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Analysis of water quality and cadmium content around Awarange beach, Barru Regency, Indonesia in relation cultivation of milkfish (Chanos chanos Forskal)

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Abstract

Objective: The study aims to determine the condition of the water quality parameters and cadmium content around Awarange Beach, Barru Regency, Indonesia, in relation cultivation of milkfish (*Chanos chanos* Forskal).

Material and method: This research was conducted from July to August 2024 at Awarange Beach, Barru Regency, Indonesia. The research location is divided into 3 stations, namely Station 1 (ST.1), namely the beach near the La Sonrai recreation area/mangrove forest; Station 2 (ST.2), namely around Awarange Port, Barru Regency; and Station 3 (ST.3), namely around the Awarange Shipyard. The parameters measured were temperature, dissolved oxygen, pH, salinity, and cadmium content of seawater. The research data obtained were then processed and analyzed using descriptive analysis.

Results: Based on the research results, it shows that the water quality at the research location, consisting of temperature, dissolved oxygen, pH, salinity, and cadmium content, only salinity has a fairly high value. Kualitas perairan yang lain masih sesuai dengan kebutuhan hidup dan pertumbuhan ikan bandeng, termasuk kandungan cadmium dengan nilai <0.003 ppm.

Conclusion:Overall, the water quality and cadmium heavy metal content at the research location are still suitable and feasible for the development of milkfish (Chanos chanos Forskal) cultivation.

Keywords: Water quality; Cadmium; Beach; Awarange; Milkfish

1 Introduction

Indonesia is a country that has a larger ocean area than land area, with a coastline of ±95,000 km^2 (Sukamto, 2017). Coastal areas and small islands are very rich in natural resource potential that can be utilized for the welfare of the community. Non-living resources, including environmental services for the growth of tourism, are one of them (Rahmawan and Gemilang, 2017). According to Dahuri (1996), coastal areas with various ecosystems within them are productive areas and are used for various development activities. As a result, coastal areas become highly vulnerable to the impacts of development. Johnson et al. (2023) showed that collaboration between governments, scientists, and local groups can boost the effectiveness of coastal region management.

Coastal resources of primary concern are fisheries, mangroves, and coral reefs (Dahuri et al., 2004). If the use of coastal land is not in accordance with its intended use, it will have a major impact on the sustainability of coastal ecosystems

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and the lives of its people. Changes in coastal areas are triggered by various activities such as industry, housing, transportation, ports, aquaculture, agriculture, and tourism (Mubarak et al., 2024). Coastal development can be beneficial economically, but it can also harm marine ecosystems, particularly coral reefs (Dahuri et al. 2008). The mismatch between coastal land use and its designation is influenced by the interests and needs of the community to obtain maximum benefits (Mubarak et al., 2024).

According to Hu et al. (2008), increasing land use from one type of use to another followed by a reduction in other types of land use over time can affect the local ecological system, including water pollution and air pollution. The impact on the status of the aquatic environment can have an impact on the community, both to meet domestic needs and other needs (Puspita et al., 2018). Although the sea has the ability to maintain balance (homeostasis) and is able to purify itself (self-purification) from all pollutants that enter the water body. However, the sea is also the final storage system for all types of waste produced by human activities. If the pollution load received by the sea exceeds its carrying capacity, the quality of seawater will decline (Elyazar et al., 2007).

Water quality is the nature of water and the content of living creatures, energy substances, and other components contained in water (Effendi, 2003). The quality of water can be determined by measuring physical, chemical (Pratama et al., 2016), and biological parameters, which are then compared with the established quality standards. Monitoring water quality is important, especially in coastal waters that are vulnerable to pollution (Palaniappan et al., 2010). Water quality monitoring aims to determine the value of water quality based on physical and chemical parameters and to compare the results of water quality measurements with quality standards in accordance with their designation (Effendi, 2003).

This research was conducted on the coast of Awarange, Barru Regency. As is known, Awarange Beach has experienced a lot of economic progress in recent years, where there is the Awarange port, the La Sonrai Beach tourist spot, and the Awarange shipyard, and this is thought to have an effect on the water quality on the beach. By looking at the condition of the waters around the Awarange coast, this study focuses more on the relationship between water conditions and the development of milkfish cultivation. Water is a habitat for milkfish, which influences their growth and survival; therefore, pond water must meet the requirements of both volume and quality (Wahyuni et al., 2020). As is known, the sustainability of pond cultivation is very dependent on the condition of the quality of the water environment, especially the waters where water sources can be obtained for cultivation activities, including milkfish cultivation. Different aquatic environmental conditions can affect environmental quality conditions both physically, chemically, and biologically. In pond cultivation, including milkfish cultivation, water quality is a key factor in success because it is an absolute requirement in maintaining cultivated organisms. For this reason, researchers conducted research on water quality studies in milkfish (Chanos chanos Forskal) cultivation around the Awarange coast, Barru Regency.

2 Materials and Methods

Taking and measuring water samples at different locations starting from 7 am until finished. Sampling and measurement were carried out 4 (four) times at each station at a sampling time of every 2 weeks for two months, namely July-August 2024. The research location is divided into three sampling stations, namely Station 1 (ST.1), namely the beach near the La Sonrai recreation area/mangrove forest; Station 2 (ST.2), namely around Awarange Port, Barru Regency; and Station 3 (ST.3), namely around the Awarange Shipyard. The parameters measured were temperature, dissolved oxygen, pH, salinity, and cadmium content of seawater. Measurement of temperature, dissolved oxygen, pH, and salinity was carried out in situ, namely water quality measurements carried out at the research site. Meanwhile, the measurement of cadmium content at the research location was carried out using the ex situ method, namely the measurement was carried out by taking samples and then taking them to the laboratory for analysis. The method used to measure cadmium content is SM APHA 23rd Ed. 3113 B, 2017 (APHA, 2017). The research data obtained were then processed and analyzed using descriptive analysis.

3 Results

3.1 Waters Temperature (^{0}C)

Based on Figure 1, it shows that the water temperature around Awarange Beach, Barru Regency, is in the range of 29.6-31.1 ^{0}C, with the highest temperature at station 1 (ST 2), namely the location around Awarange Port, Barru Regency, with an average of 30.43 ^{0}C. Meanwhile, the lowest water temperature at Station 3 (ST. 3), namely the location around the Awarange shipyard, was an average of 29.6 ^{0}C.

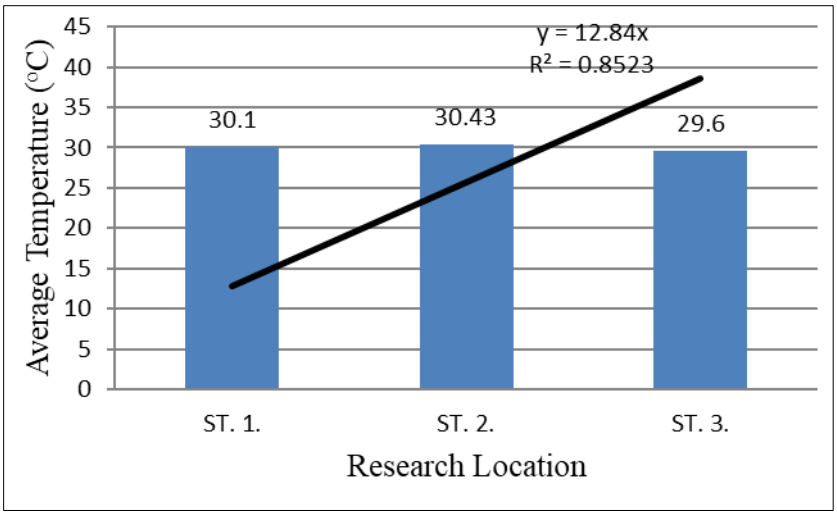

Figure 1 Average Water Temperature (°C) at the Research Location

3.2 Waters Dissolved Oxygen (ppm)

Figure 2 shows the average value of dissolved oxygen at the research location is in the range of 5.75-6.82 ppm, with the location with the highest ppm content being Station 1 (ST.1), which is the location located around the La Sonrai tourist attraction in Barru Regency, which is 6.82 ppm, and the lowest at location 3, namely Station 3 (ST.3), which is the location located around the shipyard, which is 5.75 ppm. However, all research locations have high oxygen content. The high oxygen content at Station 1 is due to the location being directly adjacent to the beach, and there are many waves so that the water movement is also high.

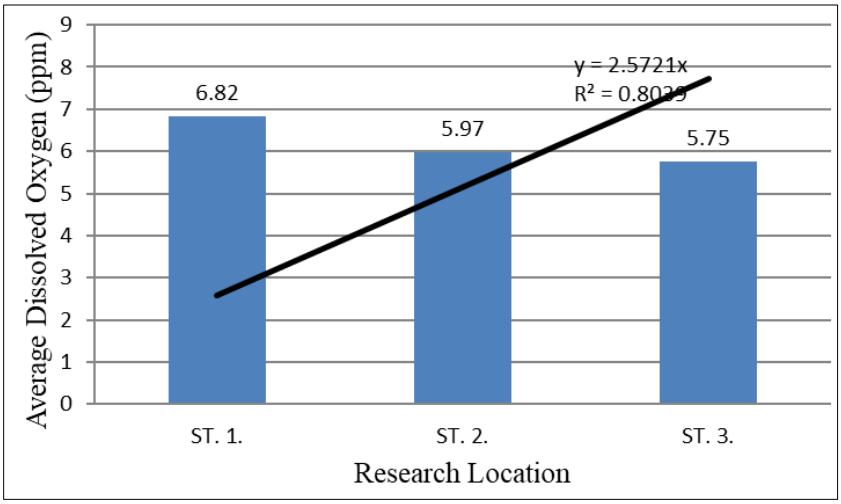

Figure 2 Average Dissolved Oxygen (ppm) at the Research Location

3.3 pH of Waters

Based on Figure 3, it shows that the average pH of the waters at the highest research location was obtained at Station 2 (ST.2), namely 7.33, and the lowest at Station 1 (ST.1) and Station 3 (ST.3), namely 7.07 each.

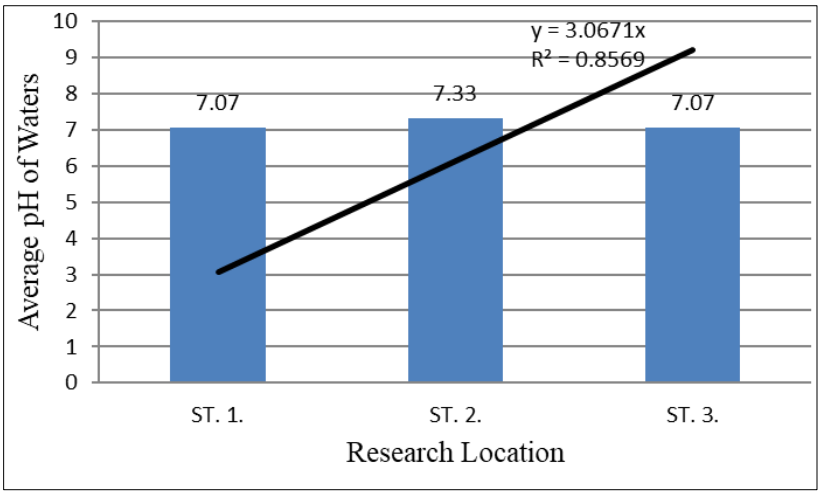

Figure 3 Average pH of Waters at the Research Location

3.4 Waters Salinity (ppt)

Figure 4 shows the average salinity at the highest research location at Station 1 (ST.1), which is an average of 37.33 ppt, and the lowest at Station 2 (ST.2) and Station 3 (ST.3), which is 36.33 ppt each.

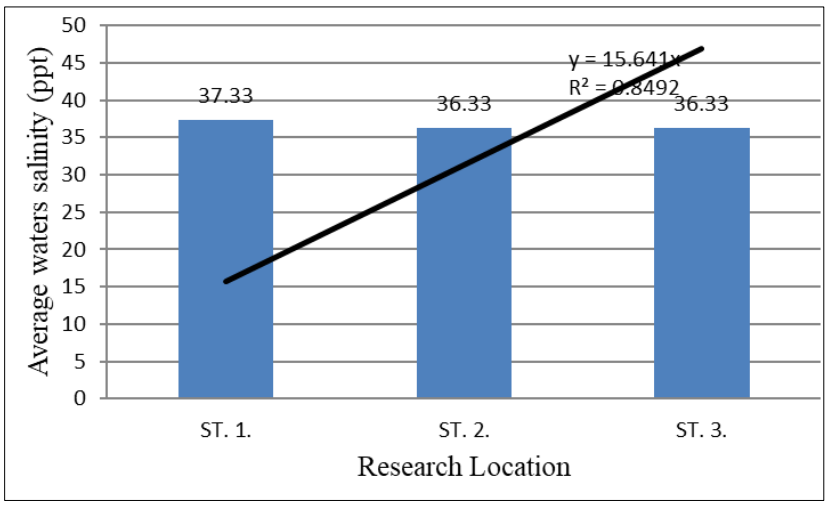

Figure 4 Average waters salinity at the Research Location

3.5 Cadmium Content of Waters (ppm)

Figure 5 shows that the cadmium content at all stations in the research location is still in the range below 0.003 ppm, so it can be stated that the waters in the research location, based on the aspect of heavy metals, especially cadmium, have not been polluted. Although the three research locations are quite vulnerable to cadmium pollution, where location 1 is a recreation area, location 2 is a location around the port, and location 3 is a shipyard, in fact, all locations have not been categorized as contaminated with cadmium metal. One source of pollution in coastal areas is domestic waste.

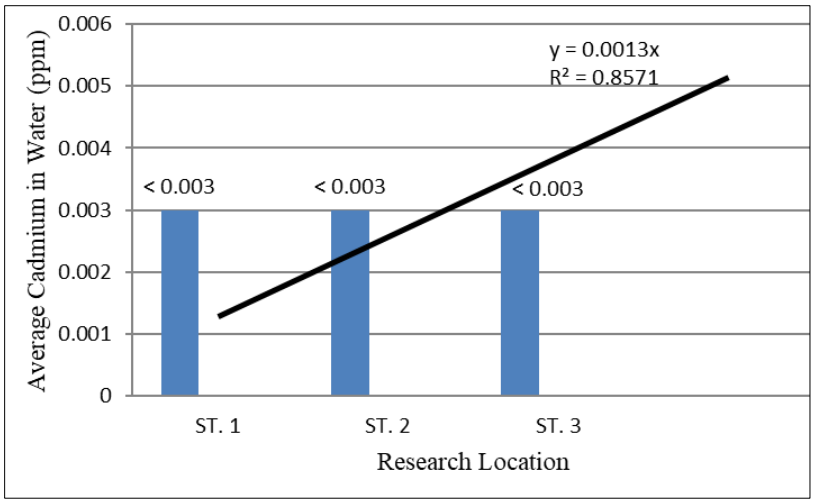

Figure 5 Cadmium Content (ppm) of Water at the Research Location

4 Discussion

4.1 Waters Temperature (^{0}C)

The water temperature in this study showed a higher value than the results of the study conducted by Ayer et al. (2024), who conducted a study on seawater quality in the Hamadi Tourism Coastal Waters showing a temperature value in the range of 27-29 ^{0}C. Fatma et al. (2023), who conducted research in the waters of Soppeng Riaja District, Barru Regency, found that the water temperature at each research station was 28-30 ^{0}C. However, based on water quality standards, it should have a temperature in the range of 28-30 ^{0}C (Government of Indonesia, 2021).

Furthermore, if the results of temperature measurements in these waters are linked to the water temperature requirements for fish, Ahmad and Ratnawati (2002) stated that fish can still live normally at temperatures of 27-35 ^{0}C. Ismail et al. (1993) stated that the temperature for milkfish growth is 27–31 ^{0}C. At temperatures that are too high, it will damage the growth of phytoplankton, which will inhibit the photosynthesis process (Wahyuni et al., 2020). Increasing water temperatures will cause dissolved oxygen to decrease (Hutabarat, 2000). Furthermore, Haerudin and Putra (2019) stated that a good temperature for fishing activities and good for the life of biota in marine waters is in the temperature range of 27°C to 32 ^{0}C. Temperature also greatly influences the life and growth of aquatic biota; the temperature in water bodies is influenced by the season, latitude, height above sea level (altitude), time of day, air circulation, cloud cover, and flow and depth of water. Water temperature plays a role in controlling the condition of aquatic ecosystems (Gustina et al., 2023). Effendi (2003) added that increasing temperatures also cause an increase in the rate of metabolism and respiration of aquatic organisms as well as an increase in the decomposition of organic matter by microbes, and subsequently result in an increase in oxygen consumption in the water. This is explained by Budi and Wiharyanto (2013), who say that the water temperature will always rise and fall throughout the day according to the air temperature or the intensity of sunlight. As a tourist area, water temperature is used to determine the potential and existence of marine animal breeding and growth. Temperature affects the metabolic activity of marine organisms. This temperature is still ideal for marine tourism (Ayer et al., 2024). According to research conducted by Nugraha et al. (2016), the optimal temperature for the life of marine organisms is in the range of 26-29^{0}C, and marine organisms live optimally at this temperature.

4.2 Waters Dissolved Oxygen (ppm)

According to Aliyah (2013), the amount of dissolved oxygen in water is one of the crucial supporting variables to take into account. Because oxygen is essential to the survival of all living beings. The dissolved oxygen value in this study was still higher than the results of the study conducted by Mudloifah & Purnomo (2023), namely 3.65±0.08 to 3.84±0.11 ppm. The range of dissolved oxygen levels from the quality standards is based on Government Regulation of the Republic of Indonesia No. 22 (2021), namely the optimal dissolved oxygen level for the survival of marine biota is >5 ppm. The low levels of dissolved oxygen at Asmoroqondi Beach are caused by low exposure to sunlight in the waters so that the phytoplankton photosynthesis process is hampered, in addition to being caused by the low speed of the water current (Mudloifah & Purnomo, 2023). Boyd (1982) asserts that a number of variables, including temperature, salinity, water turbulence, and atmospheric pressure, affect the amount of dissolved oxygen in water.

Requintina et al. (2006) state that 3-5 ppm is a good DO for fish farming. Waters with dissolved oxygen below 0.5 ppm cause fish death (Riko et al., 2012). Hardjowigeno and Widiatmaka (2001) stated that dissolved oxygen >3 ppm is suitable for use as milkfish cultivation ponds. Too high dissolved oxygen content will cause gas bubble disease (Utojo and Pirzam, 2000). According to Boyd (1982), the dissolved oxygen content in water changes are influenced by several factors, namely temperature, salinity, water turbulence, and atmospheric pressure.

4.3 pH of Waters

Water has a buffer system to prevent changes in pH; even the slightest change in pH from the natural pH will disrupt the buffer system (Gustina et al., 2023). The degree of acidity (pH) is a water quality parameter that plays an important role in the biochemical processes of water (Simanjuntak, 2012). The results of this study have the same value as the results of the study conducted by Fatma et al. (2023), namely an average of 7. The pH range is in accordance with the standards based on Government Regulation of the Republic of Indonesia No. 22 (2021), namely the optimal pH for marine biota life is between 7.0-8.5. The pH is included in the alkaline category. The pH parameter value in this study is higher than the results of research conducted by Mukamto et al. (2024) in the northern coastal waters of Palang District, which showed an average value of 6.90 with a range of 6.72-7.00.

The pH of waters has a major influence on the diversity, abundance, and dominance of plankton, as well as the productivity of marine waters (Megawati et al., 2014). According to Rais (2004), pollutants from domestic waste, such as nutrients and total suspended solids (TSS), can change the acidity and alkalinity of water (pH). The pH value for milkfish growth is between 7.0-8.5 (SNI 6148.3:2013), pH 6.5-8.5 (Koswara, 2011), and pH 6.5-9.0 (Rangka and Asaad, 2010). If the water pH is low, the heavy metal solution will be higher and vice versa. A good pH value for badeng fish cultivation, according to Odum (1996), is 6-9. The water quality standard should have a water pH of 7-8.5 (Government of Indonesia, 2021). Thus, the pH value of the water at the research location is still in accordance with the needs of milkfish life. The results of this study are also in line with the research of Ayer et al. (2024), namely the pH value of 7.3-7.5. The pH of the waters at the research location was still lower than the results of research conducted by Mudloifah & Purnomo (2023), who conducted research at Asmoroqondi Beach ranging from 8.08±0.03 to 8.19±0.05. The fact that coastal areas are densely populated areas and have high community mobilization (Mukamto et al., 2024). The development of people's economic activities also increases the supply of carbon dioxide in the atmosphere. The carbon dioxide absorbed by seawater then reacts with seawater to form carbonic acid (H2CO3-) and increases the acidity of seawater (Haiqal et al., 2021).

4.4 Waters Salinity (ppt)

Salinity is a water quality parameter that indicates the level of dissolved salt in water (Hamuna et al., 2018). Chester (1990) stated that seawater salinity can differ geographically, one of the reasons being the large amount of fresh water originating from rivers flowing into the sea. The salinity of the waters at all research locations is classified as high because when the measurements were taken, it was in the dry season. Syahid et al. (2006) stated that good salinity for the growth of milkfish in ponds is 15-35 ppt. According to Hardjowigeno and Widiatmaka (2007), milkfish can live at a salinity of 0-35 ppt. The salinity of water in the waters should be in the range of 30-33 ppt (Fatma et al., 2023). The water quality standard should have a salinity of 33-34 ppt (Government of Indonesia, 2021). Coastal areas composed of rocks tend to have higher salt content (Prastuti, 2017). This is because the sea waves that hit the rocks on the shore will dissolve the salt minerals in the rocks (Sawo & Tukan, 2023).

According to Wahyuningsih et al. (2021), one of the factors that causes changes in salinity is seasonal changes and decreases due to the influence of rainfall; varying levels of salinity in sea waters are also caused by precipitation. The low salinity in the waters is caused by the time the salinity measurement is carried out at low tide, where the mass of seawater at low tide moves towards the sea so that a distribution pattern is formed, which causes low salinity values (Yona & Ayuk, 2016). According to Patty et al. (2020), water salinity is influenced by water distribution patterns, evaporation, weather, and the influx of fresh water carried by river flows.

4.5 Cadmium Content of Waters (ppm)

Domestic waste is waste that is disposed of from residential areas, markets, shops, and offices, which is a source of pollution in the aquatic environment (Suhartono, 1998). Furthermore, Supriharyono (2002) stated that domestic waste is liquid waste originating from urban communities, including municipal waste and industrial activities that enter the city's sewer system. One indicator of high domestic waste in a body of water is low dissolved oxygen and high nitrogen, BOD, and total coliform counts (Tugiyono et al., 2015). Domestic waste is the main cause of pollution because it has waste characteristics with a fairly high Pb and Cd metal content, namely Pb of 0.021 ppm (Said, 2008). The high Pb metal content is due to the level of accumulation by the sedimentation process (Puspita et al., 2018).

5 Conclusion

Based on the research results, it can be concluded that the water quality at the research location, consisting of temperature, dissolved oxygen, pH, salinity, and cadmium content, only salinity has a value that is too high, which is in the range of 36-37 ppt because the water quality measurement was carried out during the dry season. Thus, at the research location, it is possible and feasible to develop milkfish (Chanos chanos Forskal) cultivation.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

There is no conflict of interest in this research.

References

[1] Ahmad, T., & E. Ratnawati. 2002. Intensive Milkfish Cultivation. Penebar Swadaya. Bogor.

[2] Aliyah, R. S. 2013. Evaluation of Environmental Conditions of the North Coast of Karawang Waters to Support the Development of Fisheries Cultivation. J. Tek. Ling. 14(2): 67-73

[3] APHA. 2017. Standard Methods for the Examination of Water and Wastewater (23rd edition). Washington DC: American Public Health Association

[4] Ayer, P.I.L., I. Mishbach., E. Indrayani., & K. Rejauw. 2024. Analysis of Sea Water Quality and Environmental Sanitation on the Beach Based on Sulfide, Nitrate, Phosphate, Fecal Coli, and Coliform Content in Hamadi Tourism Beach Waters. SAINTIFIC: Journal of Mathematics, Science, and Its Learning. 10(1): 115-119. https://10.31605/saintifik.v10i1.468

[5] Boyd, C.E. 1982. Water Quality Management for Pond Fish Culture. Elsevier, Amsterdam, p.318

[6] Budi, S. M. & Wiharyanto, D. 2013. Water Quality Study in Aquatic Environment of Ponds Adopting Better Management Practice (BMP) in Fish Cultivation Cycle, Karang Anyar Beach Village, Tarakan City, North Kalimantan Province. Journal of Harpodon Borneo. 6(1)

[7] Chester, A. 1990. Marine Plankton, LIPI Pess. Jakarta

[8] Dahuri, R. 1996. Integrated Management of Coastal and Marine Resources. Pradnya Paramita. Jakarta

[9] Dahuri, R.H 2003. Marine Biodiversity: Indonesia's Sustainable Development Asset. Publisher, PT Gramedia Pustaka Utama.

[10] Dahuri, R., J. Rais., S.P. Ginting & M.J. Sitepu. 2004. Integrated Management of Coastal and Marine Resources. Pradya Paramita. Jakarta.

[11] Effendi, H. 2003. Water Quality Review: For Aquatic Resources and Environment Management. Yogyakarta, Indonesia: Kanisius

[12] Elyazar, N. M.S., Mahendra, L.M., & Wardi. 2007. The impact of community activities on the level of sea water pollution on Kuta Beach, Badung Regency and environmental conservation efforts. ECOTROPIC. 2(2).

[13] Fatma., F.R. Ayyub., & S. Nurpaila. 2023. Current Condition of Coral Reefs in the Coastal Waters Near the Shipyard in Batupute Village, Soppeng Riaja District, Barru Regency. Jurnal Sains dan Teknologi Perikanan. 3(2): 101-110

[14] Gustina, A.,R. Ezraneti., Erlangga.,Muliani., & S. Adhar. 2023. Analysis of Water Quality Parameters in the Rancong Pond Area of Lhokseumawe City. Journal of Fisheries Science & Coastal Society. 9(1): 1-11. https://doi.org/10.62176/munggai.v9i01.242

[15] Haerudin, H., & Putra, A. M. 2019. Analysis of Sea Water Quality Standards for the Development of Marine Tourism in the Coastal Waters of Labuhan Haji, East Lombok Regency. Geodika: Journal of Geographical Science and Education Studies. 3(1): 13-18.

[16] Haiqal, M.R.N., Utami, B.W., Achmad, L., & Suryanda, A. 2021. Natural Mitigation of Ocean Acidification. Journal of Ecology, Society & Science (ECOTAS). 2(2). http://journals.ecotas.org/index.php/ems

[17] Hamuna, B., Tanjung R.H.R., Suwito., Maury H.K & Alianto. 2018. Study of Sea Water Quality and Pollution Index Based on Physico-Chemical Parameters in Depapre District Waters, Jayapura. Journal of Environmental Science. 16(1): 35-43.

[18] Hardjowigeno, S. & Widiatmoko. 2001. Land Suitability and Land Use Planning. Bogor: Soil Department, Faculty of Agriculture, IPB University.

[19] Hardjowigeno, S. dan Widiatmoko. 2007. Land Suitability Evaluation and Land Use Planning. Gadjah Mada University Press. Yogyakarta

[20] Hu, D., G. Yang., Q. Wu., H. Li., X. Liu., X. Niu., Z. Wang. and Q. Wang. 2008. Analyzing Land Use Changes in the Metropolitan Jilin City of Northeastern China Using Remote Sensing and GIS.8:5449-5465.

[21] Hutabarat, S. 2000. The Role of Oceanography on Climate Change, Productivity and Distribution of Marine Biota. UNDIP. Semarang.

[22] Ismail, A., Poernomo, A., Sunyoto, P., Wedjatmiko, Dharmadi, Budiman, R.A.I. 1993. Technical Guidelines for Milkfish Farming in Indonesia. Center for Fisheries Research and Development, Jakarta, 93p

[23] Johnson, T., Williams, C., & Thompson, A. 2023. Enhancing coastal resilience through community-based management strategies. Journal of Environmental Planning and Management. 66(2): 275-290

[24] Decree of the Minister of State for the Environment Number 4 of 2001 concerning Standard Criteria for Coral Reef Damage. Attachment VIII of Government Regulation Number 22 of 2021 concerning Sea Water Quality Standards.

[25] Koswara, B. 2011. Restoration of Saguling Reservoir Through Application of Ecotechnology Method. Journal of Aquatics Volume II Number 2 September 2011

[26] Megawati C, Yusuf M & Maslukah L, 2014. Distribution of Water Quality Reviewed from Nutrients, Dissolved Oxygen and pH in the Southern Waters of Southern Bali. Journal of Oceanography. 3(2): 142-150.

[27] Mubarak, H., A. Salim., & S. Bahri. 2024. Sustainable Coastal Area Development in Coastal Barru District Area, Barru Regency. 254-264. https://doi.org/10.35965/ursj.v6i2.4499

[28] Mudloifah, I., & T. Purnomo. 2023. Analysis of Water Quality in Asmoroqondi Beach, Palang District, Tuban Regency Using the Principal Component Analysis (PCA) Method.

[29] Mukamto., E. N. Hidayah., & Susilowati. 2024. Study of Water Quality and Distribution of Pollution Index in the North Coast of Palang-Tuban District on the Dry Season. Jurnal Pengendalian Pencemaran Lingkungan. 6(1): 59-72.

[30] Nugraha, D. A., Sartimbul, A., & Luthfi, O. M. 2016. Analysis of Coral Distribution in Kondang Merak Waters, South Malang. In the VI National Seminar on Fisheries and Marine Affairs, May.

[31] Odum, E.P. 1996. Fundamentals of Ecology, W.B. Sounders Company Ltd, Philadelphia

[32] Palaniappan, M., P.H. Gleick, L. Allen, M.J. Cohen, J.C. Smith. & Smith, C.2010. Clearing The Waters: A focus on water quality solutions. Nairobi, Kenya: United Nation Environtment Programme & Pacific Institute

[33] Patty S, Nurdiansah D, & Akbar N, 2020. Distribution of Temperature, Salinity, Turbidity and Clarity in Tumbak-Bentenan Sea Waters, Southeast Minahasa. Journal of Marine and Island Sciences. 3(1): 77-87.

[34] Government of Indonesia. 2021. Government Regulation of the Republic of Indonesia Number 22 of 2021 Concerning the Implementation of Environmental Protection and Management. State Secretariat. Jakarta.

[35] Prastuti O.P. 2017. The Effect of Sea Water and Sea Sand Composition as a Source of Electrical Energy, J. Tek. Kim. Ling. 1(1): 35-41

[36] Pratama, D.R., Yusuf, M., & Helmi, M. 2016. Study of Conditions and Distribution of Water Quality in the Southern Waters of Sampang Regency, East Java Province, Journal of Oceanography. 5(4): 479-488

[37] Puspita, L.V,J., N. Afiati., & P.W. Purnomo. 2018. Water Quality Appropriateness for Some Allotment in Coastal Area(Case Study: Pesantren and Mojo Village, Ulujami, Pemalang). JOURNAL OFMAQUARES. 7(1): 110-120.

[38] Rahmawan & Gemilang. 2017. Status of Sea Water Quality Standards in Outer Ambon Bay Waters for Marine Tourism of the SS Aquila Sunken Ship. Enviro Scienteae. 13(2): 139-149.

[39] Rais, J., Sulistyo, B., Diamar, S.,Gunawan, T., Sumampouw, M., Suprapto, A., Suhardi, I., Karsidi, A & Widoso, S. 2004. Integrated Marine Spatial Planning. PT. Pradnya Paramita. First Edition. Jakarta.

[40] Rangka, N. A. & A.I.J. Asaad. 2010. Milkfish Cultivation Technology in South Sulawesi. In: Proceedings of the Aquaculture Technology Innovation Forum. BRPBAP. Maros, South Sulawesi. pp. 187-203.

[41] Requintiana, E.D., A.J. Mmochi, and F.E.Msuya.2006. A Guide to Milkfish Culture in Tanzania Sustainable Coastal Communities and Ecosistem Program. Western Indian Ocean Marine Science Assosiation, Hawaii.

[42] Said, N.I. 2008. Domestic Wastewater Treatment in DKI Jakarta. Environmental Technology Center, Jakarta, 389 pp.

[43] Sawo, A.E., & G.D Tukan. 2023. Study of Seawater Salinity of Lembata Island, East Nusa Tenggara in Chemistry Learning for Class XII Science of SMA Negeri 2 Nubatukan and Its Impact on Students. Dalton: J. Education, Chemistry and Chemistry Science. 6(1):1-7

[44] Simanjuntak, M. 2012. Sea Water Quality Reviewed from Nutrient Aspects, Dissolved Oxygen and pH in Banggai Waters, Central Sulawesi. Journal of Tropical Marine Science and Technology. 4(2):290-303.

[45] Suhartono E. 1998. Identification of Coastal Water Quality Due to Domestic Waste in the East Monsoon Using the Pollution Index Method. Civil Engineering Vehicle.14:20-28

[46] Sukamto. 2017. Management of Indonesia's Marine Potential in the Spirit of Islamic Economics. MALIA: Journal of Islamic Economics. 9(1):35-61.

[47] Supriharyono. 2002. Conservation and Management of Natural Resources in Tropical Coastal Areas. Jakarta: Gramedia Pustaka Utama

[48] Syahid M, A. Subhan & R. Armando. 2006. Organic Milkfish Cultivation in Polyculture. Penebar Swadaya. Jakarta.

[49] Tugiyono., R. Diantari., & Efri. 2015. Quality Study of Lampung Bay Coastal Area. Proceedings of the 2015 Semirata in the field of Mathematics and Natural Sciences of BKS-PTN Barat. Tanjungpura University Pontianak. P: 292-299

[50] Utojo., & A.M Pirzam. 2000. Milkfish (*Chanos chanos* Forskal) and Seaweed Polyculture in Ponds. UGM Fisheries Journal. BPPP. Maros.

[51] Wahyuni, A.P., M. Firmansyah., N.F. & Hastuti. 2020. Water Quality Study for Milkfish (*Chanos chanos* Forsskal) Cultivation in the Ponds of Samataring Village, East Sinjai District. Journal of Agrominansia. 5(1):106-113.

[52] Wahyuningsih, N., Suharsono, S., & Fitrian, Z. 2021. Study of sea water quality in the waters of Bontang City, East Kalimantan Province. Journal of Development Research. 4(1): 56-66.

[53] Yona, D., & Ayuk, N. S.R. 2016 . Analysis of Mangrove Root Absorption Capacity of Rhizophora mucronata and Avicennia marina Against Heavy Metals Pb and Cu on the Coast of Probolinggo, East Java. Faculty of Fisheries and Marine Sciences, Brawijaya University Malang.