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To cite this article: M Farkan *et al* 2017 *IOP Conf. Ser.: Earth Environ. Sci.* **54** 012077

Assessment area development of sustainable shrimp culture ponds (case ctudy the gulf coast Banten)

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Abstract. Shrimp is a fishery commodity that has the economic value and important food provision, so that there is a need for increasing sustainability and continuity of the production. This research was conducted during March – December 2015 in Banten Bay, Indonesia. The objective of this research were: (1) to assess the land suitability for shrimp farming, (2) to analyze land carrying capacity for shrimp farming, (3) to establish the institutional model of shrimp farming management. The data used were primary data, collected from field survey and secondary data, collected from literature and research report which were done in the research area. The methods used to evaluate the land suitability were weighted spatial overlay. The carrying capacity were analyzed using two approaches: land suitability weight and water availability methods. The institutional model was established using *Interpretative Structural Modeling* (ISM). The results of the study showed that from a total area analyzed of 5.028.3 ha, it can be classified into two suitability classes: highly suitable (S1) area which is 141.7 ha (2,8 %) and suitable (S2) area which is 4.886.6 ha (97.2 %). In term of management, the area can be grouped as traditional farming area of 4.173.5 ha (83 %), semi-intensive farming area of 698.93 ha (13,9) and intensive farming area of 155.87 ha (3,1%). The institutional modelling shows that the most decisive institutions are universities and research institutions. The model designed showed an inter-related relationship between land suitability, carrying capacity, institutional, and social in order to increase the sustainability of shrimp farming management.

1. Introduction

Banten Bay coastal aquaculture area is ecologically a focus of activities on land and at sea. Carrying more than 351 industries that directly or indirectly impact on the Gulf coast of Banten. The area of aquaculture in coastal areas Banten Bay continues to decrease due to diversion into the industrial area, in 2015, all operating for shrimp farming only about 90 ha. The purpose of this research is to create a model of sustainable shrimp farming area management. As a case study is the Gulf coast of Banten.

2. Methodology

2.1 The location and time of the study

Aquaculture area of research was from the village of Banten with the coordinates of latitude 05 ° 57'13″ 106 ° 6'6″ BT until Ciujung river, village Tengkurak at coordinates 05 ° 57'48″ LS 106 ° 21'26″ BT. The field research was conducted in March-November, 2015.

2.2 Methods

Management model based on land suitability, carrying capacity and institutions that affect the sustainability of shrimp farming. The measured parameter is the quality of water, soil and infrastructure or supporting shrimp farming. Water quality parameters include: temperature, salinity, dissolved oxygen, pH, BOD_5, COD, TSS, ammonia, Fe and tides. The quality of the soil pH, KCl, soil texture (sand, silt, clay), redox, CEC, K, Ca, Mg, Fe, slope and elevation. While supporting parameters or infrastructure consists of the availability of infrastructure, distance from the river, the distance from the sea. Data is collected in 24-point spread in aquaculture area of the pond. Tools and materials used include test kits, pH paper, refractometer, sechi dish, thermometer, measuring tidal barrier and water and soil test equipment in the lab. Land suitability evaluation calculated using the weighting method to perform paired comparison is data obtained in the field was analyzed by comparison with the standard. To get the score level influence land suitability compared to the results of field measurements with standard shrimp farming in ponds. Figures obtained by expert opinion. The number of parameters of water and soil, and supporting shrimp farming are 25 parameters. The results of processing performed overlay with the application of land suitability map for shrimp farming.

As a basic method of determining the carrying capacity of the weighting method is very close association with qualitative land suitability later made quantitative. Rated capacity of the environment is a quantification of land suitability classes. The results declared by the pond intensive, semi-intensive and extensive. This method also uses calculations have been prepared by Prasita et al. [1] ie the assumption of maximum production and availability of sea water. Various studies have used the method to assess the carrying capacity of water supply [1, 4]. Although the development of the use of this method is different. The method used is a development method which is the adjustment of the method developed by Widigdo and Pariwono [4] based on the existing objective.

For the measurement of sea water availability as part of the calculation of the carrying capacity using a water supply line fields.

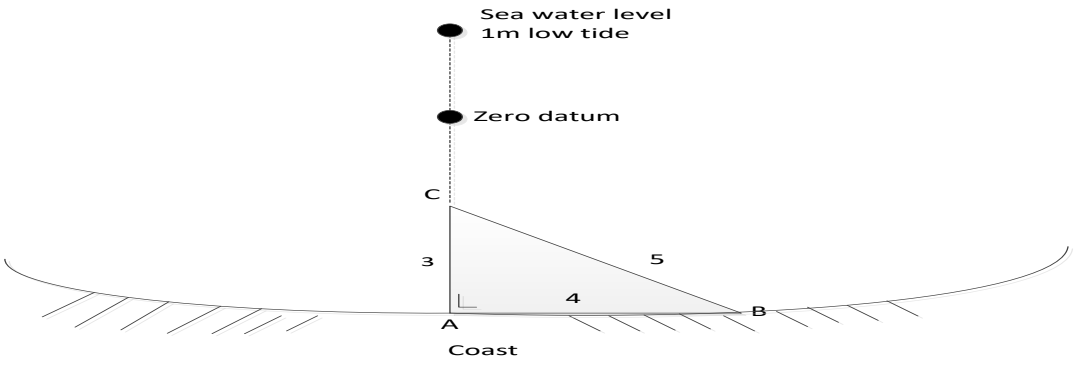


Figure 1. The straight line from the shore to the point of water height of 1 m at the time of lowest tide.

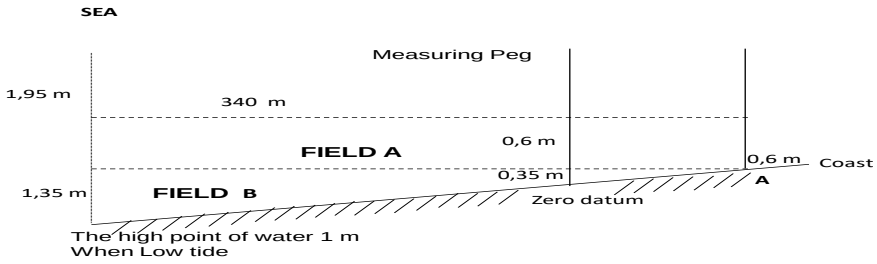


Figure 2. Field construction measurements at sea

Institutional data collection was done by direct surveys and interviews with stakeholders and experts. This institutional study using data analysis using Saxena [3]. The results of discussions with experts, analysis of secondary data from the field and 9 elements have five elements are used to assess the management of sustainable shrimp pond area that is 1) .Sektor influential community; 2) Requirement of the program; 3) The main trouble; 4) The purpose of the program; 5) Institutions involved in the implementation of the program.

3. Discussion

3.1 Water quality parameters

Based on the results of water quality measurements weight compared with a score of pairwise comparison results (pairwise comparisons) criteria is very appropriate, suitable and less suitable. These results are then carried analysis overlaying (over-lay) which resulted in land based water quality parameters as in Table 1 below.

Table 1. Total land based water quality

Criteria	Very Suitable		Suitable		Suitable Less		Total size of	
	Area (ha	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Temperature	2,564.2	51.0	2,098.2	41.7	366.0	7.3	5,028.3	100.0
Salinity	1,146.0	22.8	3,469.9	69.0	412.5	8.2	5,028.3	100.0
COD	1,606.0	31.9	2,713.6	54.0	708.8	14.1	5,028.3	100.0
TSS	5,015.0	99.7	-	-	13.3	0.3	5,028.3	100.0
pH	545.6	10.9	4,482.7	89.1	-	-	5,028.3	100.0
DO	-	-	4,899.5	97.4	128.8	2.6	5,028.3	100.0
Amonia	2,240.0	44.5	883.2	17.6	1,905.2	37.9	5,028.3	100.0
BOD_5	2,840.7	56.5	2,033.4	40.4	154.2	3.1	5,028.3	100.0
Fe	3,674.3	73.1	1,087.7	21.6	266.3	5.3	5,028.3	100.0
Tidal	-	-	-	-	5,028.3	100.0	5,028.3	100.0

3.2 Parameter soil quality

These results are then analyzed overlaying (over-lay) which resulted in a land area based on parameters such as soil quality in Table 2 below.

Table 2. Area of land based on soil quality

Kriteria	Very Suitable		Suitable		Suitable Less		Total size of	
	Area (ha	%	Area (ha)	%	Area (ha	%	Area (ha)	%
pH	1.955.3	38.9	2.558.6	50.9	514.4	10.2	5.028.3	100.0
Redox potential	5.028.3	100.0	-	-	-	-	5.028.3	100.0
KTK	561.3	11.2	3.091.8	61.5	1375.2	27.3	5.028.3	100.0
Texture	977.2	19.4	4.051.1	80.6	-	-	5.028.3	100.0
Magnesium	-	-	4.788.2	95.2	240.1	4.8	5.028.3	100.0
Potassium	1.457.4	29.0	3.486.8	69.3	84.1	1.7	5.028.3	100.0
Calcium -	-	-	-	-	5.028.3	100.0	5.028.3	100.0
Ironi	-	-	-	-	5.028.3	100.0	5.028.3	100.0
Slope	5.028.3	100.0	-	-	-	-	5.028.3	100.0
Elevation	5.028.3	100.0	-	-	-	-	5.028.3	100.0

3.3 Infrastructure

Results were analyzed overlaying (over lay) produce land based support such as in Table 3.

Table 3. Suitable criteria of infrastructure

Criteria	Very Suitable		Suitable		Suitable Less		Total size of	
	Area (ha	%	Area (ha)	%	Area (ha	%	Area (ha)	%
Distance from the road	1.795.7	35.7	1.693.4	33.7	1.539.3	30.6	5.028.3	100.0
The distance from the river	3.191.3	63.5	1.384.8	27.5	452.3	9.0	5.028.3	100.0
Distance from the beach	994.8	19.8	3.817.4	75.9	216.2	4.3	5.028.3	100.0
Rainfall	-	-	-	-	5.028.3	100.0	5.028.3	100.0

3.4 Comparison of pairs of parameters of water, soil and infrastructure

Analysis of land basetured on three parameters generated very suitable land, appropriate and less appropriate as in Table 4 below.

Table 4. The land area is based on a comparison of water quality, soil quality and support

Criteria	Very Suitable		Suitable		Suitable Less		Total size of	
	Area (ha	%	Area (ha)	%	Area (ha	%	Area (ha)	%
Water quality	655.1	13.0	4,351.0	86.5	22.2	0.4	5.028,3	100.0
The soil quality	4,358.9	86.7	669.4	13.3	-	-	5.028,3	100.0
Infrastructure	1,994.2	39.7	2.697.1	53.6	337.0	6.7	5.028,3	100.0

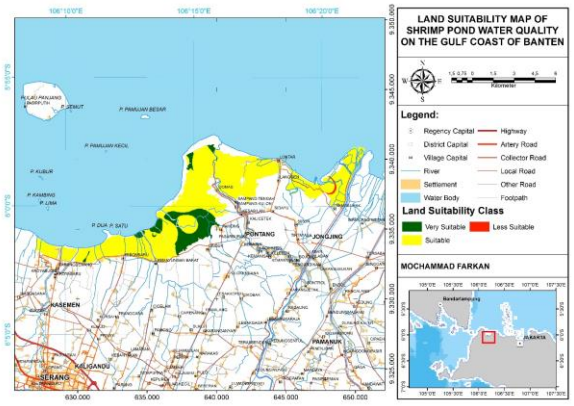


Figure 3. Map of the land suitability of water quality parameters

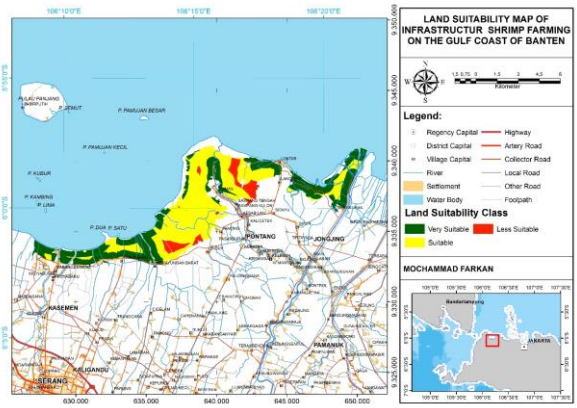


Figure 4. Map of the land suitability of infrastructure parameters

An overlay of the land suitability is based on the analysis of water quality, soil quality and land infrastructure can be seen very suitable and suitable as shown in Table 5.

Table 5. Summary of the extent of land suitability classes pond shrimp farming in the Gulf coast of Banten

Criteria	Extents	
	Ha	%
Very suitable	141.7	2.8
Suitable	4,886.6	97.2
Less suitable	-	-
Total	5,028.3	100.0

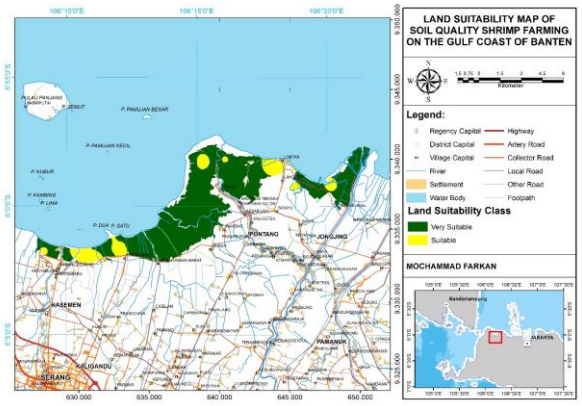


Figure 5. Land suitability maps of soil quality parameters.

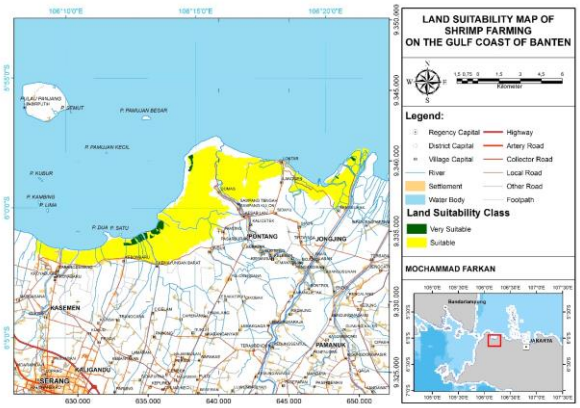


Figure 6. Land suitability maps for the Gulf Coast of pond in Banten

Measuring carrying capacity based on the availability of water. beach water volume available = 36 750 m x 433.5 m² = 15931.12 m³. Teluk Banten occur post the mixture is lower so that the potential of the water volume 1.2 times tide. So the water volume Beach = 1.2 x 20.0655 million m = 19117.35 m³. The volume provides a measure of the volume of waste ponds that can be supported at 19117.35 m³ which also means the volume of sea water supply for cultivation in ponds 19117.35 m³. Based Prasita

et al. (2008), the width of intensive pond that can be supported by 191.17 ha or 3.8%. Commodity type of shrimp reared in the coastal bays offerings are tiger shrimp and shrimp vaname. Extensive maintenance tiger shrimp average production is 36: 2 = 18 tonnes / ha / year. So the maximum carrying capacity of these waters is 18 tonnes / ha x 191.17 ha = 3441.06 tons / yr. If the semi-intensive technology with a production capacity of semi-intensive maintenance tiger shrimp is 5.1 tonnes / ha / year, shrimp vaname 12 tonnes / ha / year, the average production is 17.1: 2 = 8.55 tonnes / ha / year , Comparison of intensive: semi-intensive = 36: 8.55 = 4.21. Thus the semi-intensive pond area becomes 804.82 ha or 16%. Extensive 4033.68 ha or by 80.1 coastal ponds Banten Bay area 5028.3 ha, the area can be mapped extensive technology 4033.68 ha of ponds; semi-intensive and intensive 804.82 ha of 300.98 ha or equal to (3.8%). This calculation is only relying on the availability of sea water and fresh water supplies have not counted provided by the river. Besides, the speed of decomposition of organic materials by microbes and oxygen availability. Production facilities and infrastructure that is easy to competent and utilization are balanced by the relevant sector affect other sub element in achieving sustainable shrimp farming.

Institutional influential in managing the sustainable shrimp aquaculture ponds has 11 sub-elements.

Table 6. Institutions that play a role in the area of sustainable shrimp farming in the Gulf persisir Banten.

Code	Elemen
L1	District Department of Agriculture and Fisheries of Serang
L2	Village Institution
L3	Department of Marine Fisheries, energy and mineral resources Serang District.
L4	Financial institutions
L5	Shrimp Farmers Group
L6	The Environment Agency and Spatial Serang District
L7	Marine and Fisheries Agency of Banten Province
L8	Extension and Food Security Agency Serang District
L9	Central Government (Ministry of Marine Affairs and Fisheries)
L10	Universities
L11	Research institutions

By using VAXO approach, the results can be known expert discussion final results of reachability matrix. The value then interpreted Driver Power and Dependence in Figure 7

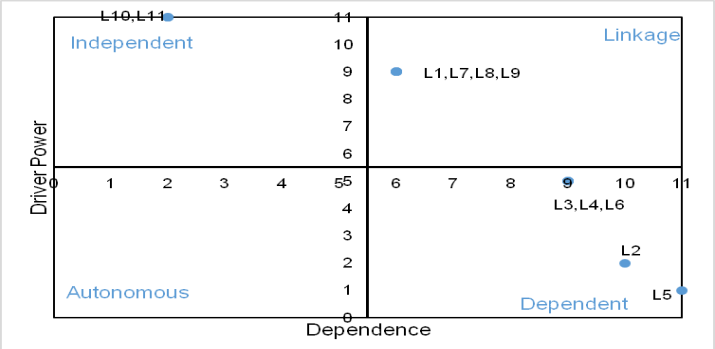
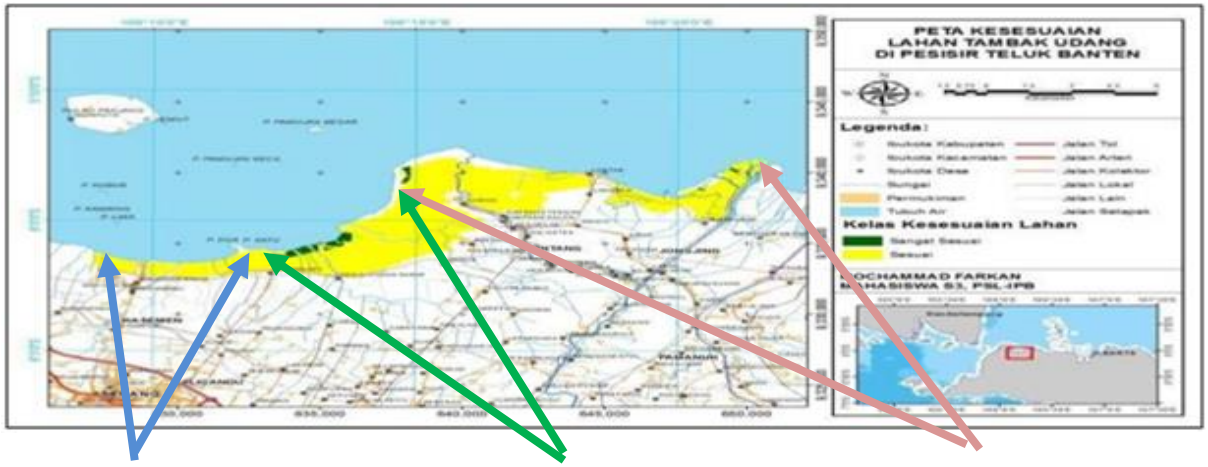


Figure 7. Matrix Driver Power and Dependence on elements of the agencies involved. In Figure 7 it appears that elements of the college (L10); research institutes (L11) be the independent sector (sector IV) which means sub-element has a very big role in the program.

That universities and research institutions have a balanced utilization by the sector can affect other sub elements in realizing sustainable shrimp farming. Based on the results of focus group discussion that using land suitability analysis, carrying capacity and institutional Banten Gulf coast region is divided into three, namely western region, central and east. Analysis result as in Table 6 and Figure 7.



Western Region: The pressure is greater ecology and culture. By the industry. Production is relatively smaller	The central region: the region is more appropriate, is relatively large security pressure	Eastern Region: many rivers carry contaminated industrial and domestic:
Treatment West area : -Technology Farming, HRD - waste treatment instalation. - Implementation and greater oversight. Reforestation	Central region: -Area management - more environmentally friendly industrial licensing - Priority Infrastructure -Design Environment is more stringent, with increased environmental Coordination	Treatment Eastern region: integrated technology and competent HRD – Monitoring & Evaluation environment is more stringent. Reservoar management.

Figure 7. The district management area of shrimp farming in the Gulf coast of Banten

Table 6. Area Regional Management

No	Region	Suitability Class Size	Luas	
			Ha	%
1	West	Very suitable	0.3	0.0
		In suitable	651.6	13.0
2	Central	Very a suitable	129.7	2.6
		In suitable	1,984.6	39.5
3	East	Very suitable	10.8	0.2
		In suitable	2.251.3	44.8
		Total Area of	5,028.3	100.0

4. Conclusions

Land coast of Banten Bay area of 5028.3 ha based on the parameters of water quality, soil and infrastructure can be mapped into a highly suitable land 141.7 ha (2.8%) and suitable 4886.6 ha (97.2%). Carrying capacity pond Gulf coast region support offerings can be mapped to a traditional or extensive cultivation area of 4173.5 ha (83%), semi-intensive 698.93 ha (13.9) and intensive 155.87 ha (3.1%). To realize the management of shrimp farming area in the coastal bays sustainable offerings, the institution most responsible among other institutions are universities and research institutes.

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