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EXTRACTION OF BENTHIC COVER INFORMATION FROM VIDEO TOWS AND PHOTOGRAPHS USING OBJECT-BASED IMAGE ANALYSIS

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ABSTRACT:

Mapping benthic cover in deep waters comprises a very small proportion of studies in the field of research. Majority of benthic cover mapping makes use of satellite images and usually, classification is carried out only for shallow waters. To map the seafloor in optically deep waters, underwater videos and photos are needed. Some researchers have applied this method on underwater photos, but made use of different classification methods such as: Neural Networks, and rapid classification via down sampling. In this study, accurate bathymetric data obtained using a multi-beam echo sounder (MBES) was attempted to be used as complementary data with the underwater photographs. Due to the absence of a motion reference unit (MRU), which applies correction to the data gathered by the MBES, accuracy of the said depth data was compromised. Nevertheless, even with the absence of accurate bathymetric data, object-based image analysis (OBIA), which used rule sets based on information such as shape, size, area, relative distance, and spectral information, was still applied. Compared to pixel-based classifications, OBIA was able to classify more specific benthic cover types other than coral and sand, such as rubble and fish. Through the use of rule sets on area, less than or equal to 700 pixels for fish and between 700 to 10,000 pixels for rubble, as well as standard deviation values to distinguish texture, fish and rubble were identified. OBIA produced benthic cover maps that had higher overall accuracy, 93.78±0.85%, as compared to pixel-based methods that had an average accuracy of only 87.30±6.11% (p-value = 0.0001, $\alpha = 0.05$).

1. INTRODUCTION

1.1 Background of the study

Monitoring of coral reefs is the gathering of data and information on ecosystems or on those who use these resources (Hill & Wilkinson, 2004). The general process of monitoring is identifying the population of benthic components in a reef such as rock, rubble, algae and sand, dead or living coral (Kenchington & Hudson, 1984 as cited in Marcos, et al., 2008). Determining the benthic population is greatly dependent on the scale required for assessment (Marcos, et al., 2008). For areas of reef that need a resolution of not less than $25m^2$, the typically-used monitoring methods are multi-spectral satellite imagery and aerial remote sensing (Mumby, et al., 2004). However, such methods require ground-truthing and acquiring such remotely-sensed images would require monetary costs. Also, reef monitoring in many countries cover a small and unrepresentative proportion, such that available data are insufficient for a quantitative assessment [18]. General visual monitoring methods are able to get information from broad to fine scale with the advantage of using inexpensive equipment, but these methods take a lot of time (Hill & Wilkinson, 2004). An alternative for monitoring is the use of digital equipment, which can greatly shorten the time in the field and reduce field expenses, since less time is required underwater as compared to visual methods (Hill & Wilkinson, 2004). The major drawback of using digital equipment is that data processing, such as digitizing, is very time consuming and equipment used are expensive (Hill & Wilkinson, 2004). Also, accurately and automatically mapping live benthic cover has remained extremely difficult to produce from multi-spectral images such as satellite images and aerial photographs, thus alternative methods of producing these maps still need to be investigated (Bour, et al., 1996 as stated in [18]) such as the use object-based image analysis (OBIA). This method initially groups pixels into objects (also called segmentation) based on certain similarities (spectral information or external variable – such as height) (Addink & Coillie, 2010). Rules are then developed in order to automatically classify the image objects produced after segmentation. With the use of OBIA, the tedious task of digitizing and manually classifying benthic cover in the acquired videos and photographs may be eliminated.

1.2 Objectives and significance

Objectives. This research aims to develop an improved method of extracting benthic cover through OBIA with the use of underwater videos and photographs with corresponding bathymetric data. Applying the same theory used in a previous research (Levick & Rogers, 2006) to this study, the height component from the bathymetric data will aid in producing a benthic cover map with better accuracy as compared to pixel-based classification methods. The specific objectives of this research are as follows:

- To investigate ways of georeferencing and mosaicking snapshots of the underwater videos, as well as means of rectifying the underwater video snapshots to the bathymetric data, given some constraints on data availability and quality;
- To develop the OBIA rule sets for accurately and automatically classifying benthic cover;
- To evaluate the performance of OBIA against commonly used pixel-based image classification algorithms.

Significance. Through this automated classification system, fast and frequent data acquisition of benthic cover such as living and non-living is possible to support reef studies that