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Application of unmanned aerial vehicle to estimate seagrass biomass in Kung Kraben Bay, Chanthaburi province, Thailand

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Abstract The seagrass beds are a unique marine productive ecosystem that provides a shelter, a food source for the marine community of animals and act as a biofilter in marine environments. An aerial photograph was reported by applying the Unmanned Aerial Vehicle (UAV). It was classified as seagrass beds in the Kung Kraben Bay. The study area covered 5.59 km2, which was shallow (depth 2.5 meters) and clear water in the Tha Mai district, Chanthaburi province, Thailand. The visual interpretation with field survey data assisted to classified in 3 classes such as a long seagrass leaves type (Enhalus acoroides), short seagrass leaves type (Halodule pinifolia and Halodule uninervis), and another object. The classification results showed that visual interpretation with the field survey data that was the overall accuracies and Kappa coefficients such as 74.42% and 0.568, respectively. The estimated biomasses of (i) E. acoroides and (ii) H. pinifolia and H. uninervis were 361.89 and 53.83 grams dry weight per square meter, respectively. The average biomass of seagrass zone showed that (i) E. acoroides was 454.24 Ton and (ii) H. pinifolia and H. uninervis were 54.28 Ton in 2017.

Keywords: Seagrass beds, Aerial photograph, UAV, Kung Kraben Bay

Introduction

Seagrass ecosystems are highly sensitive to environmental change which seagrass bed is a fertile coastal ecosystem and high biodiversity which is necessary for the marine creature's residence (Marine National Park Management, 2000). It is a vital part of the marine ecosystem due to their productivity level, seagrasses provide food, habitat, and nursery areas for numerous vertebrate and invertebrate species (Department of Marine and Coastal Resources, 2006). Seagrasses provide many important services to people as economic value though, such as commercial and recreational fisheries, nature and wildlife tourism.

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Kung Kraben Bay is in the east part of Thailand **.**This area has been classified as a wetland of national importance in Thailand **.**Kung Kraben Bay is a semi**-**closed Bay, which looks like a stingray and seagrass beds are found in the middle of this Bay Office of Environmental Policy and Planning, 1999**.** The study of seagrass community in Kung Kraben Bay in 1992, found 4 species of seagrass in descending order such as *E .accroides*, *H .pinifolia*, *H. minor*, and *H .decipiens*, and found a lot of dugongs in the past(Aryuthaka, Sangthong, & Awaiwanont, 1999). The reports on seagrass situation in Thailand showed that the current number of seagrass beds have been continuously decreasing (Waycott *et al*., 2009) because of human activities including anchoring, mining, coastal construction, fishery and toxic waste releasing (Institute of Research and Development of Marine Resources Coastal and Mangrove, 2006). The seagrass degradation affects growth, spawning, and living of marine animals in coastal marine ecosystems .Seagrass disappearing may increase current speed and trigger coastal erosion in some areas .The growing concern of seagrass degradation has made government agencies, coastal and marine resources conservation network, and private organizations work together to perform the conservation and restoration of seagrass area (Department of Marine and Coastal Resources, 2016).

The biomass is organic matter derived from living organisms, such as plants and animals .The most common biomass materials used for energy are plants, wood, and waste. It is constantly being created by living organisms around the world (Morse and Turgeon, 2012). The Geo**-**informatics technologies include 3 technologies such as Geographic Information System, Global Positioning System and Remote Sensing, which are used for spatial data analysis and mapping on the earth .The Geographic technologies are critical to the management plan in the area of efficiency, such as environmental and natural resources management, public health management, economic and social management**.** The GIS technology can be used for the data analysis process and display efficiency, as well as the change detection and monitoring which this method can evaluate quickly and efficiently. Especially in remote sensing, this method currently being used as the main tool in studying the various spatial phenomena widely .Based on data from the satellite as a tool to record information about the area and effectively continues to explore the natural resources, both on the surface and under the water covered by a wide area .The remote sensing data is an up**-**to**-**date database (Geographic Information Technology Training Alliance, 2015).

The objective of this study was to apply the aerial photograph taken by an Unmanned Aerial Vehicle (UAV) for seagrass species map based on visual

interpretation and to estimate the biomass of seagrasses zone in Kung Kraben Bay.

Materials and methods

Site Description

The study site was the Kung Krabaen Bay located in Khlong Khut Sub-district, Tha Mai District, Chanthaburi province, Thailand (Figure 1) .The area covered approximately 5.5872 km^2 from latitude of 1,391,006.31 to 1,394,816.38 North and from longitude of 811,664.24 to 816,909.16 East in WGS 84 /UTM Zone 47N.

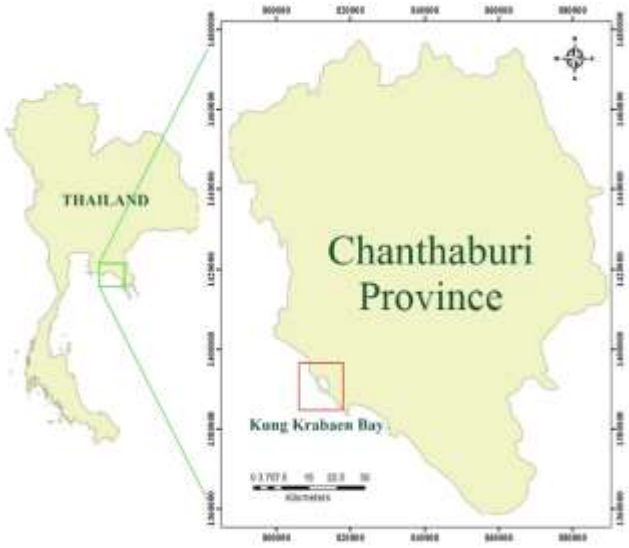

Figure 1. Study site in Kung Kraben Bay, Chanthaburi

Kung Kraben Bay is a small basin where is a famous seagrass study area on the eastern coast of the Gulf of Thailand .This area is found a mountain, which lies in a range from north to south, and 8 short line canals flowing into this Bay, including Hin, Ta Au, Ta Kwuay, Mor Suk, Baeng, Sa Lut, Pla Chon, and Nam Khao, and 4 canals for drainage of the water irrigation project .There is a plenty of mangrove forest area around this Bay about 17.6 km^2 and elevation shown in Figure 2 (Kung Kraben Bay Royal Development Study Centre, 2011).

Figure 2 . Satellite map with contour line of Kung Kraben Bay

Materials

In this study, Aerial Photograph by UAV (Figure 3) and seagrass samples from the study site used to calculating seagrass biomass data.

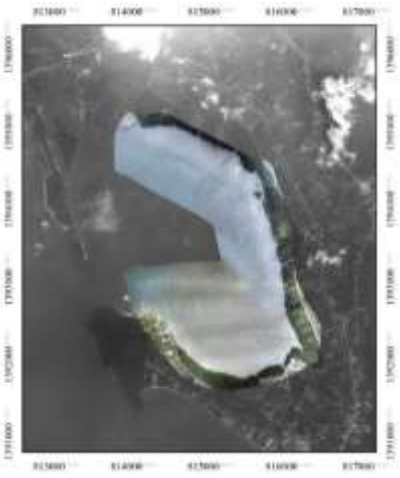

Figure 3. Study area viewed from aerial Photograph by UAV (4 July 2017)

Methods

The main processing for the analysis of seagrass classification and status is shown in Figure 4. It consisted of seven steps, namely (i) aerial photography by using UAV (DJI Mavic) with autonomous flight application on mobile (ii)

imagery processing with DroneDeply software (iii) data pre-processing including geometric correction (iv) image classification processing by visual interpretation (v) accuracy assessment by using field data (vi) seagrass species mapping and (vii) calculate seagrass biomass data by using seagrass samples data.

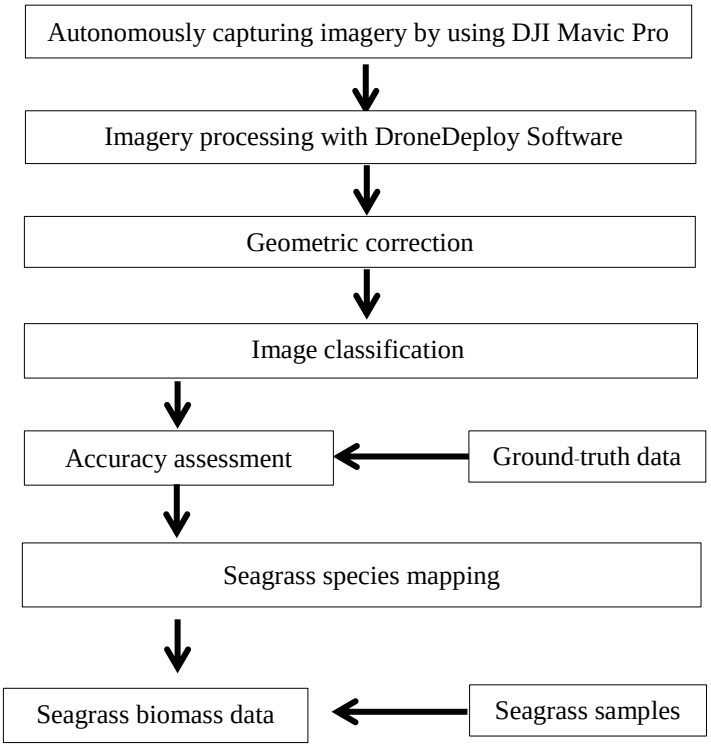

Figure 4. Workflow of aerial photograph analysis and seagrass biomass data calculation

Geometric correction

Aerial photographs were taken on 4 July 2017 by using DJI Mavic (UAV) with DroneDeploy application software .Four flight times were operated covering the area of about 7.02 km^2, and total 139 images were taken (Figure 5) . The imagery resolution is 16.6 cm/pixel and the root-mean-square error (RMSE) is 5.4 meters .The aerial photograph was geometrically corrected by using 1^{st} order polynomial transformation with RMSE of 1.67 meters to maintain the intensity of the pixels.

Figure 5. 139 images of aerial photography covering KKB

Image Classification

The process of image classification was visual interpretation with field data collection .It is classified into 3 classes of seagrass species such as a long leaves type (*E. acoroides*), short leaves type (*H. pinifolia* and *H. uninervis*), and another object.

Accuracy assessment

The accuracy of seagrass classification was assessed by comparing the pixels of classified data with those of field observation by creating an error matrix .For each location, a score of the area match was assessed and summation of the scores was normalized as the detection accuracy (Dekker *et al*., 2005).

Biomass estimation

Three seagrass species were found in the study site, namely (i) *E . acoroides*, (ii) *H . pinifolia* and (iii) *H . uninervis*. The dominant seagrass was *E .acoroides* and the mean of *H .pinifolia* and *H .uninervis* biomass were very similar, which their average biomass are shown in Table 1.

Table 1. The average biomass of sea grass species

Species	Above (*gdw*/ m^2)	Under (*gdw*/ m^2)	Value (*gdw*/ m^2)
E. acoroides	94.11	267.78	361.89
H. pinifolia and *H. uninervis*	11.91	41.92	53.83

The first stage is based on the existing seagrass species-area (2 classes) converted to biomass density using the average biomass of seagrass species by using this equation;

The total biomass area = Biomass of each species x Seagrass zone area

Results

The seagrass based on aerial photograph was classified by UAV results in 3 classes, namely (i) long leaves type (*E. acoroides*), (ii) short leaves type (*H. pinifolia* and *H. uninervis*), and (iii) another object. The classification results showed that the accuracies of visual interpretation of aerial photograph by using UAV with field data for (i) *E. acoroides*, (ii) *H. pinifolia* and *H. uninervis*, and (iii) other objects are 82.61%, 100%, 50% respectively. The accuracy of the classification using visual interpretation is 74.42% and Kappa coefficient of this method was 0.568.

The total seagrass zone area was 2.26 km^2 in Kung Kraben Bay, Thailand. Three seagrass species were found in the study area, namely (i) *E. acoroides*, (ii) *H. pinifolia*, and (iii) *H. uninervis*. The total average seagrass biomass estimated were 508.52 Ton. The estimated biomasses of (i) *E. acoroides* and (ii) *H. pinifolia* and *H. uninervis* were 361.89 and 53.83 grams dry weight per square meter, respectively. The average biomass of seagrass zone showed that (i) *E. acoroides* was 454.24 Ton and (ii) *H. pinifolia* and *H. uninervis* were 54.28 Ton in 2017.

Discussion

The aerial photograph was taken by an UAV can't use to classify seagrass species of similar size and density in the same area. The imagery from UAV can be used to classify only two types of seagrass, namely short leave and long leave types due to the differences of their length and stem (Department of Marine and Coastal Resources, 2006). The stem length of *H. pinifolia* and *H. uninervis* is approximately 5-24 cm and the leave length ranges approximately 0.6-1.25 mm. However, the stem length of *E. acoroides* is approximately 30-150 cm and the leave length is approximately 1.25-1.7 cm.

Seagrass distribution, *H. pinifolia*, and *H. uninervis* are distributed on sandy clay and seashells zone but *E. acoroides* are distributed on the only sandy zone. This other seagrass distribution studies in Kung Kraben Bay have reported similar findings (Paibulkichakul *et al*., 2014; Paibulkichakul *et al*., 2016). The *H. pinifolia* had distributed at north and south part of Kung Kraben Bay and the *E. acoroides* had distributed at south and center part of Kung Kraben Bay.

The problem of interference from the mobile telecommunication signal Antenna made the researcher cannot control UAV because electromagnetic interference from the mobile telecommunication signal mast has the same

frequency as UAV controller signal (Da-Jiang Innovation and Technology, 2016). The solution was to avoid flying near the source of interference.

It concluded that the aerial photography by using UAV is suitable for seagrass detection in a small area. The aerial photograph was taken from a very low altitude less than 500 meters. However, the DJI Mavic Pro has a short flight time of only 18-20 minutes for shooting time. This limitation can be eliminated if the UAV is developed for a longer flight time in the future.

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