Mapping Identification of Sea Water Characteristics for Cultivation Land for Giant Clams (Family: Tridacnidae) in Sekotong West Lombok

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Abstract. One of the mollusc phyla and bivalve's class which is included in the group of invertebrate animals is the giant clam. Giant clams play an important role as filter feeders in the ocean and their clams can be used by various coral reef biota as a place to live. Therefore, it is necessary to manage clam cultivation considering the importance of the economic and ecological functions of the clam. Geographic information system is one method that can be used in this research. This method can be used to make it easier to find out the location of its distribution, so that the development of clam cultivation activities can be achieved optimally. The purpose of this study is to analyze the prospect of giant clam aquaculture using a GIS application which is presented in the form of a supply map for clam aquaculture in the West Lombok Sea. This research was conducted in May–June 2022 in Gili Asahan, Gili Layar and Gili Gede, West Nusa Tenggara Province. Data was collected using quantitative survey methods, in the form of primary data and secondary data directly related to the life of giant clams. The results obtained are: 28.25–31.13°C temperature, brightness 0.89–1.46 m, current velocity 0.2–0.7 m/s, depth 0.89–1.46 m, rainfall 56–364 mm, tides 0.9 m, protection: protected, moderately protected and unprotected, pH 6.82 – 7.50, salinity 32–34 ppt, DO 6.19–6.52 mg/l, sand dunes, fracture corals and dead corals, chlorophyll a 0.26–1.38 mg/m^3, and the number of clams 1–7 individuals. The location according to the land for the very suitable category is on Gili Gede, the appropriate category on Gili Asahan and the unsuitable category on Gili Layar.

Keywords: GIS · Giant Clam · Land Suitability · Water Characteristics · Sekotong

1 Introduction

Giant clams belong's to the phylum mollusca family tridacnidae and has two genera, namely tridacna and hippopus. There are 12 species that have been identified in the world and 8 of them are found in Indonesian seas (Arbi, 2010). Giant clam has important economic value in the world of international trade. In addition, the role of clam shells is as food (consumable) and craft materials (Neo & Todd, 2013). In addition, live clams

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are also a commodity in the ornamental aquarium trade (Van Wynsberge et al., 2016). The high selling price and market demand from all over the world have resulted in overexploitation. Large clam species such as Tridacna gigas have experienced extinction in most Indonesian waters, especially in western Indonesian waters (Welsh et al., 2011).

Based on these reports, clams have been included in the appendix II CITES list (Neo & Todd, 2013). That is, they are not immediately threatened with extinction, but are likely to be threatened with extinction if they are not included in the list and trade in these species continues. Thus, giant clams are protected biota and the Government of Indonesia issued a Decree of the Minister of Forestry No.12/KptsII/1987 government regulation No. 7/1999 (Arbi, 2010). Therefore, the existence and sustainability of clams must be maintained in the ecosystem, especially in coastal areas in Indonesia.

Given the importance of the clam function, it is necessary to manage clam resources properly. Therefore, adequate information is needed that can be used for the sustainable management of clams.

Therefore, information about the spatial distribution is needed in order to make it easier to find out the location of the distribution, so that development in clam aquaculture activities can be achieved optimally.

The aim of this study was to obtain data and information regarding the identification of water characteristics suitable for clam aquaculture (Family: Tridacnidae) using GIS applications in the waters of West Lombok. The results of the study are expected to be used as a reference in making policies for the management of coastal areas and the sustainable use of natural resources by interested parties.

2 Method

The research locations are Gili Layar, Gili Gede, and Gili Asahan, West Lombok. The research was carried out in May–June 2022 covering the necessary data collection and direct sampling from the three Gili. The coordinates can be seen in Table 1.

Survey quantitative research method is the method used in this study, namely from the background of the problem, problem identification, problem formulation and field data collection regarding the condition of sea waters and the data procured were analyzed using ArcGIS 10.8.

The tools used are small boats, sample containers, tide boards, pH meter, thermometer, stopwatch, camera, rope, GPS, refractometer, pH, DO meter and secchi disk. The materials used were clams, tissue and label paper.

3 Research Procedure

The research area was conducted in the waters of West Lombok. The West Lombok Waters Digital Data is used as a base map to create a thematic map, then interpolation of each parameter is carried out. The water conditions to be measured are: temperature, brightness, depth, current velocity, rainfall, pH, salinity, DO, chlorophyll a, substrate, and clam biomass. Furthermore, contours maps are made from primary data for each parameter as a background for the digitization process so that each thematic map is divided into several classes. Furthermore, the water condition map or contours map is

Table 1. Position of the location of population data collection and Giant clam's samples

Location	Station	Coordinat Point		Location Information
		X	Y	
Gili Asahan	1	388716	9144323	A1
	2	387043	9145333	A2
	3	388022	9145639	A3
Gili Layar	1	380859	9145853	B1
	2	380124	9146435	B2
	3	380859	9146860	B3
Gili Gede	1	392267	9144813	C1
	2	392941	9146313	C2
	3	392941	9144813	C3
	4	393606	9143304	C4
	5	392543	9143702	C5

analyzed by overlaying, which is an analysis of overlapping that combines information from several maps to produce one new information that was previously built with criteria or parameters. After the criteria have been developed and analyzed, it will finally produce a map of the suitability of the clam cultivation area (Table 3).

4 Results and Discussion

The results of research conducted by in situ data collection and through observation of data from remote sensing satellites indicate that there are differences at each point of the observed research location. The difference between the points is then adjusted using the quality standard of each parameter. The use of parameter quality standards determines the level of land requirement for clam cultivation.

Rainfall data were procured from the BMKG Class I Climatology Station, West Lombok, NTB Province. From these observations, the average value of rainfall for the last 12 months, from June 2021 to June 2022, is in the range of 56–364 mm per month. The average rainfall at the study site during the study was 196 mm per month. The map picture can be seen in Fig. 1a. There is only one suitability class category, which is very suitable based on the results of comparative analysis using quality standards of shellfish culture.

The results of the observation of the protection parameters at the research site were divided into three categories, namely protected, moderately protected and unprotected. Figure 1d shows that the water depth at the study site was obtained in the range of 0.89–1.46 m. There are two classes that can be seen in this parameter, namely a very suitable class and a suitable class.And the results of observations of brightness at the research site were obtained ranging from 0.89 to 1.46 m. Based on the quality standards

Table 2. Results of Weighting and Scores on Land Suitability Values for Each Parameter.

Parameters	Criteria	Value	Weight	Score
-Physical Parameters				
Temperature Marizal (2012)	25,9 – 32 21 – 25,8 < 18 or > 32	5 3 1	1	5 3 1
Brightness Marizal (2012)	1 – 1,5 0,5 – 0,9 < 0,4 and > 1,6	5 3 1	2	10 6 2
Current Speed Litaay *et al.* (2007)	0,5 – 0,6 0,3 – 0,4 or 0,7 – 0,8 < 0,2 or > 0,8	5 3 1	1	5 3 1
Protection Nirmala *et al.* (2014)	Protected Protected enough Unprotected	5 3 1	2	10 6 3
Depth Marizal (2012)	1 – 1,5 0,5 – 0,9 < 0,4 and > 1,6	5 3 1	1	5 3 1
Rainfall Mustofa (2012)	208 – 250 125 - < 208 or 250 – 300 < 125 or > 300	5 3 1	3	15 9 3
Chemical Parameters				
pH (Hamuna,2018)	8,39 – 8,50 6,5 – 8,02 < 6,4 or > 8,51	5 3 1	2	10 6 2
Salinity Marizal (2012)	33 – 35 24 – 32 < 23 or > 36	5 3 1	2	10 6 2
DO Niartiningsih *et al.*(2013)	6,24 – 8 3 - 6,1 < 2 or > 8	5 3 1	1	5 3 1
Biological Parameters				
Clhorophyll- a Septian (2014)	3,5 - 10 0,2 - < 3,5 < 0,2	5 3 1	1	5 3 1
Substrate Purwati *et al.* (2008)	Sand dunes Coral Fracture Dead Coral	5 3 1	3	15 9 3
Biomass of Giant Clams Kordi (2012)	> 3 1–3 0	5 3 1	3	15 9 3

Table 3. Evaluation of Land Suitability Assessment for Clam Cultivation Locations

No.	Score Range	Evaluation
1.	89 – 96	Very suitable
2.	81 – 88	Suitable
3.	74 – 80	Unsuitable

of water clarity for shellfish cultivation, there are only two types of land suitability levels, namely the very appropriate and appropriate categories. And the map image can be seen in Fig. 1e.

The salinity value at the time of observation ranged from 32–34 ppt and the water conditions were included in the category of very appropriate and appropriate level of suitability. The value of dissolved oxygen (DO) at the time of observation obtained results that were not much different from each sampling point. Figure 1h shows that the DO distribution is evenly distributed in every area of West Lombok waters. The results of observations of the distribution of water pH in the field, obtained a pH range of 6.70–7.50. The lowest value is obtained at point B2, namely on Gili Layar.

The observation substrate in the sea waters of West Lombok was found to be a stretch of sand, fracture coral and dead coral. Then, chlorophyll-a data was procured from Aqua Moderate Resolution Imaging Spectroradiometer data with a range of chlorophyll a values of 0.26–1.38 mg/m3 (NASA, 2022) (Fig. 2).

Ms is due to this animal being a The small number of Giant cla type of clam shell with high economic value which is the main target of hunting so that its population has been greatly reduced. Anthropogenic pressure on clam shells and their habitat is increasing, as market demand continues to increase. Production that only relies on the ability of nature is no longer able to meet market demand. The population of clams in nature is decreasing and continues to decrease in number due to overexploitation (Triandiza, 2019). The results of the last 10 years research in Indonesia show a low clam population density and indications that the clam population has decreased as shown in Table 2. The decline in the number of individuals of Tridacnidae is caused by overfishing. The clams that can be found include seven types of shellfish, including *Tridacna crocea, Tridacna squamosa, Tridacna maxima, Tridacna swifta, Tridacna gigas, Hippopus hippopus and Hippopus porcelanus.* Worldwide, there are eight known species (Arbi, 2010).

Given its slow movement, it causes clams to become a hunting target that can easily be caught even without using a tool. Most of the people in the West Lombok area work as fishermen. Fishermen in the West Lombok waters generally already know that the clam biota is a protected biota and should not be caught arbitrarily. However, there are unscrupulous fishermen who still catch the clams. This condition is certainly very dangerous for the clam clam population considering that the growth process from the tiller stage to adulthood is slow so that the clam stock in nature will slowly run out and can affect the life of other aquatic biota. Especially clam clam predators. In addition to human beings, clam clam predators are also from other animals. Young clams under the age of 2.5 years (shell length 15 cm) are very vulnerable to predators including crabs, mollusk-eating fish, sea slugs Chriroreusromosus and cuttlefish and pests including Cymatium

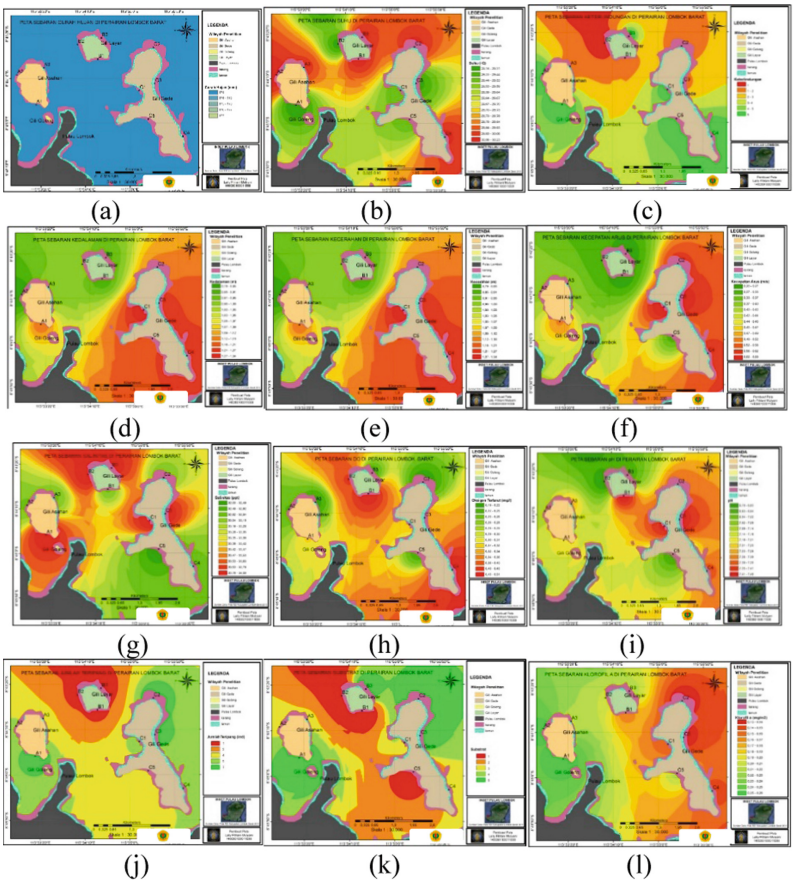

Fig. 1. **a** Rainfall Distribution Map, **b** Temperature Distribution map, **c** protection distribution map, **d** depth distribution map, **e** brightness distribution map, **f** flow velocity distribution map, **g** salinity distribution map, **h** Dissolved oxygen distribution map, **i** Acidity degrees distribution map, **j** Number of Clam Shells distribution map, **k** Substrate Distribution map, **l** Chlorophyll-a Distribution map

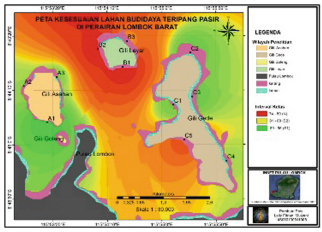

Fig. 2. Map of Suitability of Giant Clam Cultivation Areas in West Lombok Waters

muricinum and Pyrgisus sp. Predators are generally larger than their prey. Predators can destroy the thin shell of young clams and consume their soft tissue (Panggabean, 1992).

The main factor in decreasing clam stocks in Indonesia is thought to be the result of overexploitation and habitat destruction by humans (anthropogenic pressure). The denser a population and the more advanced an area is, the higher the pressure on aquatic biota, especially clam species. This has caused several areas in Indonesia where the water conditions have been damaged and polluted due to this pressure, the population of biota is decreasing and they are rarely found. The opposite, the condition of the waters and biota will be good, of course the anthropogenic pressure must be reduced. Judging from the way of life kima can be divided into two groups. The first group is clams that immerse themselves in coral substrates, for example Tridacna crocea and Tridacna maxima. While the second group is clams that live freely attached to sandy bottoms in coral reef areas, for example Tridacna swifta and *Tridacna squamosa* (BPSPL, 2011). *Tridacna* sp. Living clinging and immersing themselves in hard substrates (rocks) using bysus, while Hippopus sp. Live on sandy substrates and can be found up to 6 m deep (Knopp, 1995).

5 Conclusion

The conclusion obtained based on the results of the research that has been carried out is that the location of the characteristics of the waters that are very suitable for clam cultivation (family: tridacnidae) is on Gili Asahan and the most influential parameter in the amount of land is the substrate, number of clams and rainfall.

6 Suggestion

Based on the results of the research that has been done, the advice to be given is the need for further research to determine how wide the area's carrying capacity is to produce clams in a sustainable manner.

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