Mapping Land Cover Change in a Coastal Area of Binh Thuan, Vietnam Based on Object- Oriented Methodology

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Introduction

This poster presents the workflow applying object-oriented classification for mapping land cover, and analyzing land cover change using WorldView-2 images. Our main strategy for this project is using some of objects' characteristics, and different band- ratio indices to make a decision-tree for identifying some land cover types, such as forest, agriculture, bare land, sand surfaces, and urban. Agriculture here is quite complicated with mixture of several land uses: rice fields, shrimp fields, and salterns or solar sea salt fields.

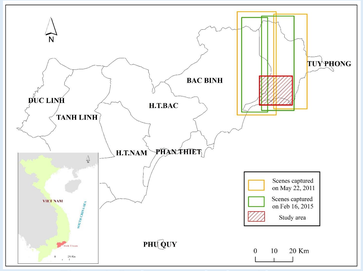


Figure 1. Study are – red color with texture.

Our case study is a small area near the coast, in the North of Binh Thuan Province, Vietnam (shown in figure 1). Images were acquired in May 2011 and February 2015 as in the end and middle of dry season respectively.

Data Preparation

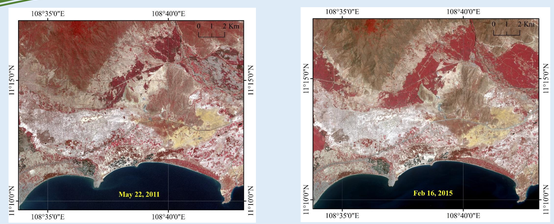


Figure 2. False color composite images of 2011 and 2015 (band combination RGB :8-5-3)

Data collection:
- 2 scenes, May 22 2011;
- 2 scenes, Feb 16 2015;
- Near coastline;
- No cloud cover.

Goals:
- Mapping land cover, and land cover changes;
- Revealing seasonal variations and influence of human activities.

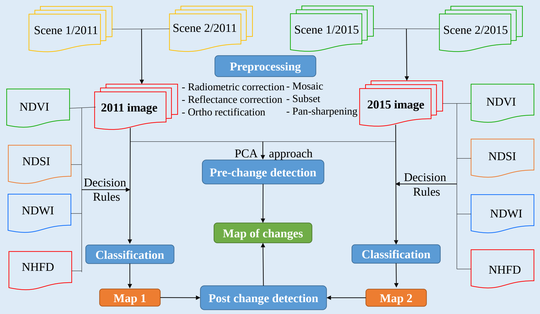


Figure 3. The main proposed workflow

Band ratios calculation

Four indices were derived from multi-spectral bands for constructing rules of classification process

Table 1. A brief explanation of 4 indices applied in the project (2)(3)(4)

No	Index ratio	Purpose
1	NDVI- Normalized Difference Vegetation Index	Vegetation cover and vegetation health
2	NDSI- Normalized Difference Soil Index	Soil dominates background and foreground materials
3	NDWI- Normalized Difference Water Index	Water body that larger than one pixel.
4	NHFD- Non-homogenous Feature Difference	Classifying areas which contrast against the background, which can be identified as man-made.

Table 2. Values extracted from 4 indices

No	Indices	2011	2015
1	NDVI	0.435 – 0.999	0.238 – 0.998
2	NDSI	-0.997 – -0.067	-0.998 – 0. 036
3	NDWI	0.238 – 0.0997	0.256 – 0.998
3	NHFD	-0.112 – -0.026	-0.144 – 0.067

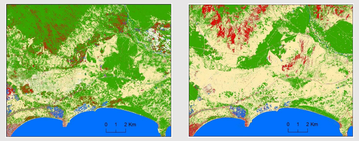


Figure 4. Land map composite images of 4 indices to categorize 4 different land types: vegetation, water body, soil and man-made

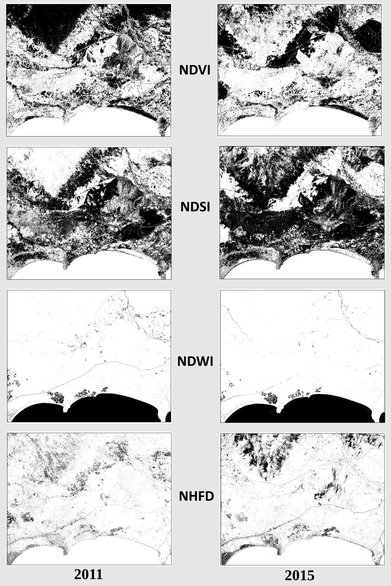


Figure 5. Extracting values to represent different land types (black color) from 4 indices NDVI, NDSI, NDWI and NFHD

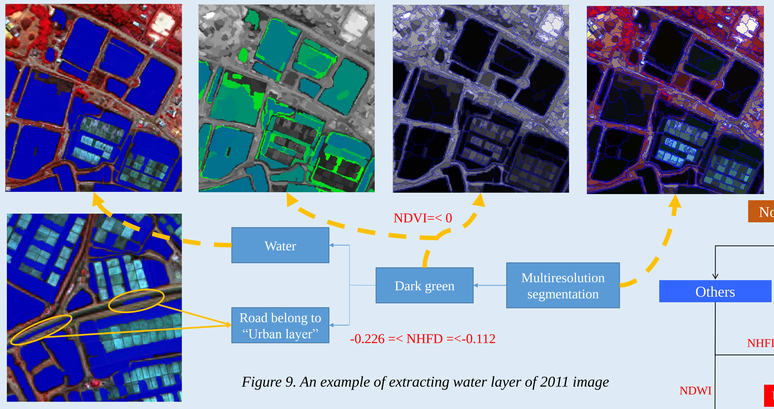


Figure 9. An example of extracting water layer of 2011 image

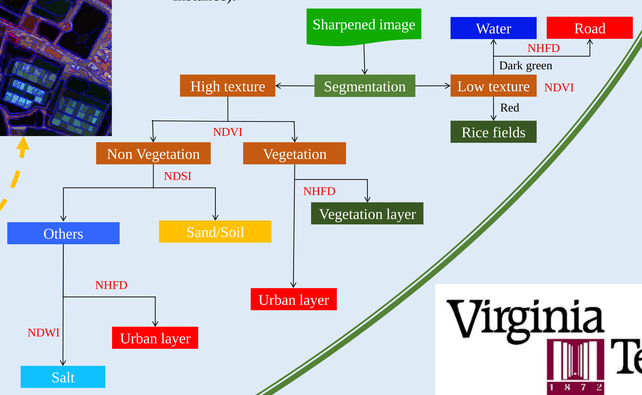


Figure 8. A simplified decision tree describes the classification process (2).

Some Notes for Classification Procedure

1. Shadowed areas: In this case study, we did not observe any significance of shadow effect. However, if the shadow effect is obvious, it is necessary to involve object-spatial relationship (neighborhood for instance) as one of indicators in the decision tree.
2. Effectiveness of band ratios: Despite of using objects' characteristics (shape, or color), applying band ratios can be considered as a good approach to categorize objects into layer due to their specific spectral information. However, values of those indices are quite sensitive and depend much on the pre-processing procedure.
3. Segmentation procedure: This procedure requires a lot of time consuming and analyst's experiences. Too small or too large sub-divided regions may lead to long time processing or missing data.
4. Decision tree: Constructing decision tree to classify objects into right categories is very important, but it is not an easy mission. Each Object has it's own specific characteristics, but also shares some common ones with others. More indicators may be helpful but costs a lot.

1. Sub-set images

Figure 6. 2011 and 2015 subset images (true color: 5-3-2).

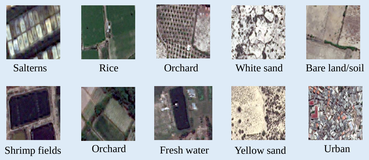


Figure 7. Some types of land cover, 2011 image

Classification

In this poster, we examine the proposed decision tree to sub-images (figure 6) before applying to the whole study area. The process of classification includes several steps: sub-setting images, segmentation, building a class hierarchy (decision tree), classifying, manually editing, merging categories.

2. Segmentation: a procedure of sub- dividing a image into separate regions. Depending on criteria of homogeneity and heterogeneity in color and shape, different algorithms will be applied and evaluated to find the optimal results- for example, an equal weight applied to shape and color.

3. Decision tree: is constructed based on object characteristics, band ratios, and other reference data (Digital Surface Model – DSM, for instance).

About Study Area (1):

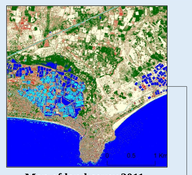
Binh Thuan province is located in Southern center with a 192 km coastline. This area is characterized as the driest area of the whole country: annual temperature is around 26-27^{0}C, and rainfall is 500 – 600mm per year (or even below 250mm per year); dry season lasts 6 months, from November to April. Sixty percent of this area are subject to desertification processes - one type of land degradation in arid and semi – arid areas. One-fourth of Binh Thuan's surface is sand, and mobile sand dunes along the coastline, sand tracking processes, which occur and disperse widely, and enhanced by long-lasting drought, buries vegetated areas and removes topsoil. The study area is located in the North of Binh Thuan, which has experienced rapid changes in land use due to economic transition. This type of human activity affects to soil productivity, and also enhances sand dominant processes. Learning how human impacts to the change of land use is expected to help for protecting land, and preserving soil fertility and environment.

Brief Description of WorldView-2 (5):

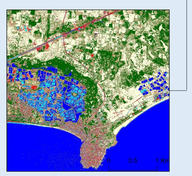
WorldView-2 is one of the commercial satellites owned by the Digital Globe for Earth Observation mission. WorldView-2 was launched on October 8, 2009, provides total of 9 spectral bands at very high resolution, including 1 panchromatic band of 0.46m resolution and 8 multispectral bands of 1.84m resolution. Eight multispectral bands are: coastal, blue, green, yellow, red, red edge, near-infrared 1, and near-infrared 2. Revisit interval is 1.1 day. Currently, Digital Globe is granting up to 1000 km^2 of very higher resolution imagery for non commercial research.

Conclusion

We are now approaching our final prelim results with both pre and post – change detection procedures. The PCA can extract and highlight the changes quickly and easily (figure 10), while the classified map-overlay (post-change detection) shows much more changes (figure 11). A further analysis will be applied to examine how sand dominant processes happened during 2011-2015, to evaluate the variation of vegetation cover between different periods of dry season, and the accuracy of our results.



Map of land cover 2011



Map of land cover 2015

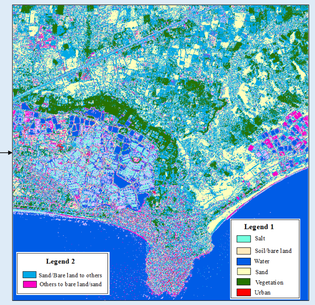


Figure 11. Maps of land cover and land cover change during 2011-2015

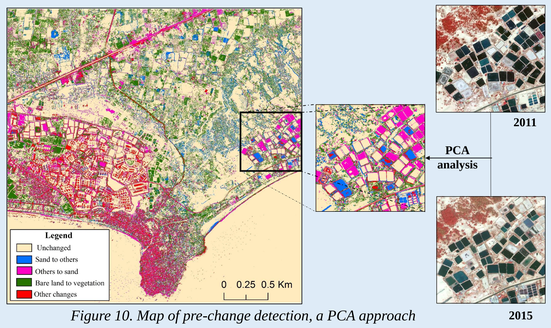


Figure 10. Map of pre-change detection, a PCA approach

Change detection

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