VEGETATION COVER IN KIEN GIANG PROVINCE

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Conservation and Development of the Kien Giang Biosphere Reserve Project

Vegetation Cover in Kien Giang province

A report by Le Phat Quoi

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PART 1:
INTRODUCTION

Kien Giang has a Biosphere Reserve with an area of over 1.1 million ha. Kien Giang biosphere reserve contains a rich, diverse and unique landscape and ecosystems of great value in terms of research, as well as tourism. Kien Giang biosphere reserve covers the territories of the districts of Phu Quoc, An Minh, U Minh Thuong Vinh Thuan and Kien Hai Kien Luong, and includes three core areas of Phu Quoc National Park U Minh Thuong National Park and the coastal mangrove protection forest of Hon Dat, Kien Luong and Kien Hai.

In general, in comparison with other places in the Mekong Delta region, Kien Giang province with the island districts has a variety of other natural factors such as geology - sedimentary terrain - geomorphology, the soil and climatic factors - hydrology. Both high mountain region and coastal alluvial soils have differences in the formation and properties inside the ground. It is such natural conditions that formed the natural ecological zones at the relatively large difference and the different ecological zones thus formed vegetation covers, representing the different ecological regions.

Coastal mangrove forests along the coast of Kien Giang play an important role in combating coastal erosion and create habitats of biological diversity particularly in the areas of Kien Giang. The coastal mangrove forests in Kien Giang have many change in area over the years and there have been adverse impacts on ecosystems and biodiversity of coastal mangroves.

Phu Quoc National Park, located north of Phu Quoc Island covers an area of approximately 31,422 ha. This place is considered to be a place of preserving and restoring the Dipterocarpacea and other plant communities, etc. According to the various sources and the Subinsitite of Forestry Planning and Inventory in 2006, there were about 1,172 vascular plant species in Phu Quoc National Park.

Phu Quoc island is located in the area, geological conditions and soil, which are quite different from the mainland. Phu Quoc has the mainland coastal climate regime; therefore, there should exist many types of forests such as Melaleuca forests, mangrove forests with dominant vegetation being Rhizophoracea, sparse forests and dipterocarp forests, mixed secondary forests, scrub forests, rocky mountain forests producing various ecological units and habitats. It can be said that dipterocarp forests in Phu Quoc National Park is the remaining unique closed evergreen forests in the islands in the Mekong region.

The flora is rich with diverse habitats is one of the favorable factors for many animal species to live. The fauna in the Phu Quoc national park area is quite diverse with 1,164

species of wildlife, including 42 rare species in the IUCN Red List and Vietnam (Institute of Ecology and Biological Resources 2005) as Big Loris (*Nycticebus bengalensis*) , small loris (*Nycticebus pyga*), long-tailed macaques (*Macaca fascicularis*), langur (*Trachypithecus germaini*), baby-clawed otter (*Aonyx cinerea*), Phu Quoc red squirril (*Callosciurus finlaysoni harmandi*).

U Minh Thuong National Park, an area of approximately 8053 hectares, is located in one of two areas of peat swamps in the Mekong Delta, Vietnam. Melaleuca is dominated and formed the different forest types, which remains a small area of semi natural Melaleuca forests (*Melaleuca cajuputi*). The abundant flora, about 226 species of vascular plants (Tran Triet, 2000) and the distribution with diverse communities and populations created the unique habitat diversity.

Many animals, including rare animals such as hairy-nosed otter (*lutra sumatrana*), baby-clawed otter (*Aonyx cinerea*), Java pangolin (*Manis javanicus*), East Striped Civet (*Viverra megaspila*) (Deng , NX et al., 2000). Approximately 187 species of birds have been recorded, including rare species such as *Pelecanus philippensis, Mycteria leucocephala*, *Leptoptilos javanicus*, *Threskiornis melanocephalus*, *Plegadis falcinellus*, *Aquila clanga*, *Ichthyophaga ichthyaetus*), (Safford et al. 1998, Buckton et al., 1999). However, according to records of the U Minh Thuong National Park, rare bird species were not seen for the past few years.

Like many other national parks, human impacts affect the flora and fauna, especially economic development activities in Phu Quoc in the last 10 years.
Kien Giang province has put enormous efforts in maintaining and protecting the coastal mangrove forest, especially establishing Phu Quoc and U Minh Thuong national parks in order to conserving and restoring natural resources with a focus on conservation of ecosystem and biodiversity in the area of Kien Giang

PART 2:

OVERVIEW OF KIEN GIANG AREA

2.1. Location and area

Kien Giang is a province in the Mekong River Delta region - the Southwest of the country: the north by the Kingdom of Cambodia on the south of Ca Mau and Bac Lieu provinces, eastern and southeastern border province of An Giang, Can Tho City and Hau Giang on the west by the Gulf of Thailand.

Kien Giang is situated in the lower Mekong Delta and has two parts of inland and offshore islands. The interior with a total area of 5638.27 km^2 and the inland areas of Kien Giang province in the geographical coordinates as follows:

- Từ 9^0 23' 50'' - 10^0 32' 30'' north latitude
- Từ 104^0 26' 40'' - 105^0 32' 40'' east longitude

North of Kien Giang bordering Cambodia, 56.8 km long border, south of Bac Lieu and Ca Mau province, on the west by the Gulf of Thailand with a coastline of 208 km respectively east of the province bordering An Giang, Can Tho City and Hau Giang.

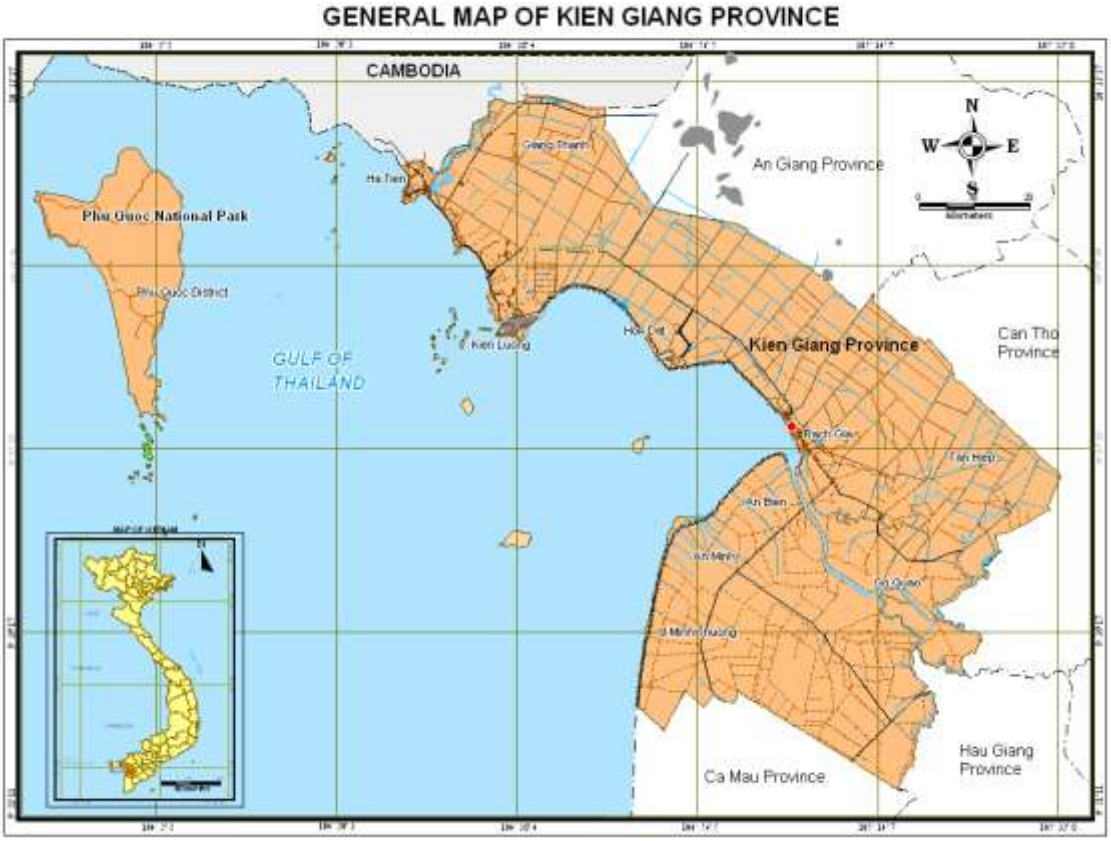
All islands of Kien Giang have a total area of about 700 km^2, located in the Gulf of Thailand. There are more than 100 islands, of which the largest is Phu Quoc and the farthest is Tho Chu Island. All 100 islands are clustered into five islands groups including Pirate Islands, Ba Lua archipelago, the islands of An Thoi archipelago Nam Du and Tho Chu Islands. The northernmost point of the province is Khanh Hoa Tan commune, Thanh Giang district. The southernmost point is located in Vinh Phong, Vinh Thuan district. The west point in My Duc, Ha Tien town and the easternmost point is situated in Hoa Loi commune, Giong Rieng district.

Kien Giang has 15 district level and town administrative units including Rach Gia City, Ha Tien town, and districts including Kien Luong, Thanh Giang, Hon Dat, Tan Hiep, Chau Thanh, Giong Rieng, Go Quao, An Bien, An Minh, Vinh Thuan, U Minh Thuong and Phu Quoc, Kien Hai.

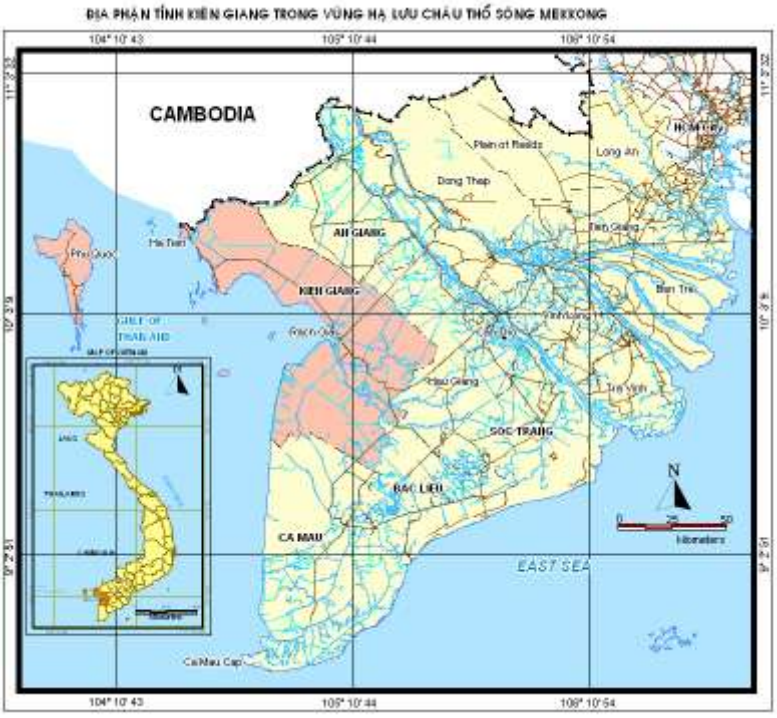
2.2. Climate and hydrology

2.2.1. Climate

Located at lower latitudes by the Sea, Kien Giang province has an ocean tropical climate; therefore, the common characteristic is hot and humid and seasonal rains. Total radiation in the year is from 120-130 kcal/cm^2. The average temperature is from 27 to 27.5^0c. The temperature varies relatively, ranging from 1 - 3^0c. The daily temperature range is quite large, from 7 - 10^0C. The average sunshine hours are about 2,500 hours per year.



Picture 2.1. General map of Kien Giang province



Picture: 2.2. Kien Giang province in Mekong delta

The rainy season starts from May to November and the dry season from December to April next year. The average rainfall in the mainland from 1,600-2,000 mm / year and from 2400-2900 mm / year in the islands, especially 2,900 mm per year in Phu Quoc. The period from July to October accounts for up to 60% of annual rainfall. August is the peak of the rainy season with rainfall of 300-500 mm. In general, the climate is quite favorable in Kien Giang: fewer natural disasters, there is no direct tropical typhoon and / or storm. It is not cold and the light and temperature are quite abundant for living and production.

2.2.2. Hydrology

The hydrological regime in Kien Giang province is affected by Mekong river systems, rain as well as tides in the west sea. The flood season usually occurs from July to November every year. October is the deep flooding time. The dry season lasts from December to June next year. During the dry seaon, the flow from upstream decreases and the sea water intrude many production areas with salinity of up to 5 g / l.

There are three major rivers in Kien Giang: The Great River, Cai Be and Giang Thanh River in addition to the old canal as the Vinh Te canal, channel Ha Tien - Rach Gia, Cai San canal, canal of Rach Gia - Long Xuyen, etc. For the past 20 years, a canal system developed with many newly built cannel in this area has helped to provide irrigation for washing acid of the soil, agriculture and transportation.

In general assessment, Kien Giang has had the abundant surface water; however, during the rainy season from May to October, the majority of surface water is contaminated by acidity and salinity due to its location at the end of the freshwater resources of Hau river, but in salt water upstream of Rach Gia Bay.

2.3. Topography and geology

Kien Giang is the variety of terrain, from lowland terrain, hills and mountains inland and mountainous areas of the island. Except for the mountainous region of Ha Tien, Hon Dat Kien Luong, the inland terrain is relatively flat, lower from the Northeast to Southwest: North East has an average elevation of 0.8 - 1.2 m, the Southwest has an average elevation of from 0.2 to 0.4 m (amsl - compared with the average water level in the standard in Mui Nai - Ha Tien). Islands have complex topography, which includes many islands and mountains scattered over the surface of the districts of Phu Quoc and Kien Hai district.

In overview, according to the topographic map by Da Lat Geography Insitute (1974) and the geological data of Tran Kim Thach (1986), the topography and geology in the area of Kien Giang province can be divided into the major form following:

Low hilly terrain:

Low hills are concentrated in Hon Dat district, Kien Luong district and Ha Tien town with the average height of 200 m. According to the geological structure, this area can be divided into three categories:

- Granite mountains: Hon Dat, Hon Me, Hon Soc.
- Limestone mountains: Chua Hang, Binh Tri, Hang Tien, Khoe La, Ngang, Tra Duoc, May and Mo So.
- Rocky mountain mixed erupted magma rock: Bai Oi, Ong Cop, Xoa Ao, Nhon, To Chau, Binh San, Phao Dai, Da Dung.

Plain terrain:

Plains are concentrated in the southern districts of the province such as Tan Hiep, Chau Thanh, Giong Rieng, Go Quao district, An Bien district, An Minh district, Vinh Thuan district and U Minh Thuong district. These areas were established by the alluvial sedimentation from Hau River with average height of 0.2 to 0.4 m (amsl) together with many canals and rivers flowing. These areas are heavily influenced by tidal regime in the west sea; therefore, these areas are heavily flooded during the rainy season and intruded by sea water during the dry season.

Low-lying delta region is located in the Long Xuyen quadrangle of Kien Giang Province, which was formed by young sediment materials. Marsh sediment materials with many elements and environments favorable to form potential acid sulfate soil rich in pyrite minerals in the low-lying plains, known as the flood openings in Kien Giang. Oxidation process of pyrite mineral in this region has formed active acid sulfate soils for many years.

Phu Quoc Island has a unique topography of mountains linking the islands running from north to south, with forest with rich flora and fauna and there are many beautiful beaches such as Bai Truong (20 km long), Bai Cua Lap - Ba Keo, Bai Sao and Bai Dai, Bai Hon Thom, etc. and there are 26 islands around the area for each of the different islands.

Compared with other provinces in the lower Mekong River Delta, Kien Giang province has abundant mineral resources. Some geological survey results, although incomplete, have identified several locations containing minerals including peat, limestone, building stone, clay, etc. In addition, there are other metal minerals such as iron, lateritic iron and materials of semi-precious stones such as black quartz – opal, of which the majority is non-metallic minerals used for production of construction materials and cement.

2.4. Soil characteristics

Based on samples from different geological materials through weathering process by various elements as well as physio-chemical processes, various soils were developed in Kien Giang area.

- Soils formed in place: formed by lava weathering process, minerals in place under the action of mechanical or chemical in nature. These soils are distributed in mountainous hills of Ha Tien, Kien Luong, Phu Quoc, Kien Hai, including two following units of land:

- Soils of ferrasols: formed by Ferralic formation process, which takes place dominantly, leading to destroying and leaching alkali cation, accumulating iron, aluminum; therefore, soils are red – yellow colored. These soils are mainly distributed in Phu Quoc and the mountains in Hon Dat district.
- Soils of Sialit - Ferrasols (Ferric Acrisols and Leptisols) formed by the ferralic and sialit processes occurring simultaneously. These soils are distributed mainly in the Phu Quoc and Ha Tien.

♣ Alluvial sedimentation: formed by river silt and deposition of marine sediments, concentrated in the lowlands of the province. Located far from the river, soils are here with heavy mechanical components, with clay percentage from 45 - 58%. The soils are over 70 cm thick, with high organic contents, which are divided into four main categories:

- Soils of fuvisols: occupy an area of about 30,000 ha, distributed mainly in the districts of Tan Hiep, Chau Thanh, Giong Rieng and scattered in Rach Gia, Hon Dat, Go Quao. Those soils are the best for agriculture in the province.

- Soils of thionic fluvisols: an area of about 223,000 ha, accounting for 40% of natural area of the province, mainly distributed in Ha Tien, Hon Dat, An Bien, An Minh, Vinh Thuan. These soils are good for some trees such as acacia, pineapple. Soils must be improved if other crops are planted on these soils.

- Salic fluvisols: an area of about 20,300 ha, distributed mainly in coastal areas or along rivers in the districts of An Bien, An Minh, Vinh Thuan, Go Quao and scattered in Chau Thanh, Hon Dat, Ha Tien, Rach Gia. These soils are often good for one crop rice a year, integrated with aquaculture.

- Salic thionic fluvisols: an area of about 225,000 ha, distributed mainly in the districts of An Bien, An Minh, Vinh Thuan, Go Quao and scattered in most other districts in the province. This soil is more affected by tide, is suitable for growing coconuts, pineapples, sugar cane or one crop rice a year in the rainy season.

2.5. Biology

Kien Giang Biosphere Reserve covers an area of over 1.1 million ha. Kien Giang biosphere reserve contains a rich, diverse and unique landscape and ecosystems of great value in terms of research, as well as tourism. Kien Giang biosphere reserve covering the territories of the districts of Phu Quoc, An Minh, U Minh Thuong Vinh Thuan and Kien Hai Kien Luong, including three core areas of U Minh Thuong National Park, Phu Quoc national park and coastal mangrove forests of Hon Dat, Kien Luong, Kien Hai.

Quite diverse forests in the area of Kien Giang are a representative of closed evergreen tropical forests in Phu Quoc National Park and Melaleuca forests in U Minh Thuong National Park and mangrove forests along the coastlines. The forests in Phu Quoc National Park are mainly untact with uneven canopy. However, in some areas, the forest canopy is over 80% with many rare plant and animal species. There are many rare species recorded in Vietnam Red Book and the world in U Minh Thuong National Park.

PART 3:

SURVEY METHODOLOGY

3.1. Rationale:

Systems National Plant Taxonomy (NVCS), which is being used to map the vegetation, have been applied to classify plants and vegetation cover in many countries around the world. This system proved to be appropriate to classify plants and vegetation cover maps at regional Mekong Delta. Appropriate approach to survey and map the vegetation covers should be based on data related to the field and the sequence of steps described in detail in the methodology.

1. Classifying plant combinations using species composition data from field samples;
2. Characteristics of the relationship between the combined distance and data variables (such as no picture models, satellite imagery, soil characteristics, climate, geological and soil samples);
3. Maps (spatial interpolation) of the combination by using the relationship established with the remote data by experimental variables, and,
4. Assessing the reliability of the map.

Vegetation cover mapping and development of the geographic information systems (GIS) in the past few years has been applied to digital mapping particular, has transformed the static data into a static database in digital form in by overlapping the data with each other information. Advances in remote sensing (RS), analysis and modeling, and theoretical models provide a fair accuracy in construction and a better understanding of the map data. Therefore, RS and GIS technology facilitated biodiversity research and cooperation for the implementation of a digital map of vegetation and vegetation cover for Kien Giang Biosphere Reserve together with other national parks in this area. Techniques of overlapping vegetation covers have been made available to apply to develop a complete map of vegetation cover as well as other maps in this study.

3.2. General objectives:

The objectives of this study are:

3.2.1. Determine the diversity of plant communities mainly present in Kien Giang Biosphere Reserve, and then set the level and distribution of each unit of vegetation cover;

3.2.2. Data on vegetation cover of Kien Giang in general and in areas of Phu Quoc National Park, U Minh Thuong Kien Luong - Hon Dat;

3.2.3. Map the vegetation cover with the current level and distribution of the cover unit. Surveys to be done and maps would be produced at a large scale (1:10.000) for U Minh

Thuong national park and Phu Quoc national park;

3.3. Methodology
3.3.1. Baseline map development

Although the collection of base map data available is very important, the spatial data collected in a number of local agencies are not exact in terms of the grid system, accuracy as well as details. Therefore, base maps have been developed through construction of vegetation cover data of Kien Giang.

Methods of the base map were used as follows:

- Using the UTM projection (Universal Transverse Mercator - WGS 84), 48 N in determining the coordinates of Kien Giang and neighboring areas;

- Collect spatial data of locations, administrative boundaries of the communes, districts, transports and canals in Kien Giang;

- The level of detail of the base map was built according to objective of developing mapping vegetation cover: 1/25.000 for the general map of Kien Giang, and 1/10,000 for U Minh Thuong national park and Phu Quoc national park;

- Using SPOT 5 satellite imagery and Landsat TM7 in 2009 to interpret and digitize objects necessary for a base map of the region and surrounding areas in Kien Giang;

- Groundtruthing and adjusting correct errors in the digitization process. In addition, the results of base maps are also checked with the connection with the spatial data attributes of the surrounding area, including the Cambodia because Kien Giang province is bordered with Cambodia in the north;

- Results of the base map will be used as a basis for mapping vegetation cover of Kien Giang Biosphere Reserve, U Minh Thuong national park and Phu Quoc national park.

3.3.2. Mapping vegetation cover

Overview of mapping vegetation cover and the implementation of each process at different stages as follows:

Step 1: Collect data

- To ensure the full application of the existing data and other information in the area of Kien Giang, information about the natural elements in the region and in the park was collected and used in the analysis and assessment during mapping vegetation cover;

- Some current data was be referenced as geological maps - sediments, soil, biological resources;

- Some data on satellite images (Landsat TM 7) of the previous years were also used to assess vegetation change over the years.

Step 2: Interpretation of digitization:

Because the current data in the region appeared on paper only; therefore, GIS software was used to digitize all the thematic maps that overlapped each other for target analysis and evaluation.

UTM grid system (Universal Transverse Mercator) (WGS 84), 48N was used to map vegetation covers of Kien Giang.

The attribute data of the map included the main data such as hydrography, roads and canal systems in the entire area of Kien Giang.

Mapinfo-GIS software was used in the digitization of spatial data attributes. All data and information was gathered to clarify the interpretation of the relationship between natural conditions with existing vegetation covers.

Step 3: Interpretation aerial photos iand satellite imagery

Aerial photos and satellite images have been widely used as sources of remote sensing data. Aerial photos were used to identify land features and soil types in the distribution map of Kien Giang Biosphere Reserve.

Results of satellite image interpretation for the plant objects and the objects on the ground and the distribution of some plant communities were recorded and identified. Contour vegetation coverss preliminarily determined using GIS system were used in the survey and groundtruthing.

Soil structure properties, high-resolution satellite images were useful for mapping vegetation cover in detail in the area of Kien Giang, particularly for vegetation maps. Interpretation of remote sensing image and groundtruthing together with some techniques were used for the classification of vegetation units and vegetation covers in the region and Kien Giang the national parks.

Satellite images, therefore, were interpreted to detect a general distribution of wild plant species. Most of the distribution of native plants and soil in Kien Giang region were reflected by using satellite image with infrared bands, such as Landsat TM 7 images and ETM plus (ETM +). The ETM + had eight spectral bands with a resolution of 30 x 30 meter space for seven spectral bands, and with 16 x 16 meters for the remaining spectrum bands. Satellite images including Landsat TM7, Landsat ETM + of the years 2003, 2004, 2005, 2006, 2007, 2008 and 2009 were used to interpret in this research.

Satellite images were interpreted to detect distribution of wild plant species in general. Most of the distribution of native plants and ground covers Kien Giang biosphere reserve were reflected by using infrared satellite images on Landsat 7 ETM.

In addition, the SPOT 5 satellite image taken in 2009 during the dry season was used to supplement interpretation of plant objects and other subjects in the study area of Kien Giang.

Different countours representing different structural units of vegetation were initially determined by the method of interpretation and then the contours were then digitalized automatically using a specialized software program (ENVI Ver 4.0) to identify different areas, including vegetation, water and bare land areas, which would be interpreted and classified at a later stage.

In addition, in order to identify the different vegetations, from which vegetation cover units were then classified, the method of determining the different vegetation indices (NDVI) was used to determine the current status the vegetation. Vegetation index was a value calculated (or derived) from remote sensors in order to detect and quantify these things on the ground thanks to remote-sense data. NDVI indices, like in most plants index, were calculated as a ratio between the measured reflectance in the red tape and tape close to infrared (NIR) of the electromagnetic spectrum. Two spectral bands were selected because they were most affected by the absorption of chlorophyll in green plants and the density of green vegetation on the surface. This work was done thanks to the support by the software ENVI.

The conversion of NDVI was calculated as the ratio of the measured intensity spectrum of red (R) and near infrared spectrum (NIR) by using the following formula:

NDVI = (NIR - Red) / (NIR + Red)

The result was the value of this sensitivity of the presence of vegetation on the ground and could be used to solve the problem in plant species, even the number of plants, and conditions where they were present.

Landsat 7 and ETM + were used in this study; therefore, the measurement of the red band (R) and near-infrared (NIR) were performed with the following formula:

(ETM +) NDVI = (Band 4 - Band 3) / (Band 4 + Band 3)

Step 4: Groundtruthing to collect data

The main objective of the vegetation survey was to identify many plant species and communities, with different species of flora present in the key sites of Kien Giang Biosphere Reserve and in the Phu Quoc national park and U Minh Thuong national park.

Sampling collection for inspection during the groundtruthing was done randomly and sampling was collected as representatives. Sample data collected was used to check results from satellite image interpretation and used to adjust the unit vegetation cover in the survey area.

Data from groundtruthing was used for classification and full description of all the plants in Kien Giang Biosphere Reserve and two national parks. Thus, at the point of the survey, the plants were inventoried in term of richness and density of plant species.

The different contours of different plant types were determined from the beginning by interpretation of satellite images were examined and checked in representative points. Sampling were collected in identified locations, and then repeated in another contour in order to check the logic and reliability of data from satellite image interpretation. Number of samples was collected to be representative and the contours were interpreted to represent the entire area of Kien Giang and national parks.

Groundtruthing:

In each identity region, boundaries were marked and landscapes were recorded.

Vegetation was divided into the visual classes (strata) and average height and percentage of each floor were recorded. Within each level, all species were determined, classified and reviewed for species richness. Howerver, abundance of species was not reviewed.

GPS was used to determine the location and presence of plant communities, vegetation cover units in the survey area. These data would be useful for monitoring vegetation cover or plant species for the following years.

The vegetation was characterized by the link between the distribution patterns of individual species, their presence in the natural landscape of the vegetation cover. Therefore, the determination of the cover unit was linked to their natural landscapes.

The description of vegetation: each plant species in the contour interpreted through satellite images were recorded and described. The description included common characteristics of these species according to wide ranges of information. Then, focus was made on specific expression of specific species in the survey area. The description included information on biological features of physiognomic and vegetation, as well as environmental relationships, dynamic process, transform communities and other relevant factors. Forms of vegetation description were based on the format of The Nature Conservancy.

Parameters describing vegetation cover: the ecologists often used the number of species and individual species to describe the vegetation. This study used the same techniques. However, the application of spectral reflectance density of satellite images

in combination with data collected from groundtruthing were used in assessing the density distribution, the presence of vegetation in an vegetation covers.

According to the plant ecologists, for wood tree species, the calculation of density and / or richness of plant communities is based on canopy cover of wood tree plants. Therefore, the determination of density of tree groups in the vegetation units based on the ratio between vegetation over an area occupied by a certain percentage with maximum number of 100% and the values obtained was an estimate.

In order to illustrate the vegetation cover, five properties related to five rating of richness of density of vegetation cover were as follows:

Layer	Note		Temperate density	Percentage
1	R	Scattered	Rare seen or if found, scattered	< 5
2	O	Open	Present with low level	5 - 25
3	F	Sparse	Fairly present, but not exceeding 50 %, maybe with other communities together	25 - 50
4	C	Average	Very popular and fairly dominant in some vegetation cover units	50 - 75
5	A	Thick	Rather popular and mainly dominant in all vegetation cover units.	75 - 100

Step 5: Evaluate the accuracy and caliber the data

The new boundaries of the contour in vegetation unit would be calibered or added after the groundtruthing. These small units, which could not be clearly defined on the ground, would be supplemented by interpreting resolution satellite images and the survey results.

Plant species would be determined by scientific name. The necessary work would be to test and identify plant species by plant classification. The accuracy of map vegetation coverss would be analyzed with the data gained from the groundtruthing including the following steps:

- Combining all the same vegetation covers into one common unit depicted on on the map.
- Conducting comparative analysis of groundtruthing data and map data.
- Reviewing data, preliminary results and editing the results if there would be many holes and errors.

After vegetation cover maps were preliminarily complished, steps would be done to check the accuracy of the classes. The accuracy of the data from the vegetation cover units would be based on interpretation of data, field data collection and analysis methods of plant communities and the vegetations covers present naturally in Kien Giang.

Coverage is the degree of canopy cover.

♣ Coverage is the percentage of forest area per unit area or territory, for example the forest coverage in Vietnam in 2005 was 35.5%;

♣ Canopy is the extent of forest canopy cover. It is often classified according to the the level 0.1, 0.2,…0.9; 1;

♣ Crown level is the level representing the spread among the individual trees in the communities. This is also is an indicator to determine the stage of the forest;

♣ Distribution of density diameter: Graph mathematical functions and density distributions under the target tree diameter;

♣ Distribution of density height: Similar to other diameter is only based on height.

To determine the type of vegetation cover in the construction of a cover map, density and ground cover were done according to the following standards.

Thick	All tree species with canopy more than 70 %.
Average	All tree species with canopy from 40 to 70 %
Sparse	All tree species with canopy from 10 to 40 %
Bushes	Poor forests with small canopy and canopy less than 10 %.

3.4. Schedule

The study was implemented from August 2009 to March 2010, of which groundtruthing was carried out as follows:

a. U Minh Thuong National Park: September 2009;
b. Phu Quoc National Park: November 2009;
c. Coastal mangrove forests in Hon Dat - Kien Luong: many field trips in December 2009.

desk work and data processing from August 2009 to March 2010.

3.5. Staff involving in survey implementation:

1. TS. Le Phat Quoi - Institute for Environment and Natural Resources, VNU HCMC City;
2. Vo Thi Thu Van - Institute for Environment and Natural Resources, VNU HCMC City;
3. The team of U Minh Thuong National Park including:

    - Mr. Pham Quoc Dan;
    - Mr. Hoang Van Chinh;
    - Mr. Chao Play;

4. The team of Phu Quoc National Park including:

    - Ho Van Phu;
    - Tran Anh Vu;

And commented by:

1. Mr. Nguyen Xuan Vinh - Ho Chi Minh City Institute of Tropical Biology, HCM City;

2.Mr.Nguyen Huu Thien - WWF Advisor.

PART 4:

VEGETATION COVER IN KIEN GIANG BIOSPHERE RESERVE

4.1. Vegetation map of Kien Giang Biosphere Reserve

Based on satellite image interpretation, groundtruthing and classification of vegetation were implemented. As a result, 27 units of vegetation cover in Kien Giang province were identified (Table 4.1).

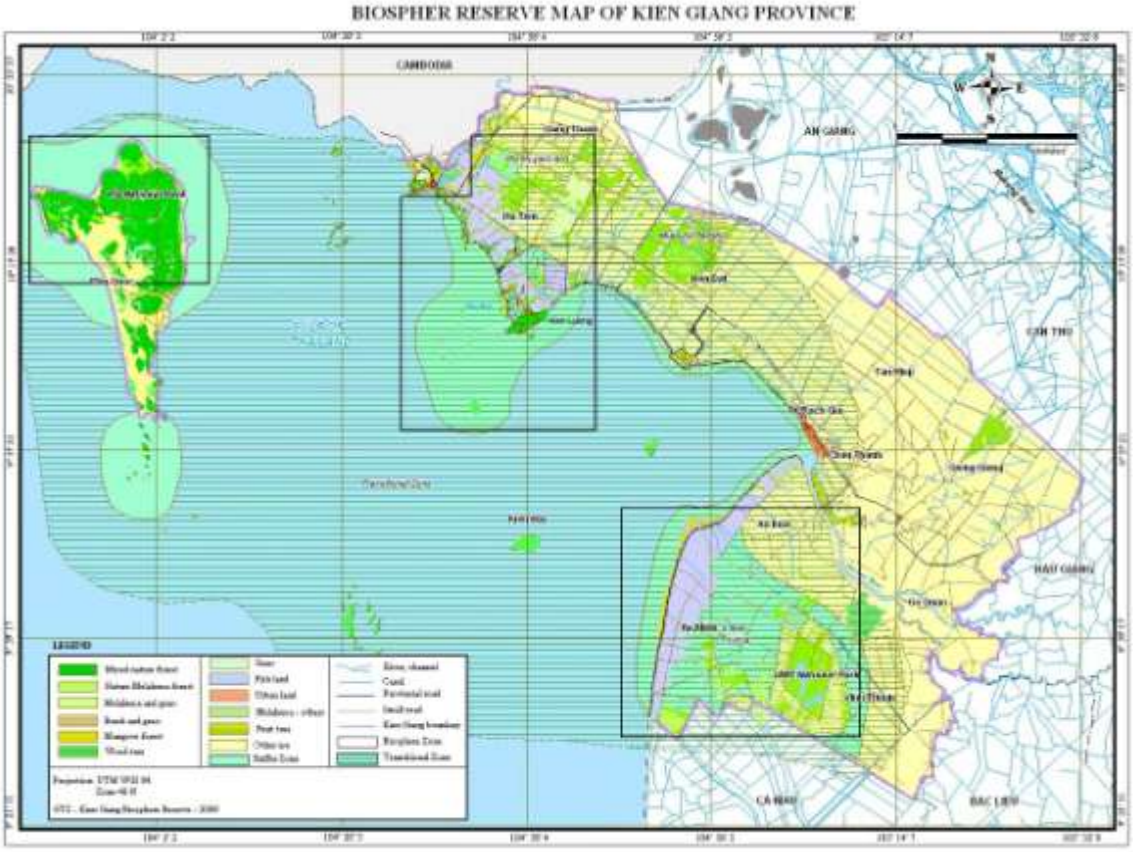


Figure 4.1. General map of Kien Giang Biosphere Reserve in Kien Giang province

Table 4.1: The unit of vegetation covers within the Kien Giang Biosphere Reserve

No.	Vegetation cover unit	Area (ha)	Coordinates (meters)	
			Longitude	Latitude
I	**Primary forest**	**3.1641,74**		
1	Dense primary forest	11.755,22	387546.4	1146794
2	Moderate old-growth forest	19.713,96	393120.5	1134425
3	Sparse old-growth forest	172,56	392254.7	1140875
II	**Primary forest - Shrubs – Grass**	**9.235,43**		
4	Sparse medium-growth forest – Shrub	9.168,63	393267.4	1144128
5	Sparse medium-growth forest – Grass	66,80	374014.9	1142070
III	**Melaleuca Forest**	**10.312,00**		
6	Natural melaleuca	1.209,27	387747.1	1150962
7	Natural Melaleuca – Shrubs	9.046,73	507875.9	1070667
8	Natural Melaleuca – Grass	56,00	398321.6	1138739
IV	**Regenerated Melaleuca Forest**	**1..356,49**		
9	Dense Melaleuca	626,50	510858.2	1059226
10	Medium Melaleuca	729,99	507270.2	1064572
	Melaleuca Plantation	**42.266,22**		
11	Melaleuca plantation	37.631,92	520476.4	1071204
12	Sparse Melaleuca plantation – Grass	4.634,30	469030.6	1146340
	Mangrove Forest	**11.804,8**		
13	Sparse natural mangrove forest	83,37	388367.8	1150137
14	Restored mangrove forest	5.765,17	447254.3	1148978

No.	Vegetation cover unit	Area (ha)	Coordinates (meters)	
			Longitude	Latitude
15	Sparse mangrove – Aquaculture	747,87	488293.9	1087410
16	Young mangrove forest in mudflat	279,19	446195.4	1149944
	Mixed tree			
17	Sparse restored young trees	4.929,2	514688	1088870
	Shrubs – Grass	**10.577,4**		
18	Shrubs – Grass	1.337,72	377992.7	1139835
19	Wild grass	7.557,16	489204.1	1139506
20	Aquatic plants	1.682,52	508988.3	1059706
	Others			
21	Wood tree - Fruit Tree	2.321,66	385596.8	1139679
22	Fruit tree	1.982,84	451117.6	1147770
23	Others - Bare ground	1.986,23	398412.5	1140768
24	Crops	230,91	452958	1136575
25	Agricultural land - Shrubs – Grass	8.489,16	387037.1	1123681
26	Aquacuture – Other	38.108,08	489824.6	1071071
27	Water Reservoir	22,36	449875.6	1149200
28	Open water	445,76	509060.8	1061988
29	Sand bar	1.547,13	398889.9	1134484
30	Urban	3.087,63	510202	1103242
31	Airport	61,32	386733.1	1130214
32	Factory land	286,16	456745.2	1129430

Forests and forest types distributed fairly typical in the natural ecosystem integrated with natural elements in the area of Kien Giang.

Forests were classified according to their origin formation in this study to describe the cover units, accounting for mainly vegetations being forests. In addition, the term in a classification by type of forest site was set up to use easily understood by local use (land forests, mangroves, flooded forests).

Two forest types were recognized in the area of Kien Giang including natural forests, and plantation.

4.1.1. Primary forest

4.1.1.1. Upland primary forests

Vegetation covers on mountainous natural forests land occupied mainly in hilly areas in Phu Quoc Island, Ha Tien, Kien Luong and some other small islands in Kien Hai district. They include primary forests and secondary vast remainder of the Mekong Delta region.

In some mountain areas, there are mixed groups of endangered species, mainly belonging to *Theaceae, Lauraceae, Clusiaceae*. There are also gymnosperms such as *Dacrydium elatum*, *Dacrycarpus imbricatus*, *Nageia wallichiana*. The coverage in these areas is not high, resulting into sparse vegetation cover.

In general, major groups of forest vegetation on the mountain under their tree oil (Dipterocarpaceae) are dominant. In some areas, there are mixed plant species belonging to *Sterculiacea, Meliace, etc.* with high density, creating high closed forest vegetation cover (Figure).

In lower elevation down to the foothills, where there are gaps with different plant species with mixed dipterocarp as *Sterculiaceac, Meliacea*), etc.

Primeval forest on the mountain land cover changes from thick to sparse. Much of the forest trees are mature trees with large diameter trunk.

On the thick forest area of about 11,755.22 hectares, premival mangrove forests appear on Ferasols with the elavation of 200 - 350 m (AMSL) of Phu Quoc Islands. The dominant trees are *Dipterocarpaceae, Dipterocarpus dyeri, Dipterocarpus costatus and* some species such as *Hopea pierrei*, *Garcinaia sp. Etc.* Meanwhile, in average primary forest with an area of about 19,713, 96 ha, , there are many patches of old age tree species with rather closed forest cover of about 50-60%. The remaining areas are with small trees and bushes. The species composition is with untact forests with dominant species of

Dipterocarpaceae, Dipterocarpus dyeri, Dipterocarpus costatus and some species such as *Hopea pierrei, Garcinaia sp., Shorea hypochra*, etc.

Figure 4.2. Mature forest with average covers with many old age trees in Phu Quoc National Park.

There are about 20 – 40 % spare forests of about 172.56 ha, with rather low cover. The rest are small trees mixed with bushes and / or grass with low density. Forest plants are dominant with *Dipterocarpus intricatus*, *Dipterocarpus obtusifolius*, *Hopea odorata*, *Paviesia anamensis*, *sp Syzigium, Dilenia ovata*, *Panirari anamensis*, etc. The mature trees create great array of old trees in sparse populations of forest plants (Figure 4.3).

Figure 4.3. Mature spare forest in Phu Quoc National Park

4.1.1.2. Primary forest - Shrubs – Grass

Forest cover is dominant with premival forests with average density of 40-60%, mixed with trees and weeds in the remaining area. The total area of mixed forest trees and weeds account for the 9235.43 hectares, most of these forest covers is located in the North and bushes near the southern island Phu Quoc islands.

Based on the density of trees and wild grass interspersed in the forest, vegetation covers are divided into two categories: 1) average aged sparse forests with bushes and 2) averaged aged sparse forests with weeds.

Tree species mixed with bushes include *Dipterocarpus, Dipterocarpus intricatus*, *Dipterocarpus obtusifolius*, other timber trees drop recorded in the vegetation covers *Hopea odorata, Paviesia anamensis, Syzigium sp., Dilenia ovata*, *Panirari anamensis*. The tree group is mixed with thick species including *Grewia paniculata*, *Memecylon harmandii*, *Croton poinanei, etc.* forming a layer of low vegetation near the ground (Figure).

Figure: Sparse forests mixed with bushes in Phu Quoc National Park.

4.1.1.1.2.2. *Sparse medium-growth forest – Grass*

Sparse average aged forests mixed with grassland forming vegetation covers fairly typical for primeval forests destroyed by many factors in the area of Phu Quoc. Vegetation covers distributed mostly in the north of Phu Quoc National Park with an area of 66.80 hectares. The average aged of trees present in the sparse forests create a definition of untouched remaining natural forests . Weed distribution between the small patches of forest or mixed clusters between the trees together (Figure).

Figure 4.4. Sparse forest with big tree average aged species with mixed grasslands in Phu Quoc.

4.1.2. *Melaleuca*

Rather broad distribution in the mangrove areas in Kien Giang, from alkaline soils in the area of the Long Xuyen quadrangle of Kien Giang to the coastal areas. Melaleuca forests are still present in areas contaminated with salt water in estuaries (Rach Melaleuca forests) of Phu Quoc Island. In this area, Melaleuca is located adjacent to mangroves and Melaleuca is present even close to the river bank, replacing an array of mangrove forests have disappeared. In addition, the Melaleuca forests network or individual clusters also grow on the coastal slopes of sandy soil in Phu Quoc Island.

Melaleuca is divided into three main units: 1) natural melaleuca, 2) naturally recovered melaleuca and 3) plantation. Melaleuca plantations include forestry farms managed by the government or the private sector and melaleuca forests in scattered parts of the province under the sovereignty of farmers.

4.1.2.1. *Nature Melaleuca forest*

Melaleuca forests naturally occupy about 10,312 ha, including natural melaleuca forests Melaleuca forests melaleuca forests merely mixed with the natural plant groups. Melaleuca forests distributed mainly in the north of Phu Quoc island, mainly concentrated along Rach Melaleuca forests and a surrounding part along

a canal outside the Phu Quoc national park area. Three units of natural melaleuca covers are as follows: 1)purely natural melaleuca, 2) melaleuca forests mixed with bushes and 3) melaleuca forest mixed with weeds.

Purely natural Melaleuca is both medium to extra density with old ages ranging from very pretty old trees to regenerated forests with average age from 8 -12 years at a later stage. Natural melaleuca forest area accounts for about 1209.27 hectares.

Some parts being sandy, acidic soil environment are not established with vegetation covers under the melaleuca with species *Eleocharis dulcis*, *Euriocaulon echinulatum*, *Xyris pauciflora, Cyperus sp. a*nd other weed species.

Figure 4.5. Natural Melaleuca forest lands on acid sulphate soil in Phu Quoc Island. Melaleuca trees with traces of fire in the dry season 2 years ago. Under the impact of fire, the seeds of melaleuca were separated and germinated forming a vegetation cover under the melaleuca forest.

Melaleuca trees naturally mixed up the area up to 9046.73 ha and mainly distributed along the edge of the natural melaleuca forest with average density in the north of Phu Quoc Island. Melaleuca forests fluctuated quite largely with the average density of 50 - 70%, but there are places below 20-30%. Age of the Melaleuca forests is quite large fluctuations, there are clusters of stations having an average age, but there are clusters of relatively high percentages with age, over 30 years (Figure).

Vegetation beneath the forest canopy is quite diverse such as *Archylea valali*, *Dillenia ovata*, *Melastoma candidum*, *Menecylon harmandii*, *Thunbergia fragrans*, etc. Tt is observed that vegetation covers the Melaleuca intercropped weeds are more varied.

Figure: Melaleuca forest mixed with many bushes in Phu Quoc National Park.

Melaleuca forests with grasses are pretty sparse density of about 20-30% of the remaining area. Its distribution in the North of Phu Quoc, occupying an area of about 56 ha, but can see this is one of the primary carpet melaleuca forest remaining on the island of Phu Quoc.

Most melaleuca forests scattered mixed with grass, but there are a few places, melaleuca is with small presence in clusters. Remaining melaleuca forest with big diameter tree with traces of the destroyed mangrove branch.

4.1.2.2. *Restored Melaleuca Forest*

Natural mangrove forests which have been destroyed before by many causes: war, fire, etc. has been reborn and restored later in the year. The total area of forest Melaleuca forests restoration is approximately 1356.49 hectares, mostly concentrated in the U Minh Thuong National Park area. Based on the coverage of the station, two units cover include: 1) densely restored melaleuca , and 2) the average restored melaleuca.

Melaleuca forests with relatively dense coverage and relatively high, ranging from 70-90%., With an area of about 626.50. In the U Minh Thuong National Park area, thick forest Melaleuca forests concentrated in areas with thick peat layer. Most melaleuca restored after fires in 2002 to only about age 7-8 years old.

Mangrove rehabilitation with an average density of the mangrove forest cover is regenerated with average of 50-60%, the rest is trees, grass and aquatic plants but these plants do not occupy this side density significantly. Vegetation covers area of Melaleuca averaging about 729.99 ha, mainly distributed in the U Minh Thuong National Park area. Average melaleuca forest is largely restored and the array Melaleuca forests remnants of natural fires in 2002.

Figure 4.7. Dense melaleuca forests regenerated after the fire 2002 in U Minh Thuong National Park (located center in the righ corner of the figure).

Many Melaleuca forests in U Minh Thuong National Park area, in mixed forests of Melaleuca species recovery is the day, vines and aquatic plants. Melaleuca coverage and density of occurrence of the species, aquatic plants can be divided into many different units when the vegetation covers map vegetation covers construction detail

4.1.2.3. *Melaleca Plantation*

As well as some other areas of the Mekong Delta, Melaleuca forests pretty much grown on alkaline soils of Kien Giang. Because of the alkaline soil, or heavy alum so low soil pH, pH range from 3.5 to 5.5 years depending on the season ttrong.

Melaleuca plantation land under the sovereignty of the State and private groups, and farmers. For the sovereignty of the State and private groups are highly concentrated area of Melaleuca forests into forestry, but it's quite private land scattered throughout the province of Kien Giang alum. Through analysis of satellite images and surveys show that most distributed in districts Melaleuca forests Kien Luong, Hon Dat, U Minh Thuong and An Minh.O other places still have a presence severely less area. and fairly distributed. Two units are divided Serious Serious is the average density and intercropping with Melaleuca forests sparse weeds.

4.1.2.3.1. *Melaleuca plantation*

These are fields planted melaleuca alkaline soil concentration and the scattered parcels of land were planted to stop the economic objectives. Melaleuca average area planted was estimated at 37,631 ha. Vegetation covers maps in this report does not show all the fields scattered melaleuca in Kien Giang province, where the entire focus in the areas planted Melaleuca focus areas and an area of 2 ha melaleuca forests Melaleuca forests.

Melaleuca forests major focus area is mainly distributed in Kien Luong, Hon Dat and the U Minh Thuong. A focus area in Kien Luong Melaleuca forests and Hon Dat Forest School are planted Melaleuca and Eucalyptus (Eucalyptus sp.) Ago. Compared with previous years, the area of Melaleuca in this area has decreased significantly. Melaleuca forests U Minh Thuong area planted area and average dispersion around the U Minh Thuong National Park. Here, despite the change of purpose of use, but due to the nature of land unsuitable for other uses should target Melaleuca forests is still quite a lot, especially in the national park's buffer zone (Figure).

Figure 4.8. Severe (left side) in the buffer zone of U Minh Thuong National Park. Melaleuca is right inside the U Minh Thuong National Park. Cai Beo aquatic plants (*Pistia stratiotes*) has covered the surface of the canal park boundary.

Figure 4.9. Melaleuca planted in alkaline soil areas of Kien Luong district, Kien Giang. Because Melaleuca is grown on alkaline soil, *Eleocharis dulcis* appears quite a lot, and interspersed along the edge of the area Melaleuca forests.

4.1.2.3.2. Sparse Melaleuca plantation – Grass

Alkaline soil areas are in the area, but coverage is not high, only between 30 - 50%, and the gaps were covered by a layer of weed. Estimated total area of the weed Melaleuca extra cents in about 4634.30 hectares. This coating distribution in many areas of Kien Luong, Hon Dat and Giang Thanh.

Melaleuca forests area focuses mainly alkaline soils and limited water resources, the weeds in this area are mainly *Eleocharis sp.*, *Panicum repens*, *Ischaemum aristatum L.*, *Ischaemum indicum, Lepironia articulata*. Two grass species are recognized features of the area is sparsely Melaleuca forests such as *Eleochris dulcis*, *Eleocharis attropurpea* and some grass species common in wetlands.

Figure 4.10. Serious focus, including the Melaleuca forests is the average density and density in the region Hon Dat district, Kien Giang province. Melaleuca forests concentrated around the rice fields. (Photo satellite SPOT 5, March 2009).

4.1.3. *Mangrove forest*

Mangroves present lot, with an area of 11,804.8 ha, and most distributed along the coastal wetlands in the area of Kien Giang. At Phu Quoc National park, mangroves are found in some estuaries and along the river also affected her salty and brackish environments such as Rach Melaleuca forests, etc. In the interior of Kien Giang, the distribution of mangroves along coastal areas stretching from Ha Tien to the U Minh Thuong, mangroves distributed largely on the accretion of coastal land with a mainly sandy mud, usually water saturated year round, so the strength of coastal land was poor, when they are inside, along both sides of the river, the soil strength increased but not significantly. Thus, the places affected by strong sea breezes will easily make the mangrove trees had fallen.

Affected by natural factors and human sequences coastal mangrove forests have various widths, there are places up to 200 m wide, but there are only few places where trees or only sign stain with the trees located off the coast affected by erosion.

Figure 4.11. Mangrove forests along the coastline in Kien Giang

Mangroves in the region including the Kien Giang mangrove nature, mostly in Phu Quoc Island, mangroves and coastal restoration. Species composition of mangrove forests including the trees and plants, vines. Trees are also quite diverse, including *Rhizophora apiculatabe*, *R. mucronata Lamk Poir.in*, *Rhizophora stylosa Griff, Rhizophora mucronata Poir. In Lamk, Avicennia alba*, *Avicennia marina*, *Avicennia officinalis*, *Sonneratia alba JE Smith.*, *Sonneratia griffithii Kurz., Sonneratia ovata*, *Sonneratia lanceolata, S . caseolaris*, *Bruguiera gymnorrhiza (L.) Lamk., stain resistant, Bruguiera sexangula (Luor.) Poir*. *Bruguiera cylindrica*) *Xylocarpus granatum*, *Excoecaria agallocha, Lumnitzera littorea*, *Lumnitzera racemosa* and *Nipa fruticans*.

In the brackish water environment, some other species of trees are recognized such as *Hibiscus tiliaceus*, *Thespesia populnea*. Although being the trees, but most species of *Thespesia populnea* present along the canal in the coastal area is shaped like the tree such as *Clerodendron inerme* also noted the presence in many parts of coastal mangrove areas of Kien Giang.

Some of the trees and vines in the region is recognized as the skin around the mangroves of *Ceriops decandra*, *Dolichadrone spathacea*, *Acanthus ebracteatus*, *Acanthus ilicifolius*, *Acrostichum aureum*, *Acrostichum speciosum*, *Derris trifolia Lour.*, *Cuscuta australis R.Br.*, etc.

4.1.3.1. *Moderate natural mangrove*

Natural mangrove forest is mainly distributed along the Rach Melaleuca forests and several other small rivers in Phu Quoc Island. Area of natural mangrove forest is not much, only about 83.37 ha. Density of natural mangrove bit sparse, only about 30-50% of the vegetation unit. Having said that only two forms of mangrove trees along the rivers and canals.

The group of plant natural mangroves in the area of Phu Quoc island is quite diverse with *Rhizophora apiculatabe, R. mucronata Lamk Poir.in*), *Rhizophora stylosa Griff*, *Rhizophora mucronata Poir. In Lamk*.), *Xylocarpus granatum*, *Excoecaria agallocha and* especially with *Lumnitzera sp.* with two species found is *Lumnitzera littorea* and *Lumnitzera racemosa*, etc.

Figure 4.12. Natural mangroves along the Rạch Tràm in Phu Quoc island.

Figure 4.13. Natural mangrove forest mixed with various plant species *Lumnitzera littorea*, *Excoecaria agallocha*) mixed with Melaleuca forests area, Phu Quoc.

4.1.3.2. *Restored mangrove forest*

The range of natural mangrove coastal formerly devastated and degraded forest area and quality, and has been restored. Much of this restoration of mangrove forests along the coastal distribution extending from Ha Tien to make the U Minh Thuong, bordering the provinces of Ca Mau, with an area of 5765.17 hectares. However, a few places in the coastal areas have no presence of mangroves, but rather to the field of aquaculture, mainly shrimp. Some places, mangrove forests have been reduced due to be sauy coastal erosion, few places are left with some mangrove trees bare and even the beach between the sea.

Plant composition of coastal mangrove forests are also quite diverse, including timber trees such as Rhizophora sp., Avicennia sp. Bruguiera sp.), Sonneratia sp.), Xylocarpus sp., etc. Thespesiaap., Clerodendron inerme common fringe and along the canal behind the mangroves.

Some tree species are mixed with the live mangroves was also recorded in Kien Giang coastal areas such *Dolichadrone spathacea, Acanthus ebracteatus*, *Acanthus ilicifolius*, *Acrostichum aureum*, *Acrostichum speciosum*, *Derris trifolia Lour.*, *Derris marginata Benth.*, *Cuscuta australis R.Br.*),...

Figure 4.14. Mangrove forests developed on depositional areas in Kien Giang

Figure 4.16. *Rhizophora sp.* Regenerated along the coastline in Kien Giang

Figure 4.17. (*Avicenia sp*. And *Bruguiera sp.* along Coastline in Kiên Giang

Figure 4.18. *Nipa fruticants* restored along the cannel in An Bien district, Kien Giang.

Figure 4.18. mangrove forest with *Bruguiera sp*.

4.1.2.3. Sparse mangrove – Aquaculture

Along the coast from Ha Tien to the U Minh Thuong Kien Giang, with an area of 747.87 hectares, an area of mangroves had previously been transferred to land for aquaculture. In many places, the transformation of a few places that still asynchronous networks mangrove forests interspersed the fields of aquaculture, forming the array of forest types leopard skin. Although the land is used for aquaculture, but along the parcel of land between fields and the cells are still people planting mangrove trees, mainly mangrove (Rhizophora). With such mixed, forming the landscape of mangrove forests interspersed aquatic ponds (Figure).

Figure 4.19.Rung mixed mangrove aquaculture ponds in the coastal region of An Bien District, Kien Giang. Above is the SPOT 5 satellite image, taken in March 2009. Blue indicator plant mangroves.

4.1.2.4. Young mangrove forest in mudflat

Some formed alluvial and coastal regions especially accretion East Lake has been disastrous invasion of mangroves, with a total area of 279.19 hectares.

Most of these carpets mangroves age range from 2-5 years old, even places that only the presence of mangrove seedlings.

Species composition of young mangroves are recorded mainly mangrove Rhizophora sp., Avicennia sp.). Mud flats in the area of Dong Ho lake (Ha Tien) is mostly mangrove trees.

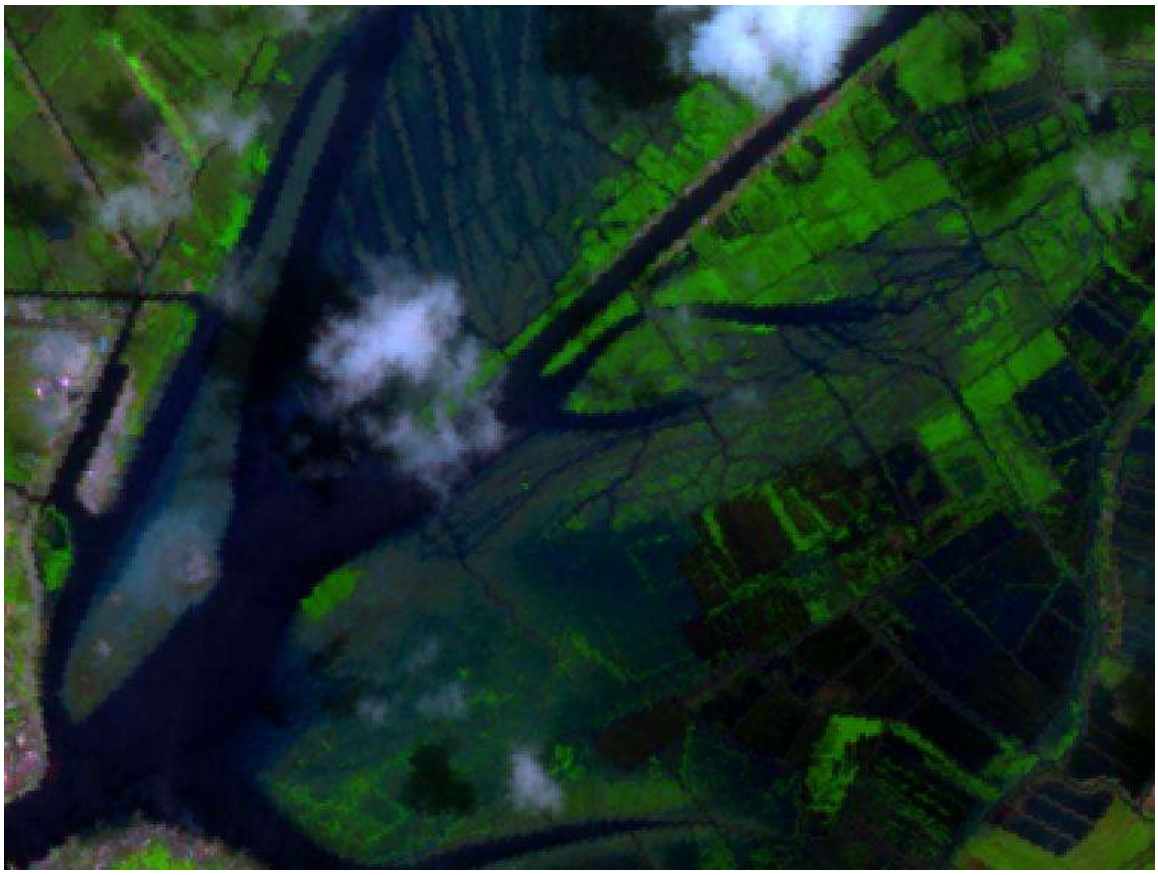


Figure 4.20. Young mangroves on muddy ground in the East Lake area (Ha Tien). Dominant vegetation is mangrove (Rhizophora sp.). SPOT5 satellite images, in March 2009.

4.1.3. Sparse restored young trees

Primeval forest land in the mountain region of Ha Tien and Kien Luong and has not been recovered by the tree species complex. Area of land recovery by the trash timber is not uniform and the coverage is not high, only 30-40%. Marginal or even mixed inside the fruit trees. The area of this coating is about 4929.2 ha.

The composition of tree species varied as dipterocarp such á *Hopea odorata*, *Meliacea*, and mixed with acacia trees (Acacia), Eucalyptus (Eucalyptus sp.) ...

4.1.4. Shrubs – Grass

Bushes and grass in occupying large areas of Kien Giang province, about 10,577, 4 ha. This vegetation of bushes and weeds distributed to many places, from Phu Quoc Island to the mainland area inside the province, especially in grasslands on alkaline soils of the Phu My, Thanh Giang and Kien Luong. The two vegetation units are divided: 1) bushes - weeds, and 2) weeds.

4.1.4.1. *Shrubs – Grass*

Bushes weeds mixed up quite a large area, about 7557.6 ha, and scattered in some inland areas and outside the island of Phu Quoc.

The inland, the vegetation and weeds are distributed mainly in the vicinity of the limestone has been exploited as raw materials and cement the region's grasslands Kien Luong, and in the area of national park buffer zone U Minh Thuong. Surrounding limestone is mined, the trees the group is quite diverse as *Melastoma sp., Pluchea indica (L.) Lees*, is a popular ... *Panicum repens*, *Cynodon dactilon*, *Cymbopogon Citratus (DC) Stapf etc. i*n the area of alkaline soil, the vegetation is mainly with *Pluchea indica (L.) Lees*, *Phragmitex sp.*, *Pandanus odoratissimus L.*, and and grass mixed with bushes is recorded as *Eleocharis dulcis, Eleocharis attropurpea*, *Panicum repens and Ischaemum sp.*, *Cyperus sp.*) ...

Figure 4.21. The vegetation, trees and *Rhodomyrtus tomentosa* on the coastal sandy soil of the island of Phu Quoc.

Phu Quoc Island, the coastal plants are recognized primarily as tree leaves *Randia tomentosa*, *Rhodomyrtus tomentosa, Morinda citrifolia*, *Memecylon harmandii*, *Connarus cochinchinensis Pierre*, *Strophanthus caudatus*, *Melastoma sp., Bignoniaceae*, etc. The bushes *Rhodomyrtus tomentosa* stretching along the sandy soils along the foothills northeast of the islands forming the vegetation is quite nice. In addition, the group of trees and weeds appear pretty much on the edge of mountain forest lands have been exploited. Many grasses mixed bushes, most grass *Imperata cylindrica L., Verbenaceae* appeared on the coastal sandy soil.

4.1.4.2. Weeds

Weed cover unit is defined on all areas where weeds appear, even on the paths that weed up to 70% of the area. Thus, large wild area in the area of Kien Giang province, about 7557 hectares.

In inland areas, wild grass lands alum or alum mainly with *Eleocharis sp.*, *Panicum repens*, *Ishaemum indicum*, *Ischaemum aristatum L.*, *Cyperus sp.*, *Fimbristylis miliacea, Cynodon dactylon, Lepironia articulata* and *Eleocharis attropurea*) pretty much present in Phu My.

Figure: 4.22. *Lepironia articulate, Eleocharis attropurea in Phu My*, Kiên Lương.

Figure 4.23. *Eleocharis dulcis*) in acid sulphate soil in Kien Luong .

Figure 4.24. *Imperata cylindrical with coconuts* along the sandy coastline in Phu Quoc.

Some of *Polypodiaceae* in the form of the trees is also present on the land of alum and alum of the U Minh Thuong and areas such as *Phragmitex sp. Saccharum arundinaceum Retz.*.

On land with higher terrain, arid land of mountains and coastal Phu Quoc island in Ha Tien, Kien Luong, many grass species present, most grass *Imperata cylindrica L.*, *Lophatherum gracile Brongn*), ...

4.5. *Aquatic Plants*

In the area of Kien Giang province, an area where aquatic plants is quite wide distribution, from the canals, ponds and swamps to rice fields submerged. However, in this paper, aquatic vegetation cover was recorded mainly in the U Minh Thuong National Park area, with an area of 1682.52 hectares.

Vegetation covers of aquatic plants mentioned in this report only focuses on the region of U Minh Thuong National Park. The composition of aquatic plants is quite diverse with *Nymphaea nouchali*, *Pistia stratiotes*, *Salvina cucullata*, *Typha domingensis*, *Nymphoides indicum*, *Haloragaceae*, *Acrostichumsp.*.

Figure 4.25. Aquatic plant in wetlands of U Minh Thuong National park.

Notably, *Ipomoea sp.* rcorded for the first time in the U Minh Thuong National Park area, but only in a small area along the central channel (Figure).

Due to the diversity and aquatic species and their distribution, density difference between the flora cover aquatic plants are divided into several sub-units present in the U Minh Thuong National Park Vegetation covers.

4.1.6. Wood tree - Fruit tree

Mixed tree fruit patches created around some mountain in Ha Tien, Kien Luong, Hon Dat and Phu Quoc Island. Except the coastal areas and mountain slopes, on plains, people planting timber trees interspersed with fruit trees in the garden around the house.

Component tree is very diverse, some of the main crops are recognized such as *Acacia auriculiformis, Acacia Mangium*, *Eucalyptus sp., Dipterocarpaceae*, etc.

4.1.7. Fruit tree

Fruit trees distributed throughout the area of Kien Giang. Most fruit trees are planted around the house and gardens on the hem. Due to the diversity of soil and water, fruit species composition is diverse.

4.1.8. Other land covers

Some other vegetation unit is recorded and shown on maps such as agricultural crops, agricultural crop mix bushes - grass, bare, sandy beaches, ...

PART 5.

PHU QUOC NATIONAL PARK

5.1. Overivew

Phu Quoc Island, an island district of Kien Giang province, an area of 56,200 ha, is the largest island in the archipelago of 14 islands. Phu Quoc Island is located in the Gulf of Thailand, located on the mainland west of Kien Giang province, about 40 km. Phu Quoc National Park is a tropical forest conservation lies northeast of the island.

Phu Quoc National Park, stretching from 10 ° 12 'to 10 ° 27' north latitude and between 103 ° 50 'to 104 ° 04' E East, in the northeast of the island belongs to the communal section of oil, Thom , Cua, and part of Duong Dong, Duong, Ham Ninh and Duong door. Northern and eastern boundaries of national parks along the coast.

History; Decision No. 194/CT on 09/08/1986 of the Chairman Council of Ministers, a part of Phu Quoc island is recognized as a natural reserve area of 5,000 ha (MARD, 1997) with the goal of conservation "forests remaining on the island with an abundance of leguminous plants such as Sao Hopea sp." (Cao Van Sung, 1995). Nature conservation areas in Phu Quoc has been established and operated during the period 1986-1992 (Anon. 1998). Protected Areas Management Board was established by decision of Kien Giang Provincial People's Committee dated 10/03/1989, and investment budgets for protected areas was approved by Decision No. 444/KL/QD Day 2 10/1989 of the Ministry of Forestry.

Kien Giang Provincial People's Committee dated 04/03/1996 Decision No. 360/UB-QD about merging the two headwater forests and natural reserves. In 1998, the Institute of Forest Inventory and Planning II has prepared a joint investment project for the conservation of natural areas and headwater areas above. According to investment projects, Conservation District, Phu Quoc has a 14,957 ha area, and watershed protection zone covers an area of Phu Quoc is 35,873 ha (Anon. 1998).

Under Decision No 91/2001/QD-TTg by the Prime Minister dated 06.08.2001 on the transfer rate of Phu Quoc Nature Reserve in the Phu Quoc National Park, this area was expanded to include both part of the protection forest Watershed Phu Quoc, Phu Quoc National Park total area is 31,422 ha, of which strict protection zones is 8786 ha, the 22,603 ha ecological restoration zones and administrative services - are 33 scientific research ha. According to the Decision on 17/01/2002thi 01/2002/QD-UB Phu Quoc national park under the

management of the People's Committee of Kien Giang Province, with a total area of 31,422 ha.

Total natural area of Phu Quoc National Park is 31,422 hectares. Phu Quoc National Park is divided into three functional areas: strict protection zones 8786 ha, the 22,603 ha ecological restoration and subdivision administration - services - 33 ha of scientific research. In addition, about 20,000 hectares of coastal buffer zone.

Topography; National Park lies to the north of Phu Quoc island with high hills of three mountains Ham Ninh, Ham Rong and section of Ganh Dau. To the east and northeast there is the high mountain peaks of Nui Chua (603 m), Mount Vo Quap (478 m), Mountain Da Bac (448 m) in Ham Ninh mountains. Major phase of mountain slope 15 - 20 degrees, with the steep slope which made long and relatively large slope, above 45 degrees. The north is blocked by the Bai Dai elevation ranges from 200 to 250 m, including Mount Pan (379 m), Ham Rong mountain (365 m).

Overall, the sloping terrain and lower from north to south and from east to west. Alternating between areas of high terrain has some low-lying areas, such as the Bai Thom Cua. In the lung often flooded valley formed several different vegetation areas on the high hills.

Rainfall, hydrology, average annual rainfall in the area of Phu Quoc is quite high, about 3038 mm with 174 rainy days in a day. Abundant surface water, rivers density is 0.42 / km 2, with two river systems, with two rivers running through the area is national park: Cua canals, and ditches Duong Dong. In addition, there are a number of rivers and canals, as Rach Melaleuca forests, Rach Vung Bau, Rach fish ... Although there are many streams, but only water, but mostly seasonal.

5.2. Flora resources

Phu Quoc National Park is considered as places are quite large area of primeval forest with tropical forest ecosystems, with rich flora and fauna, rare not only in Vietnam but also in the world.

In the area of Phu Quoc National Park, a tropical forest ecosystems have many large trees, According to the ADB study (1999) that has 929 species of plants on the island of Phu Quoc, but the recent results of Wildlife At Risk (2006) shows there has up to 1164 species of higher plants, including 137 and 531 orders, of which 5 species of the bare seeds of 3 and 4 orders. According to research results published show that there are 155 species of medicinal plants (34 species and 11 species as a tonic to cure deadly diseases), and 23 species of orchids, including three new species have been recorded received in Vietnam, just like *Liparis cf. rhodochila Rolfe*, *Calanthe lyrogolossa Reichenb.f*., and species Podochilus tenius.

According to many authors, and the recent Wildlife At Risk (2006) again commented on the flora of the area of Phu Quoc Island has close relationships with some of the vegetation in other areas of the world such as *Dipterocarpaceae* is familiar with the relationship dipterocarp in Malaysia - Indonesia. Some vegetable bare seed, sector angiosperms is related to the plant area Hymalaya - Yunnan (China), and the plants belonging to *Combretaceae,Lythraceae*, *Bombaceae,* which have a close relationship with plants of the same family in India - Burma.

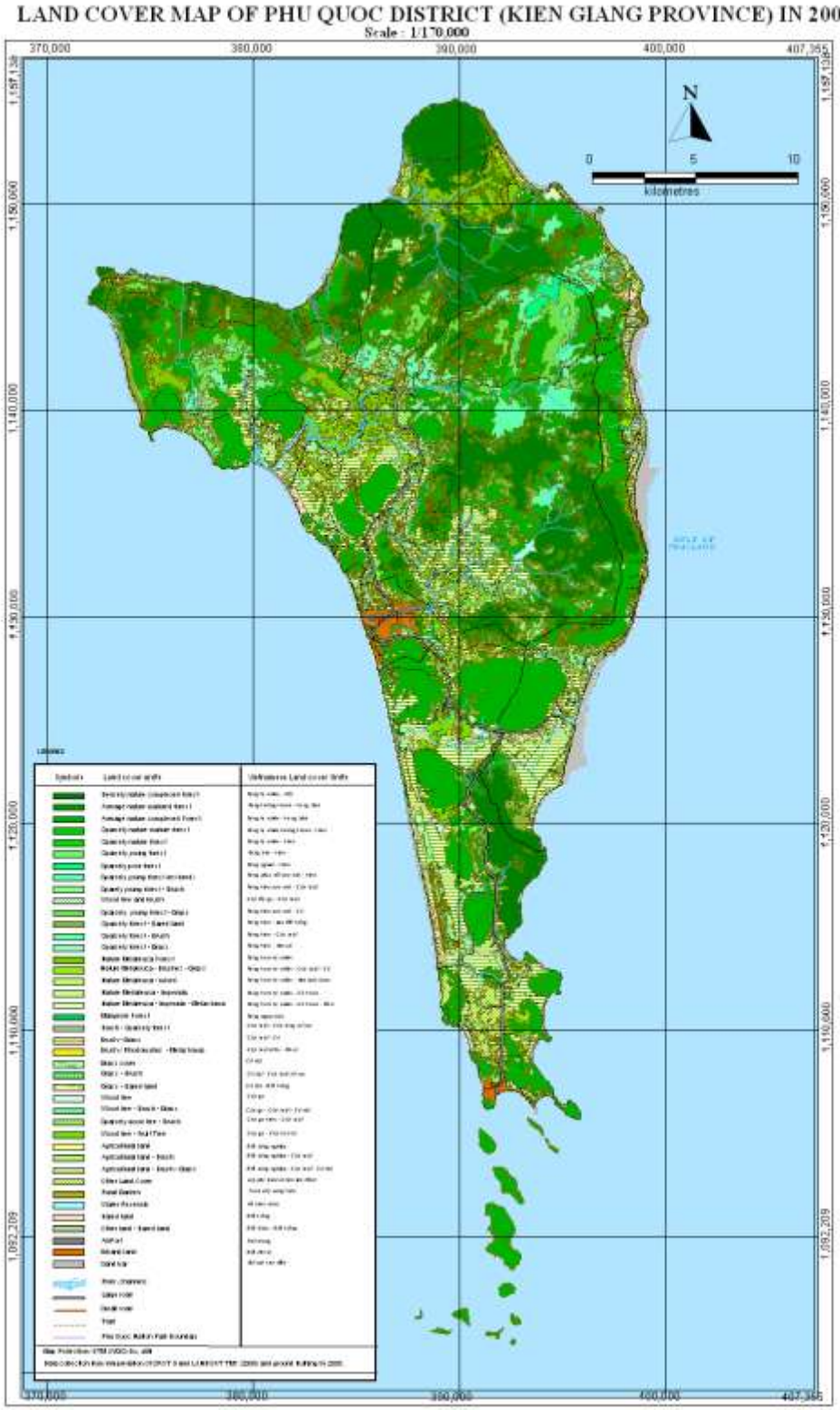


Figure 5.1. Map of vegetation covers in Phu Quoc islands in 2009

5.3. *Landcover of Phu Quoc National Park*

A vegetation cover map of Phu Quoc island made in 2009. Overall, forests occupy relatively large area, including forest outside and inside the national park area. Distribution of forest area from the north to the southeast of the Phu Quoc Island. Dipterocarpacae species is dominant in the forests in the high terrain of the mountains on the island. In addition, the receptor populations of tropical forests present in the region. Density of forest cover change by a large number of forests affected people over the years. Primeval forests have high coverage for the poor to mixed forests, the trees, weeds chie61mmo65t significant area in the region of Phu Quoc Island.

In general, the results of satellite images and field survey in late 2009 recorded vegetation cover data of Phu Quoc island is presented in summary table (Table).

Table 5.1. Summary of vegetation covers in Phu Quoc islands in 2009

No.	**Vegetation type**	**Area** (ha)
1	Natural forests	32.863,46
2	Regenerated forests mixed with bushes	5.442,33
3	Natural melaleuca forests	1.527,25
4	Mangrove forests	83,37
5	Bushes – weeds	2.503,15
6	Wood tree – bushes and grasses	3.147,09
7	Crop	8.489,17
8	Gardens	8,83
9	Ponds	51,35
10	Airport	50,79
11	Urban area	453,38
12	Barren lands	490,47
13	Others – barren lands	1.458,84
14	Sands	1.540,21
	Total	**59.636.94**

Note: area including sandy coastline in islands.

Phu Quoc national park area, with an area of 31,422 ha, with 9 vegetation unit is divided and some other sub-units are all in the table ...

Table 5.2. Vegetation units in Phu Quoc National Park in 2009

No.	Vegetation covers	Area (ha)	Coordinates (m)	
			Longitude	Latitude
		24603.5		
1	Dense old-growth Forest	10359.9	387546.36	1146794.09
2	Moderate old-growth forest	28.89	394427.51	1147343.33
3	Sparse old-growth forest	172.56	392254.68	1140875.37
4	Moderate medium-growth forest	11655.92	393120.47	1134424.82
5	Sparse medium-growth forest	68.14	374760.1	1140182.87
6	Sparse young-growth forest	82.82	377719	1138457.15
7	Open young-growth forest	234.61	394752.49	1145635.43
8	Sparse poor forest	2000.66	391640.59	1145297.17
		4739.28		
9	Sparse restored young-growth forest	902.4	393266.74	1129685.5
10	Sparse young-growth forest - Shrubs	47.97	385246.46	1142290.65
11	Sparse medium-growth forest - grass	1715.91	394846.7	1143664.85
12	Sparse medium-growth forest - Shrubs	1160.72	385930.07	1142751.44
13	Sparse young -growth forest - grass	89.95	397214.03	1146681.94
14	Open medium-growth forest - Bared ground	822.33	397599.52	1146918.38
		1371.81		
15	Moderated medium-growth Melaleuca	1130.16	387747.08	1150962.01
16	Sparse old-growth Melaleuca - Shrubs	139.29	391300.33	1151824.25
17	Saprse medium-growth Melaleuca - mixed trees	52.06	398227.89	1139665.69
18	Open old-growth Melaleuca - Imperata -Me	50.3	398321.62	1138739.06
		350.02		
19	Moderate Medium-growth mangrove	57.02	388366.3	1150180.22

20	Mixed shrubs - open forest	66.8	374014.91	1142069.67
21	Shrubs - Grass	164.92	377992.69	1139834.63
22	Rhodamnia - Melastoma	61.28	398364.58	1140523.37
		531.52		
23	Mixed grass	208.44	373159.55	1146145.49
24	Open grass	323.08	389371.55	1145368.51
25	Wood tree _ Shrubs	6.74	387167.34	1142544.58
26	Wood tree - Fruit Tree	115.92	373998.02	1141731.56
27	Agricultural land - Shrubs	106.91	392653.94	1128273.25
28	Other - Bared ground	564.81	395212.36	1150238.85
29	Water Reservoir	51.35	393396.71	1133378.25
30	Sand bar	1.18	389592.03	1155018.87
		32443.04		

The forest classification according to origin formation is applied in this study to describe the vegetation unit, which accounts for vegetation mainly forest. In addition, the term in a classification by type of forest site was set up to use easily understood by local use (land forests, mangroves, flooded forests).

Two forest types are recognized in the region of Phu Quoc National Park 1) primary forests and 2) recovered forests.

5.3.1. Primary forest

5.3.1.1. Upland primary forests

Natural forest land in the mountains and forests, including primary and secondary vast remainder of Phu Quoc.

On some mountain areas in a mixed group of endangered species, mainly belonging to Theaceae, Lauraceae, Clusiaceae. There is also gymnosperms such as *Dacrydium elatum*, *Dacrycarpus imbricatus*, *Nageia wallichiana*. The distribution of forest trees is not uniform and does not cover the high forests constitute a medium to sparse.

In general, major groups of plants on high mountain forests of dominant *Dipterocarpaceae,* where there is some crowding out other plants belonging to *Sterculiacea*, *Meliacea, etc.* with high density creating thick forest vegetation cover (Figure).

In lower elevation of the foothills, where there are gaps appear different plant species with mixed dipterocarp such as *Sterculiaceac, Meliacea*, *Parinari annamensis, Manilkara kauki*, *Anisoptera costata*, etc. and all the bushes and weeds.

5.3.1.1.1. Dense old-growth primary forest

Natural forests thick with an area of 10,359.9 hectares, mainly on the presence of mangrove forest soil with high Ferasols 200 - 350 m (AMSL) of Phu Quoc Island. Forest plants are the dominant trees of *Dipterocarpaceae* such as *Dipterocarpus dyeri*, *Dipterocarpus costatus, Hopea pierrei*, *Hopea odorata* and some other plants such as Garcinaia sp. And Parinari annamensis, etc.

Figure 5.2. Primary thick forests with many rather even aged forests in Phu QUoc National Park.

Figure 5.3. Thick primary forests in Phu Quoc National Park. The trees are identified and chosen as mother trees for restoration.

5.3.1.1.2. Moderate old-growth forest

The area of forest cover accounted for an average area of about 28.89 ha. Forest cover is rather high with about 50-60% for the age group of plants, the rest is a small tree and bushes. The composition of the species are forest vegetation remnant with plant trees mainly belonging to *Dipterocarpaceae, Dipterocarpus dyeri, Dipterocarpus costatus*, *Hopea pierrei*, and forest tree species such as *Garcinaia sp., Shorea hypochra, Parinari annamensis,* etc. .

Figure 5.4. Moderate old-growth forest with many aged trees in Phu Quoc National Park

5.3.1.1.3. Sparse old-growth forest

Sparse forest area accounts for about 172.56 ha. Located north of Phu Quoc Island. Forest cover is low, only about 20-40%, the rest are small trees or mixed with bushes or grass cover is low but not high density. Some vacant land is recognized around in a few places in the units of this coating. Forest plants are the dominant tree species such as *Dipterocarpus intricatus*, *Dipterocarpus obtusifolius*, *Hopea odorata*, *Paviesia anamensis*, sp Syzigium ., *Dilenia ovata*, *Panirari anamensis*, etc. The mature trees create great array of old trees in sparse populations of forest plants (Figure).

Figure 5.5. Sparse old-growth forest with aged trees in Phu Quoc National park.

5.3.1.1.4. Moderate medium-growth forest

These are the old forests and the average density, accounting for a large area, 11.655.91 ha, and distributed throughout the Phu Quoc national park area. Most forests have an average density along the thick forests and near the roads may be affected by human activities. Satellite image interpretation and survey showed that forest cover rather, about 50-60% in some areas coverage to 70%.

Just as the forests mature average density, average plant in the forest are still the dominant tree species such as *Dipterocarpus intricatus*, *Dipterocarpus obtusifolius*, *Hopea odorata*, *Paviesia anamensis, Syzigium sp.*, *Dilenia ovata*, *Panirari anamensis*, *Manilkara kauki*, *Anisoptera costata*, etc. Although being evaluated as average density, all the vegetation covers are recorded about the bushes, grass, alternating, but the area is not large.

Forest age and the average density should be fairly uniform, creating a very beautiful landscape of forests in the area of Phu Quoc National Park (Figure).

Figure 5.6. Moderate medium-growth forest in Phu Quoc National Park

5.3.1.1.5. Sparse medium-growth forest

Young forest with an average age occupying relatively small, about 68.14 ha. Tree density is the average age of only about 20-40% of the area. The rest are small trees or bushes. Forest plants are the dominant trees belonging to *Dipterocarpacea, Hopea odorata, Paviesia anamensis, Dilenia ovata*, *Panirari anamensis*), etc. (Figure).

5.3.1.1.6. Sparse young-growth forest

Young forests occupy about 82.82 ha. The status vegetation covers mostly young regenerating forests, have low coverage, the rest are buried trees are low and a bushes, weeds. Some common plants include *Diptarocarpus sp., Cipadessa baccifera*, *Garcinaia sp.*, *Alstonia spathulata*, *Oncosperma tigillaria*, *Ardisia sp.*, *Lincuala soinosa*, etc.

Figure 5.7. Sparse young-growth forests with many wood tree species.

5.3.1.1.7. Open young-growth forest

This area of land with scattered trees, cover only about 10-15%, the rest is farmland, a few weeds are crowded. These new forests are regenerated so young, the not so good regeneration of the plant density is low. The total area of this forest is quite sparse at about 234.61 ha. Including forest trees belong to Dipterocarpacea), and other woody plants.

5.3.1.1.8. Sparse poor forest

Occupies an area of significant areas of Phu Quoc National Park, with about 2000.7 ha. Coverage of trees is not high, about 20-30%. Forests are not well developed. Distributed over a fairly wide area, but most are located on slopes and areas near the boundaries of access to land outside the national park.

Figure 5.8. Sparse poor forest present in buffer zones in Phu Quoc National Park

5.3.1.2. Sparse restored young-growth forest

Primeval forest in occupied area of about 902.4 hectares, distributed in small clusters around the areas of primary forest in Phu Quoc national park. These areas of primary forest decline are being restored. Woody plants mostly young, and so sparse coverage is low, only about 20-30%, there are individual areas where the coverage to 40%. In the remaining area is the vacant land around the plant canopy and less like the trees and weeds, but not greater density.

Trees are woody plants belong to Diptarocarpacea, *Hopea odorata*, *Paviesia anamensis*, *Dilenia ovata* and other tree species complex.

Figure 5.9. Sparse restored young-growth forest in Phu Quoc National Park

5.3.1.3. Primary forest - Shrubs – Grass

This is where the plant cover is dominated forest cover density from an average of 40-60% interspersed with trees and weeds dominate the remaining area. The total area of mixed forest trees and weeds account for the 3836.88 hectares, most of these types of coatings distributed in most coastal areas and along the boundary roads and streams within the park.

Based on the density of forest cover of woody plants, as well as density and composition of plants and trees the wild grass interspersed in the forest, five (05) vegetation unit is divided: 1) mixed small glade bushes, 2) Young forest, mixed with an average age of weeds weeds, 3) Young forest, mixed with an average age of the tree, 4) Young forest interspersed small weeds, and 5) relatively sparse forest, the average age - vacant land.

5.3.1.3.1. Sparse young-growth forest – Shrubs

These forests are sparse cover of trees is low, about 20-30%, the rest is the bushes canopy is low and the density of trees is not high. Occupying an area of about 47.97 ha. Forest regeneration due to young age, the tree is fairly uniform. Components accounted for mainly timber trees belonging to *Diptarocarpacea,*

Dipterocarpus intricatus and the other trees such as *Hopea odorata*, *Paviesia anamensis*, etc.

Figure 5.10. Sparse young-growth forest – Shrubs in Phu Quoc National Park

5.3.1.3.2. Sparse medium-growth forest – Shrub

Area of vegetation cover occupied large areas of forest, with an area of 1160.72 hectares. Groups of woody plants in this unit with a dipterocarp, *Dipterocarpus intricatus, Dipterocarpus obtusifolius,* and other woody plants recorded in the unit class this government such as Hopea odorata*, Paviesia anamensis, Syzigium sp., Dilenia ovata, Panirari anamensis.* Group of mixed trees in the forest cover is quite different species mix together such as *Trema vingaris, Grewia paniculata*, *Memecylon harmandii*, *Croton poinanei, etc.,* forming a layer of low vegetation near the ground (Figure).

Figure 5.11. Sparse medium-growth forest – Shrubs in Phu Quoc National Park .

5.3.1.3.3. Sparse young-growth forest – grass

Dear young forests, but mixed with the grass trees are forming separate vegetation covers, occupying an area of about 89.95 ha in the region. Most of them distributed by the national park northeast, where slopes are rocky and there are many segments. In this soil, soil mixed with stones, as well as the cause is not easy to increase the density of trees after they have lost.

Receptor populations of forest trees in this area is quite diverse with many plant species of *Dipterocarpus* and other woody plants.

5.3.1.3.4. Sparse medium-growth forest – Grass

Sparse forests have an average age of grassland interspersed with each forming a fairly typical vegetation for primeval forests ravaged by many factors in the area of Phu Quoc. Vegetation covers distributed mostly in the north of Phu Quoc National Park with an area of 66.80 hectares. The average age of trees present in the sparse forests create a definition of untouched natural forests remaining. Carpet weed distribution between the small patches of forest or mixed clusters between the trees together (Figure).

Figure 5.12. Sparse medium-growth forest – Grass mixed with grasslands in Phu QUoc .

5.3.1.3.5. Open medium-growth forest - Bared ground

Some networks glade on the regional distribution of low-lying land along the streams, have been submerged periods in the short term, create a handful of students fermented. This unit occupies an area of approximately 822.33 hectares, scattered along the northwest coast of the park.

Some groups of plants have been recorded such as *Oncosperma tigillaria*, *Lincuala soinosa*, *Caryota mitis*, *Pandanus usii*, *Ardisia sp., Stenochlaena palustris*, etc. The classification of the vegetation unit aims to identify the conservation and restoration of forest vegetation with valuable plant species (Figure 5.13).

Figure 5.13. Vegeration forests distributed on low-lying areas with species of *Oncosperma tigillaria*, *Lincuala soinosa*.

5.3.2. Nature Melaleuca forests

Natural mangrove area of 3.836.88 hectares accounted for, including natural forest Melaleuca forests and Melaleuca forests simply mixed with the natural plant groups khac.Melaleuca forests distributed mainly in the north of Phu Quoc island, around Rach Tram, forests along and around a partially scattered along a canal outside the national park area.

In the vegetation unit is divided naturally Melaleuca forests: 1) natural Melaleuca forests with average density, 2) sparse Melaleuca with bushes, 3) Melaleuca with average age mixed with other plants, 4) sparese melaleuca forests with middle age mixed bushes, and 5) sparese Melaleuca forests, old mixed grasslands.

5.3.2.1. *Moderated medium-growth Melaleuca*

This Melaleuca forests have moderate to sparse density, age range from quite quite old trees to the forest regeneration is the average age from 8-12 years to be restored later. Melaleuca forest area of natural cover this up to 1135.42 ha. Distributed around the mangMelaleuca forests Rach Melaleuca forests and scattering of islands northwest of Phu Quoc.

Land in open fields, but sandy acidic soil environment so the vegetation below the Melaleuca forests is *Eleocharis dulcis, Euriocaulon echinulatum, Xyris pauciflora), Cyperus sp.* and other weeds.

Beneath the grass and Melaleuca forest crop residue left on each surface layer is quite thick vegetation forming the combustible materials in the dry season. Survey results showed traces of Melaleuca forest fires in many places in Phu Quoc Island. However, for Melaleuca aged 8 years or older, well-developed trees over 10 cm diameter, thick crust rather small, these fires will not die Melaleuca forests, Melaleuca forests and regeneration following burning pretty good.

Figure 5.14. Natural Melaleuca forest on sandy soil above average terrain in the island of Phu Quoc. Melaleuca tree spirit still traces of fire in the dry season 2 years ago.

Along and around Rach Melaleuca forests, Melaleuca forests natural forests developed quite well developed in saline soil environments. Here, in some places, Melaleuca and mangrove trees (Rhizophora sp., Avicennia sp., Lumnitzera littorea) are mixed together.

Figure 5.15. Natural melaleuca forests developing along Rach Tram, Phu QUoc National Park.

Figure 5.16. melaleuca and mangrove forests developing along Rach Tram, Phu Quoc National Park .

5.3.2.2. *Sparse medium-growth Melaleuca - mixed trees*

Melaleuca forests development on the local average sand west of the park, with an area of only about 2 hectares. Here, Melaleuca forests middle aged to elderly, density should cover only about 20-35%, mixed with many other woody plants.

5.3.2.3. *Sparse medium-growth Melaleuca – Shrubs*

Vegetation cover Melaleuca trees interspersed tthua the occupied area of about 50.03 ha. Mainly distributed along the edge of the natural forest Melaleuca forests average density in the north of Phu Quoc Island. Melaleuca forests density fluctuation is quite large, where the average density Melaleuca forests 50 - 70%, but there are places down to about 20-30%. Age of the Melaleuca forests is quite large fluctuations, there are clusters of stations have an average age, but there are clusters of relatively high percentages with age, over 30 years (Figure).

Vegetation beneath the forest canopy is quite diverse as *Archylea valali, Dillenia ovata, Melastoma candidum, Thunbergia fragrans, etc.*

Figure 5.17. Melaleuca forest mixed with many bushes in Phu Quoc National park .

Most Melaleuca forests scattered trees interspersed with the grass vegetation, but there are few places Melaleuca forests presence of small clusters. Melaleuca trees are native remnant itself is quite large, almost 1 m in diameter, and the relative with destroyed traces.

Figure 5.18. Clusters of melaleuca aged forest in the east of Phu Quoc National park .

Figure 5.19.Melaleuca forests scattered among natural vegetation and the weeds in the east of the Phu Quoc National Park

5.3.2.4. Open old-growth Melaleuca - *Imperata – Melastoma*

Distributed on sandy soils along the coastal area east of the park with an area of 50.3 ha. Natural mangrove trees interspersed sessions and weed mats.

Melaleuca forests sparse density, cover about 20 - 30%, mainly trees and tree regeneration are small. The plants are mostly trees of Myrtaceae such as *Rhodamnia dumetorum*, *Melastoma candidum.* Some of the other species in mixed forests are recognized such as *Menecylon harmandii, Thunbergia fragrans and Imperata cylindrica L.* also appear pretty much in the area Melaleuca forests.

Figure 5.20. Regenerated melaleuca forests with bushes and *Imperata cylindrica* L. in the east of Phu Quoc National Park.

5.3.2.5. Old-growth Melaleuca – Grass

This is the vegetation cover with deep development on the natural clay soil, an area of about 56 ha. Melaleuca forests relatively sparse density of about 20-30%, and grass covered most of the remaining area. Distributed in the northeast of Phu Quoc, occupying an area of about, but can see this is one of the carpet Melaleuca forests remaining native forests on the island of Phu Quoc.

The density, but the relative percentages with fairly uniform size, averaging about 30 - 40 cm. Beneath the grass is quite diverse such as *Leptocarpus diajunotus, Baeckea frutesens, Xyris pauciflora, Eriocaulon echinulatum) etc.*

Figure 5.21. sparse melaleuca forests with bigger diameter 30 - 40 cm. Grassland with *Leptocarpus diajunotus*.

Figure 5.22. *Eriocaulon echinulatum*, *Drosera burmannii*, *Xyris pauciflora* are present in the wet grass in the natural forest Melaleuca forests ..

Some of the smaller plants are also present in scattered areas of grassland interspersed Buy Melaleuca such as *Melastoma affine* occurring in low-lying ground, wet. Buy this species with other species found on sandy soils in coastal plant communities.

Figure 5.23. *Melastoma affine* mixed with grasslands in natural melaleuca forests in Phu Quoc National Park.

5.3.3. Moderate Medium-growth mangrove

Natural mangrove forest is mainly distributed along the Rach Melaleuca forests and several other small rivers in Phu Quoc Island. Area of natural mangrove forest in the area of Phu Quoc National Park is not much, only about 57.02 ha. Density of natural mangroves from medium to slightly sparse, only about 30-50% of the vegetation unit. It is said that only two forms of mangrove trees along the rivers and canals.

The group of plant natural mangroves in the area of Phu Quoc island is quite diverse such as *Rhizophora. Poir.in mucronata Lamk, Rhizophora stylosa Griff, Rhizophora mucronata Poir. In Lamk., Xylocarpus granatum, Excoecaria agallocha, Lumnitzera* with two species found such as *Lumnitzera littorea, Lumnitzera racemosa, Sonneratia alba). ...*

Figure 5.24. Landscapes of natural mangroves along the Rach Tram in Phu Quoc National Park .

Figure 5.25. Natural mangrove forest mixed with various plant species of *Rhizophora sp.*, *Lumnitzera littorea, Excoecaria agallocha in* Rach Tram area.

Pretty special thing Rach Melaleuca forests area is the arrangement of the species of mangrove and Melaleuca forest in this area naturally. A transect (transect) from the shore Rach Melaleuca forests pulling straight up the hill to see the division of forest plant species forming different ecosystems.

Rach Tram forests along is dominated by mangroves are Rhizophora (Rhizhophora), interspersed with *Xylocarpus granatum*, *Lumnitzera littorea*, , *Lumnitzera racemosa*, forming separate receptor populations.

Inside the forests of *Lumnitzera sp.* In Rach Tram area are natural extension to the foot of the mountain with moderate to sparse density depending on the place. These sequences form a tree in Rach Tram ecosystems in the region typical wetland salinity impacts. Few places, intervening between mangroves and Melaleuca trees are upon approaching the foot of the mountain, the terrain gradually began to follow the slope of the mountain plants here move dipterocarp and other plants. Receptor populations of plants with the dominant dipterocarp so forming a tropical forest ecosystem

Figure 5.26. Mangroves with range (Rhizophoracea) along Rach Tram forests, followed by *Lumnitzera sp.* and inside the natural forest Melaleuca forests extended to the foot of the mountain. From mountain peaks to tropical forests with dipterocarp (Diptecarpacea) dominant in the population and other communities.

However, the survey found a few places, the Rhizophora is replaced by *Lumnitzera sp.*These trees form clusters of mangrove forests being quite beautiful, majestic.

figure 5.27. Lumnitzera littorea in mangrove ecosystems in Rach Tram, Phu QUoc.

Figure 5.28. Fruit of *Xylocarpus granatum* in Rach Tram, Phu QUoc.

Figure 5.29. Parasite plants developing on mangrove's trunk in Phu Quoc National Park

5.3.4. Bushes

The vegetation with low tree canopy height from 1.5 to 4 g m forming coatings with unique ecosystems. Results of remote sensing image interpretation and field survey estimated the area of vegetation covering bushes has an area of about 293.10 hectares. Because of the soil, topography and the impact of water so they form ecosystems distinguishable.

3.3.4.1. Truông

Truong has an area of about 66.8 hectares, scattered low-lying areas, wet. Some low-lying areas due to local terrain is surrounded by areas of higher terrain may be flooded during the dry season. **Dai Truong** run a valley slopes along the northwest coast of Phu Quoc national park.

Although identified as Truong, this unit still has trees scattered. Mixed with fairly thick layer is thick cover of **Truong**. Botanical ingredients here are quite diverse, common plant species such as *Oncosperma tigillaria, Lincuala soinosa, Peak Caryota mitis, Ardisia sp., Pandanus usii, Stenochlaena palustris, Macaranga tribola etc, .*

Figure 5.30. **Truong** habitats with bushes species diversity of plant species: **NHum, Dung Dlnh** in Phu Quoc National Park.

5.3.4.2. *Shrubs – Grass*

The bushes array interspersed with a lot of weeds present, with an area of 165 ha in the Phu Quoc national park area. Plants are quite diverse populations living in a multi-species such as Syzygium spp, Myrtaceae) and Apocynaceae, Verbenaceae, Bignoniaceae, Morinda citrifolia. Several species of parasitic lianas and trees appear in the region such as *Stenochlaena palustris, Convolvulaceae*, ...

Many weeds growing mixed with bushes. *Imperata cylindrica L.* mixed bushes appears pretty much in the lap sandy soil along the northeast coast of Phu Quoc island such as *Panicum repens* occurring in areas where wet soil moisture.

Figure 5.31. *Melastoma affine* and *Imperata cylindrica L*. and the other plants are mixed in the grassland plants - weeds.

5.3.4.3. *Rhodamnia - Melastoma*

The notable group of trees in the area of Phu Quoc National Park is a *Rhodamnia – Melastoma* community. The dominant vegetation in this unit is Red Sim, *Melastoma affinea*. Distributed mostly to the east of the Phu Quoc National

Park covers about 61.28 hectares. *Rhodamnia* - *Melastoma* appear pretty much made up the tree row along the road into the park. However, the range size of tree-level these days is not in uniform, the largest is only about 2-3 m.

Figure 5:32. Bushes habitat for two species SIM and *Melastoma affinea* dominant in the clay sand lands on the average terrain in the east of the Phu Quoc national park.

Figure 5.33. *Rhodamnia – Melastoma* present along the road in Phu Quoc National Park.

5.3.5. Grasslands

Grasslands in the national park area are quite diverse species of plants and grass structures. The mixed grass species recorded are common in areas around the forest, or some vacant land around the natural forest. Recorded a total area of about 531.71 hectares. Distributed throughout the Phu Quoc national park area. In some places, the land is covered with weeds, but not high density forming sparse grass. Some of the species are also present scattered in the grassland, but the density is negligible.

Based on the coverage of grass, with two vegetation units weeds are divided:

5.3.5.1. Mixed grass

Mixed grass, trees and tree species on the distribution of sandy soil along the edge of the park, occupying an area of about 208.63 hectares. There is a diverse area and the distribution of mixed grass species: forming mats along the edge of national park and distributed small patches along the roads. Weed species composition is quite diverse.

The common weed species in acidic soil areas, such as *Leptocarpus disjunctus Mast., Xyris pauciflora Kurz, Panicum repens, Drosera burmannii, Euriocaulon echinulatum, Cyperus sp., Eleocharis dulcis) etc.* These trees scattered among the grass is often *Melastoma affine* and the other tree species.

Figure 5:34. Grass mixed with a little bushes species on the clay soil, acidic soil pH. Surrounded by natural forest Melaleuca forests (Phu Quoc National Park).

On the sandy soil and clay sand average terrain, vegetation composition with the dominant grass. Mixed picture in the grass or the trees are large trees, while ties sandy east coast of Phu Quoc with grassland interspersed with fruit trees.

Figure 5:35. *Imperata cylindrica L.* on sandy soils east coast of Phu Quoc Island.

5.3.5.2. Open grass

These are the small lawn, with many different species such as grass only *Cynodon dactylon*, grass is young etc. along the sides of roads within and through the national park areas and vacant land area covered lawn discrete are intermingled. The area is quite small compared to other types of vegetation cover in the national park area.

Figure 5:36. Sparse grass along the roads in the park area PQ.

5.3.6. Wood tree – Shrubs

Some degraded forest area has been covered with the trash timber and saplings, the trees; with relatively small area, approximately 6.74 ha. This type sometimes seen in clusters between the trees or grass.

Some of the fringe area of primeval forest northeast of the national park was destroyed previously been covered by trees and grapefruit. Part of this tree is planted for land adjacent to the farmers.

Figure 5.37. Vegegation cover of wood tree species and bushes seen in some coastline of Phu Quoc National Park.

Figure 5.38. Around the boundary of Phu Quoc National Park with wood tree species and bushes appears in previously destroyed areas.

5.3.7. Wood tree - Fruit Tree

National Park area has an impact on some forest area for other purposes. Along roads and in some areas along the edge of the forest, the trees and fruit trees interspersed with each other, with an area of 115.92 hectares. As observed, the density of trees predominates over fruit. Tree species is quite diverse as dipterocarp *Dipterorapacea, Hopea odorata Roxb*, *Acacia auriculiformis*, etc.

Common fruits are *Mangifera, Artocarpus heterophyllus*, *Musaceae, Cocos nucifera*, *Chrysophyllum cainito*, etc.

Figure 5.39. Habitats of wood tree species and fruit trees in sandy soil in Phu Quoc National Park.

5.3.8. Others

5.3.8.1. Agricultural land – Shrubs

Agricultural production areas mixed with scattered groups of trees are also present around the forests of the park, with an area of 106.91 hectares.

5.3.8.2. Other - Bared ground

Occupying a large area, about 564.87 ha. Soil property along the coast is not suitable for plant growth, especially in the sand. Therefore, the creation of green field scattered along the coast. Some places, there are grass or the trees but not much distributed and heterogeneous. Because of soil and water shortage during the dry season so the grass small, scattered here often wilt die.

5.3.8.3. Channels and water reservoir

A network of rivers, canals and lakes to create a significant surface area, about 51.35 hectares, the park area. Water surface area depends on the season, the rainy season, water surface area increased by a number of streams and rivers were flooded tops, but in the dry season, water surface area decreased significantly by the dry spring shallow.

Table List of plants recorded in surveyed transects in Phu Quoc National Park

VT	Floral species							
89	*Melaleuca cajuputi*	*Leptocarpus diajunotus*	*Melastoma villosum*	*Drosera burmannii*				
90	*Melaleuca cajuputi*	*Leptocarpus diajunotus*	*Melastoma villosum*	*Drosera burmannii*				
91	*River*							
92	*Rhizophora apiculata*		*Lumnitzera coocinea*					
93	*Grewia paniculata*	*Melastoma villosum*						
94	*Garcinaia sp.*	*Neolamarekia cadamba (Roxb.)Bosser.*		*Ficus altissima Bl.*	*Lagerstroemia*	*Dilenia ovata*		
95	*Cipadessa baccifera (Roth) Miq.*	*Garcinaia sp*	*Melaleuca cajuputi*	*Cratoxylon formosum (Jack,) Dyer.)*	*Glyptopetalum thorelii Pit..*	*Lagerstroemia calyculata Kurz.*	*Aronychia pedunculata (L.) Miq.*	
96	*Alstonia spathulata L..*	*Diptarocarpus sp.*						
97	*Oncosperma tigillaria*	*Ardisia sp.*						
98	*Oncosperma tigillaria*	*Lincuala soinosa*						
99	*Oncosperma tigillaria*	*Melaleuca cajuputi*	*Glyptopetalum thorelii Pit..*	*Ardisia sp.*				
100	*Shorea harmandi Pierre*							
101	*Melaleuca cajuputi*	*Mixed trees*						
10	*Melaleuca*	*Melastoma*	*Lincuala soinosa*	*Oncosperma*	*Syzygium*	*Manikara*	*Acroceras*	

VT	Floral species							
3	*cajuputi*	*villosum*		*tigillaria*	*zeylanicum (L.) DC.*	*kauki (L.) Dub.*	*munroanum (Bal.) Henr.*	
104	*Melaleuca cajuputi*	*Leptocarpus diajunotus*						
105	*Melaleuca cajuputi*							
106								
107	*Melaleuca cajuputi*							
108	*Melaleuca cajuputi*							
109	*Melaleuca cajuputi*							
110	*Diptarocarpus sp.*							
111	*Diptarocarpus sp.*							
114	*Hopea Odorata Roxb*							
115	*Diptarocarpus sp.*	*Lithocarpus sp.*	*Hopea pierrei Hance*	*Hỗn Giao*				
116	*Diptarocarpus sp.*	*Alstonia spathulata L..*	*Ficus altissima Bl.*	*Ardisia sp.*	*Hopea pierrei Hance*	*Lithocarpus sp.*	*Tristaria merquensis*	
117	*A. nitida Trec. Subsp. Lignanensis (Merr) Jarr.*	*Diptarocarpus sp.*	*Shorea thorelii Pierre*					
118	*Tristaria merquensis*	*Diptarocarpus sp.*	*A. nitida Trec. Subsp.*	*Rhodomyrtus tomentosa*	*??*	*Aronychia pedunculat*	*Rhodamnia dumetorum*	

VT	Floral species							
			Lignanensis (Merr) Jarr.			*a (L.) Miq.*	*(Poir.) Merr.*	
119	*Diptarocarpus sp.*	*A. nitida Trec. Subsp. Lignanensis (Merr) Jarr.*		*Manikara kauki (L.) Dub.*	*Fagrea fagrans L.*			
120	*Hopea pierrei Hance*	*Diptarocarpus sp.*	*Samanea saman*					
121	*Diptarocarpus sp.*	*Anisoptera cochinchinensis Pierre*	*Diospyros maritina*					
122	*A. nitida Trec. Subsp.*		*Lignanensis (Merr) Jarr.*					
123	*Dipterocarpus turbinatus Gaertn.f..*	*Rừng Dầu*						
124	*Melaleuca cajuputi*	*Diptarocarpus sp.*	*Ardisia sp.*	*Shorea thorelii Pierre*	*Drosera burmannii*	*Leptocarpus diajunotus*	*Xyris paucifl ora*	*Melast oma villosu m*
125	*Cipadessa baccifera (Roth) Miq.*	*Syzygium sp.*	*Dilenia ovata*	*Diptarocarpus sp.*	*Manikara kauki (L.) Dub.*	*Drosera burmannii*	*Cyper us sp.*	
126	*Melaleuca cajuputi*	*Leptocarpus diajunotus*	*Cyperus sp.*	*Melastoma villosum*				
127	*Melaleuca cajuputi*							
128	*Melaleuca cajuputi*							
129	*Melaleuca cajuputi*							
13	*Melaleuca*							

VT	Floral species							
0	*cajuputi*							
131	*Melaleuca cajuputi*	*Dipterocarpus sp.*						
132								
133	*Imperata cylindrica*	*Melastoma villosum*	*Dipterocarpus sp.*					
135		*Acacia auriculiformis*						
136	*Rhizophora apiculata*	*Lumnitzera coocinea*	*Xylocarpus rumphii (Kostel.) Mabb.)*					
137	*Rhizophora apiculata*	*Lumnitzera coocinea*	*Melaleuca cajuputi*					
138	*Rhizophora apiculata*	*Melaleuca cajuputi*						
139	*Avicennia spp*	*Lumnitzera coocinea*	*Melaleuca cajuputi*					
140	*Lumnitzera coocinea*	*Rhizophora apiculata*	*Melaleuca cajuputi*					
141	*Rhizophora apiculata*	*Lumnitzera coocinea*	*Melaleuca cajuputi*					
142	*Lumnitzera coocinea*	*Rhizophora apiculata*	*Xylocarpus rumphii (Kostel.) Mabb.)*	*Cupressus torulosa D. Don*				
143	*Lumnitzera coocinea*	*Rhizophora apiculata*	*Pandanus usii*	*Melaleuca cajuputi*	*Oncosperma tigillaria*			
144	*Rhizophora apiculata*	*Thespesia populnea (L .) Soland. ex Correa*		*Peltophorum pterocarpum (DC.) Backer ex K. Heyne*				
145	*Cipadessa baccifera (Roth) Miq.*	*Calamus sp.*	*Syzygium sp.*	*Suregada multiflora (Juss) H.*	*Carallia sp*			

VT	Floral species							
				Baill..				
146	*Melaleuca cajuputi*							
147	*Melaleuca cajuputi*	*Stenochlaena palustris*	*Melastoma villosum*	*Lygodium scandens (L.) Sw..*	*Cyperus sp.*			
	Rhodomyrtus tomentosa	*Melastoma villosum*		*Cipadessa baccifera (Roth) Miq.*	*Peltophorum pterocarpum (DC.) Backer ex K. Heyne*			
148	*Peltophorum pterocarpum (DC.) Backer ex K. Heyne*	*Cipadessa baccifera (Roth) Miq.*	*Diptarocarpus sp.*					
149								
150	*Melaleuca cajuputi*							
151	*Imperata cylindrica*	*Melaleuca cajuputi*	*Stenochlaena palustris*	*Pandanus usii*				
152								
153	*Melaleuca cajuputi*	*Xyris pauciflora*	*Leptocarpus diajunotus*	*Imperata cylindrica*				
154	*Melaleuca cajuputi*	*Imperata cylindrica*	*Melastoma villosum*	*Cipadessa baccifera (Roth) Miq.*	*Diptarocarpus sp.*	*Afzelia xyclocarpa (Kurz.) Craib.*		
155	*Cipadessa baccifera (Roth) Miq.*	*Anisoptera costata Kortn..*	*Diptarocarpus sp.*	*Rhodomyrtus tomentosa*	*Melastoma villosum*	*Melaleuca cajuputi*		
156	*Melaleuca cajuputi*							

VT	Floral species							
157								
158	*Peltophorum pterocarpum (DC.) Backer ex K. Heyne*	*Rhodomyrtus tomentosa*	*Anisoptera costata Kortn..*	*Melastoma villosum*	*Melaleuca cajuputi*	*Imperata cylindrica*		
159	*Imperata cylindrica*	*Acacia auriculiformis*						
160	*Acacia auriculiformis A.Cunn*	*Anacardium occidentale L.*						
161								
162	*Rhodomyrtus tomentosa*	*Rhodomyrtus sp*	*Diptarocarpus sp.*	*Dilenia ovata*				
163	*Cipadessa baccifera (Roth) Miq.*	*Diptarocarpus sp.*	*Hopea pierrei Hance*	*Carallia sp*	*Alstonia spathulata L..*			
164	*Melaleuca cajuputi*							
165	*Hopea pierrei Hance*	*Rhizophora apiculata*	*Lumnitzera coocinea*					
166	*Lumnitzera coocinea*	*Rhizophora apiculata*	*Thespesia populnea (L .) Soland. ex Correa*	*Tristaria merquensis*	*Ipomoea pes-caprea*			

PART 6.

U MINH THUONG NATIONAL PARK

6.1. Overview

6.1.1. Location

U Minh Thuong National Park, an area located in the district of U Minh Thuong (formerly An Minh district). The total area is 21,800 h for the whole area, including the core and buffer zones. The whole area of national park located in the geographic coordinates:

- From 9 · 31 to 9 · 39 'north latitude, and
- From 105 ° 03 'to 105 ° 07' east longitude.

4.1.2. History

Before 1975, the U Minh Thuong National Park area was one of two Melaleuca forests located on peat swamp forest known as Melaleuca forests in U Minh peat land areas, including the U Minh Thuong and U Minh Ha (Ca Mau province). This low-lying terrain was named Ho Rung (Lake Forest). And at this time, the U Minh area was divided into two parts: the U Minh Ha, Ca Mau province, and the U Minh Thuong Kien Giang province. Two forests separated from each other by Trem river.

Figure 6.1. Map of U Minh Thuong National Park

According to previous data, in 1950, Melaleuca forest area to 400,000 ha in U Minh there, but until 1970, only about 200,000 hectares, and reduced to about 100,000 hectares in 1990.

During the war, Melaleuca forests in U Minh Thuong has pretty much been destroyed by bombs that today still trace to the small ponds scattered in the core expenditures of the national park (Figure 6.2).

After the war ended, this area was used as Melaleuca forest Enterprise. It was seen as intensive Melaleuca forest areas on acid sulphate soils. In 1993, this area is the Government of Vietnam has decided the forest should be protected, and also an investment plan for this area had been prepared by the Forest Department and has been evaluated and approved approved in 1994 (Buckton et al. 1999). According to this decision Melaleuca forests in U Minh Thuong become Nature Reserves U Minh Thuong. The formal decision of the Government of Vietnam to protect the U Minh Thuong forest Melaleuca forests. According to the inventory data in 1995, the entire area of the Melaleuca forests on peat land is 8053 ha protected.

In 2002, Nature Conservation Area was transferred to the U Minh Thuong National Park at ythe Decision No. 11/2002/QD-TTg, dated 14/01/2002. According to this decision, the total area for the whole area was 21,107 ha, of which the core region occupied an area of 8038 hectares and the buffer occupying 13,069 ha. In the buffer zone of forest, there were many households living, farming, plant cultivation, contracted to plant and maintain forests for the state. According to this decision, the U Minh Thuong National Park under the management of Kien Giang province.

Figure 6.2. The crater during the war has left the pond to form inside the U Minh Thuong National Park (Google Earth satellite images, 2007).

6.1.3. Sedimentary terrain

U Minh Thuong region located on peat swamps were long ago in the period after the establishment of the Mekong Delta.

Peat is formed in the swamp through the process of plant decomposition after death and buried in sediments above it. In the process of formation, development on the mangrove sediments, after the death of forest vegetation and other plants had been buried and left a large amount of organic matter. This organic matter was continued gradually to a thickness of accretion in which no tidal effect. And at the time, Melaleuca forest on peat swamp began to form. Mangrove forests continue to return to the mass of organic matter into the soil and bring the presence of two main types of soil: peat soil and alkaline soil.

Like the U Minh Ha, peat material of the U Minh Thuong form a plate with a raised core area with thick layers of peat and more toward the edge of the peat layer thinner. Peat layer beneath the sediments is blue with gray clay material predominates.

The land covered by thick peat layer of 1-3 m. The new place on fire, the peat layer of topsoil is lost and thinner, and usually forming swamps. In areas already cleared land for agriculture, the peat layer is oxidised and reduced thickness (Safford et al. 1998).

Topography, much of the region of U Minh Thuong National Park has an average terrain varies between 0.5 -0.7 m (AMSL). In the central area with thick peat layer (dome), the terrain is higher than the surrounding area.

6.1.4. Hydrology

U Minh Thuong National Park is located in the freshwater wetlands, including peat land forests, seasonally inundated grassland and swamp empty. The core zone of U Minh Thuong National Park is surrounded by canals and dikes with many gates to regulate water levels. Water is removed during the rainy season and are retained in other times of the year. This reduces oxidation and keeps the coal layer thinning and reducing the risk of forest fires.

Land occupies a large area of the U Minh Thuong, this soil type when exposed in air and oxidised form sulfuric acid. Although alum is the land but the water in the core zone is the most neutral (pH 6-7) due to high rates of forest cover. However, in the buffer zone, the forest has eliminated a lot of threads used for agricultural cultivation increased oxidation process should cause the channel condition is acidic, pH = 3-4).

6.1.5. Biological resources

Peatland areas in the U Minh Thuong National Park is considered one of the remaining peat swamps of Vietnam, and is considered one of the three highest priority areas for conservation of wetlands Mekong Delta (Buckton et al, 1999). Tran Triet (2000) has divided the vegetation in the core zone of the park into four states including Melaleuca forests dominant on the peat soil and clay, the seasonally inundated grassland with dominance of *Phragmites vallatoria* and *Eleocharis dulcis*, open wetlands with the advantage of species *nouchali Nymphaea, Pistia stratiotes, Salvinia cucullata* and *Typha domingensis*; and plants on the natural flow (rivers, canals) and canals. Vegetation in the buffer zone, including seasonally inundated grassland, open swamps, Melaleuca forests, and other forms of agricultural land, fish ponds and canals. The peatlands foster a diverse flora, including many rare and endemic species. Tran Triet (2000) has recorded 226 species of vascular plants, not growing. In particular, there is Lemna tenera rare species in Southeast Asia, but quite common in the U Minh Thuong.

Forests and wetlands in the U Minh Thuong has many rare and interesting species are threatened. Besides birds, the animals here are not much interested until a comprehensive survey of the fauna in October and November 2000 (N. M. Sage and Greve in litt. 2000) . In this survey, special attention is to assess the status of the Siamese crocodile (*Crocodylus siamensis*) and saltwater Crocodile (*C. porosus*) in the park. However, the results showed that both species were not present in the national parks in 30 years (Stuart et al, 2002). The importance

of conservation of the U Minh Thuong National Park is doing better thanks to a high diversity of birds. Surveys in the wetlands in the Mekong delta by BirdLife International and the Institute of Ecology and Biological Resources (IEBR) showed that U Minh Thuong highest richness of bird species, compared with the field were surveyed (Buckton et al, 1999). To date, 187 bird species recorded at U Minh Thuong, including 9 species near threatened or endangered globally: Indians Indians (Solid Stock - *Anhinga melanogaster*), legs gray pelicans (*Pelecanus philippensis*), Decay, India (*Mycteria leucocephala*), Adjutant Java (*Leptoptilos javanicus*), the black ibis (*Threskiornis melanocephalus*), black ibis (*Plegadis falcinellus*), black eagle (*Aquila clanga*), the first gray fish (Ichthyophaga ichthyaetus0 and pulleys Gold (*Ploceus hypoxanthus*) (Safford et al, 1998; Buckton et al, 1999; Nguyen Phuc Bao Hoa, 2000). U Minh Thuong also has a substantial collection at the global level the number of birds the more common, including acid *(Porphyrio porphyrio*), Bangkok (*Phalacrocorax niger*), fire Heron (*Ardea purpurea*), black ibis (*Plegadis falcinellus*). For these reasons, the U Minh Thuong was classified as a Important bird sanctuary (Tordoff, 2002).

6.2. Flora land cover

Although Melaleuca dominates most areas of peat swamp, the flora in the region of U Minh Thuong National Park is also quite diverse. Based on the coverage density, growth duration of the Melaleuca forests, crowding together with other species and other plant communities, have more vegetation units recorded in the region of U Minh Thuong National Park.

From the results of image interpretation and remote sensing survey of the field data collection, internal processing industry, with 5 units and 38 sub-units of the vegetation covers is divided (Table 4.1.).

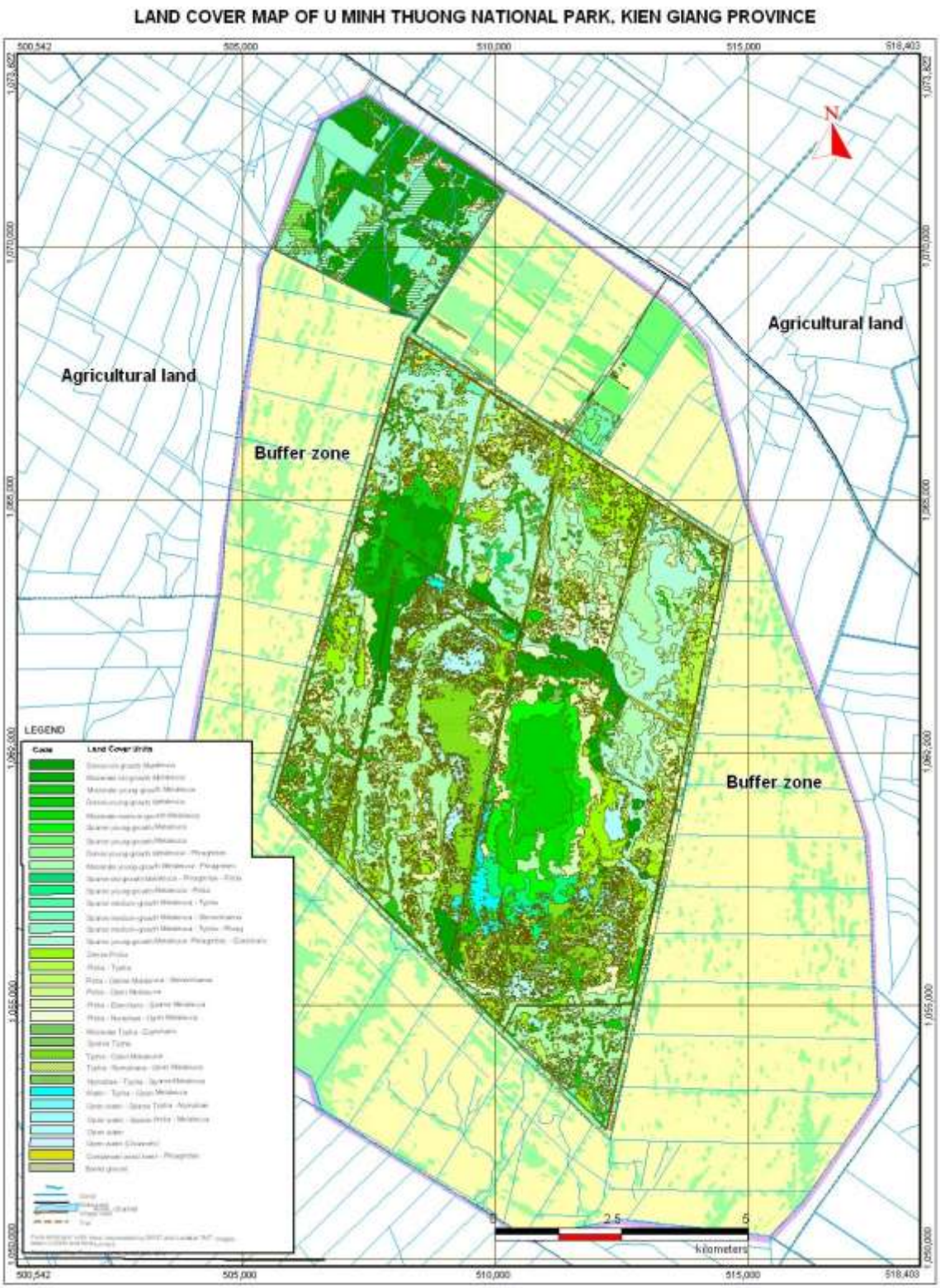


Figure 6.3. Map of flora covers in U Minh Thuong National Park in 2009

Table 4.1. Vegetation units in flora covers in U Minh Thuong National Park in 2009.

No.	Vegetation unit	Area (ha)	Coordinates (meters)	
			Longtitude	Latitude
I	**Melaleuca forests**	**1.595.04**		
1	Dense old-growth Melaleuca	370,75	507905,0	1062463.28
2	Moderate old-growth Melaleuca	182,3	507347.1	1064039.90
3	Sparse old-growth Melaleuca	358,05	508588.2	1065263.44
4	*Dense young-growth Melaleuca*	243,89	510968.3	1059578.75
5	Moderate medium-growth Melaleuca	200,33	510354.8	1059049.20
6	Sparse young-growth Melaleuca	218,87	510213.6	1059409.34
7	Very sparse young growth melaleuca	20,85	511789.8	1064776.14
II	**Melaleuca forests – other plants**	**2.851,39**		
8	Thick and young melaleuca – Phragmites	2,06	512442.7	1059567.46
9	Moderate and young melaleuca	1.343,29	508170,0	1058642.55
10	Old growth melaleuca – Phragmites, Pistia	42,42	510071.3	1063844.42
11	Young melaleuca - Pistia	107,52	510905.7	1056965.90
12	Sparse moderate melaleuca – Typha	13,05	506753.3	1058490.50
13	Sparse moderate melaleuca – Stenochlaena	88,6	509255.6	1067402.44
14	Sparse melaleuca – Phragmites Typha	91,35	507450.3	1058549.79
15	Young melaleuca - Phragmites, Eleocharis	1163,1	513357.9	1062708.83
III	**Population of** Pistia	**2.065,47**		
16	Thick Pistia	674,12	512055.2	1065162.06
17	Pistia – Typha	115,67	513742.7	1061571.07
18	Pistia – Stenochlaena, scattered melaleuca	298,49	513072.3	1058419.80
19	Pistia – scattered melaleuca	32,88	513905.8	1064448.35
20	Pistia – Eleocharis, sparse melaleuca	732,9	511973.9	1059355.03
21	Pistia – Nymphaea nouchali, melaleuca	211,41	510929.1	1063381.53
IV	**Population of Typha**	**722,62**		
22	Typha – Eleocharis, *Salvina cucullata*	72,94	509482.5	1062315.4
23	Sparse Typha	22,19	512335.7	1056390.86
24	Typha – melaleuca, *Salvina cucullata*	585,02	509256.2	1059188.67
25	Typha – melaleuca, Nymphaea nouchali	42,47	511911.9	1055770.67
V	**Open water – aquatic plants**	**606,6**		
26	Open water: *Nymphaea nouchali* – Typha, melaleuca	17,71	510787.8	1055643.77
27	Open water: Typha – melaleuca	91,2	509758.1	1057240.53
28	Open water: Typha - Nymphaea nouchali	50,81	511734.4	1057241.20
29	Open water: Pistia - Tràm	71,07	512242.1	1053412.76
30	Open water: Nymphaea nouchali	375,81	509060.8	1061988.46
VI	**Others**			
31	Channels	18,56	506602.9	1059556.70
32	Phragmites – mixed trees	137,45	509694,0	1058557.69
33	Barren lands	0,47	510552.6	1062510.96
	Total	**7.997,6**		

6.3.1. Melaleuca forest

The status shows Melaleuca (*Melaleuca cajuputi*), with coverage from 20 - 80% dominate the entire region of U Minh Thuong National Park, an area of approximately 4446.43 hectares, of which 1595.04 ha of forest Melaleuca forests with the thick density. Although most Melaleuca forests died after fire in 2002, but still a large area Melaleuca forests Melaleuca forests is considered semi-natural forest left on the peat swamp.

According to the division results in the Melaleuca forest units, 5 units of Melaleuca forest cover in the national park areas: 1) Tram growth, density, 2) Tram mature, medium density, 3) mature dense melaleuca, 4) small percentage, density, and 5) Tram medium, medium density.

6.3.1.1. Dense old-growth Melaleuca

This is a series of Melaleuca forest fires that were left after 2002, with an area of 370.75 hectares. Most stations have an average density and cover about 70%, and are aged over 15 years. Melaleuca forests relative high average between 15-30 m. Melaleuca forests located beside a row of horizontal channel is where the community Bats (Pteropus sp.) Used as a shelter.

Figure 6.4. Clusters of semi natural melaleuca forests after forest fire in 2002.

6.3.1.2. Moderate old-growth Melaleuca

Melaleuca is also the sequence left behind after fires in 2002, with an area of 182.30 hectares. Melaleuca has over 12 years of age, the average coverage from 40 - 60%. Much of this range is next Melaleuca Melaleuca adult density. Melaleuca forests between clusters have some other plants such as *Phragmites vallatoria, Stenochlaena palustris* and *Salvina cucullata* with less density.

6.3.1.3. Sparse old-growth Melaleuca

This is a Melaleuca forests with horizontal rows of small, mostly elderly Melaleuca forests are distributed unevenly along the canal inside the national park. Occupying an area of about 358.05 hectares. Observed that the Melaleuca forests is the age group over 12 years, forming a cluster or array into sparse. Melaleuca forests surrounding ranges have many other plants such as *Phragmites vallatoria*), and the species of aquatic plants such as *Pistia stratiotes, Salvina cucullata*, and *Haloragaceae*, etc.

6.3.1.4. *Dense young-growth Melaleuca*

This is the Melaleuca forests are aged between 7-8 years, which cover over 70%, in the center of the park, an area of approximately 243.89 hectares. Melaleuca forests developed on peat areas imply the greatest thickness (> 1 m), should have the highest terrain in the region of U Minh Thuong National Park.

Figure 6.5. Melaleuca also small, relatively dense regions located in the center of the U Minh Thuong National Park. The outer petals sparsely mixed mangrove trees and the aquatic plants.

Most of the secondary forest after fires in 2002, but due to development in areas with relatively high terrain, with thick layers of peat Melaleuca forests development is quite good, quite thick Melaleuca density and high coverage, compared to other areas. Although there are few places appear as a *Phragmites vallatoria* or lianas such as *Stenochlaena palustris*, but very sparse density. Satellite images show the density of Melaleuca vegetation covers differ from the surrounding area (Figure).

6.3.1.5. Moderate medium-growth Melaleuca

Surrounded by forests and thick density Melaleuca forests a Melaleuca forests clusters scattered in the canal near the national park area is forest regeneration Melaleuca forests average coverage from 40 - 60%. This forest area of about 200.33. Because of the average density of Melaleuca trees, *Phragmites vallatoria*, *Pistia stratiotes* appear scattered, low density, in units of average vegetation covers Melaleuca forests.

Figure 6.6. Melaleuca Melaleuca in the vicinity of the average thickness of peat land in the region of U Minh Thuong.

6.3.1.6. Sparse young-growth Melaleuca **-** Pristia

Melaleuca ties have low coverage, only about 30-40%, with area of 218.78 hectares. Mainly distributed along the edge of the flap peatlands in central areas and a small area scattered in the area of the park. Mangrove restoration and regeneration following fire in 2002 should be between the ages of 7-8 years. Terrain is quite low and pretty much flooded, so density is not high and creates an vegetation covers. Mosaic of forests, Melaleuca is the bushes, aquatic plants, but not high density, unstable. Through the survey found that clusters such as *Phragmites vallatoria*) was pretty much dead in the forest Melaleuca forests said.

6.3.1.7. Open Melaleuca – water)

Melaleuca tree clusters with uneven distribution of the scattered wetlands have a lot in the wetland areas of national park; co1die65n area of about 20.85 ha. Some species of aquatic plants may experience in this area, but density is not significant such as *Nymphaea nouchali*, *Pistia stratiotes*, *Salvina cucullata*, and occasionally seen *Eleocharis dulcis*.

Figure 6.7. Melaleuca clusters scattered in ununded areas in U Minh Thuong National Park.

6.3.2. Melaleuca mixded with shrubs, aquatic plants

U Minh Thuong National Park area, has a relatively large area, approximately 2851.39 hectares, Melaleuca development sessions interspersed with trees and other species of aquatic plants. The presence of the main plant species other than Melaleuca has increased the biodiversity of plants in peat land areas in U Minh Thuong.

Based on Melaleuca forest density, composition and density of plants intercropped with Melaleuca forests, 7 sub-units are recognized: 1) small Melaleuca forests, alternating with thick density *Phragmites vallatoria* 2) large cents Melaleuca forests with *Phragmites vallatoria* and *Pistia stratiotes*, 3) Melaleuca forests small, medium density mixed with *Phragmites vallatoria*, 4) Melaleuca forests small, sparsely interspersed with Pistia stratiotes, 5) station average density alternating with *Stenochlaena palustris*, 6) Melaleuca forests medium density mixed with *Typha angustifolia L.* 7) alternating with sparsely Melaleuca forests with *Phragmites vallatoria, Typha angustifolia L .*), and 8) Melaleuca forests small density alternating with *Phragmites vallatoria and Eleocharis dulcis*).

6.3.2.1. Dense young-growth Melaleuca – Phragmites

This is Melaleuca forests with relatively dense clusters interspersed with *Phragmites vallatoria* running along the banks of a canal in the area of national park. With an area of only about 2.06 ha, but the channel should be distributed along this unit made up of long sequences that can recognize quite clearly on satellite images.

6.3.2.2. Old-growth Melaleuca - Phragmitex - Pistia

Ties mixed with large Melaleuca forests of *Phragmites vallatoria* and *Pistia stratiotes* occupying an area of about 42.42 hectares located on the clay surface of organic matter (Humic Fluvisols) in the national park area. Melaleuca forests uneven development, ramshackle tree falls were flooded very often. It is saied that several clusters are dying too high due to flooding, while Pistia fills gaps within the forest Melaleuca forests.

6.3.2.3. Moderate young-growth Melaleuca – Phragmites

This is the Melaleuca forests aged 7-8 years, with an average coverage of 60 - 70% on the clay is pretty much crowding Say (Phragmites vallatoria). Occupying an area of about 1343.29 hectares large, and relatively wide distribution on the clay surface organic matter (Humic Fluvaquents) and land with shallow peat layer (Histic Fluvaquents) in U Minh Thuong National Park area.

Figure 6.8. Mixed with large melaleuca with Phragmites, and interspersed with non Melaleuca forests in the region of U Minh Thuong National Park.

Flooded for many years by a number of large trees and Melaleuca is not upright like Melaleuca forests on seasonal wetlands. In addition to the mixed clusters Say Melaleuca forests in some places there is the presence of some species of aquatic plants such as Cai Beo (*Pistia stratiote*), Tai Beo Mouse (Salvina cucullata), ...

6.3.2.4. Sparse young-growth Melaleuca – Pistia

This is a Melaleuca forests flap was not well developed due to wetlands, the density is quite sparse and coverage is quite low at about 20-30% mixed with ties Cai Beo (*Pistia stratiotes*). With an area of about 107.52 hectares, and mainly distributed in low-lying areas were flooded high ground around the center of peat and scattered elsewhere in the park area.

Figure 6.9. sparse melaleuca forests mixed with *Pistia stratiotes* with competitive distribution in the wetlands of U Minh Thuong National Park.

6.3.2.5. Sparse medium-growth Melaleuca – Typha

Melaleuca forests in flooded areas, where aquatic plants is Bon Bon (*Typha angustifolia L.*), which develop into a mixed habitat Melaleuca forests with *Typha angustifolia L.* Unit area of this vegetation is not much, only about 13.05; scattered small clusters near where high water flooded the south of the park. In addition to *Typha angustifolia L.*, some species of aquatic plants such as *Nymphaea nouchali* also appears in the Melaleuca forests area - *Typha angustifolia L.*, but the density and extent of distribution of this species is not much.

Figure 6.10. Melaleuca forests mixed with Bon Bon (Typha angustifolia L.) in the flooded areas in the U Minh Thuong National Park. Mixed between these melaleuca clusters is sparse *Stenochlaena palustris*.

6.3.2.6. *Sparse medium-growth Melaleuca – Stenochlaena*

Stenochlaena palustris is present pretty much, mainly distributed in areas where terrain is moderate to slightly higher than the general topography of the region of U Minh Thuong National Park. Along a line of canals and channels inside the national park area where the terrain is relatively high. Therefore, the forests along the Melaleuca forests in the channel are often interspersed by *Stenochlaena*. In addition, because the water level is kept too high for many years, formed a new Melaleuca forests fell below the vegetation to create conditions favorable for development of *Stenochlaena* mixed with Melaleuca. According to the interpretation and Melaleuca forests survey showed mixed with denial about 88.6 ha in U Minh Thuong National Park area.

Figure 6.11. Melaleuca forests mixed with *Stenochlaena palustris* in U Minh Thuong National Park.

6.3.2.7. Sparse medium-growth Melaleuca mixed Typha - Phragmitex

Melaleuca forests have an average age of 5-7 years, density interspersed with clusters of reeds and Bon Bon, with an area of 91.35 hectares. Because so many years of submerged aquatic plants grow in this region, is dominated with *Typha angustifolia L.*). A number of aquatic species such as *Haloragaceae*, *Nymphaea nouchali* also appeared in the white area but density is negligible. *Phragmitex vallatoria* appear in clusters, or into the range where the terrain is slightly higher than the locally surrounding areas.

6.3.2.7. Sparse young-growth Melaleuca- Phragmites - Eleocharis

Due to water retention so bad development Melaleuca forests, Melaleuca forests said so, cover about 20% occupied a considerable area in the region of U Minh Thuong National Park. Chen said both between the wings is Melaleuca forests Say (*Phragmitex vallatoria*) and scattered in the region is Power Pipes (Eleocharis dulcis). Area of forest Melaleuca forests with *Phragmitex vallatoria* with an amount up to 1163.1 ha. Due to the relatively high submerged pipe Skills development uneven and difficult record if no record observations.

Figure 6.12. Habitats of melaleuca forest mixed with *Phragmitex vallatoria and Eleocharis dulcis*.

6.3.3. Aquatic plants

In submerged conditions year round, apart from Melaleuca trees, plant communities with many species of aquatic development in the region of U Minh Thuong National Park. The most commonly Beo (*Pistia stratiotes*), Tai Beo Mouse (*Salvina cucullata*), Bon Bon (*Typha angustifolia L.*), (*Haloragacea*), *Nymphaea nouchali*) and *Nymphoides indica*), etc.

Based on uniformity and superiority of certain plant species in different communities, some of the vegetation unit of aquatic plant communities are divided in the U Minh Thuong National Park area. Among them, Cai Beo communities and mixed with other aquatic species to 2065.47 ha.

6.3.3.1. *Pistia stratiotes*

Cai Beo (*Pistia stratiotes*) pretty much developed in the region of U Minh Thuong National Park. The presence of dirt from the canal to the forests, the wetlands. According to the channel region, Cai Beo hinder moving ships, boats.

In the U Minh Thuong National Park area, *Pistia stratiotes* is present in different densities. Cai Beo a population density of up to 95%, or interfere with the

development of other aquatic plants. *Pistia stratiotes* also exist between the clusters and Melaleuca in the range Say (Phragmitex vallatoria) constitute the diversity of flora.

6.3.3.1.1 Dense *Pistia stratiotes*

In the interior region of the NP, *Pistia stratiotes* population account for 674.12 ha. water surface by the impact of wind and the area of Cai Beo can change each year due to move in the wind, but due to the growth characteristics of the area's rapidly growing Cai Beo, eradication measures are needed.

Figure 6.13: Population of *Pistia stratiotes* occupied open water surface in U Minh Thuong National Park.

6.3.3.1.2. *Pistia – Typha*

Cai Beo (*Pistia stratiotes*) and Bon Bon (*Typha angustifolia*) are distributed quite widely in the wetland areas in the national park area. By the action of wind, *Pistia stratiotes* was swept into the area beyond the surface vegetation such as Melaleuca (Melaleuca cajuputi), *Phragmitex vallatoria*), *Typha angustifolia* and they settled here. Therefore, aquatic plant communities Cai Beo - Bon Bon forming a vegetation unit of aquatic plants in the region of U Minh Thuong National Park, an area of approximately 115.67 hectares.

The distribution of this unit primarily in wetland areas is relatively high and the gap of water.

Figure 6.14. Habitats of Bèo Cái (*Pistia stratiotes*) – Bồn Bồn (*Typha angustifolia*) in peatlands in U Minh Thuong National Park.

6.3.3.1.3. Pistia - Opene Melaleuca – Stenochlaena

After fires in 2002, Melaleuca has been reborn, but not high density and flooded several years due to Melaleuca forests hard to develop the wetlands is too high. However, local areas where the terrain is slightly higher, the Melaleuca forests is still present in scattered wetland areas. Surveys showed that species of vines denied (Stenochlaena palustris) were parasitized in some clusters Melaleuca forests in the region have formed a coating Beo - Melaleuca forests cents denied. This coating is scattered in the area with water flooded an area of 298.49 hectares.

Figure 6.15. Cai Beo habitat (*Pistia stratiotes*) alternating scattered Melaleuca - (*Stenochlaena palustris*) in the national park area UMT. Water surface area was conquered by populations Cai Beo.

6.3.3.1.4. Pistia - Opene Melaleuca

Cai Beo (*Pistia stratiotes*) dominated wetlands Melaleuca forests mixed clusters. Melaleuca forests in the region of the parasitic species of vines denied (*Stenochlaena palustris*), with a relatively small area, about 32.88 ha. Scattered in areas submerged in the average surface area of clay with organic matter (Humic Fluvaquents).

6.3.3.1.5. Pistia - Eleocharis – Open Melaleuca

These areas of seasonally inundated grassland with the dominant vegetation is Power Pipes (Eleochris dulcis) and scattered in the field of Energy is the phrase Melaleuca forests, with an area of 732.9 ha. However, after being submerged too high, difficult to develop pasture that was merely Cai Beo and become invasive aquatic plants which are dominant.

Eleocharis dulcis still appears small clusters scattered throughout this region. Flooded by high so long and severe renal weak field observer noted the length of the *Eleocharis dulcis* changed from 1 to 1.8 m. Melaleuca very poorly developed in the wetlands is too high and rather scattered distribution in the region.

6.3.3.1.6. Pistia - Nymphae - Open Melaleuca

Occupying an area of about 211.41 hectares, this is the area of water surface with aquatic plants Cai Beo dominate, which is mixed with guns Ma (Nymphaea nouchali), Indian Water Girl (Nymphoides indicum), and are scattered Melaleuca forests clusters in less developed wetland environment is too high.

6.3.3.2. *Typha angustifolia*

Bon Bon (*Typha angustifolia*) is one species of aquatic plants are common in wetland areas of the U Minh Thuong National Park. Bath tub very diverse distribution of each population alone and form a community when mixed with the aquatic species as well as the bushes, Melaleuca in the region.

Depending on the density and crowding among other plants, 5 units of Bon Bon coating, with an area of 740.33 hectares and is divided as follows: 1) thick *Typha angustifolia*, 2) sparse *Typha angustifolia*, 3) scattered Melaleuca, 4) *Typha angustifolia* interfered with lotus and scattered Melaleuca, and another unit is 5) *Typha angustifolia* with lotus, scattered Melaleuca forests.

6.3.3.2.1. Dense *Typha angustifolia*

Typha angustifolia is relatively dense and form a large distribution network in much flooding in the region of U Minh Thuong National Park is high. *Typha angustifolia* pretty much on the development of peat land fires in 2002, where Melaleuca forests scatteredly developed, or just bare flooded ground. Coverage of the population of *Typha angustifolia* is thick and high, over 90% of the area (Figure).

Figure 6.16. Dense *Typha angustifolia* development in wetland areas in the U Minh Thuong National Park. Around *Typha angustifolia* is *Salvina cucullata*.

With an area of about 72.94 ha, Dense *Typha angustifolia* population distribution and its parts scattered communities with other aquatic plants or water networks completely.

Salvina cucullata also appear around the edge, or mixed in the region by the density of the *Typha angustifolia* therefore *Salvina cucullata* appeared on the water inside more fringe of *Typha angustifolia*.

Although the natural vegetation in the park area, but *Typha angustifolia* is sometimes exploited as food by local people.

6.3.3.2.2. Sparse *Typha angustifolia*

A significant area of Bon Bon (*Typha angustifolia*), about 22.19 hectares, small clusters, the density is quite covered, about 40-50%, but clusters are scattered among the aquatic plant communities students. Some places have appeared a number of other species of aquatic plants such as *Salvina cucullata* and Cai Beo (*Pistia stratiotes*) are intermingled in a cluster filled by the wind and the density of aquatic species.

Figure 6.17. Bon Bon clusters (*Typha angustifolia*) scattered in the wetland areas of U Minh Thuong National Park.

6.3.3.2.3. Typha - Open Melaleuca

Large area of Bon Bon (*Typha angustifolia*) spread across the flooded areas of deep water park, with approximately 585.02 hectares. *Typha angustifolia* clusters scattered and interspersed with clusters of Melaleuca (*Melaleuca cajuputi*) in one large area of peat land fires in 2002.

Coverage of both these plants are not high-density clusters of *Typha angustifolia* is about 30-40% and sporadic Melaleuca forests is about 10% of the entire area. The rest is surface water interspersed between clusters of *Typha angustifolia* and Melaleuca forests scattered in the region. *Typha angustifolia* in few places in the network - Melaleuca forests, the presence of a species of aquatic plants such as Cai Beo (*Pistia stratiotes*), Tai Beo Mouse (*Salvina cucullata*), (*Nymphaea nouchali*), etc. but the density of species is relatively low and unevenly distributed in the whole area of this vegetation.

Figure 6.18. *Typha angustifolia* and Melaleuca mixed clusters scattered in the park's wetlands. Some aquatic plants such as *Nymphaea nouchali, Pistia stratiotes*, *Salvina cucullata*, *Haloragaceae are present in* relatively low density.

6.3.3.2.4. Typha - Nymphaea - Open Melaleuca

A significant area, about 42.47 hectares of wetland areas with aquatic plants is Bon Bon (Typha angustifolia) dominated, although the density is only about 20-30% mixed with plant groups aquatic remaining *Nymphaea nouchali* with a density of about 20%.

Regenerated Melaleuca developed in poor condition scattered flooding in this area. Recorded from field surveys showed Melaleuca forests body size at around 30-50 cm, the body is relatively weak, not much branched. Some clusters Melaleuca forests death was recorded in various parts of the wetland areas are too high.

6.3.3.2.5. *Nymphae - Typha - Sparse Melaleuca*

This unit is considered an vegetation covers similar to vegetation covers 4.3.4.4, but Ma Gun aquatic plants predominate. This cover type occupies an area of relatively small, only about 17.71 hectares, *Nymphaea nouchali* with a density of

about 30-40%. Mixed in this swamp is a cluster of Bon Bon (*Typha angustifolia*) and Melaleuca forests clusters scattered with a density of about 10-20%.

Figure 6.19. *Nymphaea nouchali* mixed Bon Bon (*Typha angustifolia*) and a little less developed renewable Melaleuca forests scattered in the region of U Minh Thuong National Park.

6.3.4. Open water – Aquatic plants

Because the terrain is low and flooded many areas in a relatively large area, about 213.1 ha, is considered the water with a few species of aquatic plants are present. Aquatic plant communities are mainly recorded in the region such as Bon Bon (*Typha angustifolia*), Sung Ma (*Nymphaea nouchali*), Cai Beo (*Pistia stratiotes*), Beo tai chuot (*Salvina cucullata*), *Nymphoides indicum* and *Haloragaceae*.

Sung Ma and *Eleocharis dulcis* developed rather high in few places in the flooded areas with each cluster appears to be small. Places are traces of an area of seasonally inundated grasslands formerly flooded from 2003 to present. Melaleuca also appeared with very small clusters, scattered with a density of only about 1-2% in the whole area of water surface area.

Based on aquatic plant species and density of this species occur in wetlands, there are five sub-units are divided: 1) On the water at Bon Bon with less open water, 2) water surface with fewer Bon Bon and lotus, 3) The water surface is low fat and Melaleuca forests, and 4) open water with less lotus.

6.3.4.1. Nymphae - Typha - Sparse Melaleuca

Water, about 17.71 hectares are covered with Sung Ma (*Nymphaea nouchali*) about 40%, the other plant species such as Bon Bon (*Typha angustifolia*), scattered small clusters in this region. In addition, scattered in the region are not well developed clusters Melaleuca forests, there are dead trees were flooded by too many years.

Figure 6.20. Nymphaea nouchali mixed Bon Bon (*Typha angustifolia)* and the substation in a small area of wetlands in the U Minh Thuong National Park.

6.3.4.2. Open water - Typha - Open Melaleuca

With an area of approximately 91.2 hectares, the area inundated with large aperture and the presence of some plant species such as Bon Bon (*Typha angustifolia*) and regenerated scattered melaleuca forests inside.

Bon Bon (*Typha angustifolia*) is not concentrated in clusters and distributed small crowd had scattered in a vast area of water surface. Melaleuca forests appear

only traces of the cluster Melaleuca regeneration but not well developed due to be flooded for many years.

Some aquatic plants also appear in this wetland, but not high density such as *Nymphaea nouchali and Haloragaceae*.

Figure 6.21. Bon Bon scattered clusters interspersed with a few percent in a large wetland

6.3.4.3. Open water – Nymphaea, Haloragaceae

Similar units on the (4.3.4.2), an area of about 50.81 ha significant water areas with aquatic plants is Bon Bon (*Typha angustifolia*) dominated, but rather dispersed small clusters scattered. Open water surface is present with *Nymphaea nouchali* with low density.

Aquatic plant communities here also the emergence of *Nymphoides indicum* and *Haloragaceae*.

Figure 6.22. Open water with aquatic plants Bon Bon (Typha angustifolia) and Ma Gun (Nymphaea nouchali)

6.3.4.4. Open water - Sparse Pistia – Melaleuca

A relatively large surface area, with an area of 71.07 hectares, with the presence of Cai Beo (*Pistia stratiotes*) scattered small clusters. *Pistia stratiotes* moves on the water by wind and deposited as often blocked by other plants such as Bon Bon (*Pistia stratiotes*) or along the edge of the forest Melaleuca forests in the land were flooded.

In these wetlands, some trees or clusters Melaleuca forests also present, but the current situation shows that Melaleuca forests regenerated after fire and by flood water do not grow well, weak stems, poor foliage.

Figure 6.23. Water surface with the cluster Cai Beo (*Pistia stratiotes*), Melaleuca forests scattered in the wetlands of the U Minh Thuong National Park.

6.3.4.5. Open water – Haloragaceae – Nymphaea

In addition to the water surface area is the aquatic plant species, a rest area is quite large, about 375.85 ha, with no vegetation community present. One reason may be due to low terrain and high water levels flooding should make it difficult for plant growth, even those species of aquatic plants.

Figure 6.25. Mostly water with aquatic plants such as *Haloragaceae, Nymphaea nouchali, Nymphoides indicum*.

6.3.4.6. Channel

Some twisting canal and nature is still present and distributed a lot in the south of the park. To occupy mostly the canal, and even the canals inside the national park area was Cai Beo (*Pistia stratiotes*) invasion obstacling to navigation. Only about 18.56 ha of natural canals located southwest of the park has not been invaded by (*Salvina cucullata*).

Figure 4.26. The water in the canals inside the U Minh Thuong National Park area. The dirt is starting to invade.

6.3.6. Phragmites - complexed wood trees

Phragmites communities and plant complex located along both sides of the channel and the channel inside the national park boundary, with an area of 137.45 hectares. In addition to Phragmites, many species of woody plants are small trees and lianas.

Groups of trees are the dominant Melaleuca (*Melaleuca cajuputi*), few places have *Combretum quadrangulare Kurz*, *Nauclea orientalis (L.)*. In a few places, Eucalyptus (*Eucaplyptus sp.*) is planted in rows of Phragmites.

Phragmites vallatoria predominates in the herbaceous species. On the shore, where there is common grass such as *Panicum repens*. These parasites may be encountered such as *Stenochlaena palustris*, *Cayratia trifolia (L.) Domino*), *Lygodium microphyllum,* clinging on trees. The species of *Nephrolepis sp.* are also seen along the canal bank.

Figure 6.27. Phragmites vallatoria occupied the channel banks in and around U Minh Thuong National Park.

Figure 6.28. *Phragmitex sp* và wood trees along the channel of U Minh Thuong National Park.

Figure 6.29. Bèo Cái (*Pistia stratiotes*) occupied open water in the channel in U Minh Thuong National Park.

6.4. Biological ecosystem of flora

Established local conditions on the three main land is peat land, alkaline soil and alluvial soil alum and some natural factors, artificial impact created a diversity of plants in the region of U Minh Thuong National Park .

The plant communities here have formed a typical ecosystem of peat swamp U Minh Thuong. From the survey results, data analysis was divided into six ecological units: 1) Melaleuca forest on peat land, 2) mixed mangrove forests, 3) surface water with aquatic plants, 4) mixed trees and 5) Space.

Based on the age and density of forest vegetation interspersed elements constitute the different plant communities should have the spare unit in the main ecosystems (Table 6.2. And Figure 6:30).

Figure 6.30. Ecosystem map of flora in U Minh Thuong National Park in 2009.

Table 6.2. Ecosystem of flora in U Minh Thuong National Park

No.	Ecosystem	Area	Coordinates (m)	
		(ha)	Longtitude	Latitude
I	Melaleuca on peatland	1.385,93		
1	*Moderate oldgrowth melaleuca*	911,09	508165,1	1063399.23
2	*Dense moderate oldgrowth melaleuca*	474,84	510858,2	1059215.65
II	Mixed melaleuca	3.060,46		
3	*Young melaleuca* - Phragmitex sp.	1.357,14	508170,0	1058642.55
4	*Sparse melaleuca – Stenochlaena palustris*	168,81	509255,6	1067402.44
5	*Sparse melaleuca* – Phragmitex sp – *Eleocharis dulcis*	1163,1	513357,9	1062708.83
6	*Sparse melaleuca - Pistia stratiotes*	371,41	510649,5	1057196.26
III	Open water – aquatic plants	3.411,14		
7	*Dense* Typha	95,13	509482,5	1062315.40
8	Pristia	789,79	512055,2	1065162.06
9	Pristia – Typha – *melaleuca*	2.131,85	509263,4	1059191.39
10	*Open water* - Nymphaea nouchali	394,37	509060,8	1061988.46
IV	Phragmitex sp – complexed wood trees	137,45	509694,0	1058557.69
V	Barren lands	0,47	510552,6	1062510.96
	Total	**7.995,45**		

6.4.1. Melaleuca forest ecosystems on peat land

Melaleuca forest ecosystems on peat land area of about 1385.93 hectares. Distribution at the center of the peat soil peat layer thickness> 1 m, and area of alluvial soil is shallow peat layer.

6.4.1.1. Moderate old growth melaleuca forests

These are semi-natural Melaleuca forest remnant, with an area of 911.09 hectares. Forest with over 15 years of age, the average density of coverage. Despite the mixed trees or tall grass as the Forest Melaleuca forests relatively high proportion, almost identical in the woody flora here.

Figure 6.31. Habitats of remaining semi natural melaleuca forests in U Minh Thuong National Park in 2009.

6.4.1.2. Dense and moderate melaleuca forests

Distribution at the center of the peatland, with an area of 474.84 hectares, Melaleuca was restored after fire in 2002. Quite thick forest density, tree Melaleuca is homogeneous in the entire region. Some grasses, vines, but also appear more distributed and cover most of these forests.

Figure 6.32. habitats of moderate melaleuca forests on peatland in U Minh Thuong National Park.

6.4.2. Ecosystem of Mixed melaleuca

Melaleuca have mixed with other plants from the crop group sessions, vines to aquatic plants. Melaleuca forest with different levels of development mixed with other plant species formed distinct habitats within the national park area.

6.4.2.1. Melaleuca mixed Phragmites vallatoria

Forests, Melaleuca (*Melaleuca cajuputi*) developed poorly mixed with the Common Reed (*Phragmites vallatoria*), with an area of 1357.14 hectares. By perennial flooding should Melaleuca forests poorly developed, small trees, foliage uneven development. Reed development interspersed with Melaleuca, the areas are slightly higher than the terrain around. *Phragmites vallatoria* inundated by flooding should also be pretty much dead or poorly developed and therefore has created a habitat Melaleuca forests - *Phragmites vallatoria* not beautiful in the land of peat swamps of U Minh Thuong National Park.

Figure 6.33. Habitats of sparse melaleuca forests mixed with *Phragmites vallatoria* in U Minh Thuong National Park.

6.4.2.2. Spare melaleuca forest with *Stenochlaena palustris*

Melaleuca forests, sparse, poorly developed soils on average terrain mixed with refuse (*Stenochlaena palustris*) parasitic on the body Melaleuca forests. Habitat area of Melaleuca with *Stenochlaena palustris* about 168.81 hectares. Much of this habitat distribution of the national park boundary near the canal.

6.4.2.3. Sparse melaleuca forest with *Phragmites vallatoria* and *Eleocharis dulcis*.

Melaleuca forests fairly scattered distribution in the mixed pasture Say (*Phragmites vallatoria*) and *Eleocharis dulcis* form a tight fit just open habitats by a certain water area, accounting for an area of about 1163.1 ha . During the dry season, when low water, or dry, these developed a lot on this area, being the feeding areas for some water bird species.

Figure 6.34. Sparse melaleuca forests mixed with *Stenochlaena palustris* distributed along the channels in U Minh Thuong National park.

Figure 4.35. Sparse melaleuca forest with (*Phragmites vallatoria*) and *Eleocharis dulcis* in U Minh Thuong National Park.

6.4.2.4. Sparse melaleuca forests with *Pistia stratiotes*

Flooded forest regeneration through a lot, uneven development, and only scattered areas were flooded in high water. *Pistia stratiotes* has developed rapidly and covered an area said to have formed a Melaleuca forest habitat Melaleuca forests - *Pistia stratiotes* in the wetlands, an area of about 371.41 ha in U Minh Thuong National Park.

Figure 6.36. Spare melaleuca forests with *Pistia stratiotes* in U Minh Thuong National Park.

6.4.3. Waters - Aquatic plants

Because water is kept for many years, the peat swamp area of the U Minh Thuong National Park has formed a large area of water surface area of about 3411.14 hectares, and this is the appropriate environment for many species of aquatic plants development such as Bon Bon (*Typha angustifolia*), Cai Beo (*Pistia stratiotes*), Rong (*Haloragaceae*), *Nymphaea nouchali*, *Nymphoides indicum* and *Haloragaceae*, etc. Surface water and aquatic plants have created the unique wetland habitat for the region of U Minh Thuong National Park. ,

The distribution of populations and plant communities of different aquatic habitats were formed separately for each ecosystem vegetation in the swamp.

6.4.3.1. Habitats of *Typha angustifolia*

Bon Bon (*Typha angustifolia*) in the development of many wetlands of national park. Bon Bon population distribution in the low-lying areas, flooding is high. *Typha angustifolia* habitat types occupied an area of about 95.13 ha, distributed into the network in the swamp.

Figure 6.37. *Typha angustifolia* in wetlands of U Minh Thuong National Park.

6.4.3.2. Habitats of *Pistia stratiotes*

Cai Beo (*Pistia stratiotes*) occupies a relatively large area, about 789.79 ha of peat swamp wetland nature reserve of the Upper UMInh. In addition to previous wetland nature reserve, *Pistia stratiotes* has developed on lands Melaleuca is a high water retention many years after fires in 2002.

Figure 6.38. *Pistia stratiotes* in peatlands of U Minh Thuong National Park.

6.4.3.3. Habitats of *Pistia stratiotes,* Typha angustifolia and melaleuca forests

In addition to the population Bon Bon (*Typha angustifolia*) and Beo cai (*Pistia stratiotes*), both species of aquatic plants has developed this together in the same area in the community of Beo Cai - Bon Bon, with an area quite large, at about 2131.85 ha. Although peat swamps are flooded quite high, but there are still scattered in clusters Melaleuca swamps this.

Figure 6.39. one corner of communities of Bèo – Bồn Bồn and melaleuca in peatland of U Minh Thuong National Park.

6.4.3.4. Open water, *Haloragaceae* and *Nymphoides indicum*

In high water conditions are kept for many years, where the terrain has become a low-lying areas have large blank surface area of approximately 394.37 hectares. During the rainy season, general habitat can see is a vast water surface, but it still has explored many species of aquatic plants growing in these waters constitute a habitat communities of (*Haloragaceae*) mixed with (*Nymphaea nouchali*), or (*Nymphoides indicum*).

In the dry season, when the water level lowered, the density of Rong Duoi Chon recorded to be increased. This does not mean much on rapid development of Rong Duoi Chon, but hardly recognized by the presence of this aquatic species when the area is flooded.

6.4.3.5. Flowing waters

A significant area in the region of U Minh Thuong National Park is complete channel system around and inside the national park. Objectives of building this canal system for moving vehicles in the fishery and water supply for fire fighting season is not.

With a relatively large surface area and a suitable environment for some species of aquatic plants such as development of Cai Beo (*Pistia stratiotes*), (*Haloragaceae*) etc. Especially fast development cause obstacles in transportation in the park. A surface with aquatic plants also form a separate habitat of U Minh Thuong National Park.

6.4.4. Habitat of channel along forests

Both sides of the channel inside and around the U Minh Thuong National Park, occupying an area of about 137.45 hectares, with the dominant group of plants is the Common Reed (*Phragmites vallatoria*) and many other plants such as Melaleuca (*Melaleuca cajuputi*), *Stenochlaena palustris*, *Panicum repens*) ... grass (*Imperata cylindrica L*) appears in some places the canal is quite high.

Figure 6.40. habitats of channels along the forest with dominant *Phragmitex vallatoria*.

6.5. Assessment

U Minh Thuong National Park is one of two peat swamp land remaining the largest of Vietnam (the rest is U Minh Ha). With the combination of many factors that form a natural flora and the ecosystem is quite typical of peat swamps, and is recognized as one of three areas of wetland conservation priority especially in the Mekong Delta. Peat swamp

forests in U Minh Thuong plays an important role in preventing the acidification of surface water and topsoil, fresh water reserves, as the area of reproductive and live fish, animals crustaceans, and filter surface water. Therefore, peatland swamp forests provide environmental benefits and livelihoods for communities living in the surrounding area.

Biological diversity of each ecosystem in the region of U Minh Thuong National Park is considered quite special compared to other nature reserves in the lower Mekong Delta.

Forests dominated by Melaleuca (*Melalleuca cajuputi*), and with age, the distribution, the mix of communities have formed within the different forest types and also form the units of different forest ecology.

Seasonal wetlands with populations and communities of aquatic plants such as *Haloragaceae* mixed with *Nymphaea nouchali*, or *Nymphoides indicum, Salvinia cucullata*, *Typha angustifolia*) etc. forming an ecosystem with a diversity of habitats of U Minh Thuong National Park

The other plants such as ferns (*Acrostichum* s.), *Stenochlaena palustris*, interspersed with the development of other plants also form habitats featured in the national park area.

The distribution of the communities, flora diversity also creates habitat for animals. Many birds have been recorded live, reside on the same plant communities, and the distribution of diverse flora and fauna have formed many separate habitat in the region of U Minh Thuong National Park.

After wildfires of Melaleuca forests in 2002, keeping the water level high throughout the year reduces the ecosystems within the park. Melaleuca forests and fallen melaleuca forests by flooding are too high for many years, has made a very poor ecosystems and preliminary determination. Seasonally inundated grassland food cards of some water birds, only scattered areas of grassland. The high and submerged almost all year round so was not favorable environment for some plants you grow. *Nepenthes mirabilis* is present in the mangrove forest but now no more.
As indicated, a core area of the U Minh Thuong National Park is located on peat swamp. The role of peat is considered quite important in the formation of carbon storage environment, creating habitat characteristics of wetlands, ... Therefore, if forest fires, Melaleuca forests can recover through re-route birth or may grow back, but the peat land will be ruined. If too dry for peat and oxygen penetration into the peat layer and make it be oxidation also decreased the peat. However, keeping the water flooded all year round will degrade the ecosystem and biodiversity of peat swamp U Minh Thuong.

Therefore, one of the issues to be interested in the restoration of natural ecosystems in the region of U Minh Thuong National Park is the study tested a model of water management - to be able to fire and conservation restoration of vegetation, ecosystems and biodiversity in the peat swamps of the U Minh Thuong National Park is more effective.

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