USING REMOTE SENSING AND GIS TO BUILD VEGETATION STATUS MAP FOR PHU LOC DISTRICT, THUA THIEN HUE PROVINCE, VIETNAM

Nguyen Huy Anh[1], Nguyen Vu Ky[1], Ho Ngoc Anh Tuan[1], Hoang Ngoc Tuong Van[1]
[1] Institute for Resources , Environment and Biotechnology - Hue University
7 Ha Noi street, Hue city, Thua Thien Hue province, Vietnam
E-mail: nhuyanh@hueuni.edu.vn; huyanhgis@gmail.com

KEYWORDS: Maps, vegetation, GIS, RS, Phu Loc district

ABSTRACT: Today, GIS (Geographic Information System) and RS (Remote Sensing) has been used in many different fields. In particular, the application of GIS and RS for vegetation mapping is an effective and high accurate modern method. Research results of mapping vegetation for Phu Loc District, Thua Thien Hue province by analyzing Landsat images have been divided into 3 main types of covers: natural vegetation, planted and aquatic plants vegetation. Amongst natural vegetation has an area of 23366.16 hectares, accounting for 32.32%; planted vegetation cover with the area of 36469.28 hectares, accounting for 50.46%; aquatic vegetation covering an area of 12450.36 hectares, accounting for 17.22% of the total natural area. The mapping of current state of vegetation cover contributes substantially to the management, protection and reasonable exploitation of vegetation. Besides, the current state vegetation map is also an important resource to serve for the territorial planning rationally and sustainably.

1. RATIONALE

Vegetation cover plays a very important role for humans in particular and the life of the Earth in general. It provides the basic materials to sustain human being, as well as a common home for all organisms on the Earth, against the harshness of nature, especially natural disasters and climate change. However, the process of population growth and rapid urbanization requires people to exploit more natural resources to cater for growing demand. This made vegetation cover change rapidly, strongly affect the biodiversity on Earth and impact on environmental and socio-economic development.

Phu Loc is a south district of Thua Thien Hue province with the total natural area of 72085.9ha [4,5], located on the National Road 1A and North-South Railway, located between two important cities of key Central economic region as Hue and Da Nang. In recent years, due to socio-economic development, the vegetation covers of Phu Loc district showing signs of decline in both area and quality. This made increase the impacts of natural disasters e.g., typhoons, floods, landslides, erosion ... and thus affecting socio-economic development of Phu Loc district. Therefore, mapping vegetation for Phu Loc district to be the foundation for management and proposal of necessary measures in time to protect vegetation and serve for socio-economic development is a pressing issue.

2. RESEARCH METHODS

2.1. Method for RS image analysis

This study uses remote sensing images downloaded from the free website http://www.usgs.gov and http://www.landsat.org. These images will be processed and classified by the software ENVI, image was taken in 2010.

2.2. Mapping method

Map has a very important role, especially in the natural sciences. It is called the language of geography because it presents the most evident, the most visual the spatial characteristics of the study subjects. In this study, we have used administrative maps, current state of land use maps, forest status map of Phu Loc district in 2000, 2010, together with remote sensing images to analyze, to overlay for mapping vegetation.

2.3. Application method of GIS software

Based on softwares like ArcGIS, FME ... to digitize, edit, overlay and build the database for the vegetation mapping in the study area.

In addition, we also use other methods such as field survey method to test and check the results obtained and expert methods to collect expert opinions on research findings.

3. RESULTS AND DISCUSSIONS

3.1. Characteristics of factors affecting vegetation of Phu Loc district

3.2.1. Geographical location

Phu Loc geographical coordinates: 16o10’32”-16o24’45” North latitude to 107o19’05”-108o12’55” East longitude. The district has 18 administrative units with two towns and 16 communes, the north borders to Phu Vang and Huong Thuy districts, the west borders to Nam Dong and the south borders to Da Nang. Phu Loc is a natural boundary between the northern and southern climates (Bach Ma - Hai Van mountain range). This is a transitional boundary between the tropical climates of North-South of Vietnam, also the intersection, convergence of many flora migrated both from northern and the southern, so flora in Phu Loc district is diverse and rich.

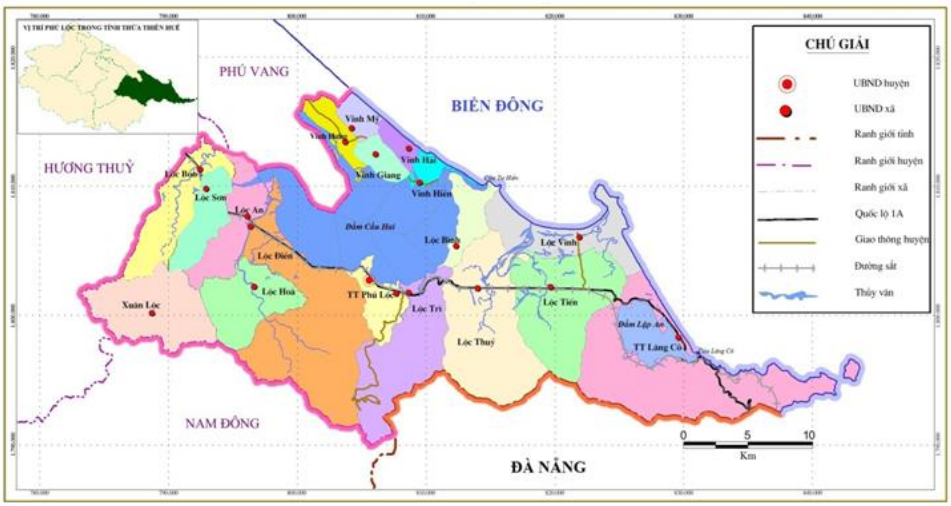


Figure 1. Administrative map of Phu Loc district

3.2.2. Geology - topography

- Geological characteristics of hilly areas of Phu Loc District is mainly Hai Van Complex (GaT3hv), distributed in the mountains of Truoi, Bach Ma, Hai Van, Vinh Phong, Chan May... The complex has penetrative phase and gangue phase. Phase 1: melanogranit biotite, biotite granite, granite porpluyr 2 mica accounting for 90%; Phase 2: light, small-medium particles of granite 2 miaca, granite alxit; Gangue phase: small particles of granite aplite, pegmatite muscovite – tourmaline [6, 7].

- Topography of the hilly area of Phu Loc district is divided into 3 main types.

+ Medium mountainous region: This region is dominant with Bach Ma - Hai Van mountain range with many peaks above 1,000 m such as Bach Ma, Dong Truoi, Dong Nong, Hon Chay, Hoi Mit..., Dong Nong 1,241m altitude, Dong Truoi 1,154 m, Hon Than 1,517 m on the upstream of Bu Lu river, Hon Chay peak (1,413 m), Hoi Mit peak (1,292 m) on the upstream of Hoi Mit river, followed by gradually lowered mountains like Hoi mountain (1,192 m) through Hai Van Pass (724 m) [6].

+ Low mountainous areas: areas with the absolute elevations of 250-750 m, relative height of 100 m. Lower mountain areas distribute into a narrow strip shifting from medium mountain to hill and plain.

+ Hill: This is the area adjacent to the plains composed of groups and hills with elevations from 10-250 m .

3.2.3. Climate

Phu Loc topography is gradually high from east to west so the temperature tends to decrease gradually from east to west. Average annual temperature: on mountain: 20oC, plain: 25.2°C; Absolute high temperatures: plain: 44oC, mountainous 430C; Absolute low temperature: mountains: 8.8oC, plain: 11.2oC. Hill and mountainous region of Phu Loc district consists of mountainous regions with high altitude located around Bach Ma - Hai Van and Dong Truoi having cool climate all year round with the main characteristics: total average annual temperature ranging from 6,500 - 8.000oC and an average temperature of 18 - 24oC. Average annual rainfall is 3,000 mm, this is the area with the greatest precipitation of Thua Thien Hue province [6, 7].

3.2.4 . Hydrology

Phu Loc rivers system distributed evenly over the territory. Most of the rivers originate from the mountains of northern and eastern slopes of Bach Ma mountain range and tend to flow from west to east across majority of hilly area down narrow plain blocked by dunes before pouring into the sea.

- Nong River originates from low mountains at an altitude of about 1,154 m. River flows southwest south - northeast north and integrates with Dai Giang canal in the delta of south Huong river, then through Dai Giang river and pour into Cau Hai lagoon. The mainstream has a length of 20 km, the catchment area of 99 km2, the average slope of the basin is 37.5 m/km, average flow 3.57m3/s, the average dry season flow 1.2 m3/s [6].

- Truoi River originates from Bach Ma - Hai Van mountain range at 820m altitude, flows closely to the South - North pouring into Cau Hai lagoon. Truoi river has the mainstream length of 24 km, the catchment area is 149 km2, average riverbed slope is 34.5 m/km, the density is 0.48 km/km2 [6].

- Cau Hai river: it orginates from Bach Ma - Hai Van mountain range from a height of about 500 m, length of the mainstream of 10 km, catchment area is 29 km2, and the average slope of the bed on the river is 62m/km [6].

- Lu Bu river: coming from Hon Than peak at 1.517m high, flows closely to the southwest South - northeast North. In the upstream, there two tributaries, Thua Luu and Nuoc Ngot, apart Canh Duong beach from the mouth about 7 km these two tributaries flow into the main stream named Bu Lu and enters into the East Sea. Bu Lu River mainstream length is 17 km, catchment area of 118 km2, and the average slope of the river bed is 58.8 m/km [6].

3.2.5 . Soils

Soils here are developed based on a complex terrain with many different types of bed-rocks so classification of soil types is various and diverse, including the following major soil types: sandy coastal land (7089.84 ha), saline soil (1143.11 ha), alluvial soils (1836.34 ha), red-yellow soil on shale (4793.46 ha), reddish brown soil on ancient alluvium (2990.9 ha), yellowish brown soil on granite (26713.17 ha), reddish-yellow soil turned by growing rice (7913.47 ha), upland soil (606.02 ha), reddish-yellow humus ferralitie soil on acid magma on acid magma (3465.52 ha), erosion soil with gravel and stones (3875.99 ha) [2, 4].

Together with the characteristics of geography, climate, hydrology, geology, soil and other artificial factors, etc., plants in Phu Loc district is buffer tropical flora with the exchange from the Tertiary age of the northern and southern flora, diverse in composition, species and ecosystems, including: mountains; hilly; coastal plain; mounds, dunes, lagoons, coastal sea. In particular, forest flora occupies the largest area of evergreen moist broadleaf forest.

3.2. Results of vegetation mapping for Phu Loc District by GIS and RS

3.2.1. Study process of vegetation mapping

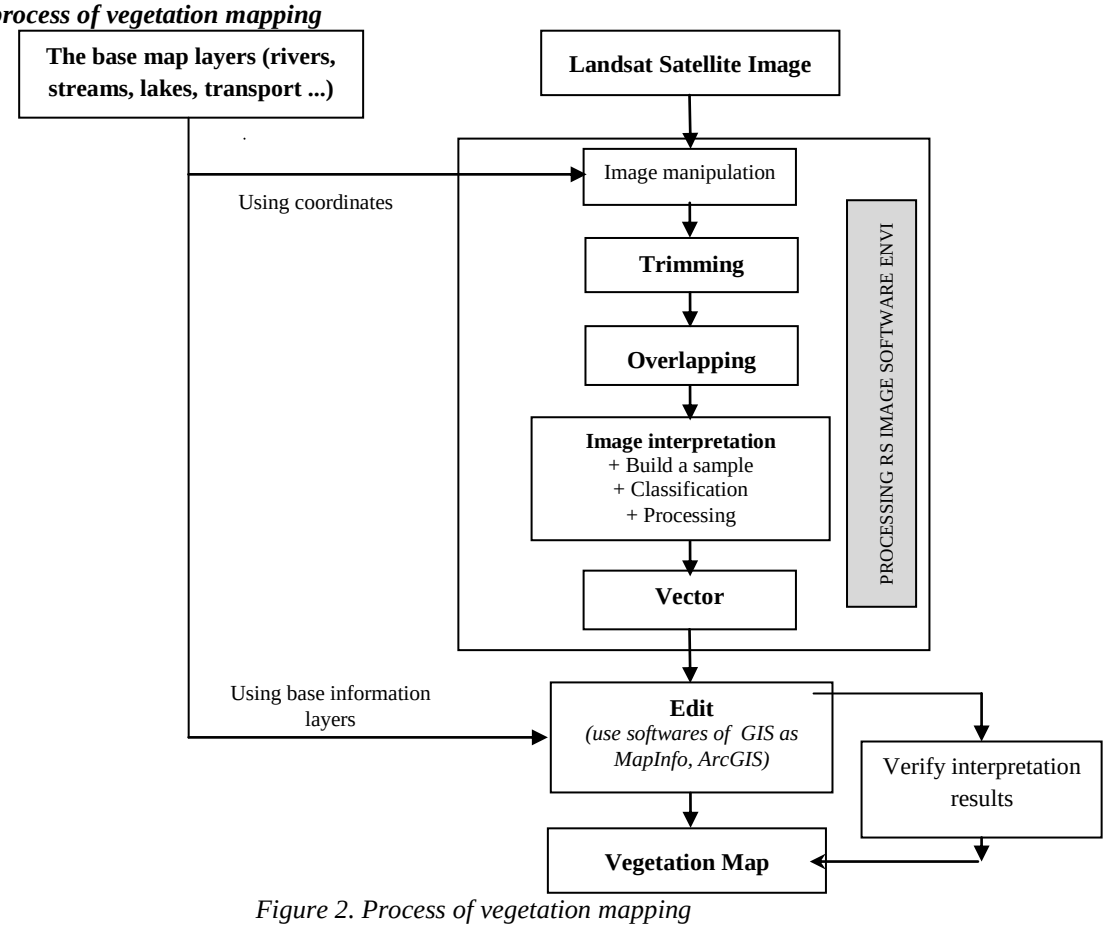


Figure 2. Process of vegetation mapping

The construction of vegetation map using GIS technology and RS for Phu Loc district has been implemented through many different stages. From the RS data collected, using remote sensing analysis software to process. After collecting processed image data, GIS tools are used to build complete vegetation maps and map contents should be based on vegetation characteristics of Phu Loc district.

- Collect RS images data on free Website provided by foreign countries. The RS data were used to record the characteristics of the study area followed by a certain timeline. In the research process of mapping vegetation of the district, it was used and made reference base maps, thematic maps (land use status map) for image manipulation, comparing and verifying results analysis, interpretation of remote sensing image.
- RS analysis software (ENVI 4.8) was used to process remote sensing data, followed by these steps:

+ Photomontage: combines multiple photos into a collage. Pairing can be based on image pixel coordinates or map coordinates to create an image covered wider geographical area. The study area is located on two different images, so it should have conducted photomontage to get a full picture of the study area.

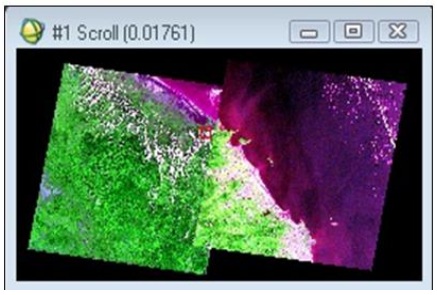


Figure 3: Collage Results

+ Cropping image of the study area

As a solution to help reduce tasks of image interpretation and manipulation because the study area has a small area whereas the Landsat image is large size. It is not mentioned the process of overlapping two images in two different pieces. The study area is bounded in two pieces so that the image cropping to limit the study area is essential.

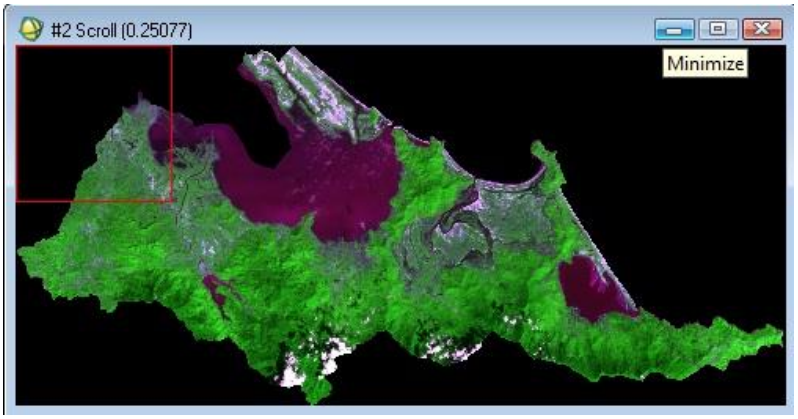


Figure 4: Image cropped by regional boundary

+ Combination picture: is combination of multiple image bands into one image to fit the purpose. The combination of image-based band satellite images is provided by foreign suppliers. Due to the project used Landsat, it should only conduct a combination of Landsat band.

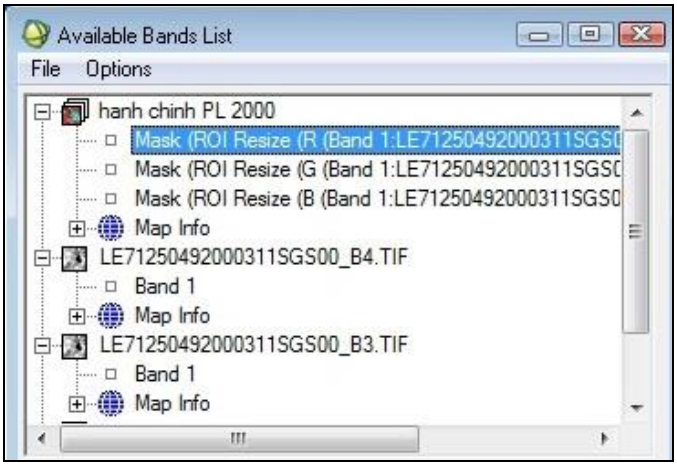
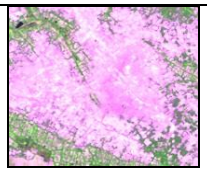
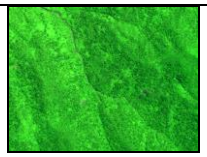
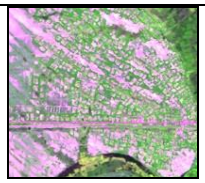
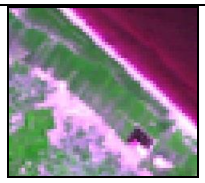
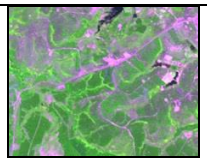
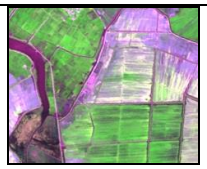


Figure 5: The band images combined together

+ Build a sample: is the sample point (sample point system) for automatic interpretation of object recognized on images. Based on supervised classification method, conduct sampling. By selecting the sample, the software will determine the number of pixels with the same feature on reflectance spectra. Sampling process is performed as follows:

Object	Sample on image	Field sample	Characteristics
Pond, river, stream			- Including the area of freshwater and saltwater. - Good level of reflectivity. - Black green, dark green.
Areas with low coverage			- Pale pink, white. - Demonstrate clearly on the image.
Natural forest			- Dark green. - Uniform color, another evenly on the image.
Plants for creating landscape			- Pale pink mixed green vegetable; intermixing to form the specific areas on the image.
Mangrove forest			- Dark green, blackish along the edges close to the sea, estuaries or lagoons.
Plantation forest			- A light blue, irregular intervals. Surface split.
Soil, sand			- Includes sand beach, coastal dunes; typical white alternating scrub, grassland.
Cultivated rice			- Areas with large rice growing area, low presence of other objects, uniform reflectivity.

+ Classification image based on interpretation

Using a Maximum Likelihood algorithm to classify the selected sample areas. Maximum Likelihood algorithm is the most used algorithm with supervised classification. It shows spectral bands with normal distribution and pixels will be classified into a class having the highest probability. The calculation is not only based on distance value but

also on the variation trend of gray level in each class. This is an accurate classification method but time consuming and depends on the normal distribution of data.

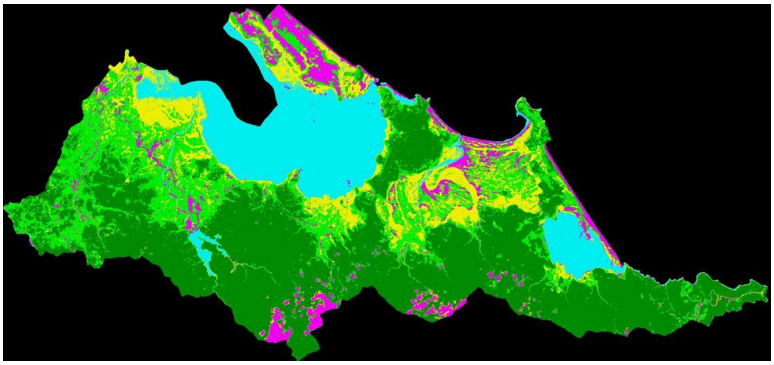


Figure 6: Products after supervised classification of RS images

+ Processing after classification

The results of the classification is to bring different classification classes, objects on the image after classification are usually spotted and can not comparable with the actual distribution, the object size is too small. It is necessary to be preliminary processed to produce better results. In this project, the way to handle after classification is sorting objects (Sieve Classes). The object after interpretation is heterogeneous distribution, scattered throughout the image, so it is necessary and convenient to sieve these objects for later editing.

+ Error matrix

Error matrix is a square matrix arranged in rows and columns indicating the number of pixel samples to be assigned to a separate class related to the current classes, is done by the reference data. Overall accuracy is calculated by the total pixels correctly classified and the total number of separated pixels. In this study, random sampling method was used to evaluate the accuracy of classification. To assess the accuracy of cover classification, random samples are described for a separate class of plants.

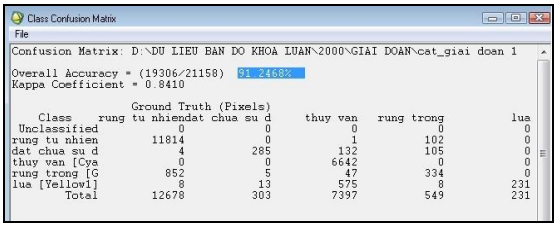
Very high accuracy of classification is usually accepted over 0.85 (85%), moderate accuracy is in the range 0.4÷0.8. These parameters are regulated by the U.S. Geological Survey. Kappa coefficient is used as the measure for the accuracy of classification. Kappa coefficient is usually between 0 and 1, the value lies in this range, and the accuracy of classification is approved. Kappa values have 3 groups:

- K > 0.8: high accuracy

- 0.4 < K < 0.8: moderate accuracy

- K < 0.4: low accuracy

Below is a matrix assessing classification results, the results show that it brings a relatively high accuracy.


Class Confusion Matrix

File

Confusion Matrix: D:\DU LIEU BAN DO KHOA LUAN\2000\GIAI DOAN\cat_giai doan 1

Overall Accuracy = (19306/21158) 91.2468%
Kappa Coefficient = 0.8410

Class	Ground Truth (Pixels) rung tu nhien	dat chua su d	thuy van	rung trong	lua
Unclassified	0	0	0	0	0
rung tu nhien	11814	0	1	102	0
dat chua su d	4	285	132	105	0
thuy van [Cya	0	0	6642	0	0
rung trong [G	852	5	47	334	0
lua [Yellow1]	8	13	575	8	231
Total	12678	303	7397	549	231

Figure 7: Error matrix of classification results

However, two Landsat images in 2000 and 2010, the average resolution (28.5 m), the classification accuracy is not high. Error rate is quite high between samples, between pairs of objects having similar spectral reflectance: cultivated rice cover, vegetation cover in residential areas and crops cultivation.

3.2.2. Results of mapping vegetation

After collecting processed image data, GIS tools are used to build complete maps on vegetation of Phu Loc District in 2010, the characteristics and structure of vegetation types in 2010 are shown in Figure 8 and table 1

- Natural vegetation: The distribution of vegetation in 2010 based on vegetation characteristics of the study area. In particular, subtropical evergreen moist broadleaf forest was 4426.01 ha. At lower elevations, tropical moist

evergreen broadleaf forest dominated with the area of 18940.15 ha. The area of tropical moist evergreen broadleaf forest at 600-800m high was 3136.99ha. From 300-600m was 7512.15 ha and less than 300m was 5899.37 ha. The area of secondary scrub and grass land, bamboo forest was 2189.88 ha and coastal mangrove was 201.76ha (see table 1).

- Planted vegetation: Paddy fields with an area of 6561.91 ha accounted for 9.08% of the total area. This area is less variable compared to the previous period. This agrees with the actual that wet rice agriculture remains a key tree; despite some activities make to reduce its area but it is not significant. The other area crops, upland crops and industrial trees was of 1900.16 ha, 19292.84 ha of planted forest area accounting for 26.69% of the natural district area - was the type of carpet to have the largest area of planted plants. Vegetation in the residential area was 5465.12 ha and the area had low coverage of 2263.5 ha.

Table 1: Statistics of vegetation area in 2010

	Vegetation cover type	Area (ha)	Structure (%)
A	Natural vegetation		
	A1. Subtropical vegetation cover (over 800m)		
	1. Subtropical evergreen moist broadleaf forest	2216.61	3.07
	2. Special communities on mountain	49.74	0.07
	3. Secondary scrub and grassland	2159.66	2.99
	A2. Tropical vegetation covers (less than 800m)		
	4. Tropical moist evergreen broadleaf closed forest		
	4.1. 600-800m	3136.99	4.34
	4.2. 300-600m	7512.15	10.39
	4.3. Under 300m	5899.37	8.16
	5. Secondary scrub and grassland	2189.88	3.03
	6. Coastal mangrove forest	201.76	0.28
B	Planted vegetation		
	7. Paddy rice	6561.91	9.08
	8. Crops, burnt-over land, short-term industrial crops	1900.16	2.63
	9. Plantation forest	19292.84	26.69
	10. Plants in residential quarters	6465.12	8.94
	11. Areas with low coverage	2249.25	3.11
C	Aquatic vegetation		
	12. Aquatic plants	12450.36	17.22
		72285.80	**100**

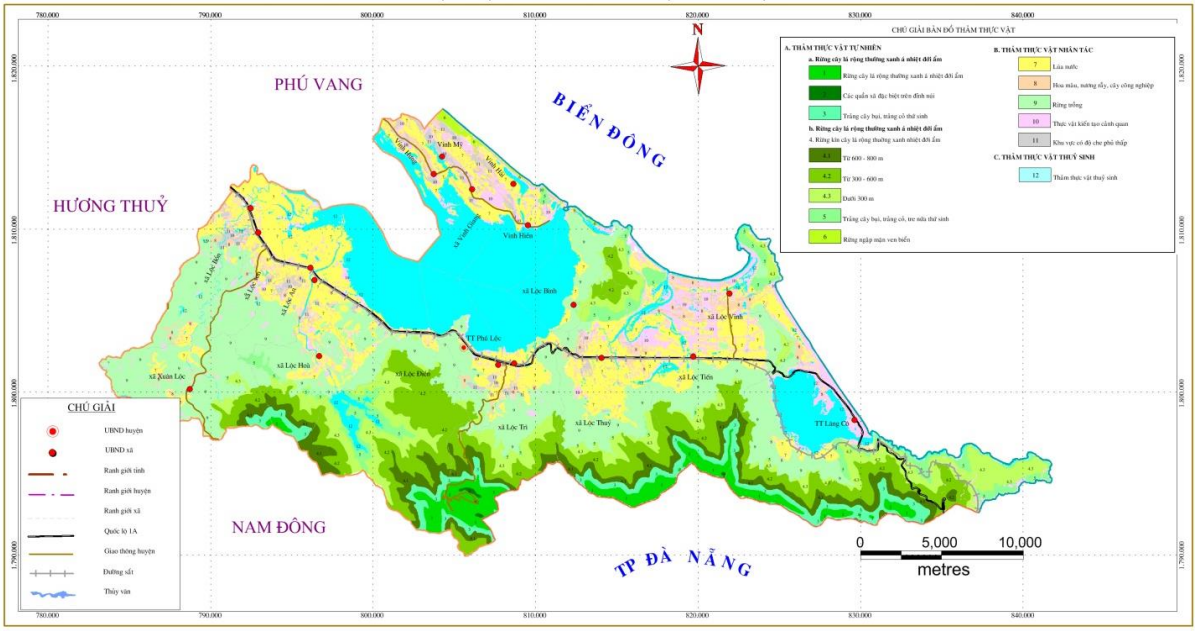


Figure 9: Vegetation status map in 2010, Phu Loc district

- Aquatic vegetation: an area of aquatic vegetation in Phu Loc district in 2010 had also changed compared to 2000.

4 . CONCLUSION

The study result to develop vegetation status map for Phu Loc district, Thua Thien Hue Province in 2010 by RS and GIS technology has identified three main types of carpet: natural vegetation with the area of 23 366 ha, accounting for 32.32 %; planted vegetation with the area of 36469.28 ha, accounting for 50.46 %; aquatic vegetation covering an area of 12450.36 ha, accounting for 17.22 % of the total area.

The development of vegetation status map contributes substantially to the management, protection and rational exploitation of vegetation. In addition, mapping the current state of the vegetation is also important resources to serve territorial planning in a rational and sustainable manner.

Through research, we found that using RS and GIS technology for vegetation mapping is a modern method, brought high efficiency.

REFERENCED

1. Nguyen Huy Anh et al, 2013. Application of GIS and RS to assess the risk of landslides in the hills of Phu Loc district, Thua Thien Hue Province. Final Report, Science and Technology subject of Hue University Level, Hue, 2013 (Vietnamese).

2. Bui Thi Thu et al, 2005. Integrated Assessment of natural conditions for agricultural development - sustainable forestry in Phu Loc district, Thua Thien Hue province. Final report of the ministerial level scientific and technological subject, Hue (Vietnamese)..

3. Thai Van Trung, 1987. Vietnam forest vegetation, Scientific and Technical Publishing House, Hanoi (Vietnamese)..

4. Phu Loc District People's Committee, 2010. Report explaining the land use plan from 2007 to 2010, Phu Loc district, Thua Thien Hue, Phu Loc (Vietnamese)..

5. Phu Loc District People's Committee, 2011. Statistical Yearbook 2010 of Phu Loc District, Phu Loc (Vietnamese)..

6. People's Committee of Thua Thien Hue,2005. Thua Thien Hue Monography, Natural Part, Social Sciences Publishing House, Hanoi (Vietnamese)..

7. People's Committee of Thua Thien Hue Province,2005. Baseline, synthesis-oriented survey of natural conditions, natural resources of Phu Loc district, Thua Thien Hue Province, Subject Final Report, Institute of Geography, Hanoi (Vietnamese)..