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FEASIBILITY STUDY OF FLOATING NET FOR GROUPERS (EPHINEPLEUS SP.) IN SUKABUMI REGENCY USING GIS

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KeyWords
Floating Net, Groupers, Feasibility, Sukabumi, GIS, Fisheries, Aquaculture

ABSTRACT

This study aims to collect information for grouper aquaculture suitability in Sukabumi Regency, West Java Province, Indonesia. The data consisted of water quality (temperature, salinity, wave height, bathymetry, clarity, water current, dissolved oxygen, chlorophyll, nitrate and acidity). The method used in this study is a survey method based on Geographic Information System (GIS) with Inverse Distance Weight (IDW) interpolation. The obtained data was analyzed descriptively using scoring systems with four criteria, i.e. very suitable, suitable, conditionally suitable, and not suitable. The results showed that Sukabumi Regency has an area of 1,554,97 ha with 'very suitable' category, 1,533.87 ha 'suitable', 8.829.34 ha 'conditionally suitable', and 21,794.08 ha 'not suitable' for Grouper Aquaculture.

INTRODUCTION

Fish resources in Indonesia rely on two main sectors : fishing and aquaculture[1]. Aquaculture has been increasing greatly in the last decade. One of the main commodities in marine culture is grouper. Grouper is one of the highest economic fish commodities with promising export market opportunities[2]. Besides having good nutritional content, grouper also has a delicious taste which makes it a leading export commodity [3].

West Java Province is geographically located between 5°50'-7°50' S and 104°48'-104° 48' E with a sea area of 18,860.04 km^2[4] and a total coastline of 848,63 km which is divided into 416.31 km in the southern areaand 432.32 km in the northern part[5]. This region has a high potential in both fishing and marine aquaculture activities. The planning of marine aquaculture development in Indonesia is still facing difficulties. One of these challenges is the unsuitability of aquatic environments for marine aquaculture activities due to their incompatible water quality parameters [6]. Therefore, in order for marine aquaculture activities to develop properly, determination of suitable locations with excellent and correct data analysis is required to figure out the ideal water conditions [7]. Furthermore, after going through the stages of determining aquaculture locations, the grouper culture processes also require good handling [8]. Carrying out aquaculture activities based on of Better Management Practices (BMP) implementation can produce standardized fish quality[8][9].

This study aims to analyze the suitability of floating net cages for grouper culture using the GIS method in the southern region of West Java waters. Geographic Information System (GIS) with overlay analysis can assess water suitability for grouper culture based on environmental parameters and water quality [10][11].

METHOD

Location

Sukabumi Regency is an area of 4,162 km^2 or 11.21% of West Java which is the same as 3.01% of the whole total area of Java Island. It is located between 106°49 to 107° East and 60°57 to 70°25 South with administrative boundaries as follows: in the North with Bogor Regency, in the South with the Indonesian Ocean, in the West with Lebak Regency, in the East with Cianjur Regency[12]. The border is 40% enclosing the ocean and 60% land.

Figure 1. Sukabumi Regency

The sampling was carried out on 3-5 September 2019 in Sukabumi, Palabuhan Ratu and Ciletuh. During sampling, the West Monsoon season had not reached the area yet.

Data Collection

In general, this research used survey method. The definition of a survey is generally limited to research in which data is collected from a sample or population to represent the entire population [8]. As additional information, secondary data is used to support the analysis processes; bathymetry from General Bathymetric Chart of the Oceans (GEBCO) with a 30-meter resolution; temperature and wave height from European Centre Medium-Range Weather Forecasts (ECMWF) 0.25° x 0.25° grid; salinity and Dissolved Oxygen from ERDAPP 1° x 1°grid; and chrophyll, nitrate from Asia-Pacific Data-Research Cente (APDRC) LAS7 0.75° x 0.75° grid.

Analysis

The scoring and weighting system in GIS is one of the superior method for research effectiveness as it can span over a wide areaeto understand the land suitability towards specified boundary parameters with a range of values for each parameter. These values is given a score and a weight to see how strong the influences of the parameters are on the study. Suitability analysis was carried out based on the following table.

Table. 1 Suitability Matrix for Aquaculture (Groupers) with Floating Net

Parameters – (Score)	Percentage (%)	Criteria			
		Very Suitable (S1)	Suitable (S2)	Conditionally suitable (S3)	Not Suitable (S4)
Depth (m) - (4)	16	10 - 30	4 - 10	4	>30 & <4
Temperature (°C) – (2)	8	24 - 29	29 – 30	24 & 30	<24 & >30
Salinity (ppt) – (3)	12	28 - 32	32 - 35	28 & 35	<28 & >35
Clarity (m) - (1)	4	4 - 15	15 – 25	4 & 25	<4 & >25
Chlorophyll (mg/l) - (1)	4	>10	4 - 10	4	<4
Acidity – (2)	8	7,5 – 8	7 - <7,5 & >8 - 8,5	7 & 8	<7 & >8
Current (m/s) – (2)	8	0,15 – 0,3	0,05 – 0,15	0,05 & 0,3	<0,05 & >0,3
DO (mg/l) - (3)	16	>5	4-5	4	<4
Phospate (mg/l) – (1)	4	0,2-0,5	0,6-0,7	0,2 & 0,8	<0,2 & >0,8
Nitrate (mg/l) – (1)	4	0,9-3,2	0,7-0,8 & 3,3-3,4	0,7 & 3,4	<0,7 & >3,4
Waves Height (m) - (3)	16	0 – 0,3	0,3 – 0,5	0,5	>0,5

Source: Modification from [13][14][15][16][17][18][19]

Suitability analysis in this study is targeted for grouper aquaculture with an analysis spatial system and parameter weight overlay. The final score and weight suitability evaluation is shown in Table 2 below.

Table 2. Final Score for Suitability

No	Percentage (%)	Remark
1	76 - 100	Very Suitable
2	51 - 75	Suitable
3	26 – 50	Conditionally suitable
4	0 - 25	Not Suitable

Result and Discussion

Temperature

In general, temperature in Indonesia is very fitting foraquaculture[20].The maximum temperature for groupers' growth is around 27 - 30.9°C [21]. In Sukabumi Regency, the temperature ranges from 24 to 25.5°C. This temperature is still suitable for marine fish farming [22].

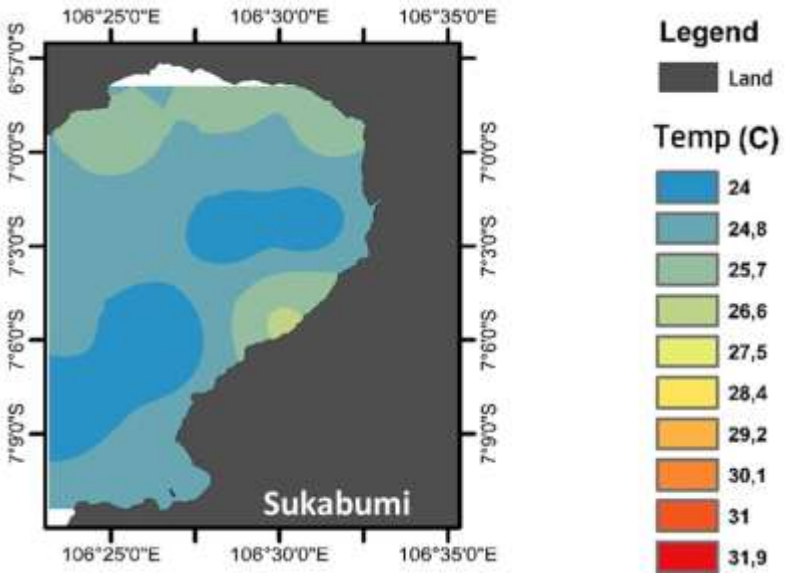

Figure 2. Temperature Distribution in Sukabumi Area

Salinity

The right salinity for groupers' growth is 30-32.9 ppt [23]. In this study, salinity is still considered good for their growth. The estuaries' natural salinity in Indonesia varies between 15-32 ppt. Groupers and Snappers can live in estuaries and coral reef areas [21].

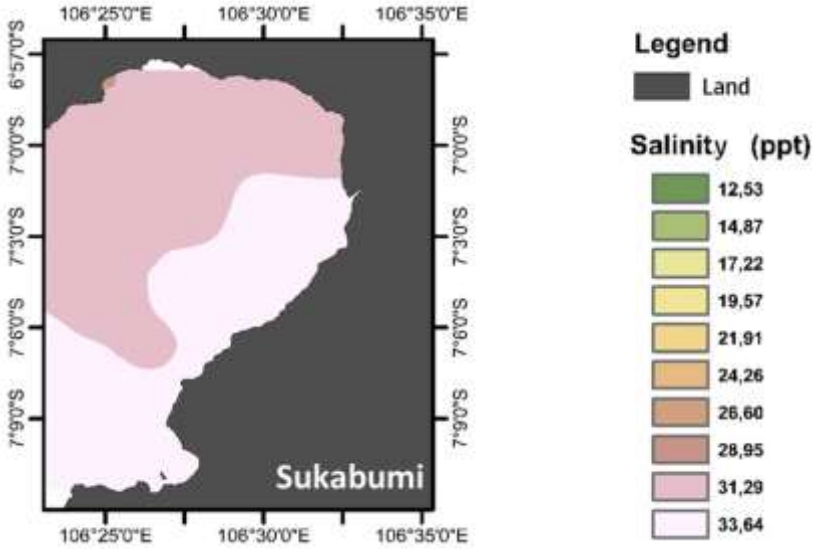

Figure 3. Salinity Distribution in Sukabumi Area

Wave Height

Waves are one of the biggest obstacles for aquaculture [18]. Generally, waves are not much studied in freshwater or closed aqua-

culture areas; unlike this study area which is quite open and located around the bay. However, waves also sometimes help water circulation.The distribution of toxic and culture-supporting substances depends on the surrounding area's suppliers.

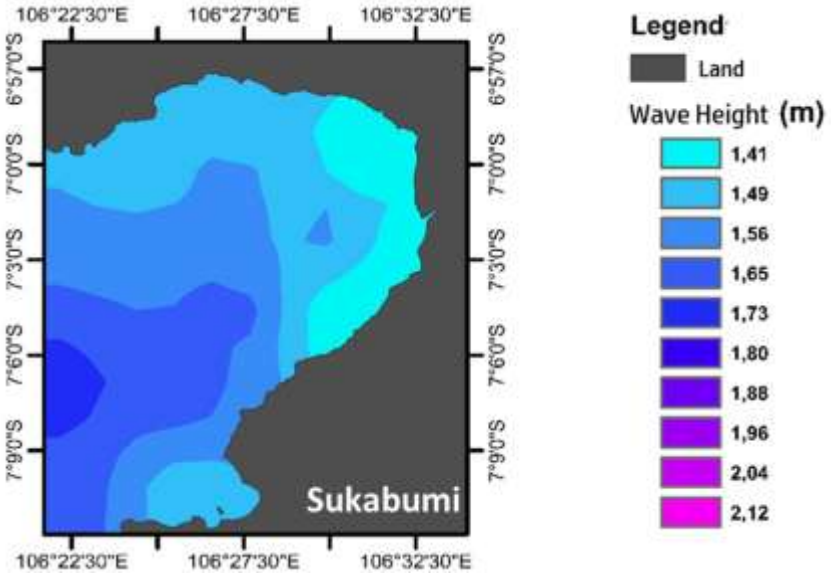

Figure 4. Wave Height Distribution in Sukabumi Regency

Bathymetry

A good depth for aquaculture ranges between 2-5 m from the bottom of the net. This causes the period of water change to be smoother which allows the rest of the feed waste or metabolic products not to accumulate in the Floating Net [24]. For grouper culture, generally a good depth ranges from 10-30 m. However, this does not take into account the depth and width of the net.

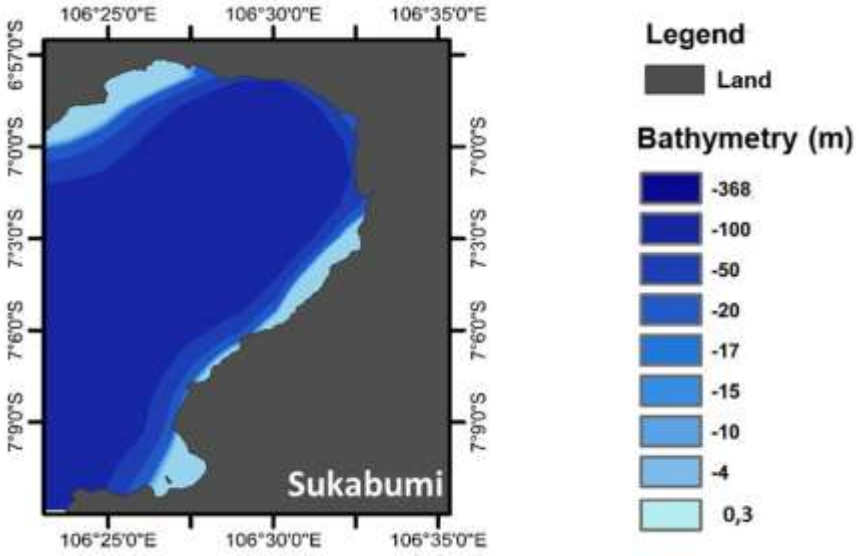

Figure 5. Bathymetry in Sukabumi Area

Clarity

In the research area, clarity in coastal areas is relatively low due to turbulence of shallow water and sedimentation. Clarity in areas near open water is higher. In marine aquaculture business of Floating Net, clarity is an important factor because it is only influenced by natural factors [25].

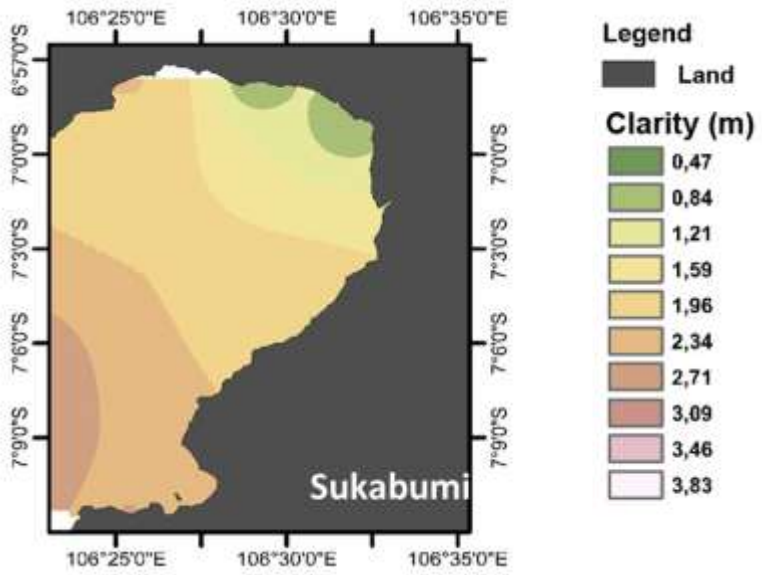

Figure 6. Clarity Distribution in Sukabumi Area

The clarity value is assumed to be inversed with the density of suspended substances in water. Water clarity has no direct effect on the cultured biota. However, the effect is long-termin which if there isn't enough light in the water, it will cause disturbances towards aquatic and benthos organisms. This has a negative effect, not only on their growth cycle, but many other factors as well.

Dissolved Oxygen

In this research, clarity in coastal areas is relatively low due to turbulence of shallow water and sedimentation [22][25]. Clarity near open water is higher. DO directly affects the ogranisms' metabolisms and chemical reactions that occur in water. DO is a source of energy for the body's metabolic system. DOin Sukabumi ranged from 5.8 to 6.3 mg / l; the suitable DO range for groupers in Floating Net is > 5 mg / l [23].

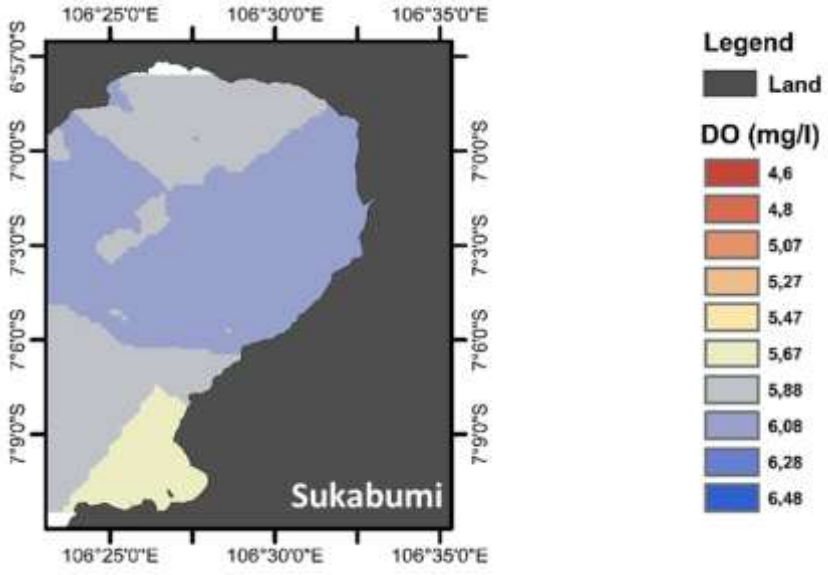

Figure 7. Dissolved Oxygen Distribution in Sukabumi Area

Based on a 24-hour observation of dissolved oxygen level with a3-hour intervals, the average oxygen content (O_{out}) is 6.75 mg / l. So the difference between oxygen inside (O_{in}) and outside (O_{out}) is 2.75 mg / l.

Chlorophyll

The closer the water is to the coast, the greater thechlorophyll value is. This is because the main food source of phytoplankton is nitrogen which is usually abundant in household waste. The negative effect that's caused due to blooming of phytoplankton is

the decrease in water clarity. Basically phytoplankton can be considered as suspended substances in water. Besides, plankton are in water surface and become the first barrier when light enterswater.

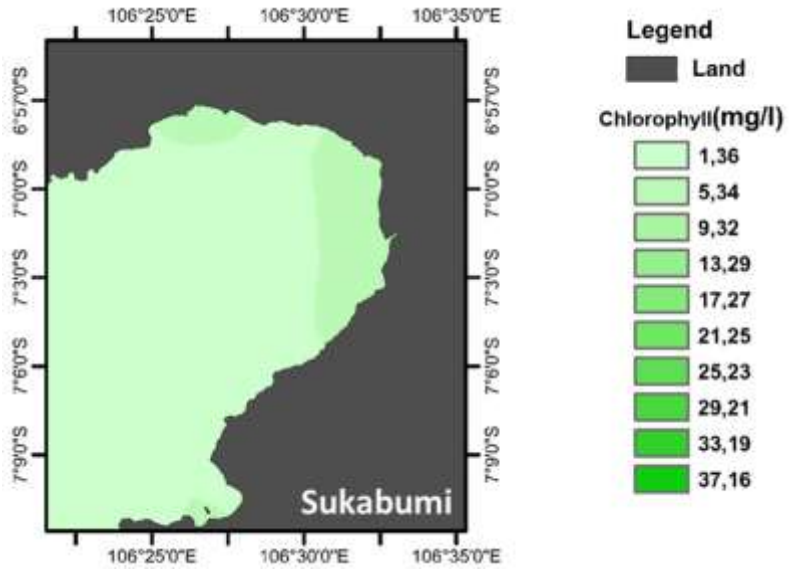

Figure 8. Chlorophyll Distribution in Sukabumi Area

Chlorophyll in Sukabumi ranged from 1.3 - 5.3 mg / l. A good chlorophyll value is > 10 mg / l and a bad one < 4 mg / l [26]. Water that experience eutrofication or plankton blooming are usually assumed to be fertile waterbecause the food chain occurs many times when plankton bloom. However, in certain events there are toxic plankton which cause mass death of fish up to a certain trophic level.

Nitrate

Nitrate values in the two study areas were low even in the coastal regions wherewaste are mostly dumped [27]. This could be an indication that the situation is not too bad because this means that the primary producers' absoprtion of nitrate is good or the nitrification processes work well. Even so, nitrate content in water has no direct effect on the cultured fish. In Sukabumi, nitrate ranges from 0.33 to 0.35 mg / l.

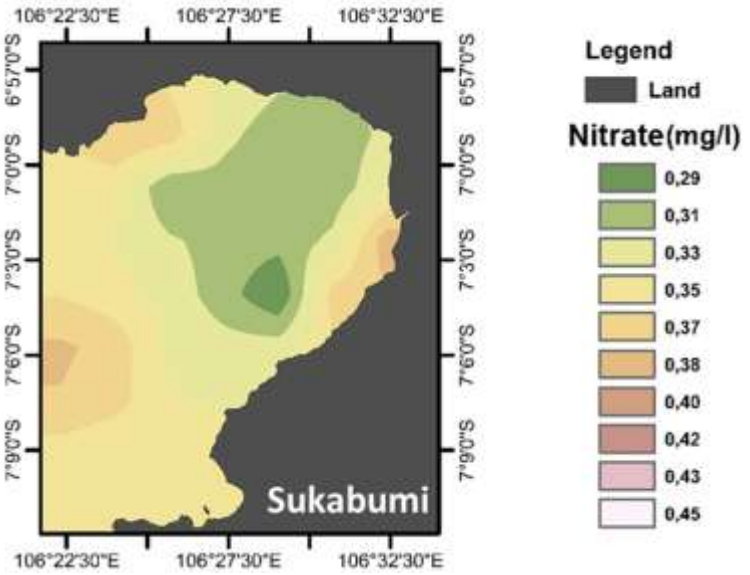

Figure 9. Nitrate Distribution in Sukabumi Area

Acidity

Aquatic life tolerances towards pH depend on many factors including temperature, dissolved oxygen concentration, various anions and cations, species and life cycle [28].

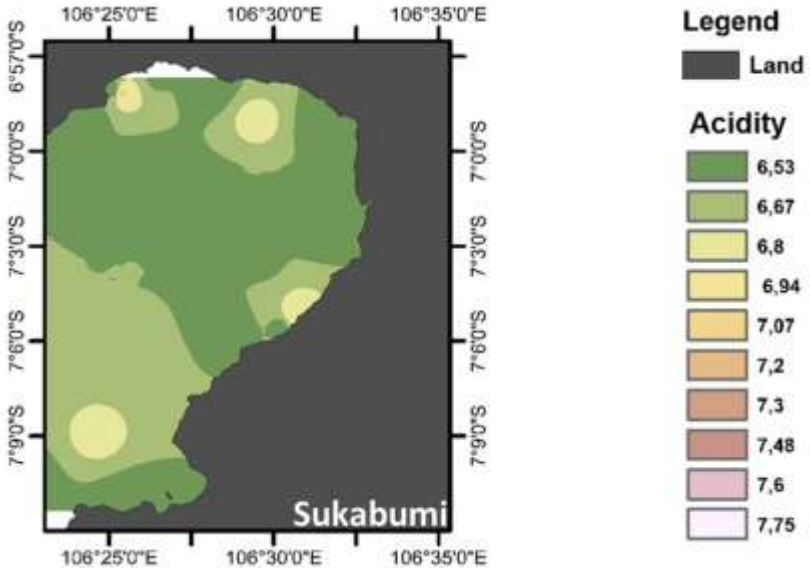

Figure 10. Acidity Distribution in Sukabumi Area

The acidity value in Sukabumi ranged between 6.5 - 6.8 and is considered as moderate. Water acidity is influenced by many factors because the main components which form the degree of acidity are H^+ and OH^- ions, and they are possessed by almost all substances.

Suitability Area

Assessment of suitable locations is based on the consideration of oceanographic parameters i.e. wave, salinity, temperature, water current, depth, clarity, dissolved oxygen, chlorophyll-a, nitrate, nitrite, phosphate and pH. Then, an overlay is performed to obtain the suitability criteria. Afterwards, it is determined based on scoring with 4 criteria which is 'very suitable' as illustrated in green,'suitable' as orange, 'conditionally suitable' as yellow and 'not suitable' as red.

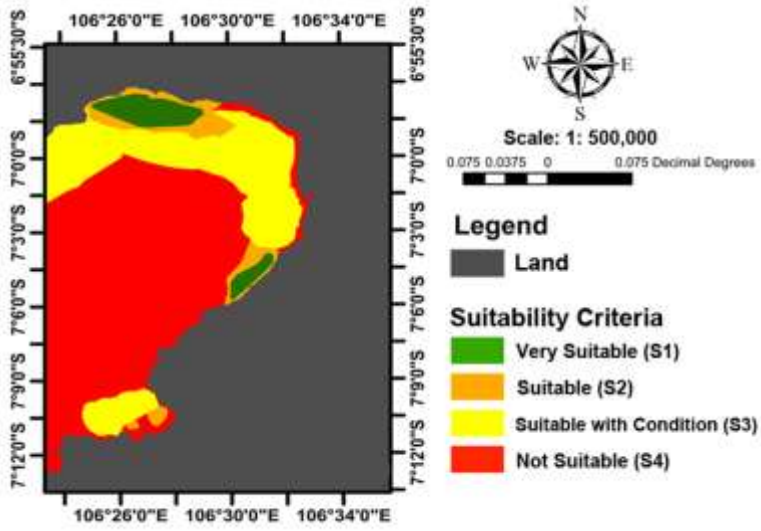

Figure 11. Suitability Map for Groupers Culture in Sukabumi Area using Floating Net

The results showed thatSukabumi Regency has an area of 1,554,97 ha that is 'very suitable', 1,533.87 ha 'suitable', 8,829.34 ha 'conditionally suitable', and 21,794.08 ha 'not suitable' for Grouper Aquaculture. With a total area of 33,702.26 ha, Sukabumi is dominated more by the criteria 'not suitable' for the grouper aquaculture with Floating Net method, amounting to 64.67% of the

total area. The most influential factor in this suitability assessment is wave where it is relatively high in Sukabumi water regions[29]. The area with 'conditionally suitable' criteria, of around 26.19% indicates that it can be used as a Floating Net aquaculture area in certain seasons (not all year), whereas for areas that are included in the S1 and S2 criteria, whichis only 9.1%, can carry out the operation throughout the whole year.

Flushing time is the average residence time of a particle in a water body that is characterized by the effectiveness of waste transferwhich allows the water to become clean[30]. It is an important characteristic to determinewater sensitivity in response to the potential damage of a location due to waste disposal from aquaculture activities. It is also a major factor in determining the concentration of organic matter waste and other wastes that would be stored in water bodies. Based on analysis and calculation of bay volume and area [31], the flushing time of Sukabumi region is 0.56 days.

The carrying capacity estimation of bay water with an N waste load approach refers to N waste which originated from the floating net activities. The waste load result is 21.1 kg N. The calculation is done by figuring out the nutrient hypernutrification level (N) in bay water[32]. If the amount of water volume in Sukabumi that can be used as a culture area has a flushing time of 0.56 days, the total hypernutrification level of these waters during one production cycle (10 months) is 7.6×10^{-7} mg/l. The carrying capacity in Sukabumi area can support a production of 340 tons or around 17,497 units.

Conclusion

With a total region of 33,702.26 ha, Sukabumi Regency has an area of 1,554,97 ha that is 'very suitable', 1,533.87 ha 'suitable', 8.829.34 ha 'conditionally suitable' and 21,794.08 ha 'not suitable' for Grouper Aquaculture. The flushing time is 0.56 days and it is calculated that Sukabumi can support around 17,497 units of floating net with 340 tons of production.

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