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Comparing Object-based and Pixel-based Classifications for Benthic Habitats Mapping in Pari Islands

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Abstract. Object-based classification methods suitable for high resolution satellite imagery Worldview-2 provides a valid alternative to pixel-based methods. This study compares the results of an object-based to pixel-based classification for benthic habitats map in Pari islands of DKI Jakarta-Indonesia. The object-based approach involved segmentation of image data into object at multiple scale levels. The objects of the research were assign classes using training object to the support vector machines classification (object-based and pixel-based classification). Ground truth habitats for accuracy assessment using confusion matrices of both classification were undertaken based on 230 reference sites. An optimized segmentation was performed to get optimum classification result. The results showed, the overall accuracy on object-based classification was 75%, while the pixel-based classification produce the low overall accuracy was 61%. This research suggest that the object-based technique could be a promise approach for mapping benthic habitats, where the information obtained from this research was more accurate.

1. Introduction

Islands is a area which has a uniquely in geomorphology and benthic habitat around the shallow waters. Pari Islands is combinations of small islands that are geomorphology formed by ocean processes with landforms are quite varied. Pari Islands has several coastal ecosystem is the habitat that occupies an area of shallow marine waters. And then, in benthic habitats there are coral reefs, seagrass, sponges, algae, sand, sediment, rubble and rock (biotic and abiotic). The information about benthic habitat very important to know, because it can be used for various



necessary. A method which possible to determine information were used satellite remote sensing technology. Coral reef environments mapping of geomorphic zones and benthic habitats were used as basic information for the planning and development of an area towards the optimum utilization[1].

Application of the classification method from remote sensing data has been used and shows the accuracy of mapping geomorphic zones and habitats benthic different. The results of satellite imagery obtained need to be ascertained the level of accuracy through the process of testing or benchmarking with a number of existing methods[2] [3]. This benchmarking process is also intended to ensure efficiency in the remote sensing process[4]. Differences in mapping accuracy depends on the location, habitat complexity studied, classification methods and schemes used[5]. General classification method using pixel-based classification, while the object-based method (OBIA) is still very limited application. OBIA approaches were expected to improve the accuracy for benthic habitats and geomorphic zones mapping[6].

Multispectral classification methods largely on the criteria used is the value of the spectral entire channel (band). The classification method applied to extract information based on user requirements such as resource mapping that is in the land (terrestrial) and water (aquatic). Much research has used satellite imagery for mapping the benthic habitat, among other classification of multispectral QuickBird imagery in marine waters have been able to benthic habitat map[7]. Shallow water habitat mapping and reef fish stock estimating using Worldview-2 imagery[8]. Monitoring the status of the coral reef environment[9]. Multi-site evaluation of IKONOS data for classification of tropical coral reef environment[10]. Geomorphic zones mapping of coral reef ecosystem with OBIA method, case study in Pari island[11]. Mapping of geomorphology and ecology of coral reefs[12]. However, the utilization of this technology there are difficulties and specific problems that the influence of surface waters and depths of the waters of the reflectance of the bottom waters [5], [5] . Another problem has determining the image classification method with a good accuracy of the maps produced[14]. This research was aims to compare pixel-based and object-based classification using Worldview-2 imagery. The benefits of this research are expected to be used into consideration in the management of coral reef ecosystems in a sustainable manner.

2. Materials and Methods

This research done in Pari Islands District Kepulauan Seribu. The field survey done in March 2014. The material used in this study is Worldview-2 multispectral imagery which acquisition August 28th, 2012 with meta data. The method used in this study consisted of quadrat photo transect method (field data identification), atmospheric and geometric correction (pre-processing Worldview-2 imagery), pixel-based and object-based classification method using support vector machine, and accuracy test (Figure 1).

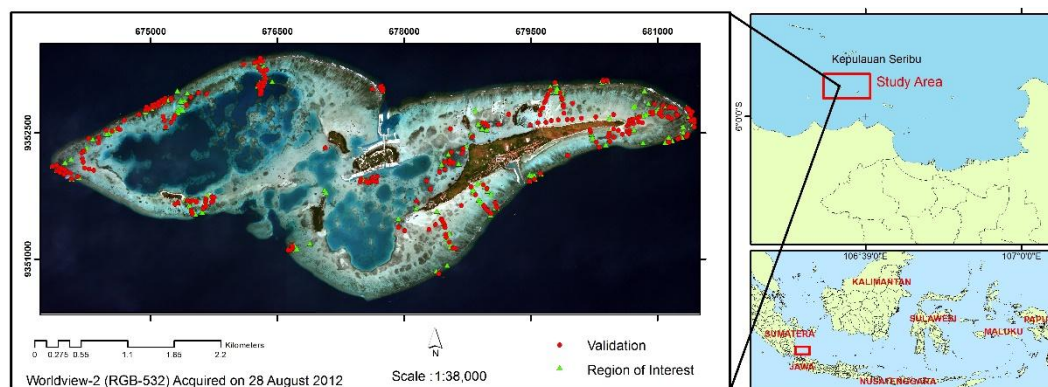


Figure 1. Research location and Worldview-2 imagery. Red and green dots indicated field observation points

This research used pixel-base and object-based techniques which applied on WorldView-2 (WV2) imagery. A FLAASH atmospheric correction was implemented on WV2 and used as input image layer (IIL). The support vector machine (SVM) was applied as classification algorithm for both techniques. The object-based approach involved segmentation of image data into object at multiple scale levels. The objects of the research were assigned classes using training object to the support vector machines classification (object-based and pixel-based classification). Ground truth habitats for accuracy assesment using confusion matrices of both classification were undertaken based on 230 reference sites. An optimized segmentation performed to get optimum classification result. The pixel-based image classification technique used compare of the accuracy on benthic habitat map.

3. Results and Discussion

3.1. Classification of Benthic Habitats

Classification of Worldview-2 imagery using support vector machines resulted 9 substrate classes of benthic habitats. Categorized the benthic habitat into 9 substrate classes i.e., live coral (KH), live coral + rubble (KHR), seagrass + sand (LjPs), dense seagrass (Lp), sand (Ps), sand + dense seagrass (PsLj), sand + rubble (PsR), pavement/ rock (Pv), and rubble (R) (Figure 2).

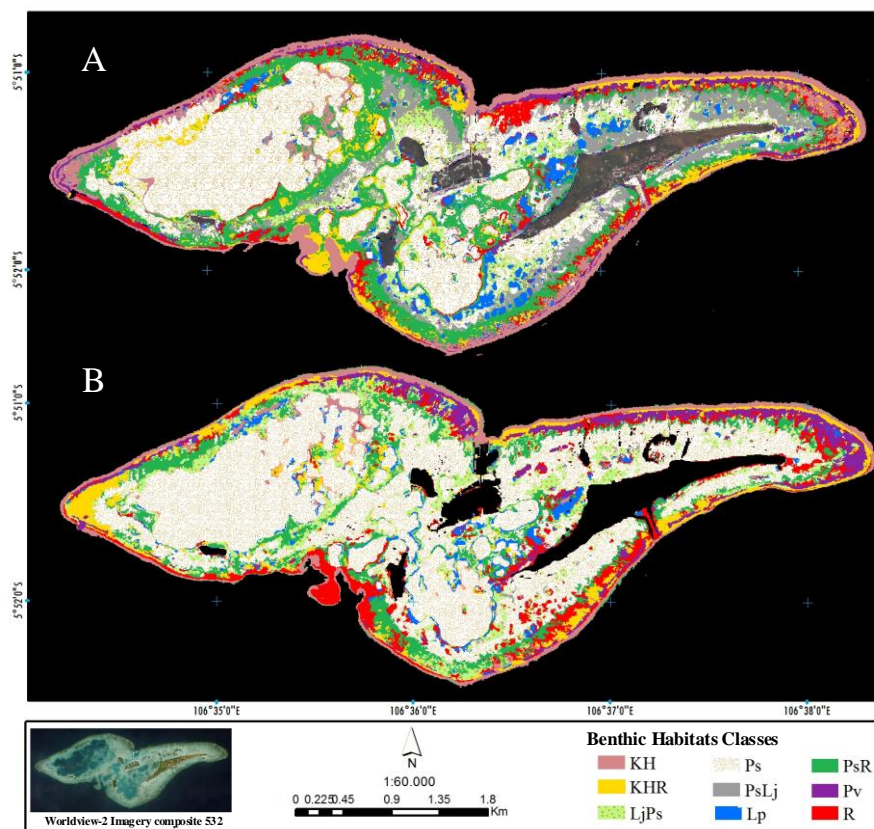


Figure 2. Classification result of pixel-base method (A) and object-base method (B)

Classification results used pixel-based method shows many miss-classification especially in areas with high complexity. Miss-classification shown in class rubble (R) contained in reef crest zone and outer reef flat, whereas usually benthic habitat occupies in this zone is rubble classes, live coral, reef life + rubble, sand + macroalgae and seagrass. Object-base method is very possible to be applied based on the principles of ecological combined with field observations.

3.2. Comparing Accuracy

Validation approach quantify the overall and individual accuracies of each map product using a standart validation set and method. In conducting this assessment using the same type of satellite image and fied data comprehensive analysis resulting in valid data [15]. Photo quadrat transects and their associated composition and percentage cover assessment combined the very high spatial resolution satellite image data. The results showed, the overall accuracy on object-based classification was 75%, while the pixel-based classification produce the low overall accuracy was 61% (Table 1). The overall accuracy of the benthic habitat result 61% in pixel-base method. While user and producer accuracy vary from 6% -100%. Producer accuracy at the lowest grade sand sparse seagrass (LJPS) of 9%. This class spread around the reef crest and outer reef flat, while the field observations that the class habitat that dominates in this zone is a live coral, rubble, and the pavement, causing the error classification results. Fault classification results in other grades were also found as rubble (R) is the class of living coral rubble + (KHR) due to the similarity of habitat benthic composition was 30% accuracy producer and 35 % to user accuracy.

Overall accuracy the benthic habitat was 75% from result in object-base method. While user and producer accuracy vary from 44% -100%, and it can be seen that some classes of benthic habitat can be mapped properly. Benthic habitat classes that can not be mapped properly obtained low accuracy of each class is KHR (37%), LJPS (47%), and R (48%). Factors affecting the low accuracy due to habitat complexity were very high in the study area. Another factor due to correspondence between the GPS accuracy with a spatial resolution imagery.

Table 1. Accuracy result of pixel-base and object-base; Overall accuracy (OA), Producer Accuracy (PA), User Accuracy (UA)

Accuracy Class	Pixel-base		Object-base	
	PA	UA	PA	UA
KH	91%	95%	87%	98%
KHR	53%	35%	47%	39%
LjPs	9%	6%	64%	47%
Lp	71%	57%	71%	86%
Ps	48%	96%	96%	89%
PsLj	25%	22%	44%	100%
PsR	100%	54%	67%	59%
Pv	79%	60%	84%	67%
R	30%	88%	52%	48%
OA	61%		75%	

Higher value object-based accuracy in this research was also influenced from using the input data. The more data input number used in object-based classification process, the more accurate classification result produced[16]. Benthic habitat mapping in Pari Islands has many done with the method of classification and vary accuracy results. The classifications are commonly used for pixel-based classification method, while the method of the object based classification has never been done in this area. Siregar *et al.*[14]Reported shallow water habitat mapping and reef fish stock estimation using worldview-2 imagery with pixel-based classification (maximum likelihood classification) produced an overall accuracy about 78%.Congalton and Green [4]Conducted a geomorphological zone approach to improve the accuracy of thematic maps generated from the substrate water column correction method Gobah Karang Lebar shows that this combination is accurate enough to be used as the base on a base substrate map-making in the waters Gobah. The results of geomorphological zone map accuracy and the base substrate in Gobah Karang Lebar respectively was 82.1% and 68.8%. According to [6] suggest that the

benthic habitat mapping accuracy that can be used with an overall accuracy of > 60%. The difference in accuracy mapping of several studies in Pari Island group due to differences in classification methods, the number of field observation point, the number of classes benthic habitat and imagery used. The results in this study the overall accuracy of 75% of ninth grade and the benthic habitat maps classification results can be used.

Comparing map accuracy obtained from the classification pixels and object-base method. Application of the object-base method able to improve the accuracy of the benthic habitat mapping experiment with some parameters. Accuracy test showed the highest on object-base method with 75% and Z-test = 27.1442. Object-base overall accuracy of the method and pixels, respectively 75% and 61%. Improved overall accuracy using methods object-base of 14%. Congalton and Green [4] states that to determine the ratio between two or more mapping accuracy in image classification is by analyzing Kappa and Z-test. Overall comparison object-base method showed higher results than pixel-based method. Object-base classification method produces overall accuracy highest was 75%(Table 2).

Table 2. Comparison of accuracy value

III	Overall Accuracy	Variance	Z-Test	Kappa-Test
Pixel-base	61%	0.0007	21.5650	0.5528
Object-base	75%	0.0007	27.1442	0.7062

A previous study reported that the method OBIA and classification of contextual more accurate than the method of pixels from Landsat 7 ETM + is the method OBIA amounted to 68.7% while the method of pixels of 44.8% and a Quickbird image which method OBIA amounted to 83.5% while the method of pixels at 59.1%[17]. Application of the method OBIA significantly improve overall accuracy than the method of pixels on benthic habitat mapping coral reefs using Landsat 8 OLI and recommends using SVM algorithm OBIA method with an overall accuracy of 73%[18].

Object-base classification methods can be an option at this time for the mapping benthic habitat. The advantage of the method that it can connect object-base between spectral and spatial aspects of the image simultaneously certain class. The classes were classified by linking two aspects of the above apply to relationships between objects. Phinn *et al.*[12]conducted a mapping of benthic communities resulted in an overall accuracy of 78% in the Heron, 52% in Ngderack, and 65% in Navakavu. Whereas, for the zone of geomorphological mapping generated mapping accuracy > 80%.Roelfsema *et al.*[19] reported the results of accuracy ranging used OBIA method on geomorphological mapping zones from 76% to 82% and benthic community with an overall accuracy of 52% -75%. Zhang *et al.* [20]combined the object-based image analysis (OBIA), hyperspectral image processing methods, and machine learning techniques in the mapping procedure with total accuracy of 84.3% was obtained for the group-level classification, and a total accuracy of 86.7% was achieved for a code-level classification with 12 code communities. Correction is done that just equates the coordinate system used in each image so as to obtain accurate and consistent data results [21] in [15]

4. Conclusion

Comparison of support vector machine algorithms between pixel-based and object-base classification showed the overall accuracy about 61% and 75%, respectively. Overall accuracy was significantly different between pixel-based image classifications with object-base technique, about 5.99. Application of the OBIA technique for mapping benthic habitats could be the best choice than pixel-based image classification, where the information obtained from this research was more accurately.

References

- [1] P. Danoedoro, *Pengantar Penginderaan Jauh*. Yogyakarta: Penerbit ANDI, 2012.
- [2] D. Abdullah *et al.*, “A Slack-Based Measures within Group Common Benchmarking using DEA for Improving the Efficiency Performance of Departments in Universitas Malikussaleh,” *MATEC Web Conf.*, vol. 197, p. 16005, 2018.
- [3] D. Abdullah, Tulus, S. Suwilo, S. Efendi, Hartono, and C. I. Erliana, “A Slack-Based Measures for Improving the Efficiency Performance of Departments in Universitas Malikussaleh,” *International Journal of Engineering & Technology*, vol. 7, no. 2, pp. 491–494, Apr. 2018.
- [4] D. Abdullah, S. Suwilo, Tulus, H. Mawengkang, and S. Efendi, “Data envelopment analysis with upper bound on output to measure efficiency performance of departments in Malaikulsaleh University,” *J. Phys.: Conf. Ser.*, vol. 890, no. 1, p. 012102, 2017.
- [5] P. J. Mumby, E. P. Green, A. J. Edwards, and C. D. Clark, “The cost-effectiveness of remote sensing for tropical coastal resources assessment and management,” *Journal of Environmental Management*, vol. 55, no. 3, pp. 157–166, Mar. 1999.
- [6] K. Navulur, *Multispectral Image Analysis Using the Object-Oriented Paradigm*. Boca Raton: CRC Press, 2006.
- [7] V. P. Siregar, “Pemetaan substrat dasar perairan dangkal karang congkak dan lebar kepulauan seribu menggunakan citra satelit quick bird,” *e-Jurnal Ilmu dan Teknologi Vol. 2 No. 1 Tahun 2010*, 2010.
- [8] V. P. Siregar, S. Wouthuyzen, A. Sunuddin, A. Anggoro, and A. A. Mustika, “Pemetaan Habitat Dasar dan Estimasi Stok Ikan Terumbu dengan Citra Satelit Resolusi Tinggi.” 01-Aug-2018.
- [9] E. P. Green, P. J. Mumby, A. J. Edwards, and C. D. Clark, *Remote Sensing Handbook for Tropical Coastal Management (Coastal Management Sourcebooks)*. Paris: UNESCO, 2000.
- [10] S. Andréfouët *et al.*, “Multi-site evaluation of IKONOS data for classification of tropical coral reef environments,” *Remote Sensing of Environment*, vol. 88, no. 1, pp. 128–143, Nov. 2003.
- [11] A. Anggoro, D. Syamsul, V. P. Siregar, and B. Agus, “Geomorphic zones mapping of coral reef ecosystem with obia method, case study in pari island,” *Jurnal penginderaan Jauh dan Pengolahan data Citra Digital*, vol. 12, no. 1, pp. 1–12, 2015.
- [12] S. R. Phinn, C. M. Roelfsema, and P. J. Mumby, “Multi-scale, object-based image analysis for mapping geomorphic and ecological zones on coral reefs,” *International Journal of Remote Sensing*, vol. 33, no. 12, pp. 3768–3797, Jun. 2012.
- [13] D. R. Lyzenga, “Remote sensing of bottom reflectance and water attenuation parameters in shallow water using aircraft and Landsat data,” *International Journal of Remote Sensing*, vol. 2, no. 1, pp. 71–82, Jan. 1981.
- [14] R. G. Congalton and K. Green, *Assessing the Accuracy of Remotely Sensed Data: Principles and Practices, Second Edition*. Boca Raton: CRC Press, 2008.
- [15] Supriyono, F. W. Citra, B. Sulistyo, and M. F. Barchia, “Mapping Erosivity Rain And Spatial Distribution Of Rainfall In Catchment Area Bengkulu River Watershed,” *Journal of Environment and Earth Science*, vol. 7, no. 10, pp. 153-164–164, 2017.
- [16] C. Roelfsema, S. Phinn, S. Jupiter, J. Comley, M. Beger, and E. Paterson, “The application of object based analysis of high spatial resolution imagery for mapping large coral reef systems in the West Pacific at geomorphic and benthic community spatial scales,” in *2010 IEEE International Geoscience and Remote Sensing Symposium*, 2010, pp. 4346–4349.
- [17] S. L. Benfield, H. M. Guzman, J. M. Mair, and J. A. T. Young, “Mapping the distribution of coral reefs and associated sublittoral habitats in Pacific Panama: a comparison of optical satellite sensors and classification methodologies,” *International Journal of Remote Sensing*, vol. 28, no. 22, pp. 5047–5070, Nov. 2007.

- [18] N. Wahidin, V. P. Siregar, B. Nababan, I. Jaya, and S. Wouthuyzen, "Object-based Image Analysis for Coral Reef Benthic Habitat Mapping with Several Classification Algorithms," *Procedia Environmental Sciences*, vol. 24, pp. 222–227, Jan. 2015.
- [19] C. Roelfsema, S. Phinn, S. Jupiter, J. Comley, and S. Albert, "Mapping coral reefs at reef to reef-system scales, 10s–1000s km², using object-based image analysis," *International Journal of Remote Sensing*, vol. 34, no. 18, pp. 6367–6388, Sep. 2013.
- [20] C. Zhang, D. Selch, Z. Xie, C. Roberts, H. Cooper, and G. Chen, "Object-based benthic habitat mapping in the Florida Keys from hyperspectral imagery," *Estuarine, Coastal and Shelf Science*, vol. 134, pp. 88–97, Dec. 2013.
- [21] S. Supriyono, F. W. Citra, B. Sulistyono, and M. F. Barchia, "Estimasi Perubahan Tutupan Lahan untuk Deteksi Erosi Tanah di Catchment Area DAS Sungai Bengkulu dengan Menggunakan Citra Landsat," presented at the Seminar Nasional Pendidikan Geografi IKIP UMP 2017, Puwokerto, 2017.