APPLICATION OF GIS FOR ASSESSING PRAWN FARM DEVELOPMENT IN TULLY-CARDWELL, NORTH QUEENSLAND

Zainul Hidayah

Department of Marine Science and Technology
Trunojoyo University
Jl. Raya Telang No 2 Kamal Bangkalan
email: zain.hidayah99@gmail.com

Abstract

In recent years, Geographical Information Systems (GIS) has been employed for various studies in aquaculture where geographical factors, natural resources and human activities are involved. With an adequate database GIS, can serve as powerful tools in aquaculture. GIS have capabilities of organizing, analyzing, and displaying large, spatially explicit datasets due to spatial nature of the factors involved in aquaculture development particularly for site suitability studies. This study is intended to become a preliminary investigation for the development of prawn farm in Tully-Cardwell region of North Queensland. The aim of this research is to identify suitable sites for development of prawn farming using GIS multi-based criteria based on the basic requirements for prawn farming, for instance: suitable elevation and slope, proximity to water and distance from urban areas.

Key words: Geographical Information Systems (GIS), Tully Cardwell, North Queensland, Prawn farm

INTRODUCTION

Coastal aquaculture in Australia has become one of the top increasing industries. As the result of its fastest growing, a demand for a new farm sites and the need to optimize sustainable production from the existing sites is essential. In comparison with most agriculture sectors, aquaculture has great requirements for practical scientific knowledge on potential areas for site selection, development and expansion (Ross and Aguillar-Manjarrez, 1993). Therefore, aquaculture industry needs reliable analytical tools to be used to assist in optimizing aquaculture site selection.

In recent years, Geographical Information Systems (GIS) has been employed for various studies in aquaculture where geographical factors, natural resources and human activities are involved. With an adequate database GIS, can serve as powerful tools in aquaculture. GIS have capabilities of organizing, analyzing, and displaying large, spatially explicit datasets due to spatial nature of the factors involved in aquaculture development particularly for site suitability studies (Salam *et.al*, 2003). For example, a study conducted in Tenerife Canary Islands by Perez *et.al*., (2003) to determine finite locations for both marine aquaculture and tourism; evaluation on multi-criteria approach to GIS-based land suitability for Tilapia (*Oreochromis niloticus*) farming in Bangladesh (Hossain *et.al*, 2007); application of GIS for determining potential sites for salmonid cage culture in Scotland (Nath *et.al*, 2000). In addition, several studies have further exploited the modeling capacity of GIS, including modeling of particulate waste distribution at marine fish cage sites in Canary Islands (Beveridge *et.al*, 2002); assessing development patterns of small-scale rural aquaculture in Laos using GIS model (Bush, 2003); analyzing water

quality requirements for marine fish cage site using GIS predictive modeling (Perez *et.al*., 2003).

This study is intended to become a preliminary investigation for the development of prawn farm in Tully-Cardwell region of North Queensland. The aim of this research is to identify suitable sites for development of prawn farming using GIS multi-based criteria based on the basic requirements for prawn farming, for instance: suitable elevation and slope, proximity to water and distance from urban areas. Another objective of this study is to generate land suitability map and to quantify total area for potential prawn farming in the region.

This research report will be divided into 4 sections. First of all is the introduction, which consists of background information and literature review. Methodology and a flow chart that explain data analysis processes are presented in the second section. Furthermore, interpretations of the results are presented in the third section. Finally, explanations and discussions regarding the results and comparison with the literatures are given in the last section.

METHODS

Study Area

The study area, Tully-Cardwell, is located in the North Queensland between 17°47'-18°39' S and 145°59' – 146°17' E. It occupies an area of 283,348.63 Ha. Average annual rainfall ranges from approximately 2000 mm to 4500 mm. Topography ranges from precipitous mountains to level depositional plains. The depositional surfaces range from very extensive low angle fans to riverine and marine plains and extensive beach ridge systems (Queensland Government, 2008).

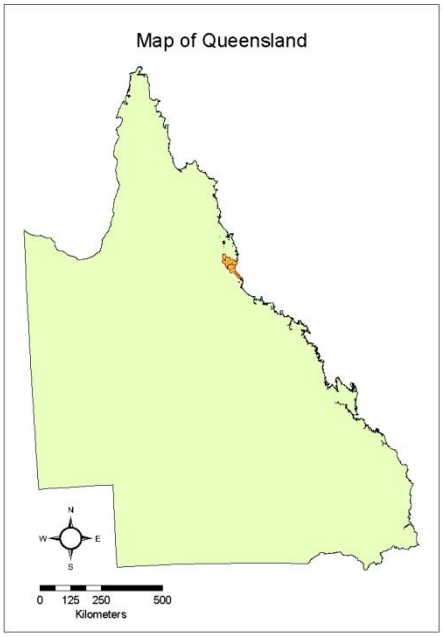

Figure 1. Map of Queensland

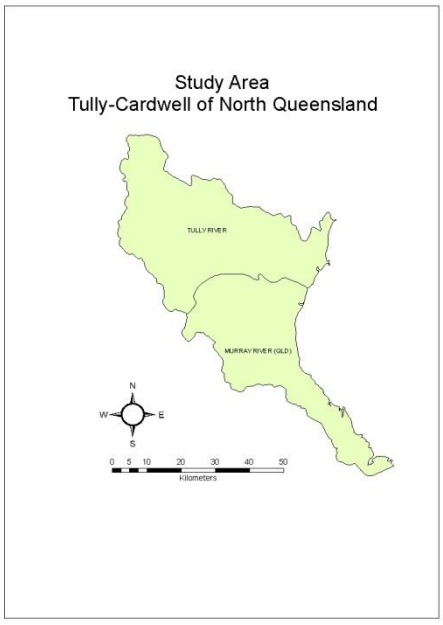

Figure 2. Map of Tully-Cardwell Area

Data

The primary data used in this study including Digital Elevation Mode (DEM) of study area with 80x80 meters grid cells, topographic maps showing coastline, rivers and urban areas. The data are divided into five layers to meet the requirements of suitable areas for prawn

farming. The layers and the required classification are shown in this table:

Table 1. Suitability Criteria for Prawn Farm

Constraint	Layers	Criteria
Study area	Study_area.shp	Tully-Cardwell
Elevation	DEM (80x80 m) resolution	< 20 m
Slope	DEM (80x80 m) resolution	< 5%
Distance from coastline	Coastlines_shp	< 10 km
Protected/ Unprotected area	Protected_area.shp	Unprotected
Urban Areas	Builtup.shp	> 2 km

Source : McLeod, Pantus&Preston, 2003; Hossain et al, 2007

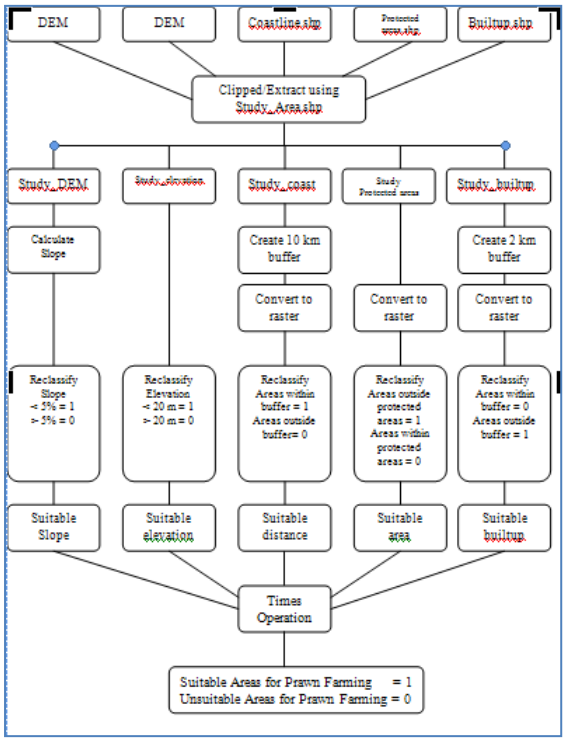

Figure 3. Flow Chart of the GIS Analysis

RESULT AND DISCUSSION

The environmental characteristics of study area based on classifications which are used to generate land suitability analysis for prawn farming are summarized in Table 2. As can be seen from the table, most of the area (68.95%) of Tully-Cardwell is located 20 meters above sea level; however the proportion of steep and flat area is almost equal, 50.71% (143,118.08 Ha) and 49.29% (139,121.28 Ha) respectively. In addition, the length of coastline of the study area is approximately 197.04 km; with 63.20% (179,072 Ha) of the study area is to be found 10 km from the coast. Around 66.31% (187,827.84 Ha) of the area are protected areas with only 2.47% (6,993.92 Ha) area situated within 2 km from the urban areas.

Table 2. Land Characteristics of the Study Area

Criteria	Classification	No of cells	Areas in ha	Percentage
Elevation	> 20 m	303385	194166.4	68.95
	< 20 m	136614	87432.96	31.05
Slope	> 5%	223622	143118.08	50.71
	< 5%	217377	139121.28	49.29
Distance from coast	< 10 km from coast	162929	104274.56	36.80
	> 10 km from coast	279800	179072	63.20
Areas	Protected	293481	187827.84	66.31
	Unprotected	149112	95431.68	33.69
Builtup areas	Distance < 2 km	10928	6993.92	2.47
	Distance > 2 km	431801	276352.64	97.53

Based on all criteria of prawn farm suitability analysis, GIS predicted that about 12.76% (36,006.67 Ha) of the study area can be classified as suitable areas, whereas 87.24% (246,141.53 Ha) are unsuitable. Most of the suitable areas can be found in the east and south east part of Murray River, while some other suitable areas positioned in the east and north east part of Tully River. Distribution of suitable and unsuitable areas is shown in Figure 4.

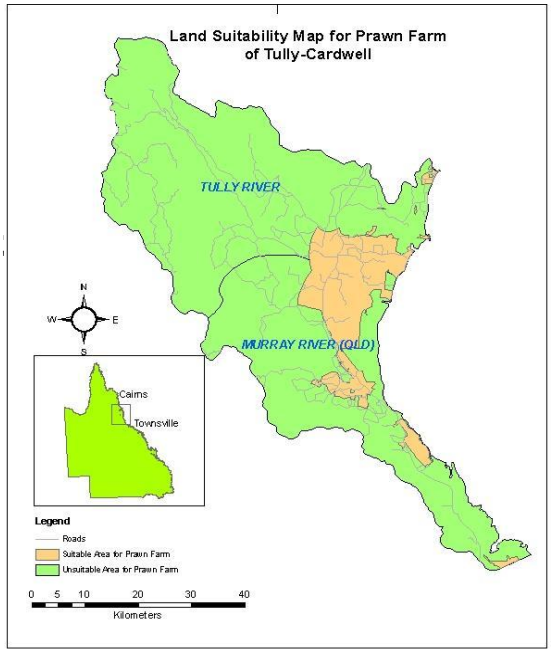

Figure 4. Results of Suitability Analysis of Prawn Farm Area

A suitability study is a preliminary step when assessing whether land or any other area is likely to be practical and potential for sustainable development of an intended venture. In many instances prawn farm has been promoted in regions which are unsuitable in terms of geographical conditions (e.g elevation, slope), salt water supply and land use. Hence, a suitable site is a prerequisite for successful aquaculture (Hossain *et.al*, 2003).

Further analysis explains that 36,006.67 Ha of area which consists of 52 polygons are identified as suitable for the development of prawn farm in the region. Nevertheless, the areas of the polygons are different. Forty-five polygons are classified to have area less than 10 Ha, 3 polygons have 10-100 Ha area and finally, only 4 polygons have area greater than 100 Ha (Figure 3). To develop potential prawn farms, the size of the area should also take into account. In the US, prawn farms are developed in the area range from 80 to 245 Ha (Dasguppta, 2003). Whereas in developing countries such as Indonesia, Thailand and Malaysia areas of 10 – 30 Ha are considered to be a potential area for prawn farming. According to these recommendations, therefore, areas which are less than 10 Ha should be excluded from the development plan of prawn farming in Tully-Cardwell region.

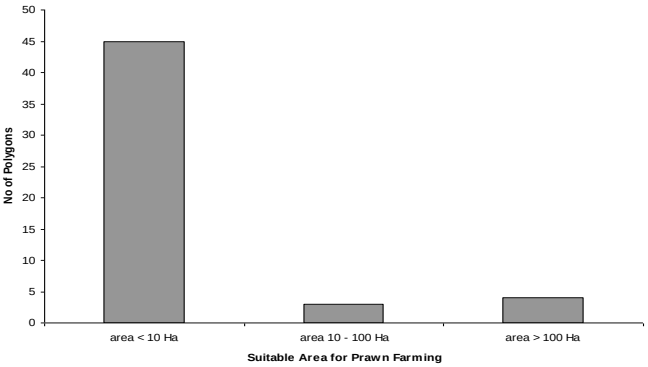

Figure 5. Classification of Suitable Area for Prawn Farm of Tully-Cardwell

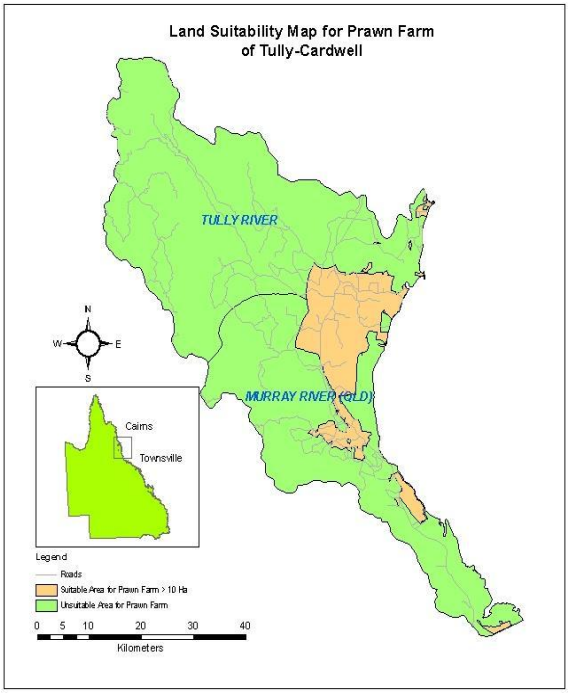

Figure 6. Land Suitability Map (With Suitable Areas > 10 Ha)

Most of the suitable areas are located near the coast with low elevation. This condition ensures easy access to saline water which is essential for prawn farming (Salam *et.al*, 2003). Transportation will not be a problem as well, because the areas

are situated next to main roads. Furthermore, due to the significant distance from urban areas (> 2 km), there is a possibility for expansion of aquaculture in the region. However, because the suitable areas are situated close to protected areas, waste disposal system from the farm should be planned and constructed carefully in order to avoid water and soil contamination.

The high efficiency of GIS to analyze complex spatial data was confirmed by this study. The land suitability map, derived from GIS, for development of prawn farms was partly verified by analysis of satellite images, published data and field surveys. The result of land suitability analysis is depending on data input, classification and scoring/ weighting. Thus, different mechanism in classification and scoring could generate variety of results (Giap *et.al*, 2003).

To increase the accuracy of land suitability analysis for aquaculture by means of GIS, the use of qualified and up to date information is crucial, for instance the latest land use map or satellite images (Giap *et.al*, 2003). The addition of other chemical and physical information of soil and water, such as salinity, soil texture or tidal regime should also be included for further studies.

CONCLUSIONS

In conclusion, with the aid of GIS analysis, some of the parts of Tully-Cardwell region are recognized to be potential areas for the development of prawn farm. The result demonstrates the modeling power of GIS for aquaculture studies. Therefore, GIS application has important role in planning processes and decision support system, particularly when complex spatial features and various criteria are required.

REFERENCES

Beveridge, C. M., Pérez, O. M., Telfer, T. C., & Ross, L. G. (2002). Geographical information systems (GIS) as a simple tool to aid modeling of particulate waste distribution at marine fish cage sites. *Estuarine, Coastal and Shelf Science*, 54, 761-768

Bush, S. R. (2003). Using a Simple GIS Model to Assess Development Patterns of Small-scale Rural Aquaculture in the Wider Environment (Vol. 12010210): Aqua KE Government Documents

Dasguppta, S. (2005). Economics of fresh water prawn farming in the United States. *SRAC Publication*, 4830, 1-8

Giap, D. H., Yi, Y., Cuong, N. X., & Diana, S. J. (2003). Application of GIS and Remote Sensing for Assessing Watershed Ponds for Aquaculture Development in Thai Nguyen, Vietnam, *Map Asia Conference, 2003*. Bangkok: Pond/Aquaculture Dynamic Collaborative Research Program

Queensland Government. (2006). Wet Tropical Coast - North Queensland - Cardwell/Tully/Innisfail Area (CTI): Dataset description. Departement of Natural Resources and Water (Ed.)

Hossain, M. A., Chowdhury, S. R., Das, N. G., & Rahaman, M. M. (2007). Multi-criteria evaluation approach to GIS-based landsuitability classification for tilapia farming in Bangladesh. *Aquacult Int* ,15, 425-443

McLeod, I., Pantus, F., & Preston, N. (2002). The use of geographic information system for land-based aquaculture planning. *Aquaculture Research*, 33, 241-250

Nath, S. S., Bolte, J. P., Ross, L. G., & Aguilar-Manjarrez, J. (2000). Applications of geographical information systems (GIS) for spatial decision support in aquaculture. *Aquacultural Engineering*, 23, 233-278

Pérez, O.M., Telfer, T.C., and Ross, L.G. 2003. Use of GIS-based models for integrating and developing marine fish cages within the tourism industry in Tenerife (Canary Islands). *Coastal Management*, 31,355-366

Pérez, O. M., Ross, L. G., Telfer, T. C., & del Campo Barquin, L. M. (2003). Water quality requirements for marine fish cage site selection in Tenerife (Canary Islands): predictive modeling and analysis using GIS. *Aquaculture*, 224, 51-68

Ross, L. G., & Aguilar-Manjarrez, J. (1993). Aquaculture development and Geographical Information Systems in the Institute. *Aquaculture News*, 16, 14-15

Salam, M. A., Rossa, L. G., & Beveridge, C. M. (2003). A comparison of development opportunities for crab and shrimp aquaculture in southwestern Bangladesh, using GIS modelling. *Aquaculture*, 220, 477-494

Subasinghe, S. 1999. Chtitin from Shellfish Waste-Health Benefits Over Shadowing Industrial Uses. Infofish International. No 3: 58-65.