EXPLOITATION DEVELOPMENT OF CA MAU FORESTRY PLANTS BASE ON GOOGLE EARTH ENGINE (GEE) FOUNDATION

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ABSTRACT

The coastal areas of Ca Mau province are most affected by natural disasters, especially the impact of climate change and the rise of sea level. This study aims to evaluate the applicability of Google Earth Engine (GEE) platform to establish a map of forest status in Ca Mau Province from the year 2005 to 2017. In order to determine the status of mangrove and shrimp forests during the duration period, the researchers have developed a method using the NDVI index value and the change in the threshold values of 13 sets of image data; including Landsat 7 (2005-2013), Landsat 8 (2014-2015) and Sentinel-2A (2015-2017).

The research aims to indicate the possibility of using the two types of Landsat and Sentinel-2A images in forest land mapping. The result accuracy of the research was assessed by comparing with the forest area reported in the Ca Mau Provincial Statistical Yearbook in 2016. The area of mangroves exhibited the highest value in year 2005 (35,897.52 ha) and the lowest value in year 2017 (17,668.39 ha). It is shown that the area of shrimp forest was highest in year 2014 (39,062.03 ha) and it had the lowest area in year 2011 (22,046.92 ha). The area of mangroves and shrimp forests are mainly distributed in three districts: Ngoc Hien, Nam Can and Dam Doi. This study has shown promising results to be the first research to apply GEE-based Landsat and Sentinel-2A data to monitor the forest area change in Ca Mau province.

1. INTRODUCTION

Coastal areas of Ca Mau province are often deal with natural disasters, especially in the face of climate change and sea level rise (Carew-Reid, 2008). Increased aquaculture area, groundwater extraction has resulted in a great deal of damage to infrastructure, salinity intrusion and coastal flooding (BKvan Wesenbeeck et al., 2014). Rapid assessment techniques are needed to assess coastal vulnerability and to update information on coastal mangroves as well as to monitor the development and functions of mangroves (HH Nguyen, Pullar et al., 2010).

Studies on mangroves over the past three decades, especially using optical satellite imagery data, especially medium-resolution satellites (Vo QT et al., 2013). However, the limitations of image data sources and image processing, image interpretation are time-consuming, especially in large areas of study. Recently, Google Earth Engine (GEE) provides the ability to analyze over 40 years of historical Earth observation imagery to the present and to constantly update new satellite imagery data from resolution. High resolution and even Radar data, introduced as the most advanced cloud-based geospatial platform in the world (Gorelick et al., 2016), GEE Remote sensing data and free geospatial data can overcome the disadvantages faced by traditional image processing.

2. DATA USED AND METHODOLOGY

2.1 Data used

- Remote sensing data: Sentinel-2A optical image (20m x 20m resolution) collected in Ca Mau province in 2015 and 2017; image of Landsat 7 (2005-2013), Landsat 8 (2014-2015)
- Map of administrative boundaries of Ca Mau province
- Statistical data for the 2016 Ca Mau Statistical Yearbook

2.2 Google Earth Engine's image-based interpretation method

Use JavaScript-based programming algorithms to import image data, process images, analyze images, and export

results. Specific steps are as follows:

Step 1: Import the Sentinel-2A image data set and research area into Google Earth Engine

Import the image data set by typing Sentinel-2A, Image ID of Sentinel-2A "COPERNICUS / S2" image code, the internal focus of this image gallery is overlapping and compressed by Google Earth Engine. chronologically recorded and this image is not affected by clouds.

To include the research area Shapefile into the Google Earth Engine platform, first transfer the Shapefile data of the research area (Ca Mau province) to the ArcGIS KML format, thereby loading data into the Google Fusion Tables tool, it then uses KML ID on Google Fusion Tables to connect to the Google Earth Engine platform.

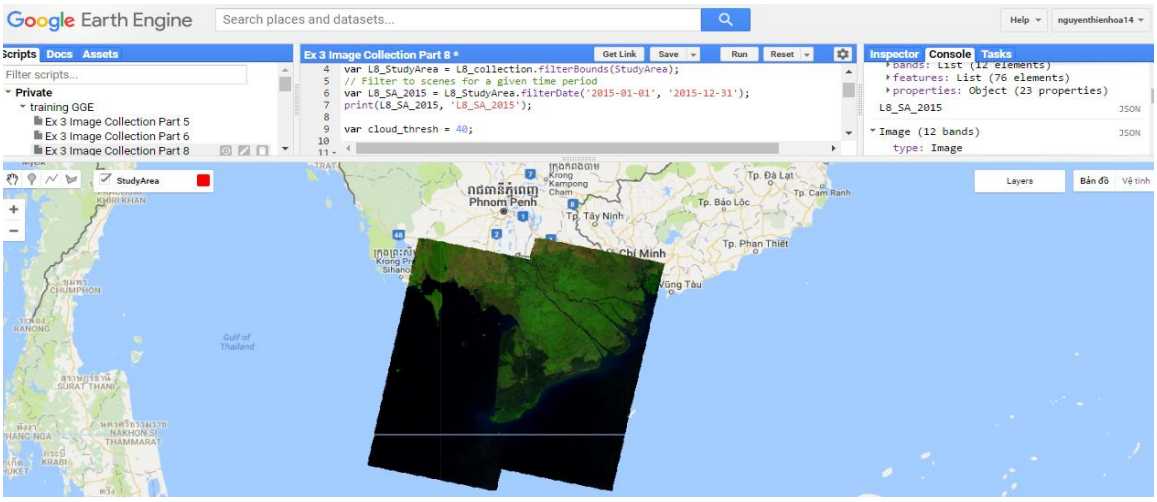


Figure 1: GEE interface with working tables and Landsat imagery for the study area was collected and processed using the GEE platform.

Step 2: Filter photos by study area and study time

After loading the study area Shapefile data and Sentinel-2A image data set, filter the satellite image data according to the study area to reduce the processing time of the image. Use the declaration code:

```
Var connectCM = ee.FeatureCollection('ft:1XPgyHDQHN4d5IF4x8u5ZkJxkVQ_xKWFFuUTi9ofT');
var loadCollection = function(start_date, end_date, bounds, max_cloudiness) {
var descriptor = start_date+' - '+end_date+' ('+max_cloudiness+'%)';
var collection=
ee.ImageCollection('COPERNICUS/S2').filterBounds(bounds).filterMetadata('CLOUDY_PIXEL_PERCENT GE',
"less_than",  max_cloudiness).filterDate(start_date, end_date);
 print(descriptor+" images ", collection.sort('system:time_start', false).limit(80));
print(descriptor+' number of '+start_date+' ->'+end_date+' images: ', collection.size());
var imageDates = collection.toList(80).map(function(img) { return [ee.Image(img).date().format(),
ee.Image(img).get('CLOUDY_PIXEL_PERCENTAGE')]}).getInfo()
  return collection;}
```

Step 3: Define the value of the NDVI value collected over the 2017 period and display it on the map

```
// Set image capture time is in 2017 for Ca Mau area
var summer2016Collection = loadCollection('2017-01-01', '2017-12-31', connectCM, maxCloudPercent);
var summer2016 = summer2016Collection.reduce(ee.Reducer.median());
var computeNDVI = function(image) { return image.normalizedDifference(['B8', 'B4']).rename('ndvi')}
var summer2016_NDVI = summer2016Collection.map(computeNDVI).max().rename('ndvi');
Map.addLayer(summer2016_NDVI, {min: -1, max: 1, palette: ndvi_palette}, 'NDVI 2016', true);
```

Step 4: //Export the image

Export.image.toDrive({

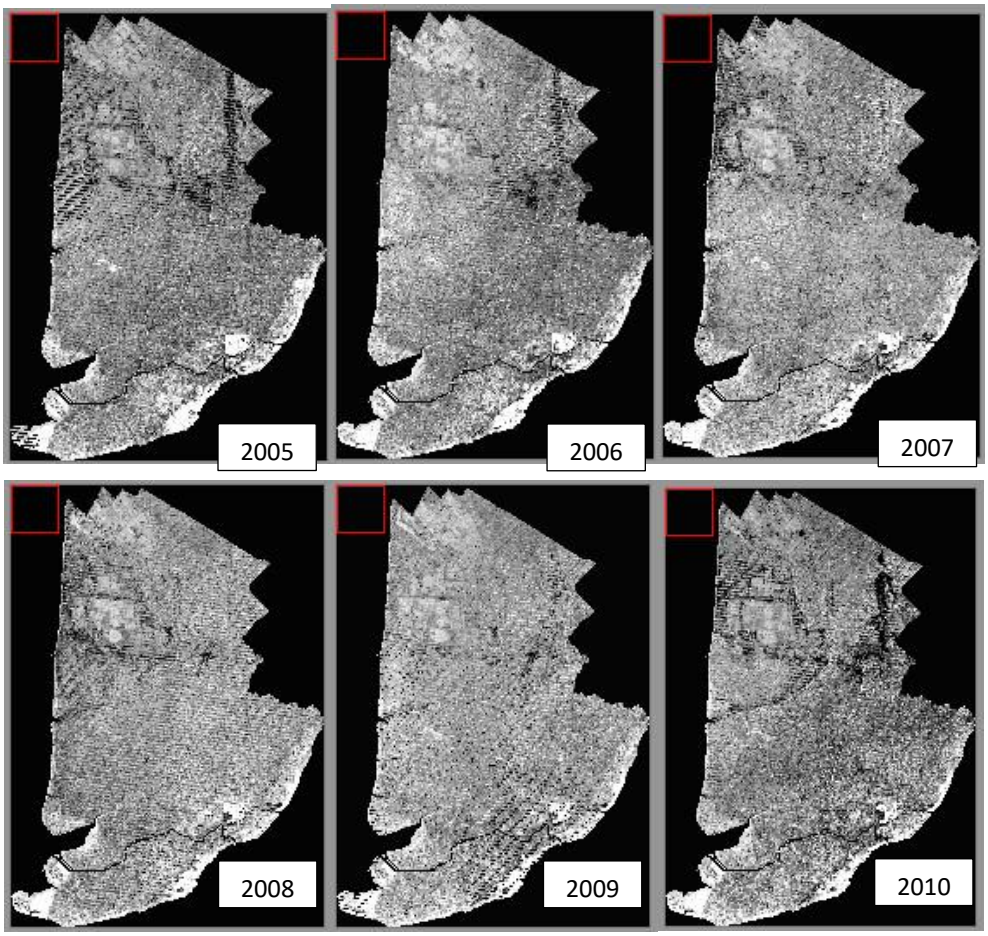
image: summer2016_NDVI, description: 'S2_ndvi2017', scale: 10, region: ConnnectCM.geometry().bounds() });

Note: image: exported image (result); description: The name of the output data to be exported; scale: is the image pixel size declaration; region: Image export area.

3 RESULTS AND ANALYSES

3.1 Results of NDVI image processing by GEE method

The NDVI images from the GEE show the Ca Mau area each year during the study period (2005-2017) (figure 2), resulting in 13 photographs. On the NDVI image, the light-colored area represents the forest area, which is concentrated in the coastal area and is identified as the mangrove forest and forest area in U Minh Ha National Park. In the period from 2005 to 2012, the area of plantation forest and forest area of U Minh Ha National Park is not clear, from 2013 to 2017 the area of forest is quite clear, the area is gray turning to black (water surface) prominently demonstrates the land use patterns (rice, fruit trees, shrimp farming, etc.).



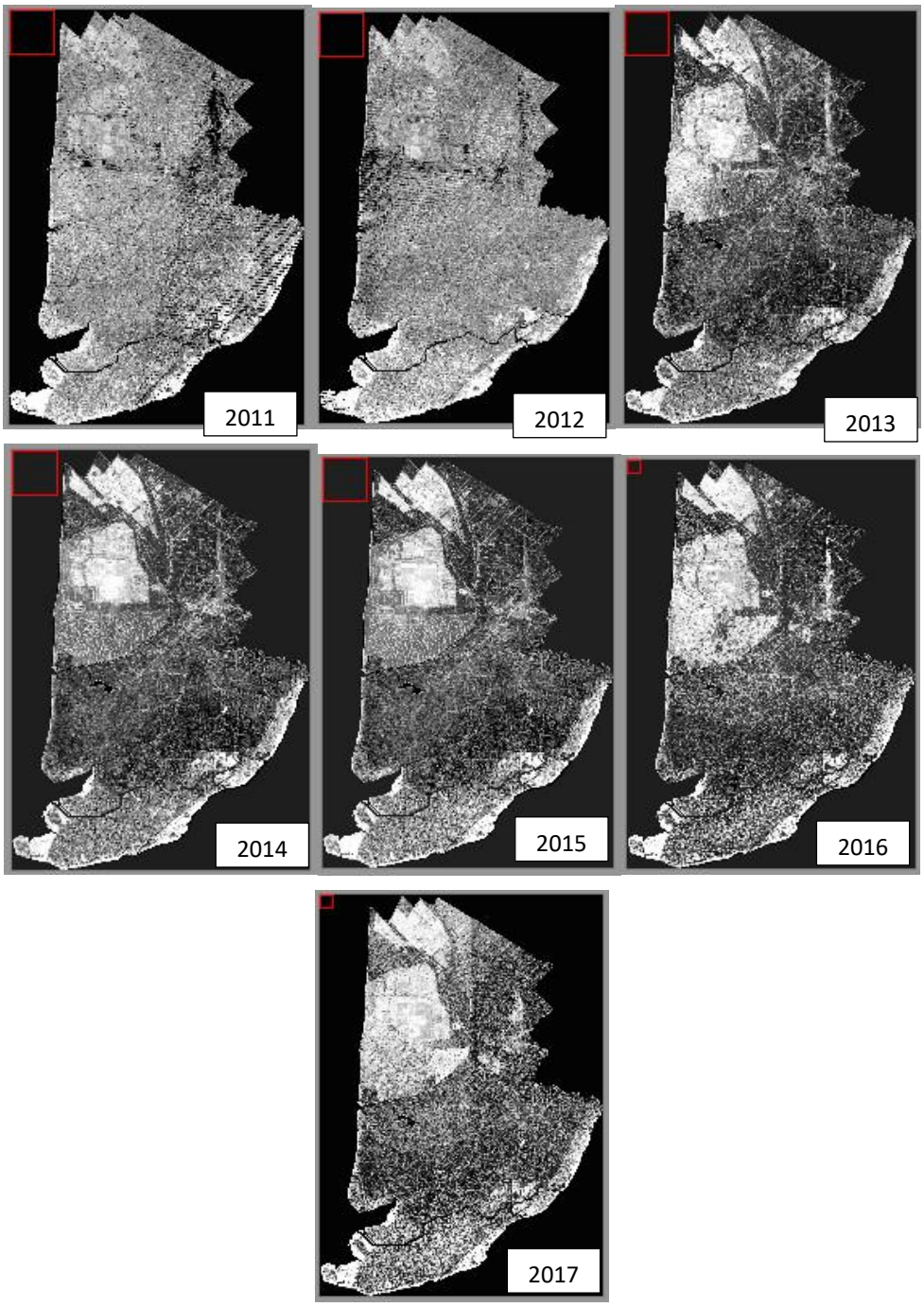
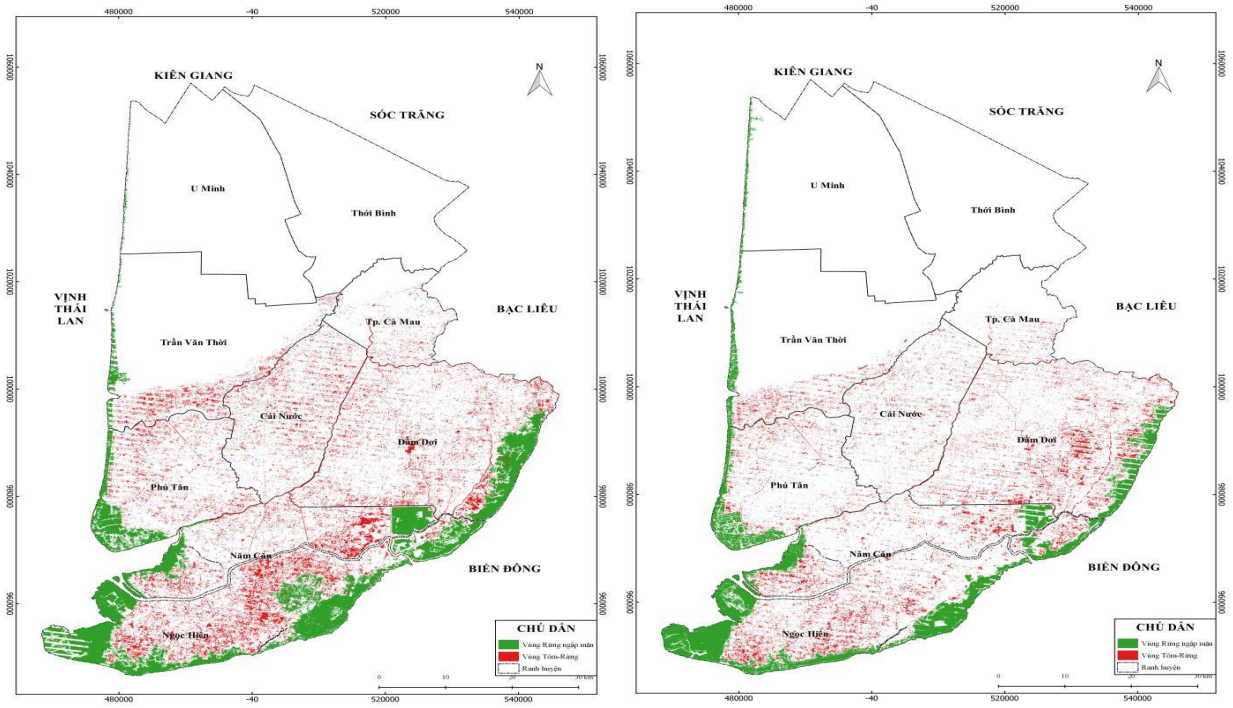


Figure 2. NDVI image series from 2005-2015 (Landsat) and 2016-2017 (Sentinel-2A)

3.2 Establish a map of the status of mangroves in Ca Mau province

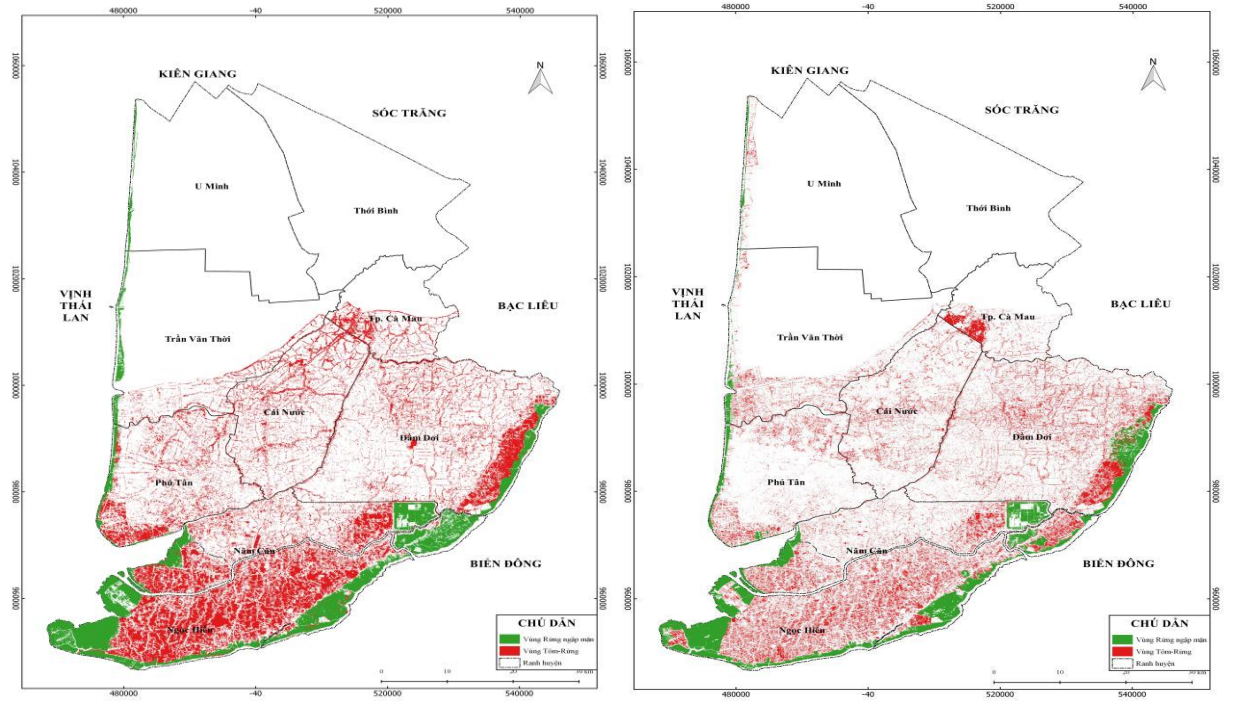
In general, the area of mangroves and forest shrimps of Ca Mau province has changed considerably from 2005 to 2017. Mangrove forests are mainly concentrated in coastal districts such as Phu Tan, Nam Can, Ngoc Hien and Dam Doi. The area of shrimp ponds is deep in the inland, concentrated in Phu Tan, Dam Doi, Ngoc Hien, Nam Can and Cai Nuoc districts, where the model of intensive shrimp farming is developed (Figure 3).



(a) (b)

Figure 3: Map of forest cover in Ca Mau province in 2005 (a) and 2011 (b)

Total area of forest interpretation from Landsat 8 in 2016 is 104,551.93 ha, of which mangrove forest area is 29,145.83 ha and forest shrimp area is 75,406.1 ha. The total area of forest interpreted from Sentinel-2A in 2006 was 63,512.37 ha, of which mangroves and forest shrimps were 21,673.49 ha and 41,838.88 ha respectively (Figure 4).



(a) (b)

Figure 4: Forests map of 2016 interpreted from Landsat image (a) and Sentinel-2A (b)

3.3 Evaluation of interpretation results

The results are compared with the statistical data in the Ca Mau Provincial Statistical Yearbook 2016 (Table 1). Data on forest area of 5 districts: Phu Tan, Ngoc Hien, Tran Van Thoi, Dam Doi and Nam Can were used for comparison and evaluation of interpretation data. The results show that the area of mangrove forest interpreted from the Landsat image is less than the area interpreted from the Sentinel image.

Table 1. Comparison of mangrove forests and shrimps from two types of photos with the statistical yearbook 2016

Districts	Landsat 2016		Sentinel 2016		statistical yearbook 2016 2016	
	Mangroves	Mangrove-shrimp	Mangroves	Mangrove-shrimp	Mangroves	Mangrove-shrimp
Phu Tan	1.173,72	8.387,43	1.006,47	2.996,86	1.185	2.005
Ngoc Hien	15.835,85	29.056,7	11.995,11	15.275,72	19.104	15.356
Tran Van Thoi	1.360,45	1.750,58	712,42	1.728,87	5.071	2.419
Dam Doi	2.187,55	14.425,96	3.432,84	9.463,96	5.129	821
Nam Can	7.993,22	11.824,8	4.526,65	7.194,66	5.552	6.708
Total	28.550,79	65.445,47	21.673,49	36.660,07	36.041	27.309

4. CONCLUSIONS

This study has shown promising results to be the first research to apply GEE-based Landsat and Sentinel-2A data to monitor the forest area change in Ca Mau province from the year 2005 to 2017. In order to determine the status of mangrove and shrimp forests during the duration period, the researchers have developed a method using the NDVI index value and the change in the threshold values of 13 sets of image data; including Landsat 7 (2005-2013), Landsat 8 (2014-2015) and Sentinel-2A (2015-2017).

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5. REFERENCES

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