-1165.pdf

ORIGINALITY REPORT

16%	13%	14%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Padjadjaran University Student Paper	2%
2	ejournal.unpatti.ac.id Internet Source	1%
3	download.garuda.kemdikbud.go.id Internet Source	1%
4	www.jica.go.jp Internet Source	1%
5	Y Harjoyudanto, N Asiah. "Mapping of Water Quality as Aquaculture Media, Comparative Study on Three Rivers in Riau Province", IOP Conference Series: Earth and Environmental Science, 2021 Publication	1%
6	rasayanjournal.co.in Internet Source	1%
7	L L Silaban, A S Atmadipoera, M T Hartanto, Herlisman. "Water mass characteristics in the Makassar Strait and Flores Sea in August-	1%

September 2015", IOP Conference Series: Earth and Environmental Science, 2021
Publication

8	Tarzan Purnomo, Kandilia Sahani, Toni Wahyudi. " Analysis of Carrying Capacity of Blekok Beach and Kerapu Beach Situbondo as Conservation Areas for Mangrove, Blekok Bird ( ) and Grouper Fish Cultivation ( ) ", E3S Web of Conferences, 2021 Publication	1 %
9	csirspace.csirgh.com Internet Source	1 %
10	jurnalsyntaxadmiration.com Internet Source	1 %
11	repository.ugm.ac.id Internet Source	1 %
12	link.springer.com Internet Source	1 %
13	Henri, R Syafa'ati, Randiansyah. "Species composition and vegetation structure of mangrove forest in Baskara Bakti Village, Central Bangka Regency, Bangka Belitung", IOP Conference Series: Earth and Environmental Science, 2022 Publication	1 %
14	M J Wibowo, W Winarno, B Hariono, R Wijaya. "Evaluation of Kalibomo watershed water	<1 %

quality using the storet method", IOP Conference Series: Earth and Environmental Science, 2021
Publication

15	www.science.gov Internet Source	<1 %
16	Giri Rohmad Barokah, Farida Ariyani, Tuti Hartati Siregar. "Comparison of Storet and Pollution Index Method to Assess the Environmental Pollution Status: A Case Study from Lampung Bay, Indonesia", Squalen Bulletin of Marine and Fisheries Postharvest and Biotechnology, 2017 Publication	<1 %
17	www.scilit.net Internet Source	<1 %
18	jurnal.unigo.ac.id Internet Source	<1 %
19	Submitted to Universitas Diponegoro Student Paper	<1 %
20	www.wepa-db.net Internet Source	<1 %
21	Lisbet Sagala, Sulistiono, Djamar T.F.L. Batu. " Heavy metal contents of Hg, Cd, Pb, and Cu in splendid ponyfish (Cuvier, 1829) meat in	<1 %

Banten Bay, Indonesia ", E3S Web of Conferences, 2021
Publication

22	S Arofah, L A Sari, R Kusdarwati. "The relationship with N/P ratio to phytoplankton abundance in mangrove Wonorejo waters, Rungkut, Surabaya, East Java", IOP Conference Series: Earth and Environmental Science, 2021 Publication	<1 %
23	prr.hec.gov.pk Internet Source	<1 %
24	repo.unsrat.ac.id Internet Source	<1 %
25	Submitted to Birla Institute of Technology and Science Pilani Student Paper	<1 %
26	N N Dewi, W H Satyantini, A M Sahidu, L A Sari, A T Mukti. "Analysis of water quality on several waters affected by contamination in West Sumbawa Regency", IOP Conference Series: Earth and Environmental Science, 2018 Publication	<1 %
27	N Y Hasan, Driejana, A Sulaeman, H D Ariesyady. "Water quality indices for rainwater quality assessment in Bandung urban region",	<1 %

IOP Conference Series: Materials Science and Engineering, 2019
Publication

28 www.iap.pr.gov.br
Internet Source <1%

Exclude quotes	On	Exclude matches	< 15 words
Exclude bibliography	On		