

Analysis of Pond Land Suitability for Catfish Cultivation using GIS in Padang City



Siti Aisyah, Abdullah Munzir, Muzzneena Ahmad Mustapha, Aprizon Putra

Abstract: *The pond land suitability in a fish cultivation business is very necessary to be considered to increase the catfish production in Padang city suitability can be done based on 2 aspects, i.e economic (economic evaluation) and physical evaluation. This research aims to the analysis of pond land suitability for the cultivation of catfish enlargement in Padang city using Geographic Information System (GIS) application. The method is overlaid using 9 parameters: a) cultivation pond; b) distance of cultivation from transportation facilities; c) location of cultivation from water sources (rivers/drainage); d) slope; e) soil type; f) land use; g) altitude; h) flood disaster; and i) landslide, then obtained the result of the most suitable area for the catfish cultivation in Padang city is Kuranji Sub-district with the most important parameter is the land use.*

Keywords: *pond, suitability, catfish, cultivation, GIS, Padang.*

I. INTRODUCTION

The fishery sub-sector has strategic value especially in fulfilling animal proteins for the public in addition to contributing to the economy in Padang city. The fisheries sub-sector is the first largest contributor to Gross Regional Domestic Product (GRDP). Seen from GRDP Padang city 2011 the business field of fisheries at 7.04 billion, in 2012 for 7.53 billion, and in 2013 for 7.89 billion [1]. This indicates that the fishery subsector has increased annually. Types of fish commonly cultivated by fish farmers in Padang city in the year 2013-2015 among others are goldfish, parrotfish, gourami fish, catfish, and grouper [2]. Based on statistical data of fisheries production of fish cultivation in Padang City [3] shows that in the 3 consecutive years catfish occupy the highest position of all types of fish consumption, Catfish production number every year is always increased by 1,321.12 tons in the year 2013, as much as 1.521.28 tons in 2014, and as much as 2,106.01 tons in 2015 this is due to market demand for catfish that continues to increase. [4] explain that catfish is one of the important alternative freshwater superior commodities in the context of fulfilling community nutrition improvement. Catfish agribusiness is currently developing rapidly. The main market for catfish is

Lesehan food stalls and catfish pecel, besides that fresh catfish or various processed catfish are starting to be found in restaurants, supermarkets, and processed industries.

According to [6], the marketing of catfish has grown in many areas of West Sumatra Province including coastal areas. The catfish aquaculture is considered by the coastal community as an alternative option to divert activities from fishing to fish cultivation. Its uncomplicated technology, low investment costs and government support are important reasons for small farmers who running a cultivation business in part or in full. Based on research [6] in Padang City, the average production of catfish each year continues to increase. But the result of the production of catfish in Padang City lower than the production of fish the other regency/city in West Sumatra Province, this is due to the limited production land as the capital of the province with a high level of land-use competition. Data on fish production using pond media in Padang City in 2011 was 89.22 tons, in 2012 were 2762.04, in 2013 were 2187.53 tons, in 2014 were 2141.33 tons, and in 2015 were 2980.74 tons [7]. The production of catfish in Padang City should be bigger, considering the market demand in Padang city is very high, one way to increase catfish production is to analyze the efficiency of fish production of catfish in Padang city. In the implementation of enlargement of fish cultivation activities, every fish farmer always expects success in his efforts by examining the level of profit gained. Therefore, the efficient use of production factors is necessary to produce the maximum output. In addition to seeing the level of efficiency of business cultivation success of cultivation can be seen from the class of pond land suitability, pond land suitability can be done based on 2 aspects, i.e economically (economic evaluation) and physically (physical evaluation) [8]. [9] adds economic suitability is evaluated based on an analysis of costs and benefits of certain forms of land use, while physical suitability is evaluated based on the physical nature of the environment such as climate, soil and topography. Along with current technological developments, it is very necessary to process data faster and can cover a wider area of spatial conditions and attributes in digital form. The technology in question is the technology of GIS. Because according to [10] GIS is a very useful information system to help decision making because it can manage and analyze partial and textual data. Thus, the information generated is not only textual or descriptive but also information about its location. Based on the description above, this study aims to an analysis of pond land suitability for catfish cultivation using GIS in Padang City.

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II. RESEARCH METHODS

Overall research was conducted during January – April 2018. Based on secondary data [3], there are 30 groups of catfish cultivation in Padang City which spread over 8 sub-districts i.e Bungus Teluk Kabung, Lubuk Begalung (1), South Padang (3), North Padang (2), Nanggalo (1), Kuranji (11), Pauh (2) and Koto Tengah (9) [Fig 1].



Fig 1. Map of research location points

Where the population in this research are all areas of Padang City. Sampling point determination is performed in Purposive sampling, at each point of the sample carried out measurements, observations, and interviews. Whereas for the GIS software used to analyze the data in the circuit is the Arc Gis 10.3 program conducted in GIS Laboratory of University Kebangsaan Malaysia, Kuala Lumpur.

For analyzing of pond land suitability, the required

parameters are the pond land suitability of catfish cultivation, distance from the cultivation location of transportation, distance from the cultivation of rivers, slope, soil type, land use, altitude, flood disaster and landslide. Where the source of the observed parameters for the pond land suitability of catfish cultivation can be seen in Table 1 below.

Tabel-1 Data Sources Parameters Observed

| No | Data Source | Parameters |
|----|---|--|
| 1 | Direct observation at the study site using weighting | Criteria 1 |
| | | Temperature, brightness, colour, smell, pH, DO, salinity, ammonia, nitrate, an abundance of plankton |
| | | Criteria 2 |
| | | Pond shape, pool type, water height, water source, pond shade, hazardous biota, pool water availability, topographical condition |
| | | Criteria 3 |
| | | Ease of access, security, legality aspect |
| 2 | Measurement using the software help of Arc GIS and Google Earth | The cultivation location distance from the transportation Distance from the river cultivation location |
| 3 | Secondary data obtained from relevant agencies | Map of the slope, map of soil type, land use map, altitude map, disaster-prone map (flood and landslide) |

Matrix of pond suitability parameters for catfish cultivation is a modification of [8, 11-12] adjusting to the standard [13]. As for how to calculate the pond land suitability for catfish cultivation is referring to the following formula [14].

$$RCI = \sum [N_i / N_{max}] \times 100 \%$$

Information :

RCI = Regional Criteria Index

N_i = Value of Parameter to – i

N_{max} = Maximum value of a region category

Where the calculation of pond suitability of catfish cultivation uses the parameter matrix in Table-2 below.

Table-2 Matrix of Pond Land Suitability Parameters of Catfish Cultivation

| Parameters | Unit | Weights | Category | | | |
|---------------------------|-------|---------|---------------------------------|--------------------------|------------------------|------------|
| | | | VS | ES | CS | NS |
| Criteria 1 (50%) | | | | | | |
| Physics: | | | | | | |
| Temperature | °C | 4 | 25-30 | 22-24 | < 21-11 | > 30, < 10 |
| Brightness | Cm | 5 | 15-20 | 21-30 | 31-35 | > 36 |
| Colour | - | 5 | green, greenery | brownish, brownish green | black | dark black |
| Smell | - | 5 | are | smell sharp | sting | very sting |
| Chemical: | | | | | | |
| pH | - | 3 | 7-8 | 6, 9 | 10, 5-6 | > 10 < 5 |
| Do | Mg/L | 3 | 4-5 | 3 | 2 | < 1 |
| Salinity | ppm | 3 | 0 | 1 | 2 | > 2 |
| Ammonia | ppm | 3 | 0-0,01 | 0,01-0,08 | 0,08-0,1 | >0,1 |
| Nitrate | Mg/L | 3 | 10 | 11-12 | 13-14 | >14 |
| Biology: | | | | | | |
| The abundance of Plankton | Ind/L | 5 | > 15.000 | 10.000-15.000 | 2000-15000 | < 2000 |
| Criteria 2 (40%) | | | | | | |
| Pool shape | Unit | 3 | Round, Oval (no angle) | Square | Pond with many corners | - |
| Pool type | Unit | 5 | Semi-Permanent (Muddy concrete) | Concrete, tarp | Rice fields | KJA |
| High Water Pond | Cm | 5 | 70-100 | 65-70 | 30-65 | <30 |

| Parameters | Unit | Weights | Category | | | |
|--------------------------|------|---------|-------------------------------|---|---|--|
| | | | VS | ES | CS | NS |
| Pond Water Source | - | 3 | Paddy Fields, Plantation | River | Well | Contaminated irrigation tract |
| Pool Shade | - | 3 | Permanent Shade | Shady trees | Outdoor Pool | Always hit by the sun |
| Dangerous biota | - | 5 | No | Snake | Snake, Alligator fish | Snake, alligator fish, crocodile |
| Water availability | - | 3 | Available throughout the year | Enough | Limited if the water dry season (drought) | Just rain |
| Topographical conditions | - | 3 | Good | Are | Ugly, swamp | Very bad, always exposed to flooding when it rains |
| Criteria 3 (10%) | | | | | | |
| Ironing facilities | - | 3 | Easy | Are | Somewhat difficult | Difficult |
| Security | - | 3 | Safe | Are | Less secure | Unsafe |
| Legal aspects | - | 3 | According to local regulation | Not yet compliant with local regulation | Unplanned local regulation | Not compliant with local regulation |

Source: Modifications [8, 11-12] refer to [13].

Information :

VS: Very Suitable with a score of 80- 100 %

ES: Enough Suitable with a score of 55 - <80

CS: Conditional Suitable with a score of 20 - <55.

NS: Not Suitable with a value <20

The method of analysis overlays on the whole map of parameters already in the form of the raster will result in one map of pond land suitability for the enlargement of catfish cultivation in Padang city and do test T to see the influence of Each parameter statistically against the pond land suitability of catfish cultivation in Padang city.

III. RESULT

This analysis of pond suitability using 9 parameters (Table 1), the first parameter is the pond suitability of catfish cultivation, the measurement results showed not too many variations of results, which range from 87.35% to 97.86%. The highest pond suitability is in Lubuk Begalung

sub-district of 97.86%. Pond land suitability for the cultivation of catfish enlargement in Padang City can be seen in Table 3 and Fig 2 below.

Table-3 Pond Suitability for Catfish Cultivation

| District | Suitability |
|---------------------|-------------|
| Lubuk Begalung | 97,86 % |
| Kuranji | 96,26 % |
| Koto Tangah | 95,11 % |
| North Padang | 94,64 % |
| South Padang | 92,48 % |
| Bungus Teluk Kabung | 91,35 % |
| Pauh | 89,89 % |
| Nanggalo | 87,35 % |

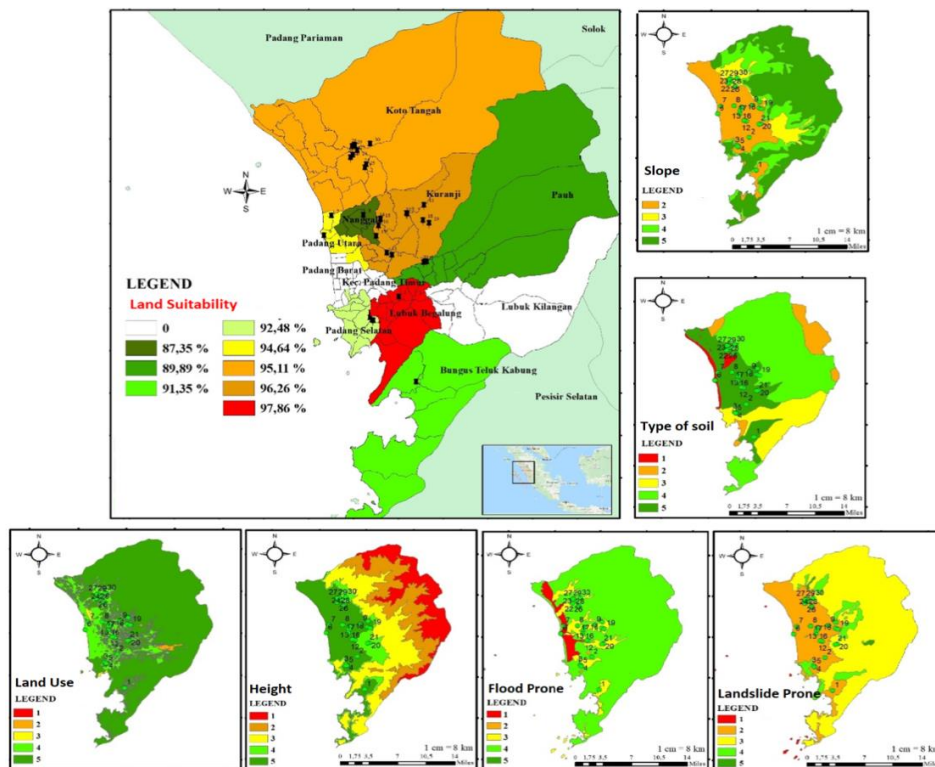


Fig 2. Map of Pond Land Suitability for Catfish Cultivation in Padang City

The next pond land suitability parameters are the distance of research location from transportation and water source (rivers/drainage). The average distance of research location from means of transport or highway is not too far, the closest distance is at the point of the 23 cultivation location in Koto Tangah sub-district with a distance of 88.97 m, and the farthest distance is at the 7 cultivation point in North Padang sub-district with a distance of 105.82 m. The average distance of research site from the water source is also not too far, the closest distance is at point of cultivation location to 4 in South Padang sub-district with distance 97.49 m, and the farthest distance is at the point of cultivation location to 3 in South Padang sub-district with a distance of 103.64 m.

The next parameters are slope, type of soil, land use, height, flood-prone and landslide-prone [Fig 2]. Map obtained from the Public Works Department and Padang city Spatial planning. Each Parameter of pond land suitability is divided into classes. After the overlay on all the parameters, then the result of one map of pond land suitability for catfish cultivation in Padang City can be seen in Fig 2. In Fig 2 is rated 15 (low)-25 (high) with a colour indicator (low)-red (high), value 15 still belongs to the category of pond land suitability for the cultivation of catfish, but the value 15 is the low result of the calculation of cultivation land Obtained from every point of cultivation location. Therefore, the number of 25 locations is increasingly suitable to serve as a cultivation area. The more the red colour will indicate the more suitability the region be the location of the catfish cultivation and the bluer, signifying the lower level accordingly to the region to be the location of the catfish cultivation. The research location has largely been in the red-coloured area. This indicates that the catfish cultivation in Padang City have put their pond or fish cultivation location in a region suitable because it meets the criteria of the parameters that have been tested.

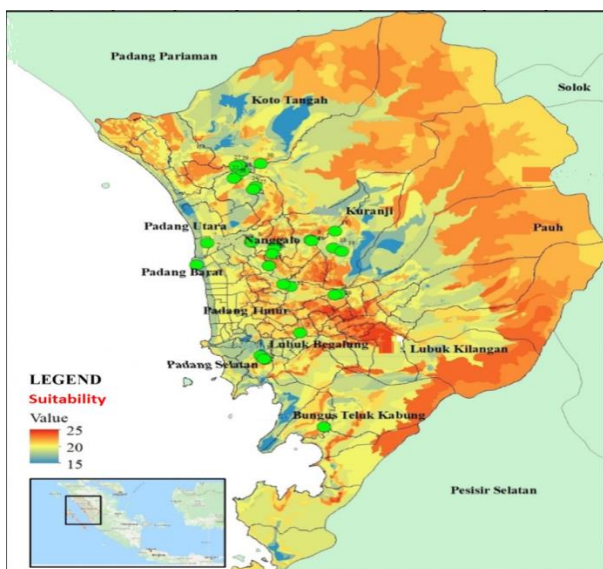


Fig 3. Map of Locations Suitability Value for Catfish Cultivation in Padang City

From Fig 3 It appears that the location that has a value closer to No. 25 is dominated by Kuranji sub-district. This is because the Kuranji sub-district is intended for cultivation area (paddy, fields, gardens, ponds). The catfish cultivation in Kuranji sub-district also get a high value of 96.26%, the

distance of research with the means of transportation is not too far from an average of 94.5 meters, the distance of research location from the water source is also not too far Averaging 497.50 meters. Kuranji sub-district also supported by soil type in the dominant Kuranji sub-district is alluvial land, a pond land that is suitable for cultivation, slope and altitude in sub-district Kuranji also not too steep, as well as Kuranji sub-district is also safe from flood-prone and landslide-prone. Furthermore, to know from the 6 map parameters (slope, type of soil, land use, height, flood-prone and landslide-prone) are most statistically influential of each individual in the formation of pond land suitability map catfish cultivation in Padang city then needs to do *T-test*.

The result of the influence of each parameter to the pond land suitability of catfish cultivation in Padang City can be seen n in Table 4 is seen that the highest value of the calculated *T-test* in land use parameters is with a value of 267.081. The value indicates that the use of land parameters most influence the pond land suitability of catfish cultivation in Padang. The lowest counting *T-test* value is in the altitude parameter with a value of 54.957. The value signifies that the lower altitude parameter affects the pond land suitability of catfish cultivation in Padang City.

Table-4 *T-test* Result of Pond Land Suitability of Catfish Cultivation in Padang City

| Model | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|------------|-----------------------------|------------|---------------------------|---------|------|
| | B | Std. Error | Beta | | |
| (Constant) | 9,945 | ,042 | | 236,909 | ,000 |
| Flood | ,421 | ,005 | ,169 | 92,870 | ,000 |
| Height | ,310 | ,006 | ,108 | 54,957 | ,000 |
| Soil type | ,618 | ,004 | ,282 | 146,448 | ,000 |
| Landslide | ,261 | ,004 | ,124 | 58,374 | ,000 |
| Land use | ,661 | ,002 | ,463 | 267,081 | ,000 |
| Slope | ,807 | ,005 | ,294 | 169,322 | ,000 |

From all parameter maps, it can be seen that the most land use maps are classified in class 5, i.e the high class or class that is included in the category very suitable for catfish cultivation in Padang City.

IV. CONCLUSION

Analysis of pond land suitability using 9 parameters and T-test, obtained the results of the area that is very suitable for catfish cultivation in Padang City is Kuranji sub-district with the biggest parameter affecting is the land use parameter. The pond land suitability in Kuranji sub-district also received a high score of 96.26%, the distance of the research location and transportation facilities was not too far which was an average of 94.5 meters, the distance of the research location from the water source was also not too far ie an average of 497, 50 meters. Kuranji sub-district is also supported by the Alluvial soil type that is suitable for cultivation, slope and height in Kuranji sub-district is also not too steep, and also safe from flood and landslide.



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