COMPARATIVE STUDY ON FEATURE EXTRACTION METHODS USING ORTHOPHOTO IMAGES AND LIDAR DATA

Sherwin P. Pulido, Linbert C. Cutamora, Jesiree L. Serviano, Jojene R. Santillan, Meriam M. Santillan

CSU Phil- LiDAR 1 Project, Caraga Center for Geo-Informatics,
College of Engineering and Information Technology, Caraga State University,
Ampayon, Butuan City, 8600, Philippines
E-mail: sherwinpulido281@gmail.com

KEY WORDS: Feature Extraction, LiDAR, Orthophoto Images, Segmentation, ENVI

ABSTRACT:

Manual extraction of features such as roads, buildings, and water bodies from high resolution satellite images requires a lot time. A common solution that is being resorted to is the use of automated feature extraction methods. In this study we evaluated the methods of automated feature extraction of building features using Orthophoto images. Environment for Visualizing Images (ENVI) software developed methods that will automatically detect features without manually digitizing it. These are rule-based method which defines features by building rules based on object attributes, and the example-based method which selects training data to assign objects of unknown identity to known features. In achieving the best result in the classification process, we used LiDAR Digital Surface Model (DSM) as ancillary data. After the segmentation process, training areas for different classes were obtained. Output classifications of these methods were then evaluated using the manually digitized building features within the study area. Results show that the example-based feature extraction method offered better result (accuracy of 87%) than the rule-based method (accuracy of 66%).

1. INTRODUCTION

Manual extraction of features such as roads, buildings, and water bodies from high resolution satellite images requires a lot time. A common solution that is being resorted to is the use of automated feature extraction methods. Feature Extraction is an object-based approach to classify imagery where a group of pixels with similar spectral, spatial or texture attributes are segmented. Recently, the ENVI version 5 software (VIS, I., 2008; Exelis VIS, I., 2016a; 2016b) have developed a feature extraction workflow that consists of two methods, namely Example-based and Rule-based classifications. In a previous study, pan- sharpened Quickbird image was used as input to test these methods and acceptable results were generated by the researcher (Petrila, 2015). It would be interesting to determine how these two methods would perform when applied to orthophotos with the use of LiDAR digital surface model (DSM) as ancillary data.

In this paper, we conduct a comparative study on the performance and accuracy of the two methods. Knowing which of the two methods will produce better outputs can help in deciding what method can be used as alternative manual digitization of building features seen in an image. We used a 0.5-meter resolution orthopoto image with LiDAR DSM as ancillary data to assess the accuracy of these methods.

2. STUDY AREA

For this work, we focused on a portion of Cabadbaran City with available orthophoto images. Cabadbaran is one of the cities in Caraga region, Mindanao, Philippines. It lies 9 degrees north latitude and 125 degrees and 30 minutes east longitude in the northeastern part of Mindanao (Wikipedia.org, 2016). Land use of the urban area mixed with portions of grassland and trees make its suitable to be the pilot area to test the classification capabilities of the two extraction methods being studied.

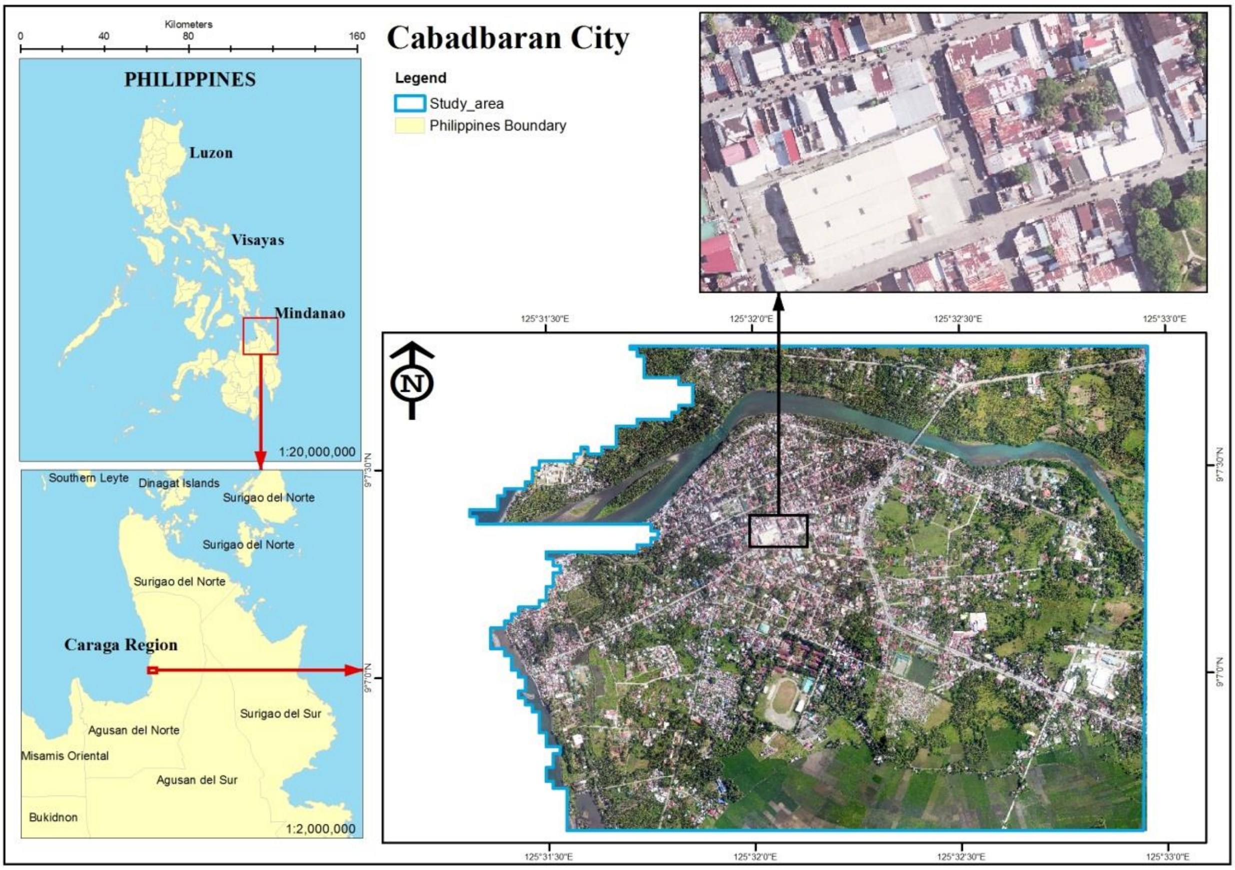

Figure 1. Map of the Study Area

3. MATERIALS AND METHODS

3.1 Orthophoto and LiDAR DSM

Orthophoto images used were acquired in the year 2014 by Phil-LiDAR 1. Hazard Mapping of the Philippines using LiDAR program funded by the Department of Science and Technology (DOST). These images have 0.5 meter spatial resolution and have of three bands (RGB bands) .These will be the input image for the classification process. In segmentation process digital surface model (DSM) was also used as an ancillary data for aiding classification process using ENVI software. Based on literature, adding elevation models to the image undergoing classification will produce more accurate data.

3.2 Feature Extraction Workflow

With ENVI's segmentation capability or the process of partitioning an image into segments by grouping neighboring pixels with similar feature values (brightness, texture, color, etc.) it will segregate features from different classes. The workflow consists of two primary steps: Find Objects and Extract Features. The Find Objects task is divided into four steps: Segment, Merge, Refine, and Compute Attributes. Both methods used the workflow of the first task (Exelis VIS, I., 2016a; 2016b). For the segmentation, edge algorithm and merging settings were set to produce the desired segmented image. After segmentation, training data were assigned to objects of unknown identity to one or more known features for example-based classification while in rule-based classification building rules and thresholds were done. .

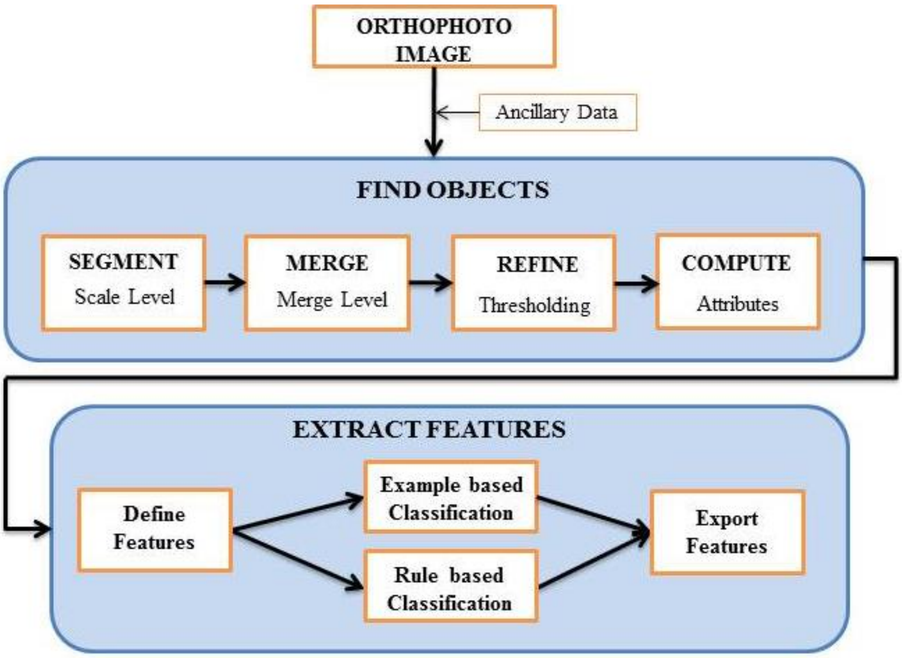

Figure 2. Process flow for ENVI feature Extraction

3.3 Example and Rule-based Feature Extraction

Edge algorithm was set to scale level 40 while merging level 90 was used. This is to produce the optimal target segmentation of the image. Sample of training data were then collected: Buildings= 200, Grass= 50, Roads= 46, Rice field =10, Trees = 100 and Water =4. All training data were selected manually within the image. The classification method was K Nearest Neighbor (KNN) which classifies segment based on their proximity to the neighboring training regions. Then the result shapefile classification undergo contextual editing to remove obvious misclassification specially shadows and roads being identified as buildings. Building features were then exported to a new shapefile to evaluate its accuracy based on the manually digitized building data in the area.

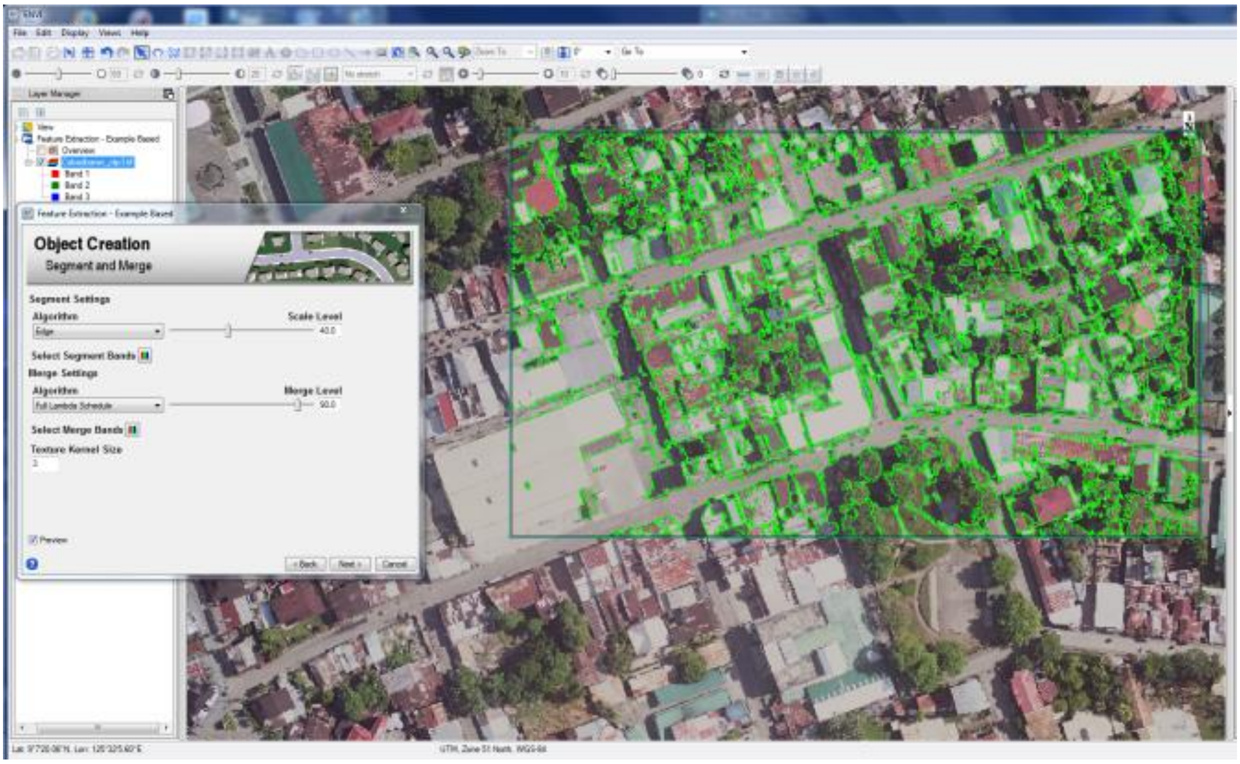

Figure 3. Example-based feature extraction workflow

Rule-based classification is a powerful tool for feature extraction, often performing better than supervised classification for many feature types (VIS, 2008). Segmentation level in this method was similar to the 1st method, what differs was the parameters used. The process of rule-building is primarily based on human knowledge and reasoning about specific feature types: For example, roads are elongated, some buildings approximate a rectangular shape, and trees are highly textured compared to grass. Rule built should isolate building features from the rest of other class within the image. With different trials and exploration of the researcher rules were built with its corresponding threshold level.

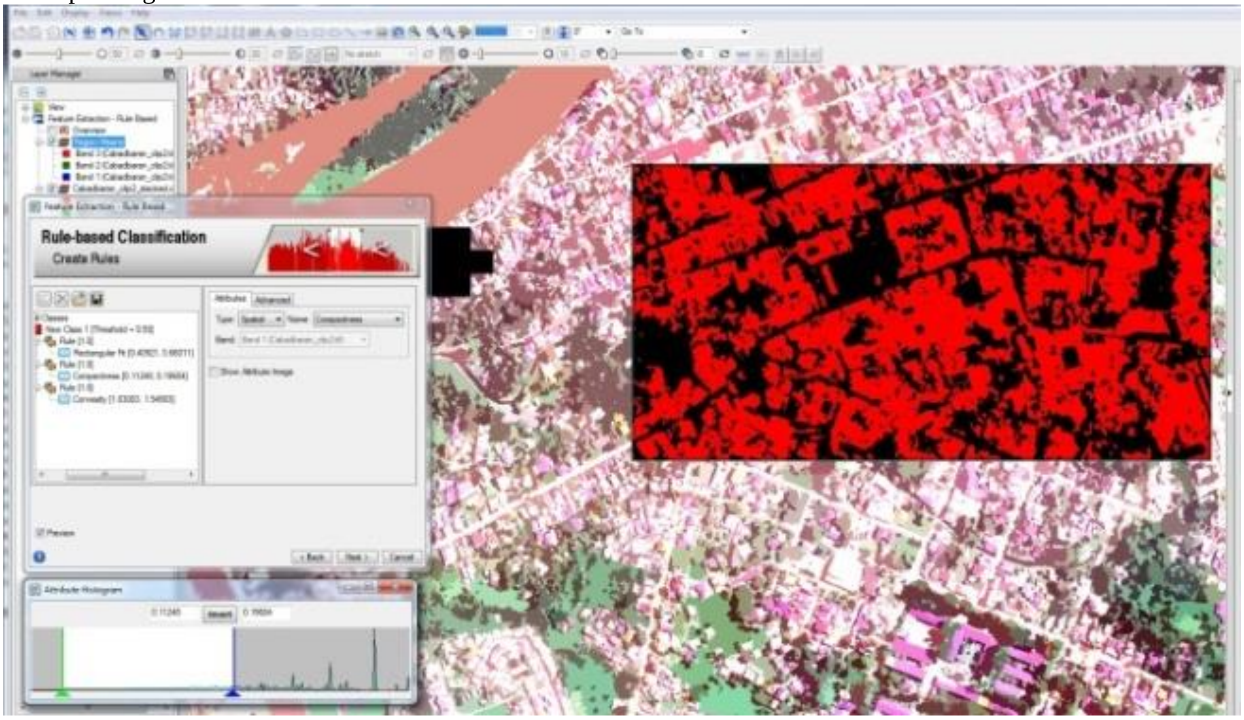

Figure 4. Rule-based feature extraction workflow

3.4 Accuracy Assessment of Results

Results of the two methods underwent accuracy assessment. Validation points where taken from the input image. For example-based classification 50 points per class where selected as validation points. Though the major concern is to know the accuracy of building features, its necessary to create validation point for other feature to calculate the overall accuracy of the classification. Confusion matrix was then created based on those validation points.

Since in rule-based classification only building features were extracted using rules its accuracy assessment was done using the manually digitized building data available. This data was manually digitized based on the same ortophoto image used in this study. The resulting rule-based building class was intersected to the manually digitized data. Since the output of the classification of buildings are segmented buildings features, those segments which did not intersect to the manual data were considered errors. Percentage of accuracy was acquired by dividing the total number of segments intersected the manually digitized buildings over the total segments classified as building using rule-based. This process was also conducted to evaluate the accuracy of building features extracted from example-based method.

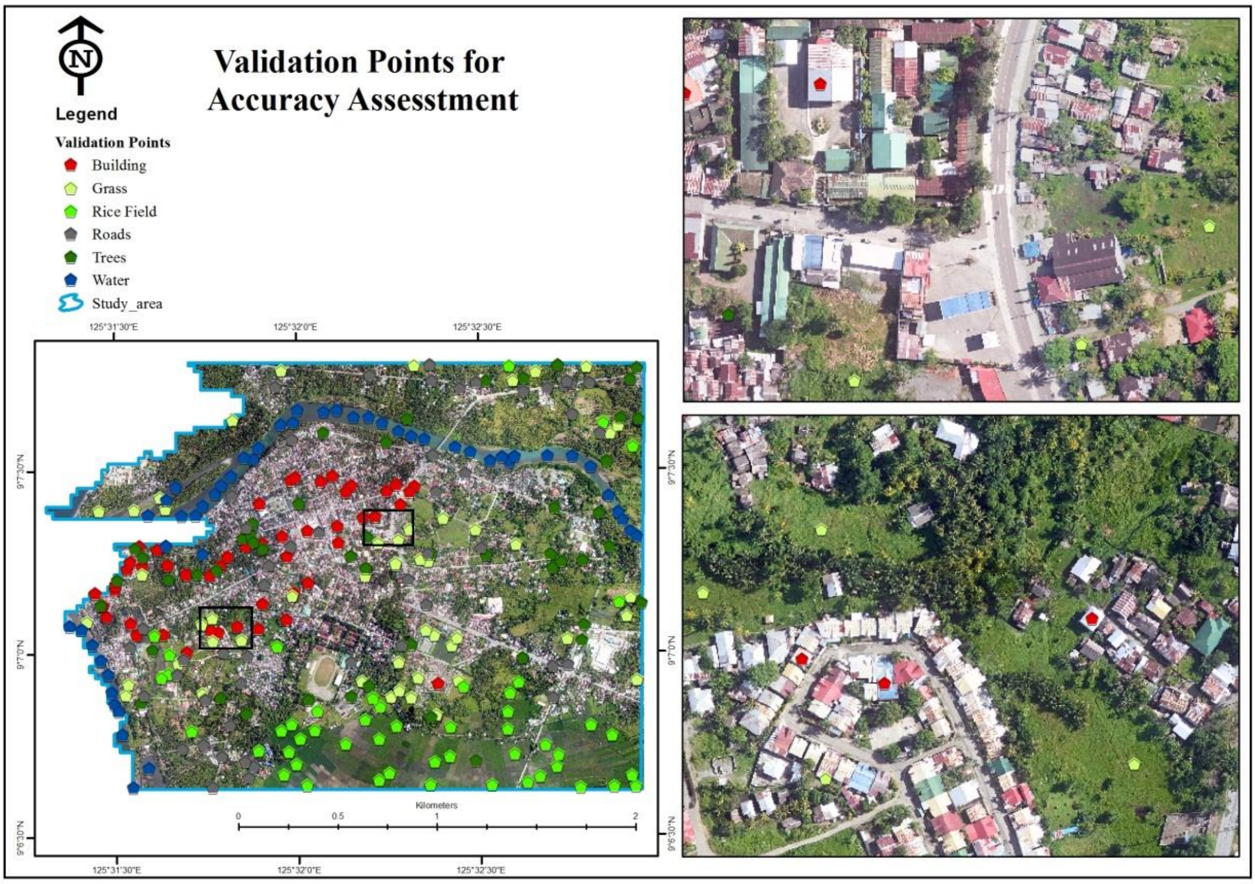

Figure 5. Location of Validation Points

4. RESULTS AND DISCUSSION

4.1 Example vs. Rule-based Feature Extraction

Based on the result of the accuracy assessment using the manually digitized building data (Table 1; Figure 6) it can be concluded that example-based feature extraction method offers better result than rule-based. Maps of the classification result shown in Figures 7-9 visually support the conclusion that example-based classification produced better results than the other method.

Table 1. Accuracy based on Manually Digitized Building Features.

Classification Method	No. Of Segmented Building features Extracted	No. of Segmented Building features identified as buildings	Percentage of Accuracy (%)	Not Building Segments
Example-based	27,027	23,473	87	3,554
Rule-based	30,945	20,423	66	10,522

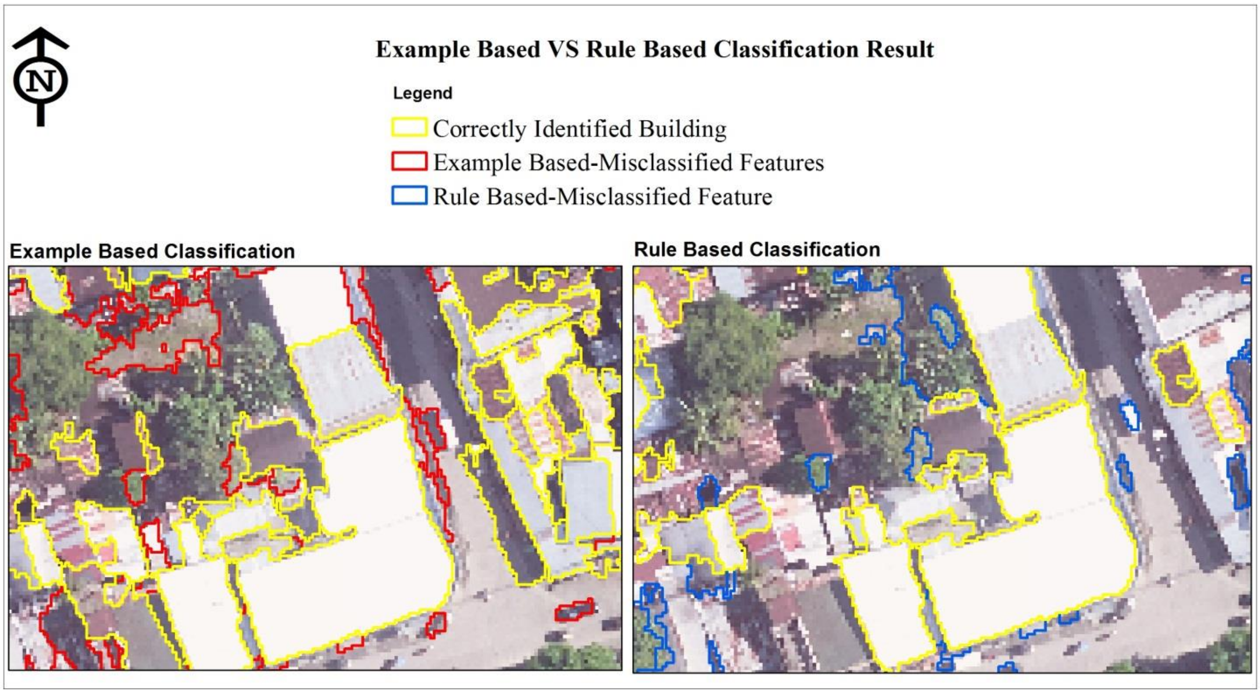

Figure 6. Sample of correctly classified and misclassified features in both methods

5. CONCLUSION

In this study, two methods of extracting building features were evaluated. Adding ancillary data to the classification process showed a better approach and improves the outcome of the classification. We conclude that Example-based has better result than Rule-based feature extraction method but maybe for this case only. Results of different classification methods rely on the qualities of data input and knowledge of the researchers. The classified map obtained with the Example-based, compared to the Rule-based offered better results.

6. RECOMMENDATION

Further studies should be conducted to produce more accurate extraction result. For the Rule-based method, exploring more rules to create acceptable results would be a good subject of future studies. In our case, we were not able to build many rules because of the limitations of the input data with only three bands.

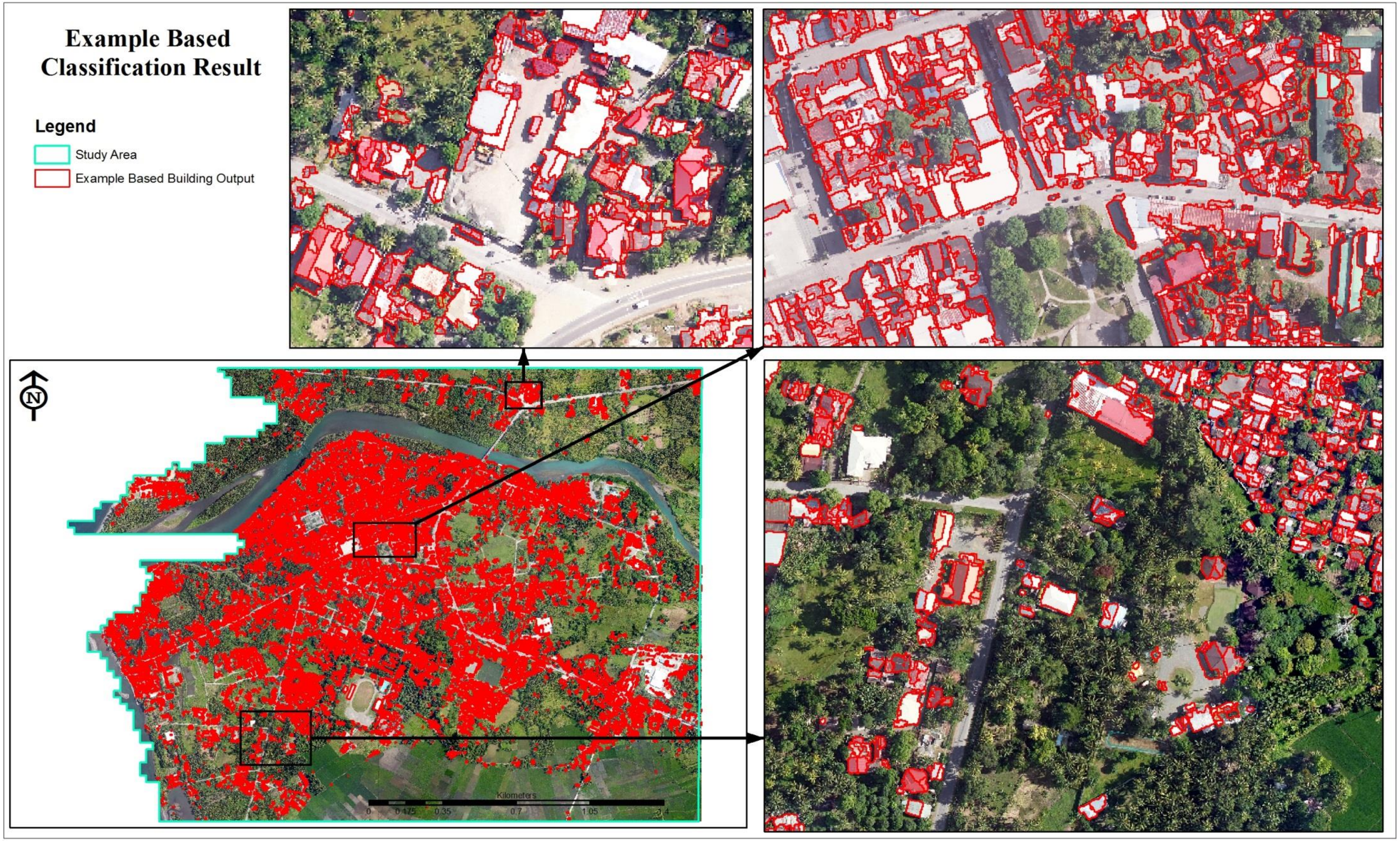

Figure 7. Result of Example-based Image Classification

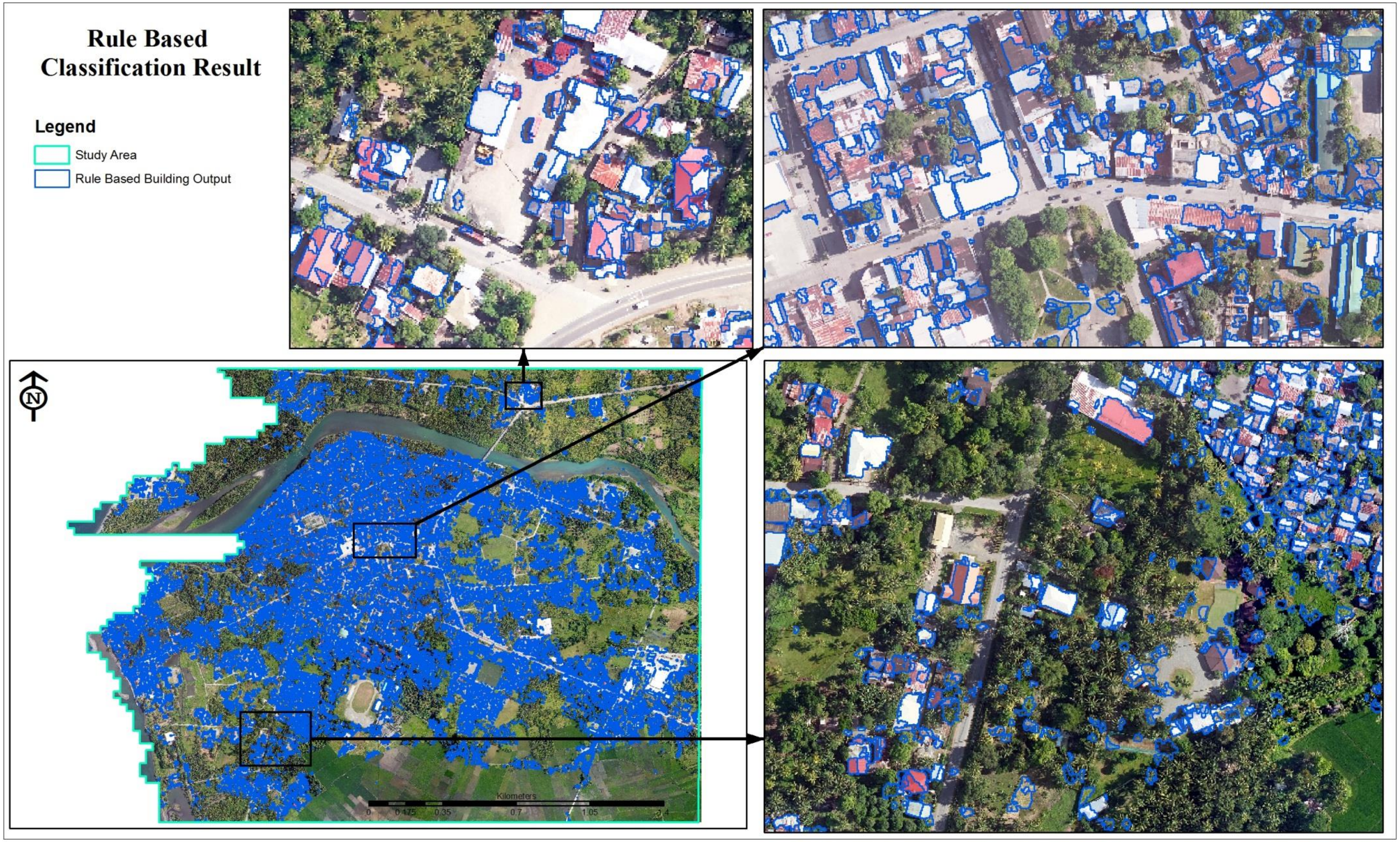

Figure 8. Result of Rule base Image Classification

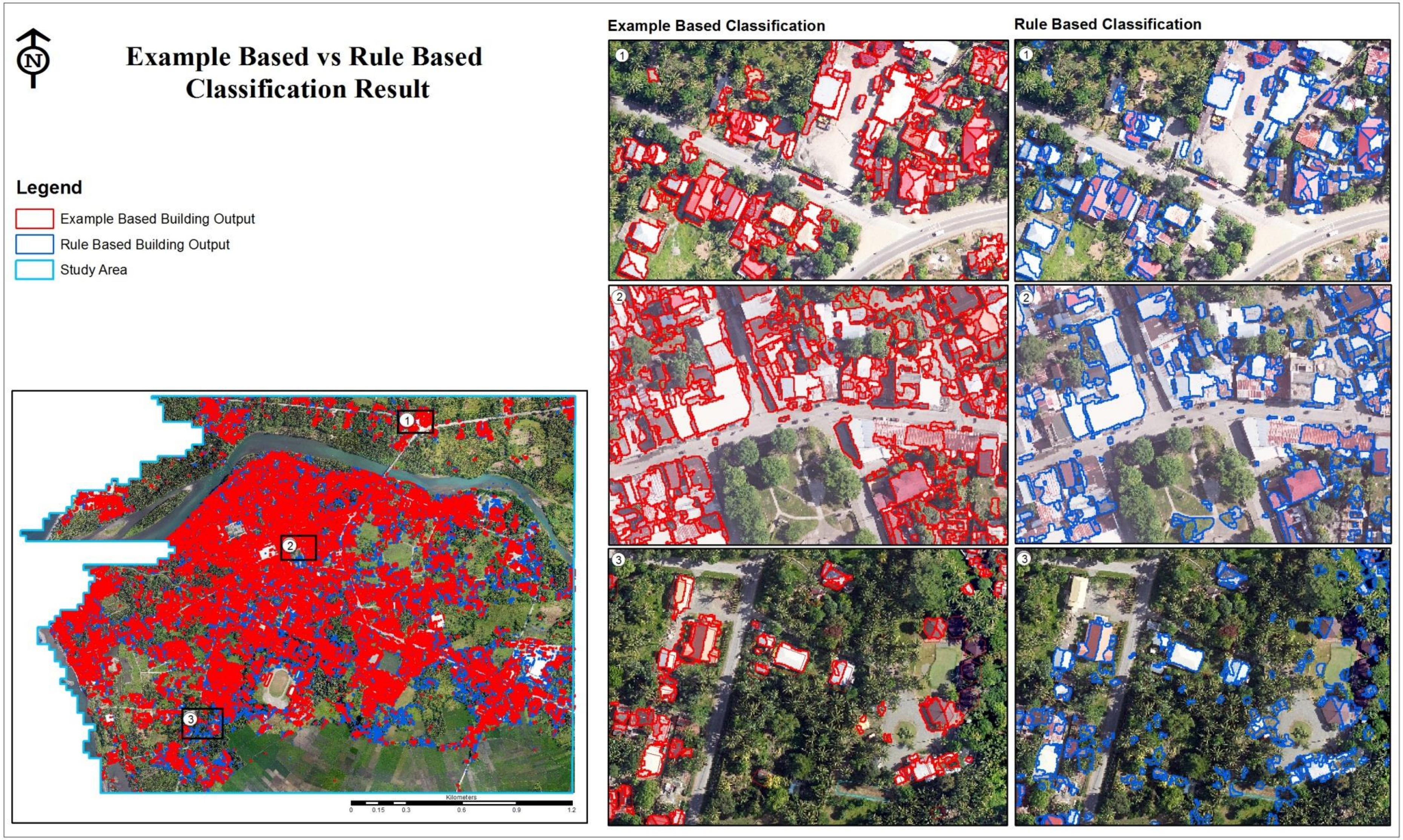

Figure 9. Output of Example and Rule-based Classification

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