

Monitoring mangrove vegetation dynamics in the Can Gio Biosphere Reserve and implications for management

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Abstract

This study aims to investigate the changes of mangrove forest associations and possible reasons for changes via the Can Gio biosphere reserve, Viet Nam case study by using SPOT imagery, object-based image analysis, and the Support Vector Machine classifier.

The highest overall accuracy of this combination was 81.6%, confirming the applicability of using remote sensing on assessing the development of mangrove forests.

There was a decrease in the *Avicennia alba – Sonneratia alba* area by 20.1% caused by the development of aquaculture and other human activities, but there was an increase in the *Rhizophora apiculata* area by 34.8%. These trends may result in the exacerbated risk of soil erosion and make the region become more vulnerable to climate change and tropical storm events. Management policies should be revised to harmonize the benefits of economic development, environmental protection, and species diversity.

Introduction

Remote sensing data can be used as a useful source for mapping vegetation because of its cost-effectiveness and large coverage.

For image processing, the pixel-based classification approach has been commonly used. Recently, the object-based approach has shown many advantages compared to the pixel-based, including:

- Integrating spectral, spectral and contextual information into the classification process;
- Identifying multi-scale objects from images;
- Improving accuracy classification.

Materials and methodology

The mangrove forest in Can Gio has high biodiversity with about 250 species of fauna and flora dominated by mangrove and covers an area of over 75,000 ha. Two images (SPOT 4 and SPOT 5) were used (see Figure 1).

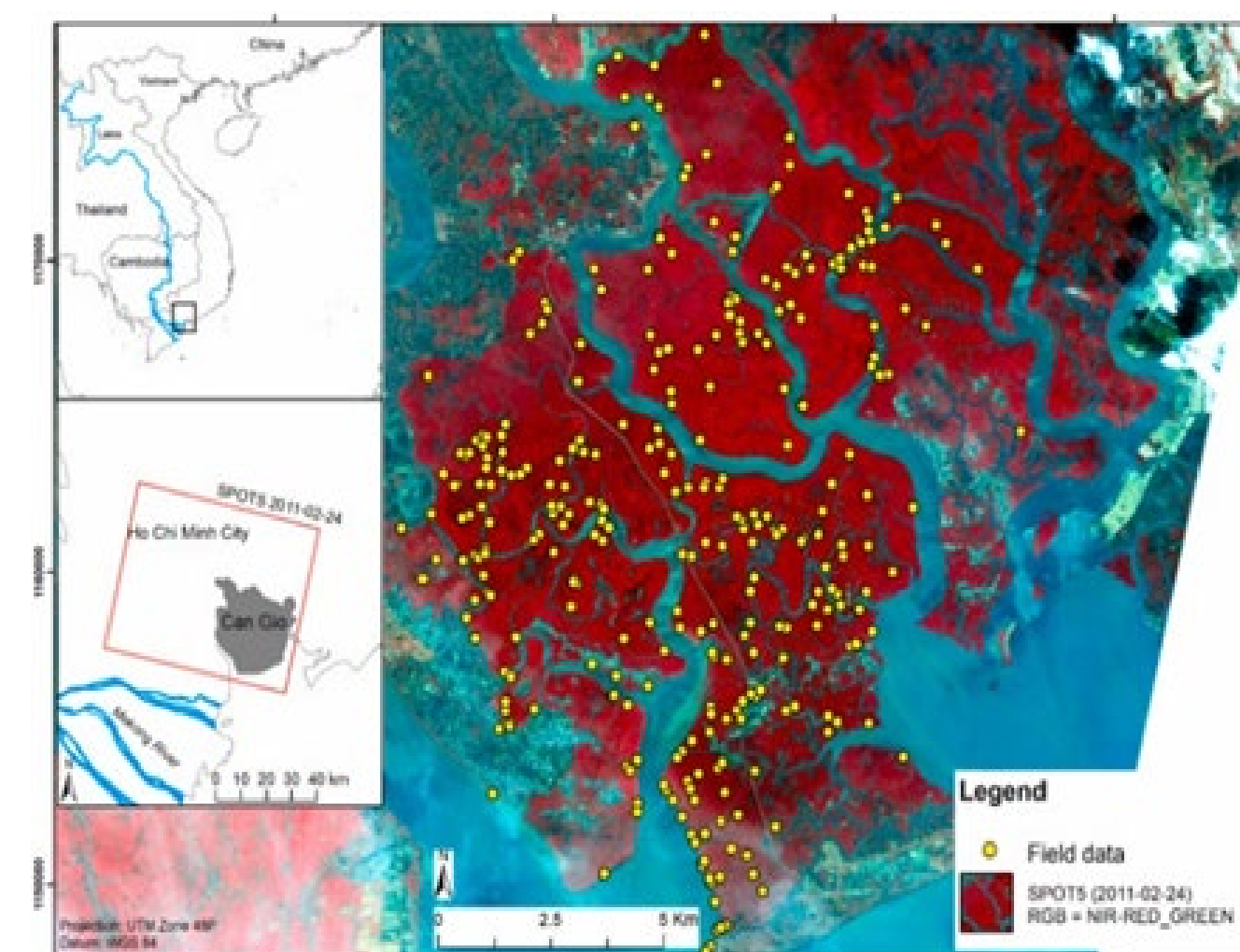


Figure 1. SPOT5 image of the Can Gio study area and field data

The mapping procedure of OBIA is shown in Figure 2

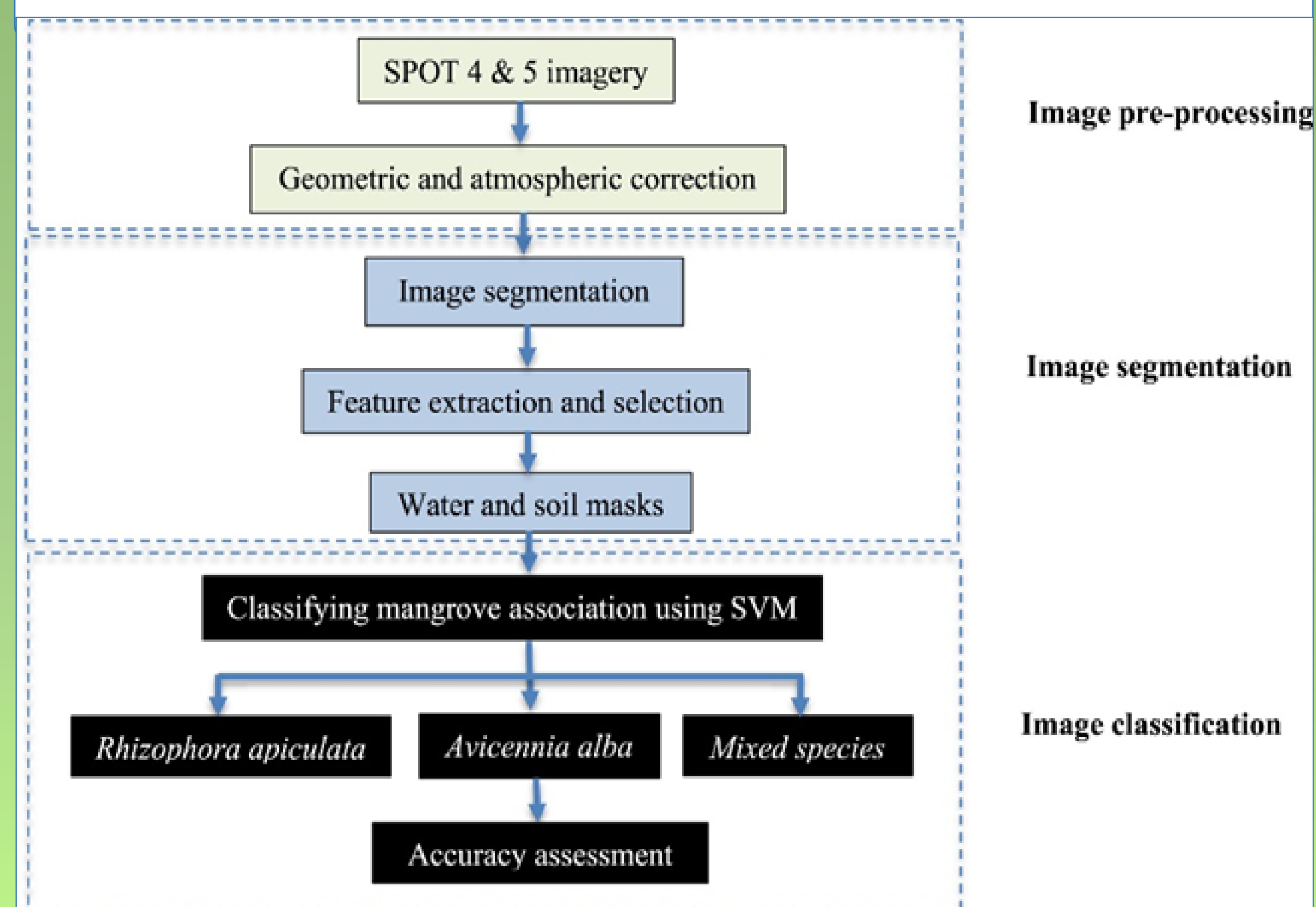


Figure 2. A workflow of mangrove association classification from satellite imagery.

Results

Result 1: The applicability of remote sensing in mangrove type mapping

Mangrove association classification in this research had an overall accuracy of 71.9% and 81.6% in the years 2000 and 2011 respectively (see Table 1 and Figure 3). The classification results of Association II (*Rhizophora apiculata*) seem to have the highest accuracy because of the homogeneity resulting from the plantation processes. Associations I (*Avicennia alba – Sonneratia alba*) and III (mixed species) and have the lower classification accuracies because of their high heterogeneity resulting from naturally expansion.

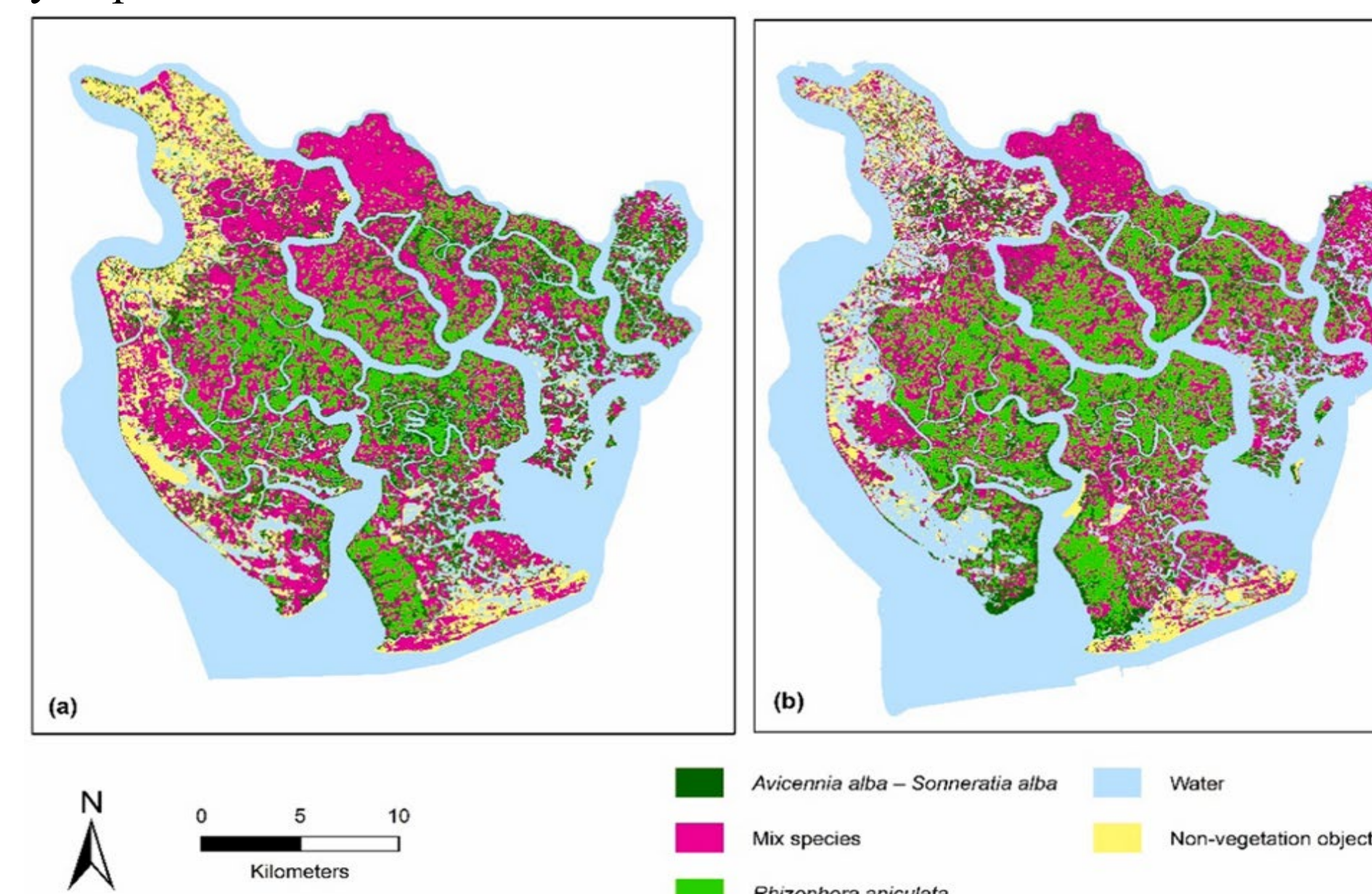


Figure 3. Mangrove classification maps of Can Gio in 2000 (a) and 2011 (b) using OBIA and SVM

Table 1. Confusion matrix of classification accuracies in 2000 and 2011

Class	2000				2011			
	Reference data				Reference data			
	MG1	MG2	MG3	UA (%)	MG1	MG2	MG3	UA (%)
MG1	51	1	18	72.8	84	8	15	78.5
MG2	1	59	10	84.3	9	93	5	86.9
MG3	21	8	41	58.5	14	8	85	79.4
PA (%)	69.8	86.8	59.4		78.5	85.3	81.0	
OA (%)	71.9				81.6			
K (%)	58				72.4			

Class key: MG1: *Avicennia alba – Sonneratia alba*; MG2: *Rhizophora apiculata*; MG3: mixed species; OA: overall accuracy; UA: User's accuracy; PA: Producer's accuracy; K: Kappa Statistics

Result 2: Changes in land use in Can Gio and possible consequences

Only Association II (*Rhizophora apiculata*) exhibited an increase of 3459 ha. Association I (*Avicennia alba – Sonneratia alba*) and Association III - mixed species reduced.

Table 2. General descriptive statistics of areas of each type of land use in Can Gio in 2000 and 2011

Vegetation type	Year 2000 Area (ha)	Year 2011 Area (ha)	Change Total area (ha)
Type I	11,625.89	9,286.36	-2,339.53
Type II	9,916.65	13,375.76	3,459.11
Type III	18,490.2	17,411.4	-1,078.8
All Type	40,032.8	40,073.5	40.8
Water	30,490.8	33,145.4	2,654.6
Others	6,937.9	4,201.8	-2,736.2

Recommendations

- In future research, ancillary data such as soil conditions could be considered to improve classification accuracy further.
- The mangrove association classification maps can be served as an input for forest monitoring and management, biomass prediction, and diversity conservation in this region.
- Can Gio is a strategic region to South-East Viet Nam, especially Ho Chi Minh City; therefore, we recommend that any land use transformation and rehabilitation effort should be implemented with care to increase the diversity and capacity of mangrove to endure natural hazards.

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