FISHPONDS EXTRACTION USING RULE BASED CLASSIFICATION AND SUPPORT VECTOR MACHINE OF LIDAR DATA

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Keywords: Fishponds, LiDAR, Support Vector Machine, Rule based classification, Levees, OBIA

ABSTRACT: Monitoring and inventory of aquaculture production specifically the fishpond structures play an important role in economic and ecological growth of fishery production in a local government unit. However, availability of maps of fishponds in large scale in many areas are often not available thus, planning and inventory is not possible in case of immediate aquaculture monitoring. To generate maps out of LiDAR data, extraction of fishponds were carried out using the combination of Support Vector Machine (SVM) and Rule-based classification process. The Support Vector Machine was used to separate land and water, while rule set based was used to extract fishponds from water using geometrical features. Combination of Support Vector Machine and Rule based classification in mapping massive fishpond areas resulted to high accuracy map of 90+ %. The combined approach in the classification was proven to be effective in mapping fishponds in large areas.

1. INTRODUCTION

Mapping of fishponds are valuable to achieve proper monitoring and inventory of fish production. Due to yearly changes in the fishpond structures and operation, inventory of these aquacultures tend to become time consuming and laborious. On the other hand, the possibility of using remotely sensed data to generate maps of aquatic resources must be explored considering that remote sensing data were proven to be useful in generating high accuracy maps of land covers.

LiDAR data is one of the remotely sensed data that were frequently used in mapping which has 0.5m x 0.5m resolution. LiDAR data is produced by projecting laser that transmits very short pulses in optical or near infrared part of the electromagnetic spectrum (Rees, 1999). Using LiDAR data, different raster layers can be produced and used in mapping of land covers in various ways of classification processes. "Support Vector Machine" and "Rule Based Classification" are some of the classification processes that are commonly used in mapping purposes. Support Vector Machine (SVM) is one of the best machine learning algorithms in which a given set of training samples or objects, will analyzed the data and create new examples based on the similarities of patterns and categories in the given set of training samples (Pradhan, 2012). "Rule Based Classification", on the otherhand, is a process that is highly expressive as decision trees which is easy to interpret, generate and can immediately classify objects (www.mimuw.edu.pl).

Mapping aquatic structures can also be performed with good accuracy and at regular intervals by satellite remote sensing, which allows observation of vast areas and even areas of difficult accessibility at a fraction of the cost of traditional surveys (Travaglia et. al, 2004). This study was conducted to develop a protocol in extracting large numbers of fishponds by combining the SVM and "Rule Based Classification" using LiDAR Data.

2. OBJECTIVES

The objective of the study is to extract large scale fishponds using Object Based Image Analysis by combining with SVM and Rule Based Classification approaches.

3. MATERIALS AND METHODS

3.1 Data and Study Area

The data used in this study are LiDAR data from the Phil-LiDAR 1, Data Acquisition Component, University of the Philippines Diliman, Philippines. The selected study site was a 31.04km^2 land cover area in the municipalities of Samal and Abucay, Bataan. Both municipalities lies in coastal zone having numerous fishpond structures (Figure 1).

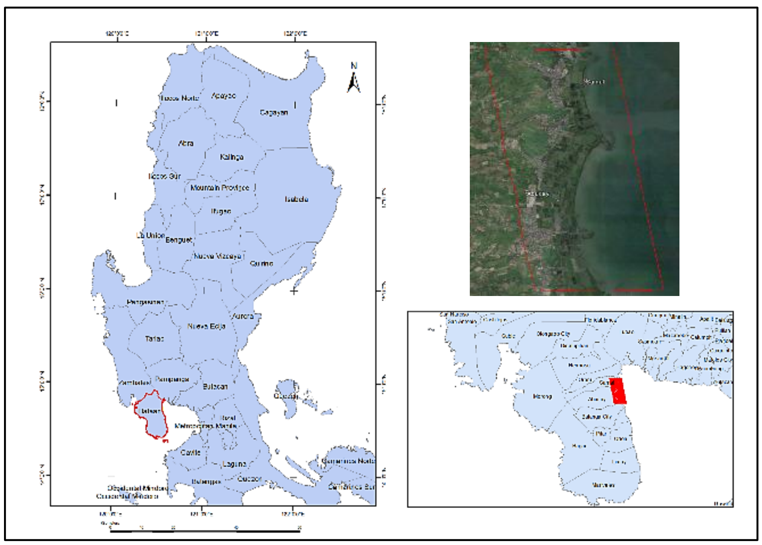

Figure 1. Aerial image of the study site

3.2 General Methodology

The methodologies used in this study are the same methods used in classification processes for mapping land covers using various remotely sensed data. Some modifications in the methods were carried out to achieve the objectives of the study. Figure 2 shows the flow chart of the general methodology of the study

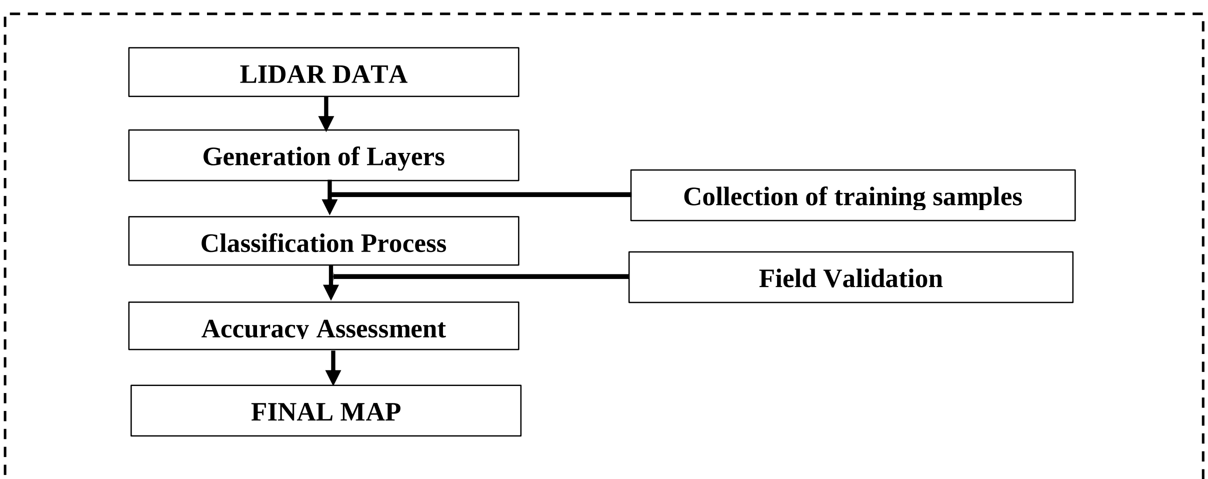

Figure 2. Flow chart of the general methodology of the study.

3.3 Derivation of Layers

LiDAR data was used to generate layers using LasTools and ArcGIS softwares. Digital Surface Model (DSM) and Digital Terrain Models (DTM) were derived using Blas2Dem and processed in ArcGIS to generate various layers. All layers produced were mainly height dependent to magnify fishpond levees. Description of all layers used in classification is shown in Table 1.

Table 1. Layers used in the study.

LAYER	DESCRIPTION
DSM and DTM	Digital Surface Model: Earth surface objects Digital Terrain Model: Earth surface without any objects
nDSM	DTM grid subtracted from the DSM grid to obtain the height of objects above the ground
Slope	Steepness of certain straight line.
Slope of slope	Slope of DSM undertaken another slope computation to amplify levees.
Curvature	Degree to which a curve deviates from a straight line, or a curved surface deviates from a plane.
Surface area to planar Area (SAPA)	Ratio between the 3D surface area and the planar area of the surface, and optionally also provides the surface area itself.

3.4 Image Segmentation Method

Two pronged approach in image segmentation were used in the classification process using eCognition developer. Multi-threshold was used in separating large objects based on pixel/layer values and this segmentation approach was used in separating ocean bodies from the land cover mass through DSM layer. Using Rule Based classification, objects were classified as higher ground, ocean bodies and fishpond areas based in the DSM and geometric features (Figure 3).

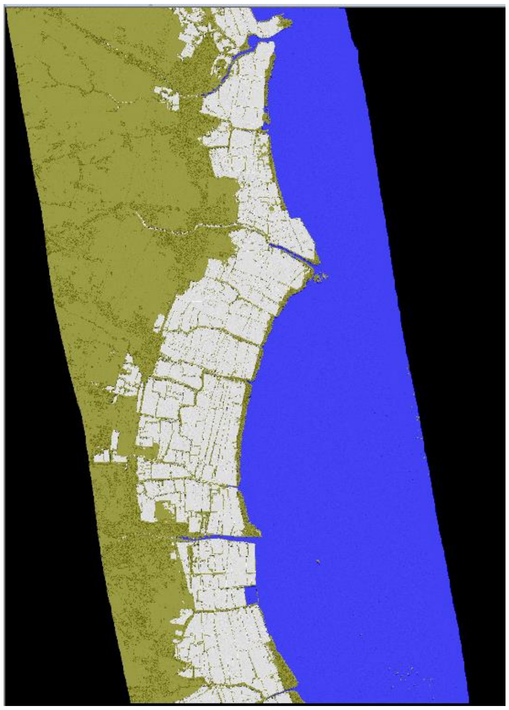

Figure 3. Image segmented using multi threshold segmentation

Multi-resolution segmentation (MRS) was used to compensate the fishpond areas which were incompletely segmented. Objects of interest typically appear segmented from the other objects by controlling the scale parameter and layer weights (Baatz and Schape, 2002). In eCognition software, three criteria must be satisfied to have a good set up and these are: scale parameter, shape and compactness. These three criteria are very vital in having a good segmentation. Therefore, height dependent layers were used in the segmentation process to properly dissect fishpond levees. Table 2 shows the parameters and layer weights used in segmenting the levees from the classified fishpond areas.

Table 2. Multi-resolution segmentation parameters

Criteria	Value
Scale Parameter	60
Shape	0.2
Compactness	0.8
Layers	**Weights**
Curvature	0
DSM	1
DTM	0
nDSM	0
Slope	1
Slope of slope	1
SAPA	0

In Multi-resolution segmentation, the values and weights dictates the degree or influence of the criteria and layers in the segmentation, thus, trial and error are needed in the process to choose the best results. Figure 4 shows the result of the MRS by applying the values and weights in the fishpond areas.

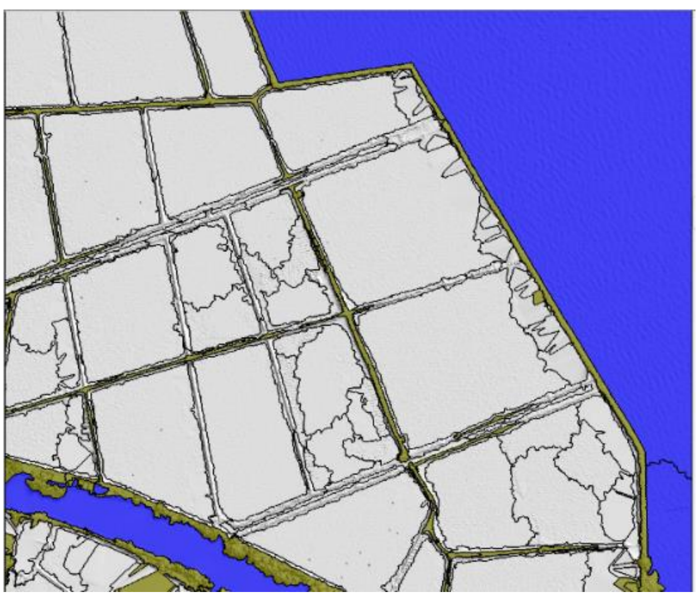

Figure 4. Segmented fishpond levees in Samal, Bataan

3.5 Support Vector Machine (SVM) Classification Process

Support Vector Machine (SVM) is one of the best machine learning algorithms that automatically classify segmented objects. SVM is a technique suitable for binary classification tasks, which is related to and contains elements of non-parametric applied statistics, neural networks and machine learning (Auria et.al, 2008). From the segmented objects of the fishpond areas, this approach can classify the fishpond levees from the water bodies. Given the height dependent layers generated from the LiDAR data, classification of levees, water bodies, unwanted triangulations and other water artifacts e.g. boats, bamboo, nipa hut will be much better. Layers used in the SVM classification process have undergone trial and error to select the best results. Table 3 shows the layer values and geometry assigned for the SVM classification process.

Table 3. Layer values and geometry used in the SVM classification process.

Layer Values	Layers
Mean	Curvature
	DSM
	DTM
	Slope
	Slope of slope
Standard Deviation	Curvature
	DSM
	DSM (hillshade)
	Slope
	Slope of slope
Geometry	**Features**
Extent	Length (pxl)
	Length/Width

3.6 Rule Based Classification Process

Extraction of fishpond levees and other water artifacts was carried out using SVM. The remaining water bodies e.g. fishponds, river ways and small water reservoir were further classified using "Rule Based Classification" which function as decision trees that is easy to interpret and quick to execute. Table 4 displays the geometrical features used in the classification process.

Table 4**.** Geometrical features used in the classification process

Geometry	Features
Extent	Number of Pxls
Shape	Compactness
	Elliptic fit

Geometrical features are vital for extracting fishpond structures from other water bodies because of their polygonal shape. On the other hand, river or water ways were observed elliptical and linear, while small water embankment has an indefinite or irregular in shape. With that, the rule based classification approach was observed as effective way to extract fishpond structures and be classified individually. Flow chart for the classification process is shown in Figure 5.

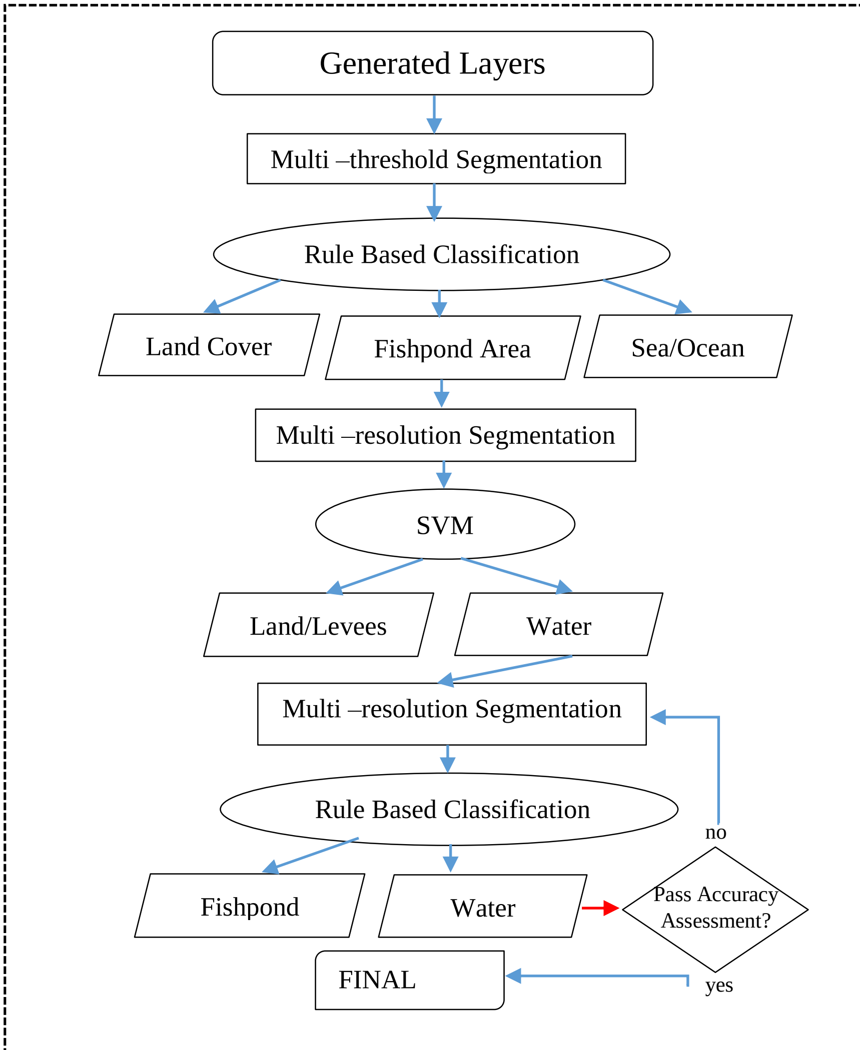

Figure 5. Flow chart for the modified method for classifying fishpond structures.

4. RESULTS AND DISCUSSION

4.1 *Results of Segmentation and Classification:*

In image segmentation, Multi-threshold segmentation was found to be the best way to separate different classes in large homogenous object. On the other hand, generated layers such as slope, DSM, and slope of slope were observed to have the highest influence to dissect the fishpond levees in Multi-resolution segmentation, thus, these layers are vital in the classification process. Geometrical features such as: number of pixels, compactness and elliptic fit were observed to be useful in separating fishpond areas from the other water bodies.

4.2 *Accuracy Assessment Report:*

Accuracy assessment was carried out to evaluate the classification process and in extracting fishponds structures. It was observed that the classification process obtained high accuracy of 98.22% with a *kappa* coefficient of 0.94. Results of the accuracy assessment is shown in Table 5.

User \ Referenc...	Land mass	Water 1	Fishpond	Sum
Confusion Matrix				
Land mass	21155	1603	0	22758
Water 1	0	17478	0	17478
Fishpond	0	2100	165932	168032
unclassified	0	0	0	0
Sum	21155	21181	165932	
Accuracy				
Producer	1	0.8251735	1	
User	0.9295632	1	0.9875024	
Hellden	0.9634960	0.9042138	0.9937119	
Short	0.9295632	0.8251735	0.9875024	
KIA Per Class	1	0.8091579	1	
Totals				
Overall Accuracy	0.9822200			
KIA	0.9473286			

Table 5. Accuracy assessment for the classification process.

Figure 6 shows the final classified map of fishpond structures using the combined approaches of Support Vector Machine and Rule Based Classification.

Figure 6. Extracted fishponds in Samal and Abucay, Bataan

5. CONCLUSION

Proper scaling and weighing values are vital in using Multi-threshold and Multi-resolution segmentation to separate different classes. “Support Vector Machine” and “Rule based Classification” effectively extracted large number of fishpond structures in Samal and Abucay, Bataan. The study shows that using the modified method for classifying fishpond structures, an accuracy of 90+ can be obtained putting only height dependent layers of the LiDAR data. Accuracy may vary by using different layers and remotely sensed data.

6. ACKNOWLEDGEMENT

We would like to thank the Department of Science and Technology (DOST) for funding support for the Phil-LiDAR 2 Program, and Philippine Council for Industry Energy and Emerging Technology Research and Development (PCIEERD) as the program monitoring agency.

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