

GIS AND REMOTE SENSING APPLICATION IN MAAPING LAND COVER FOR CU CHI DISTRICT, HOCHIMINH CITY

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ABSTRACT

The study is a result of Landsat 8 image processing, GIS application, field survey to analyze the land cover status in Cu Chi District in 2017. The result, land cover map in 2017, divides the natural land area of the district into 9 categories: residential area (23.06%), secondary grassland – shrubland (20.30%), paddy field – cropland (19.62%), rubber plantation (18.33%), planted forestland (11.58%), vegetable (2.86%), industrial land (1.76%) and natural forest (0.32%).

Keyword: Landsat 8, remote sensing, GIS, land cover map

1. INTRODUCTION

Cu Chi District is an outskirts district in the Ho Chi Minh City, located from 10°53'00"N - 10°10'00"N and 106°22'00"W - 106°40'00"W. The natural area is 43,477.18 ha (UBND huyện Củ Chi, 2017). It connects the Eastern Southern Region and Western Southern Region, bordering on large industrial zones. Road and waterway transport systems are relatively comprehensive developed, creating advantages in economic and cultural exchanges with the outside. As a result, more and more industrial parks and subsequently residential area are being built, leading to significant change in land cover. Major land cover changes from agriculture land, especially paddy field, into industrial parks and residential areas. In official master planning, the district would become a major urban centre in the northwest of Hochiminh City. It is expected that urbanization and industrialization process in Cu Chi District will remain as the major factors in land cover change.

The above factors give reason to study the current status of land cover in Cu Chi District to provide timely recommendation for urban and environmental management, especially in the context of climate change.

2. RESEARCH METHOD AND INPUT DATA

2.1. Research procedure

There are 4 steps in research procedure: Step 1: Identifying research object; Step 2: Analyzing, data processing and classification; Step 3: Evaluation of accuracy and mapping land cover for 2017; Step 4: Evaluation of research result and reporting.

There are 213 samples collected during the 2 field trips to Cu Chi District. Different land cover types were identified including: (1) Residential area; (2) Water cover; (3) Grassland – Shrubland; (4) Paddy field - cropland; (5) Barren land; (6) Industrial land; (7) Forest land includes: natural forest, planted forest and rubber plantation.

2.2. Research methods

2.2.1. Field survey



Figure 1. Field survey route.

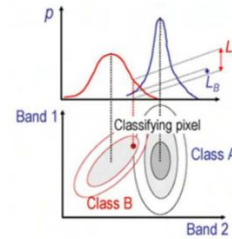


Figure 2. Classification methods

2.4.2. Land cover classification system

The research employs U.S. Geological Survey Land Use/Cover System founded by Anderson et al. (1976), with 4 classes (I, II, III, IV) (Anh, 2012, Nhat, Loi, 2009). Based on this system, classification for Cu Chi District is built as follow:

Table 1. Classification system for land cover

Cover		Definition
Class I	Class II	
Urban or construction land	Residential area	Including dense multi-centered urban area and sparsely populated outskirts area
	Road	National, provincial roads, railway, airport, seaport
	Industrial plants	Industrial zones, industrial plants
Paddy field - cropland	X	For stable food or fiber production
Forest land	X	Canopy coverage from 10%, including trees or other products which affect water and climate regime
Water surface	X	Continuously covered by water. At least 200m in width or 16ha in size.
Barren land	Grassland	Area where vegetation covers is less than 1/3, including cropland before and after harvest, infertile land, cemetery, and landfill.
	Shrubland	

The research employed verified classification, such as Maximum Likelihood Classifier (MLC). This is the method is applied to the common variable and be used as a regular algorithm for compare with other algorithm. This method is used widely in land cover research. Each pixel is assigned into a certain category based on the most probability calculated (Anh, Kien, 2012, Nhat, Loi 2009). This assignment is based on Gauss distribution.

3. RESULT AND DISCUSSION

3.1. Image collection

The image data used is a 30m Landsat 8-LDCM (OLI and TIRS sensor), downloaded from <https://earthexplorer.usgs.gov/>, with Path / Row: 125/49. Date taken 14/2/2017, image quality 9/10, cloud cover 0.51%. Photo Landsat 8 after taking a total of 11 spectral channels.

3.2. Image enhancing

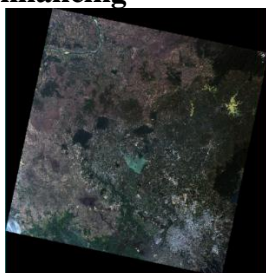


Figure 3. Pre-enhancement image

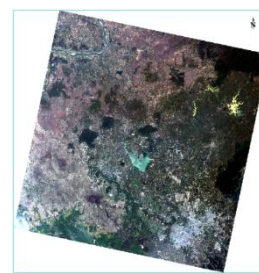


Figure 4. Enhanced image

Prior to Landsat 8 image processing, Radiometric Calibration was performed on the ENVI software to obtain the best quality possible before decoding which can decide directly on the accuracy of the sample on the image.

3.3. Extraction of Cu Chi District from Landsat 8

Based on the image LANDSAT 8 (14/2/2017) after enhancing image quality, using ENVI software adds administrative boundaries of Cu Chi District.



Figure 5. Cu Chi District after extraction



Figure 6. NDVI for Cu Chi District

3.4. NDVI calculation







Areas with high NDVI (> 0.5) are natural forest areas at Ben Duoc and Ben Dinh, and there are rice growing areas in Tan Phu Trung, Tan Thanh Dong and Trung Lap Ha. . The area with low NDVI is residential area of Cu Chi town, Cu Chi cemetery area (< 0.1). Areas with negative NDVI are areas of lakes such as Kenh Dong Lake, East Sea and Saigon River. The results of NDVI have been evaluated accurately. This is one of the sources to supplement the accuracy of the image interpretation results.

3.5. Classification

In order to successfully implement the image interpretation process, it is necessary to develop a decoding key for each real layer, thus enabling the creation and selection of training samples quickly and accurately. In this study, the interpretation was developed for 7 types of cover in Cu Chi District as follows.

Table 2. Classification criteria for research area

Land cover	Sample image	Field survey	Classification criteria
Residential area			White, grey to light violet color. Mixed and unidentified pattern
Natural forest			Dark green to black, mixed pattern
Melaleuca forest			Purple-ish dark green due to wetland nature
Rubber plantation			Dark green color, lined pattern by row
Barren land			Dark yellow to brown, unidentified pattern
Paddy field-cropland			Green color, by clear lined pattern

Land cover	Sample image	Field survey	Classification criteria
Grassland – secondary shrubland			Light green, mixed unidentified pattern
Water surface			Green to light grey color in linear shape
Industrial land			White color due to reflective roof in large area.

Color similarity between rice cover - crops and grasslands - secondary scrub, between natural forest cover and rubber forest is relatively similar. Therefore, in addition to looking at color to interpret, it is necessary to rely on the distribution and structure of each type of overlay and field data for classification. For example, the rubber plantations are structured in beds and have a clear shape; In short, the natural forest cover has no apparent shape. The easiest way to overlay the water surface is to separate the colors from the rest.

Based on photo lectures and training samples gained from the fieldwork as well as support from GOOGLE EARTH software. Classification workflow - Use training data is used to classify the area of Cu Chi District.

One sample taken from the fieldwork if the area covered by the sample at that location is large, it is possible to get more samples around to increase the accuracy, in addition to the sample collection also pay attention to the structure - the shape of the coating to distinguish and classify the most accurate coating. The current classification shows that it is not possible to classify roads and part of the river system of Cu Chi District, as the image resolution is 30m, so it is difficult to distinguish between two layers.

3.6. Post-catergorization image processing

Once classified, the image needs to be processed by post-classification processing to create layers that can be mapped out by generalizing the information. Majority Analysis method is used to aggregate single pixels, which are classified either in the layer itself or in the result of the minor pixel in the filter window instead of the central pixel.

3.7. Post-catergorization evaluation

One of the most commonly used indicators is the Kappa index (K) to measure, test and evaluate fit between different data sources or when applying different algorithms.

The results of land cover classification accuracy are shown in the table above, with Kappa = 0.7485. Global accuracy and Kappa index are average, but still can be trusted. That is because the image resolution is not high, the difference in the time interval of the source data is compared to the time of sampling, specifically:

3.8. Mapping current land cover

After categorization, the image is converted to a Shape file, and ArcGIS editing software is used. The editing process needs to add to the layers of data such as traffic and water systems (rivers, canals, and canals), administrative boundaries, mathematical data.



Figure 9. Sample collection

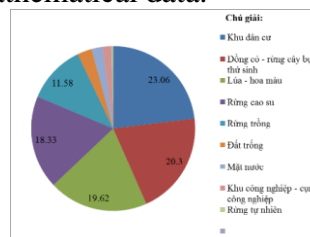


Figure 10. Ratio of land cover types

Comparing Figure 9 with the results of the classification (Figure 8), it is found that the samples were relatively accurate. It means that the classification results were relatively high, acceptable for mapping.

From the results of the mapping of the land cover of Cu Chi District 2017, it shows that the cover types have uneven distribution, each type of cover concentrates mainly on each region and each terrain characteristics.

Table 4. Area of different land covers types

Land cover	Area (ha)	Percentage (%)
Natural forest	140.45	0.32
Rubber plantation	7968.70	18.33
Residential area	10025.28	23.06
Paddy field - cropland	8532.54	19.62
Secondary grassland - shrubland	8825.38	20.30
Planted forest	5032.95	11.58
Water surface	943.66	2.17
Industrial land	764.71	1.76
Barren land	1243.51	2.86
Total natural land	43477.18	100

- Residential area covers the largest area of 23.06% of the total natural land area, followed by secondary grassland - shrubland with 20.30%, paddy field - cropland with 19.62%, rubber plantation 18.33% and planted forest 11.58%. These are the major types of land cover (over 10% of the total natural land area).

- The remaining covers account for a relatively low proportion (less than 3%). The lowest is natural forest (0.32%), at 140.45 ha distributed mainly in two historical tunnel systems of Ben Duoc and Ben Dinh. Compared to the status of special-use forest in 2011, which was about 40 ha, it can be seen as the difference in natural forest area is from protection and rehabilitation activities. In addition, current forest inventory also accounts for riparian natural forest under the canopy of Melaleuca forests.

Rubber plantation, distributed in hilly areas and hilly areas, is estimated at 7968.70 hectares, accounting for 18.33% of the natural area of the district. It is expected that rubber plantation area will increase given high economic returns and stable income.

The cover of plantation forest accounts for about 5032.95 hectares corresponding to 11.58% of the total natural area of the district. This cover is mainly the area of Melaleuca forests distributed in the area along the Kenh Xang River in the southwest of Cu Chi District, adjacent to Long An Province.

The area of paddy field and crops accounts for 19.62% of the total natural area of the district with about 8532.54 ha. Compared with the total area of rice in 2016, which was 8932.81 ha. The decrease is in part due to the master land use plan for 2016-2020. In addition to some rice fields have been harvested but not yet sown to raise grass for cattle.

Secondary grassland and shrubland is about 8825.38 ha (20.30%). The cover includes pastures that are intended for cattle and natural pastures that are abandoned or uncultivated. In addition, there are secondary bushes growing in remote areas or along rivers and river branches of the Saigon river. It can be seen that the people in Cu Chi district are moving from rice farming to animal husbandry, as a result unused land is still abundant.

Land cover for industrial park is about 764.71 ha (1.76%). Compared with 2016 statistics, which was 1188.29 ha, there is a difference due to the small number of individual industrial area clustered in the residential area. This is one of the difficulties when using low resolution images.

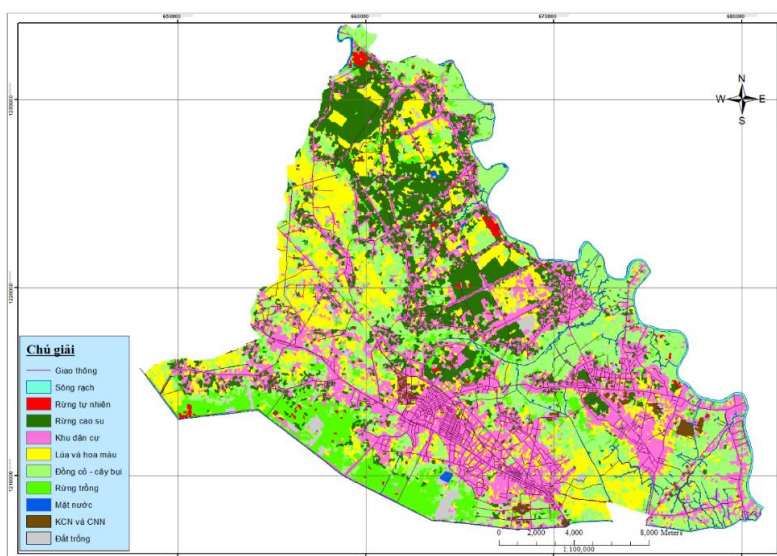


Figure 11. Land cover map for Cu Chi District, 2017

The water surface cover covers an area of 943.66 hectares, accounting for 2.17%. Compared with 2016 figure, which was 966.05 ha, it can be seen that the difference is quite low and the sampling and classification of this land cover type is quite accurate due to distinction of this type of cover coupled with the support from the ARCGIS in intergrating available river data into land cover map.

Barren land cover occupies 1243.51 ha (2.86%). According to statistics of 2016, the area of land for national defense and security (military camp, training field), landfill and waste treatment, cemetery land was about 1435.69 ha. It can see the difference is not large and acceptable because a part of the land for defense and security, cemetery land is inside the residential area.

4. CONCLUSION

Remote sensing data with the ability to provide updated information on large geographic area, combined with topographic maps and field surveys, coupled with GIS technology has helped the mapping of land cover rapid, effective and updated.

Applying verified classification, such as Maximum Likelihood Classifier (MLC), classification become easier and more accurate especially when combined with field verification. The results of the study have successfully mapped land cover of Cu Chi district into 23.06% of residential area cover, 20.30% of grassland - secondary scrubland, 19.62% of paddy field – cropland, 11.58% of planted forest, 2.86% of barren land. Small percentages includes 1.76% of industrial land and 0, 32% of natural forest.

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