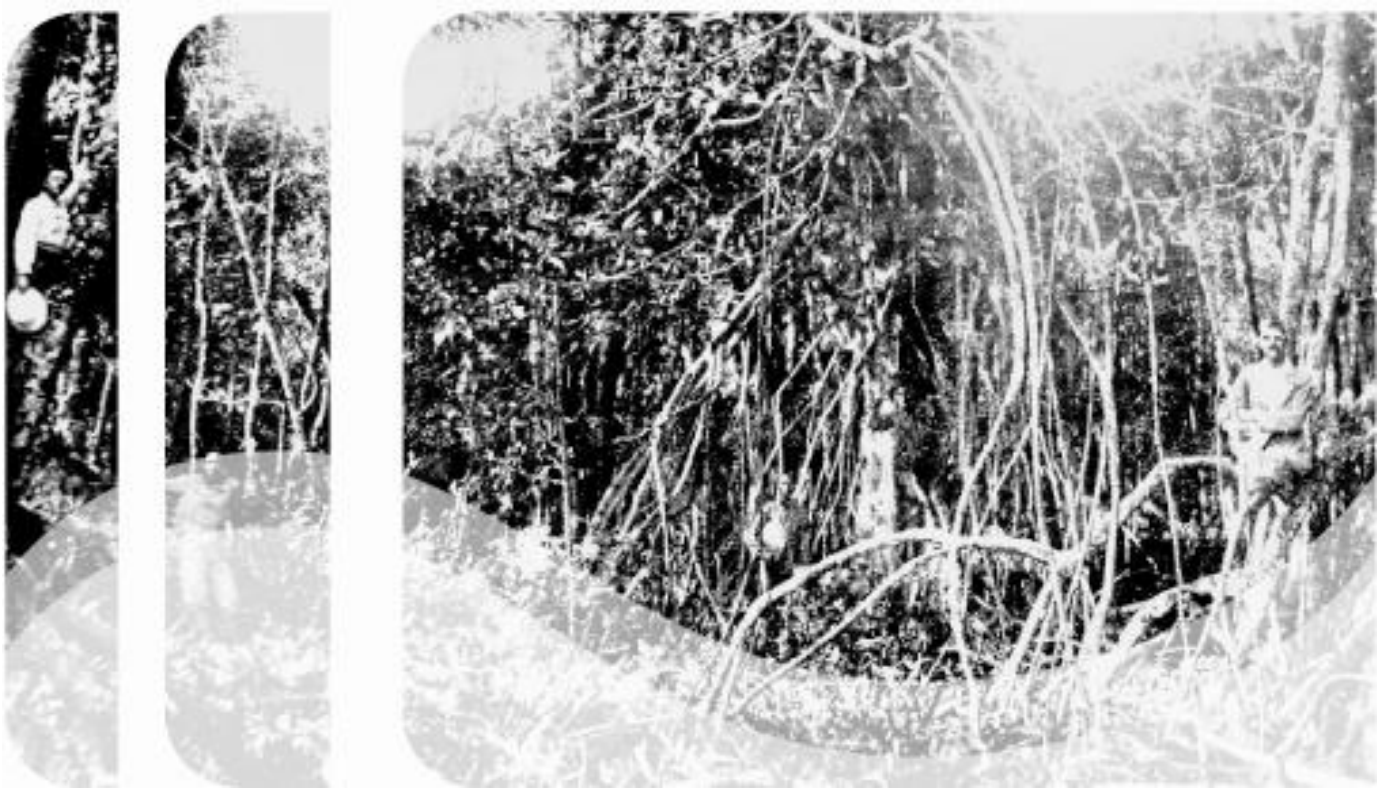

Management of Natural Resources
in the Coastal Zone of Soc Trang Province

Mangrove Dynamics in Soc Trang Province 1889 - 1965

Olivier Joffre

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"Peuplement de Paletuvier" in Maurand P. 1938. L'Indochine Forestière

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November 2010

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Foreword

When I came to Soc Trang in 2007 many people told me that there was always a thick belt of mangroves protecting the coast from erosion and that these mangroves were to a large extent destroyed by defoliants used during the American War (Vietnam War) and, after that, by the conversion of mangrove forests into agricultural land and shrimp farms.

This sounded plausible but did not explain the fact that erosion is now destroying mangrove forests along parts of the coast of Vinh Chau District. The questions remain: why did the mangroves withstand erosion before the use of defoliants (1965-1971) but not afterwards? why are forests planted in the 1990s being destroyed by erosion while forests in the same place before 1965 were allegedly not affected by erosion?

To answer these questions the project "Management of Natural Resources in the Coastal Zone of Soc Trang Province" initiated an analysis of the development and current status of mangrove forests in Soc Trang Province covering the period 1965 to 2008. This study was carried out by the Southern Sub-institute of Forest Inventory and Planning (Ho Chi Minh City).

Topographic and photo maps produced by the US Army Map Service based on 1965 aerial photos showed that there were no mangrove forests along a 37 kilometre stretch of the coast of Vinh Chau District. Therefore, the use of defoliants does not explain the absence of mangroves along most of the coastline of Vinh Chau in 1965.

The project therefore initiated an in-depth study of the historical development of mangrove forests and the coast line of Soc Trang before 1965.

For this study all available and relevant documents, maps and aerial photos of the area from before 1965 and dating back to 1889 were located in archives and libraries in France (*Archives Nationaux d'Outre Mer* in Aix en Provence and in Paris *Bibliothèque Nationale de France*, *Départements des Cartes et Plans*; *Services Historique de l'armée de l'Air; Services Historique de l'armée de Terre et de la Marine*; and *Institut National Géographique*) and Vietnam (*National Archives II* in Ho Chi Minh City). In addition, interviews were held with people with long-term knowledge of the Soc Trang coast.

The results of the analysis of the historical material show the dynamic changes in the shape and extent of coast line, the changes in mangrove cover and species composition.

The analysis of these historic developments, together with the information from a numeric model which simulates current hydrodynamics and shore-line development, will be an important input in the development of appropriate climate change adaptation strategies.

Klaus Schmitt

Chief Technical Advisor

Table of contents

List of figures

List of tables

1. Introduction

Coastal zones are dynamic. They are the home of 40% of the population in Vietnam, and are under pressure and undergoing rapid change. Changes occur during relatively "short" periods with the environment being transformed by different types of drivers. Change in the state of the environment is multifaceted. It can be related to human factors, such as demography, economics, institutions and technology, or it can be related to natural factors. Most of the time change involves a combination of both.

A key concern is the way that natural habitats, principally mangrove forests and mudflats, have been exploited for forest products or converted to other uses, such as shrimp farms. In Asia, mangroves have been heavily exploited for timber, fuel wood and other forest products for centuries, and population pressure has led to serious forest degradation

Soc Trang Province in the Mekong Delta is an example of an area where the landscape and land use are changing fast, and ultimately modifying coastal livelihoods. Recently, the mangrove belt in Soc Trang province has suffered from the rapid development of shrimp farming. Currently, erosion is shaping the coastline, and the actual mangrove belt is the result of reforestation programmes in the recent years. Recent studies show that accretion in some parts of the coastline has reached 45 meters per year, with an increase in land area of about 2,000 ha between 1965 and 2008[1]. However, historical records of the coastal zone are sparse before 1965 and "long term" changes are not well known.

To understand the changes in the mangrove and coastal zone, including erosion and accretion patterns, it is helpful to compare changes over the past half century with older materials. The French Administration (1862-1954) mapped Cochinchine and included forested areas in some of their maps. In addition, the Colonial Administration had a role in forest management through the development of forest legislation since the early period of colonisation. Records from this period can reveal i) the different types of regulations applied to forest resource exploitation during this period, ii) the use of mangroves during the colonial period, and iii) the perception of this specific ecosystem by the decision-makers and planners.

In addition to other resources such as maps and aerial photos, the documents of the French and Vietnamese Administration help in understanding the changes - and subsequent drivers - in the coastal area of the Mekong Delta between 1862 and 1965. The use of an historical approach allows us to understand the sequence of changes which happened in this area. It also helps to give us a better understanding of the "original" ecosystems before man-made influences. Ultimately, this approach helps to design future adaptation measures to protect and manage the coastal zone.

After presenting an historical perspective on the study area, we introduce some historical data on mangroves forest management and policy from the French Administration. In the next section, we provide some general data from the French Administration on forest exploitation in the Mekong Delta. The last three sections focus on the analysis of mangrove forest dynamics in 5 specific sites of the Soc Trang coastal area based on maps and aerial photos.

[1] In Thinh *et al*. 2009. Tool Box for mangrove rehabilitation and management. Management of Natural Resources in the Coastal Zone of Soc Trang Province. GTZ and Soc Trang Provincial People's Committee. 55 pp.

2. Objectives, methods and study area

2.1 Objectives and methods

The objective of this study is to document the evolution of mangrove forests in the coastal zone of Soc Trang province, Vietnam, based on existing materials, including forest department reports since 1875, and maps and aerial pictures from 1875 to 1970.

The materials include topographic maps and later thematic maps on forestry and natural resources dating back to the French colonial period, starting with the first exploration of the Mekong Delta and later with the production of detailed maps (1:25,000), including a series of aerial photos by the French Army and the French National Geographic Institute. Forestry policy during the French colonial period also documented efforts both to exploit and preserve the mangrove forests during the first part of the 20th century. In order to collect these materials, we visited several archives:

- *Archives Nationaux d'Outre Mer* in Aix en Provence (France) where a series of maps and documents on forest policy and forest exploitation are found (Fond Boudet, FIMOM).
- *Bibliothèque Nationale de France (BNF)*, Départements des cartes et plans (Sites Richelieu, Paris) for additional maps.
- *Services Historique de l'armée de l'Air* (Château de Vincennes, Paris) for aerial photos of 1953.
- *Services Historique de l'armée de Terre et de la Marine* (Château de Vincennes, Paris) for maps and documents on the coastal areas.
- *Institut National Géographique* (IGN) (Saint Mande, Paris),for aerial photos of the study area in 1950.
- *National Archives II* in Ho Chi Minh City (Vietnam) for access to Fond Goucoh, Fond Goucoh Divers and additional maps, mainly from 1965-1970, including photo maps.

Information on mangroves forests and their exploitation were summarised and maps of interest were classified and chronologically ordered. Historical aerial photos and maps of the study area were then compared with the current mangrove forest based on recent (2006 - 2007) aerial and satellite photos.

2.2 Study area

Curently, the coastal zone of Soc Trang province includes three districts, Vinh Chau, Tran De and Cu Lao Dung. The total coastal shore is 72 km in length. Cu Lao Dung District is the largest island in the province, surrounded by two branches of the Bassac River, Tran De and Dinh An. The Tran De coastline is along the west bank of the river mouth, and the Vinh Chau coastline is on the South China Sea. Administrative divisions during the French Colonial Period and the current administrative units of the Mekong Delta are shown in Figures 1 and 2.

Both Tran De and Cu Lao Dung districts have mangrove forests composed of similar species (mainly *Sonneratia sp.*), whereas Vinh Chau District's mangrove forest is mainly composed of *Avicennia and Rhizophora sp*. Vinh Chau District can be divided into two main agro-ecological areas, with an accretion area in the eastern part, including a large mangrove belt, mudflats and a sandbank, and a western part, with erosion of the coastline due to the long-shore current. In this area, the mangrove forest is not well established.

Interestingly, Vinh Chau District was part of Bac Lieu Province during the French colonial period (1862-1954). In documents dating back to the French Administration, Soc Trang Province did not include Vinh Chau District, but only Tran De and Cu Lao Dung Districts (Figure 2). Cu Lao Dung was part of Dinh My District (currently Tran De District). Therefore, gathering information on forest also required us to collect documents on Bac Lieu Province. This specificity explains why a part of the information on forest management presented in this report during the colonial period includes, not only Soc Trang, but also Bac Lieu Province.

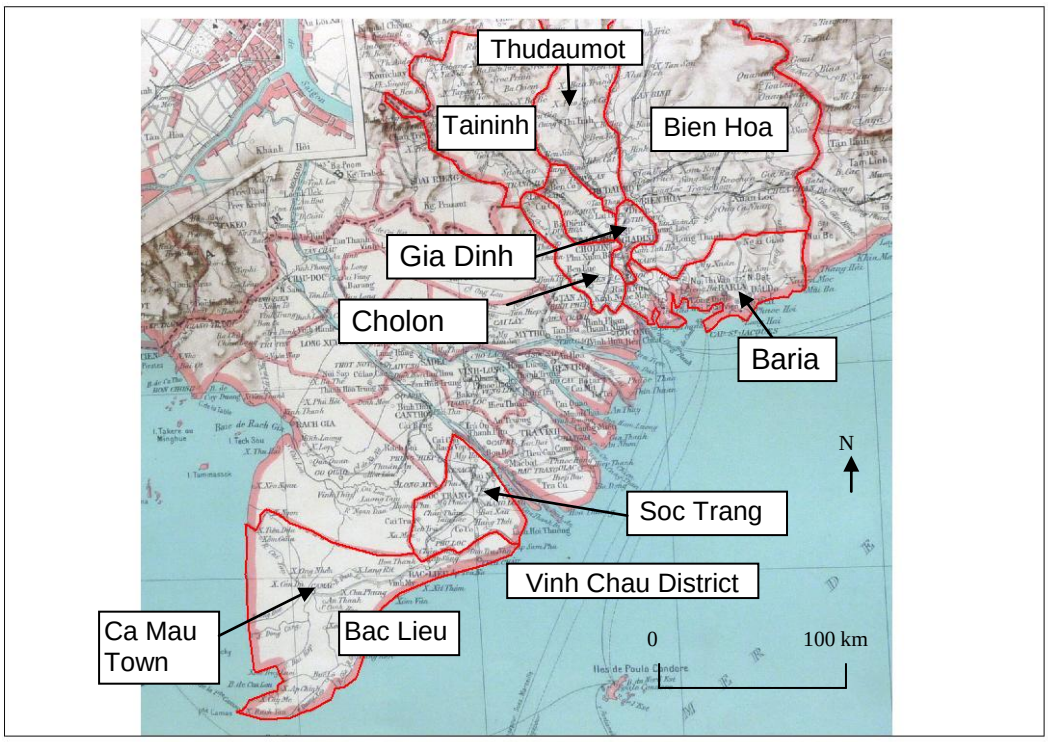

Figure 1: Detail of the map "*Cochinchine Politique*" (1929). In *Atlas Colonial Francais* 1929 (Scale 1:2,100,000). Provinces corresponding to *Service Forestier* cantonments in 1904 in east Cochinchine (Baria, Thudaumot, Bien Hoa and Taininh) and other provinces mentioned in this report: Soc Trang, Bac Lieu, Gia Dinh and Cholon. The boundaries of Soc Trang and Bac Lieu provinces have changed (see figure 2) and present day Ca Mau Province was part of Bac Lieu. The term Ca Mau was frequently used for the southern part of the Delta/Bac Lieu (scale on the map added by O. Joffre).

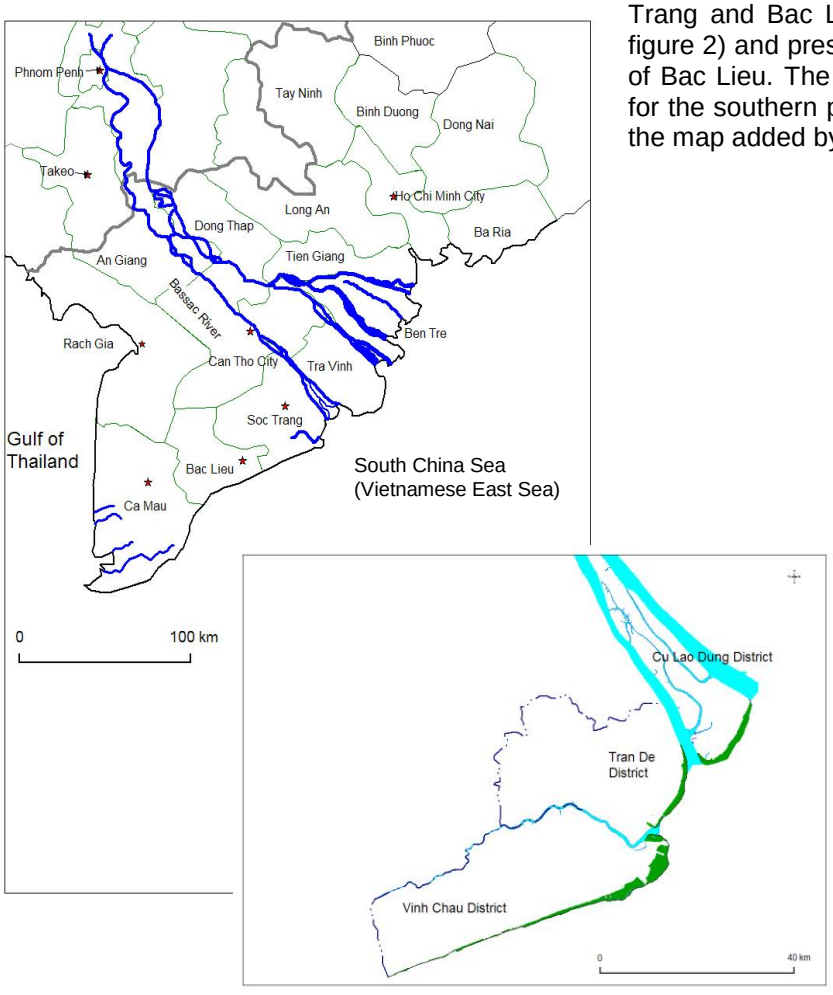

Figure 2: Provinces in 2010 corresponding to the former Cochinchine territory and the study area.

2.3 Limitations and documents available

The study area is located in a very specific part of the Mekong Delta, where no forest related or marine activities had occurred. In fact, during the first years of colonisation by the French Administration, the west Cochinchine coastline was not of prime interest to the Government. In a note of the "*Ingenieur Chef du Service des Ponts et Chaussées to the Lieutenant Gouveneur*" in 1892, the author indicated that the west coast of Cochinchine in the Gulf of Siam and South China Sea was not much used for shipping due to the absence of a port. The development of coastal protection for boats and other infrastructure was limited to the eastern part of the South China Sea (Saigon, Cap Saint Jacques)[2], a better documented area of the coast. Similar examples can be found for the hydrographic resources and mapping of the coast, with the Government focusing on the eastern part of Cochinchine and the Amman region. The western part of Cochinchine was largely ignored: "*Les reconnaissances dans cette region s'arrêtent au bras le plus Ouest du fleuve; de ce point jusqu'a la Pointe de Camao […] la cote n'a jamais été reconnue ; il est vrai qu'elle est absolument sans intérêt pour la navigation …*"[3].

Later mapping of the river mouth of the Mekong faced technical constraints due to the presence of shallow sand banks, necessitating a specific boat[4] [5]. Even in 1934, the Service Hydrographique described the mangrove forests, and specially the access to the coastline for field surveys (triangulation of coordinates), as "*pratiquement inaccessible*"[6] (almost inaccessible) for mapping.

Concerning the forest resources, the absence of large forested areas or high-value wood and the presence of protected areas, limited the number of documents related to mangrove forests in the study area. Most documents from the Forest Department (*Service Forestier*) during the colonial period are related to upland forests, with a few related to mangroves Concerning the Ca Mau region. Therefore, we decided to present not only legal aspects and changes in mangrove forest management within the entire Cochinchine, but also some specific aspects (exploitation and management) of the mangroves based on reports about Ca Mau region. Most of the documents directly related to the study area are maps and aerial photos.

[2] Protection des cotes de l'Indochine contre le mauvais temps. Secrétariat Général, 12 Janvier 1892.

[3] Service Hydrographique de la marine. Correspondance : L'Ingénieur en chef de 1er classe, chef du service de l'hydrographie générale a Mr le Directeur d'hydrographie. Rapport de travaux hydrographiques en Indo-Chine. Paris le 28 Mars 1901. "The survey of this region stops at the West branch of the river, from there until Ca Mao […] the coast was never surveyed; it is true that it is of no interest for shipping …" (translation O. Joffre).

[4] Rapport de l'Ingénieur hydrographe principal, directeur des travaux, sur les opérations effectuées par la Mission Hydrographique de l'Indochine pendant le mois de Novembre 1910. 17 Décembre 1910.

[5] Mission hydrographique de l'Indochine, 1er Aout 1908.

[6] Mission hydrographique d'Indochine. Annexe au rapport mensuel Mars 1934. Note sur les levés côtier de Cochinchine, du cap Saint Jacques a Poulo Obi.

3. Forest Laws and Service Forestier

3.1 Forest laws and regulations during the colonial period

Forest resources were seen as important in Indochina. Their exploitation was considered of primary importance, with high-value wood for the domestic market and export. Therefore, the Administration began to regulate and organise the sector. Starting in the 1860s, a series of decrees were used to manage the forest and extract revenue from forest exploitation for the Indochina Government.

On September 5th, 1862, the first decree forbidding the exploitation of certain forest species was created, and soon after a second decree (14th May 1866) enacted a tax on the "*Coupe Libre*" (free cut). The Government made these decisions to allow the development of the forest sector, provide new sources of revenue and create lucrative activities for private enterprises. To control forest exploitation, a Forest Department composed of 16 persons was organised. This department later became the *Service Forestier*.

On December 31st, 1873, l'Amiral Dupre appointed a *Commission* to investigate the best way to exploit forest resources in Cochinchine. However, according to Thomas (2000)[7], no competent forester was part of this *Commission*, which was mainly composed of private sector and administration representatives.

Later in 1875, the *Service Forestier* in Cochinchine was created, including forest guards in charge of the surveillance of the forest. These guards were under the direct command of the *Commision Permanente des Forets* [8]. The service was decentralised with seven forest divisions and a forest guard at the head of each division. The *Commision Permanente des Forets* provided all regulations and laws concerning the forest sector. The *Commision* created the new Forest Law with permits to exploit the forest. Each annual permit (of a value of 400 francs) gave unlimited rights to exploit the forest in terms of volume of timber or number of workers. The Administration controlled the volume of timber during transport on the river. This new legislation created a favourable environment for excessive exploitation of the resource.

Following the first reports on massive deforestation, the Government voted on the first forest protection decree on the 12th of June 1891 with the creation of "*réserve forestière*" (forest reserves). This decree was followed with a second decree signed on the 23rd of June 1894 which included complementary measures. The creation of "*réserve"* clearly showed that earlier legislation was not effective in protecting forest resources. The forest "*réserve*" was to be the key legal instrument for forest policies during the following French Administration. However, outside the "*réserve*" perimeter, the new regulations reduced the price of the permit to exploit forest resources to 275 francs and the Administration fixed a minimum diameter for the harvesting of 63 tree species (24 more species than in 1875), which did nothing to slow the pace of deforestation.

Concerning mangroves, a tax on fuel wood exploitation was created only in 1903[9]. Mr. Ducamp proposed a tax on its exploitation to increase the income for the local administration with an estimated consumption of 7 Million m^3 in Cochinine, including 3 million m^3 for industry. In addition, in a letter to the *Conseil Colonial*[10], the *Lieutenant Gouverneur* explained that the tax on fuel wood was necessary to protect the forest and that the resource should not be given freely. However, the tax was low (0.10 \$/m^3 in *Domaine protégé*[11] and 0.03 \$/m^3 in *Domaine reservé*) in order not to constrain the economic growth of businesses using large amounts of fire wood. According to this new regulation, one fifth of the tax would be used in the provincial budget of the area where the fuel wood originated from and more specifically in the forested area.

In 1904, the *Regime Forestier* for Cochinchine established new rules to control massive deforestation and over exploitation of forest resources. For example, *Art. 13* indicated that no charcoal furnace or other type of industry requiring fuel wood could be developed within 1 km of a forest[12]. *Art. 17* stipulated that it was forbidden to clear forest less than 50 m from a river. Exportation of fuel wood outside local areas required a fee of 0.10 \$/m^3 (*Art. 24)*.

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[7] Thomas F. 2000. Forets de Cochinchine et "bois coloniaux", 1862-1900. Autrepart (15): 49-72.

[8] Historique et Programme du Service Forestier, 1907. Hanoi-Haiphong.

[9] Le Courrier d'Haiphong. 17 Décembre 1903.

[10] Analyse de l'Affaire: Redevance a percevoir sur les bois de feux. Lieutenant Gouverneur aux Conseil Colonial, 8 Décembre 1903.

[11] \$: Economic value are given in *Piastre*, the currency in use in Indochina during the French Administration.

[12] Arrêté Réglementant Le Régime Forestier en Cochinchine. 1904. Hanoi.

Home consumption of forest resources and the role of villages and villagers in forest management were also included in this new regime of forest exploitation. For example, branches and dead wood could be collected by villagers for their own consumption and villagers could use and exploit non-registered wood species for their own use (*Art. 31*). No fee was collected for the exploitation of secondary forest products by villagers (*Art. 31*). In exchange for these rights, villagers had to help create forest trails and perform other collective work for forest management.

This legislation divided forest resources into two domains, with different types of access rights and exploitation types: namely, the *domaine forestier protégé* and the *domaine classé (ou reservé)*.

3.2 The different *"Domaine Forestier"*

A decree issued on December 1st, 1913, clearly defined the existing division of the forest domain into "*foret protégée*" and "*foret réservée*"[13]. Later, on March 21st, 1930, the various decrees and regulations concerning forest resources were blended into a Forest Regime, with some changes concerning minimum size, fees and costs.

3.2.1 Domaine protégé

"*Foret protégée*" was the status of most of the forest area in Cochinchine in the early 1900s. Under this regime, access to forest resources for exploitation required a permit from the local administration. According to *Les Forets Indochinoises*, the permit included the volume and the duration of forest exploitation allowed for individuals or businesses holding the permit. This type of exploitation was labelled "*exploitation en coupe libre*" (or "free cut").

However, considering the large areas to guard and the human resources of the *Service Forestier*, surveillance and enforcement were almost impossible. According to Maurand (1943)[14], the exploitation *"en coupe libre se fait sous le signe du gaspillage du bois et de la détérioration des peuplement[15]"*.

3.2.2 Domaine réservé

The *Service Forestier* did not have the resources to supervise the exploitation of the forest, especially of the "*Domaine protégé*", and so focused on the other "*domaine*", the "*Domaine réservé"*. The "*réserves*" were developed because "*coupe libre*" (free cut) status was not sustainable for forest protection. In "*coupe libre"*, only the most valuable species were selected, leaving the forest with no valuable species for future generations[16]. The first decree stipulating the creation of "*réserve*" dates from 1891 (12th June).

Forest "*réserves*" were delimited and mapped. They were created by order of the Governor of Cochinchine in order to be exploited in a sustainable way. The forest was under the control of forest agents who determined which trees needed to be kept and which trees could be cut. Illegal cuts and trespassing by individuals or their domestic animals were punished with fines.

The annual cuts were conceded by auction (*adjudication*), mutual agreement (*marcher de gré a gré*) or special contract (*exploitation en perimeter réservé*) according to the decrees of 5th September 1905 and 15th April 1909. Long term contracts extended for a maximum period of 20 years and involved areas smaller than 20,000 ha. Later on, legislation included aspects of reforestation in order to promote sustainable exploitation of forests.

Starting in 1891, the forest department tried to develop the "*réserves*". The objective was to include 25 to 30% of the forest cover (1.5 million ha) in the *"réserves*". This type of management regime had already been mentioned in legal documents but was not effective, with selected areas that were already too heavily exploited and too large. According to Maurand (1943), the "*réserves*" were developed first around Saigon and later in large forested areas on the Ca Mau Peninsula. Figure 3 shows the location of "*réserves*" in Cochinchine in 1904. Only one "*réserve*" was located in the western part of the Delta, near Ha Tien (a divison of Vinh Trung).

[13] The decree is completed by the other decree of 11 July 1907. Code Penal Forestier.

[14] Maurand P. 1943. L'Indochine forestière, Hanoi, IDEO, 252 pp.

[15] ("[…] free cut regime is under the sign of inefficiency of wood exploitation and deterioration of forest" (translation O. Joffre).

[16] Rapport sur la Situation Forestière en Indochine, 1917.

In 1907, 61 *"réserve*s" covering 122,628 ha were managed in Cochinchine[17]. The document advocates the development of larger forest divisions and the creation of forest mapping in Indochine. This indicates the need for a clear description and demarcation of forest resources in Cochinchine, with the *Service Forestier* not having a clear assessment of the forest resources in the region. What is interesting is to see that "*forest réserves"* already included mangrove areas near Cap Saint Jacques. According to Tran (2006)[18] it was in Cohinchine that the Government made the biggest effort to exploit forests in "*réserves*" .

In 1921, the number of "*réserve*" in Indochina increased to 165, for a total area of 487,024 ha[19]. At that time, the mangrove forest in Ca Mau was under the "*réserve*" regime (Figure 4), but no "*réserve*s" were created in Vinh Chau District or the Soc Trang Province coastal area. Only a "*réserve*" of 866 ha of *Melaleuca sp*. was created in Phung Hiep in 1904 to protect the forest from a rapid deforestation[20].

In 1917, the entire mangrove forest in Ca Mau was estimated at 300,000 ha and remains the main mangrove forest of Cochinchine because of the exploitation of mangrove forests in the eastern part of the delta[21], with 4 main "*reserves"* (Figure 4). Later in 1926, the mangrove area under *"réserve"* was estimated at 194,502 ha[22]. Bac Lieu forest was considered in that period as the future of wood stock for Cochinchine, able to supply forest products for the entire colony. The authors advocated sustainable management of the resources, which were already in danger with clear cutting even in *"réserve"*.

In 1931, the *Inspecteur General de l'Agriculture, de l'Elevage et des Pêches* proposed the creation of a forest "*réserve*" of 13,107 ha in Bai-Dun (Bac Lieu Province)[23]. This document stipulates that the area is covered with mangroves, under tidal influence and cannot be used for agriculture. It also mentions that developing the "*réserve*" is important in order to protect mangrove cover and thus enhance protection against erosion. The location of forest "*réserves*" in Cochinchine in 1938 can be seen in Figure 5.

Even if the forest "*réserves*" were supposed to improve the management of forest cover, there was no specific plan for mangrove exploitation until 1927. Before that, foresters were looking for the most valuable species as well as large and old trees. *Rhizophora sp.*, *Bruguiera sp.* and *Ceriops* sp. were the most valuable and most exploited species. In order to stimulate the regeneration of *Rhizophora* sp. and *Ceriops sp.* trees in the "*réserve*", the *Service Forestier* decided to maintain a number of mature trees in each plot.

In 1943, the mangrove forest in Ca Mau was divided into 4 divisions[24]. In total there were 9 *"réserves*" of mangrove forest and 31 "*coupe d'exploitation*" covering a total area of 10,323 ha in Bac Lieu Province, but none of them were located in Vinh Chau and no "*réserves*" were developed in Soc Trang Province, illustrating the difference in forest resources management between the two provinces. In Ca Mau, the 10 large "*réserves*" covered an area of 201,900 ha in 1947. The major species on these "*réserves*" were *Rhizophora sp.* (50%)*, Bruguiera* sp. (30%), and *Avicennia sp.* (9.5%), while other species such as *Ceriops sp.* made up less than 5%.

The Colonial Administration introduced the basis of a management regime for forest resources in Cochinchine. Initially the regime was based on permits which was not successful and hindered development due to several constraints. The development of "*réserve*" was more successful, with the Administration focusing on specific areas. The fact that several "*réserves*" included mangrove forests shows that the Administration recognised the importance of this specific ecosystem and its growing economic value. In the following section, we will discuss the *Service Forestier* and its organisation and role in forest management.

---

[17] Historique et Programme du Service Forestier, 1907. Hanoi-Haiphong.

[18] Thao Tran. Les perturbations anthropiques contemporaines dans les mangroves du Sud Vietnam entre nature, civilisation et histoire. PhD Thesis, Univeriste de Paris IV, 609 pp. 2006.

[19] Les Forets Indochinoises, extrait du Numéro Spécial "L'Indochine". La Vie Technique et Industrielle eds. Paris.

[20] Création et Révision de Réserves Forestières en Cochinchine; 30 Juillet 1904. Correspondance au Gouverneur Général de l'Indochine.

[21] Rapport sur la Situation actuelle des Forets de la Cochinchine. 30 Novembre 1917. Service Forestier d'Indochine.

[22] Rapport d'ensemble sur la situation de la province, du 1er Juin 1926 au 1er Juin 1927.

[23] Classement en Réserve forestière du Massif de Bai-Dun (province de Bac Lieu). 14 Novembre 1931.

[24] Les Foret de Paletuviers en Cochinchine. *L'Europe*. 20 February 1943: 3 "*réserves"* in Damdoi (47,086 ha); Namoan Est (3 "*réserves"* – 33,292 ha) and the protected forest of Tan Hung Tay. In Namoan Ouest Divison the "*réserves"* of Vien An cover 34,955 ha. In the Tanan division of Tanan is found the "*réserves"* no 355.

3.3 Service Forestier de l'Indochine (Forest Department)

We have seen that the *Service Forestier* was responsible for forest protection and management in Cochinchine starting in 1875. Before 1901 the *Service Forestier* was labelled *Service des forest* and was dependent on the *Services agricoles*. Before 1901 the *Service Forestier* was labelled *Service des forest*. It was part of the *Services agricoles* and under the direct authority of the *"Affaires Indigenes".* After 1901, the *Service Forestier d'Indochine* was transferred to the authority of the *Inspection Générale de l'Agriculture, de l'Elevage et des Forets*.

3.3.1 Organisation, duties and legislation

The Department of *Service Forestier de l'Indochine* included several administrative levels: circonscription, cantonments, division and guarderie. In 1907, Cochinchine (the circonscription unit) consisted of 5 cantonments and 30 divisions, 32 guard posts within divisions and 17 isolated guard posts in forest areas. The management unit was the division level, each one under the responsibility of a European agent in charge of a maximum of 100 km^2. Four of the cantonments in Cochinchine were Baria, Bienhoa, Tayninh and Thudaumot corresponding to the provinces of the same name. The last cantonment[25] was comprised of all the remaining provinces, including Gia Dinh, Cholon and all other western provinces, showing the lack of resources and interest in the provinces of the Mekong Delta.

This structure was based on the reform of 1894, which still showed a high level of decentralisation. However, in 1907, a central forest guard in Saigon was established as part of the *Commision Permanente des Forets*. The main duty of the *Service Forestier* in its early years was to collect taxes on forest exploitation and verify of the volume exploited by foresters. The *Service Forestier* had no legislative power regarding forest policies.

In 1907, the *Service Forestier* was not yet properly organised and legal instruments were not well adapted to the situation or the resources of the Service. There were simply not enough resources to protect the forest and collect taxes. The *Service Forestier* was dependent on the *Direction des Services Economiques* within the *Inspection Générale de l'Agriculture, de l'Elevage et des Forets*"[26]. In 1913, the Government indicated that 80% of the revenue from forest exploitation could be re-invested in the *Service Forestier*. Therefore, the *Service Forestier* became dependent on its own revenue. With the development of "*réserves*" and the new fiscal regime, the annual revenue of the *Service Forestier* increased from $122,000 in 1907 to $331,000 in 1916, allowing more investment in human resources and forest management.

In 1938 (decree of 12th February) the "*Service des Eaux, Forets et Chasse aux Colonies"* was created. This new department was in charge of conservation, transformation or creation of forests necessary for the country[27], and replaced the "*Service Forestier"*.

3.3.2 Human resources

In the Mekong Delta in general and in Ca Mau peninsula in particular, the *Service Forestier* was not active until 1912, due to lack of human resources. In a letter to the *Gouverneur de Cochinchine*, the *Inspecteur Adjoint des Eaux et Foret* (*Chef du Service Forestier*) requested 10 new indigenous forest guards, four of them to be assigned to the newly created Ca Mau Division[28].

The main activity of the foresters in the first years was to map and characterise the forest. But the Ca Mau Peninsula was not popular within the *Service Forestier*. The French civil servants did not stay long in Ca Mau because of malaria, and new forest agents never asked to be posted in the inundated area for their first assignment. For example, on March 3rd 1913, the same *Inspecteur* explained that the *Service Forestier* de Cochinchine lacked human resources, with 2 agents in hospital, two others about to enter the hospital and two others about to be evacuated from Cochinchine for medical reasons. The number of sick expatriate personnel shows the difficulties of working in forested areas and the problems faced by this department in developing long-term knowledge of forests in Cochinchine. In another letter by the *Gouverneur de la Cochinchine* to the *Gouverneur General*, the author mentioned that the lack of human

[25] This cantonment had no specific name. In Couffinhal (1918) it is mentioned as "Centre".

[26] Les Forets Indochinoises, extrait du Numéro Spécial "L'Indochine". La Vie Technique et Industrielle eds. Paris.

[27] Marcon Y. 1938. Le rôle du service forestier aux colonies. Bulletin Economique de l'Indochine: 1375-1388.

[28] Correspondance de Mr Roullet, Inspecteur Adjoint des Eaux et Forets, Chef du Service Forestier de Cochinchine a Monsieur le Gouverneur de Cochinchine. 15 Mars 1913.

resources was limiting revenue from the exploitation of forest resources. To illustrate the lack of human resources, records in 1917 show that the *Service Forestier* was composed of 17 expatriates, 11 Secretaries (Vietnamese) and 139 Vietnamese agents on the ground to manage 2 million hectares. In 1918, there were 22 forest divisions in Cochinchine, and each one was supposed to be supervised by a Chief of Division. In 12 of those divisions, the chiefs were missing. Moreover, in 1930, the same number of local agents was in charge of the 24 Divisions of Cochinchine[29]. In 13 years there had been no increase in the human resources of the *Service Forestier*, with less than 150 agents in the field to protect and manage the entire forested area of Cochinchine.

The *Service Forestier* was in charge of an important task in Cochinchine. With a complete resources assessment to develop at the beginning, the *Service Forestier* was later in charge of the management and protection of resources, helped by new legislation and new financial resources. However, it seems that even with new revenue, the human resources of the *Service Forestier* were always limited, which partially explains the deforestation of Cochinchine.

[29] Rapport 1933-34 sur le fonctionnement du Bureau d'Agriculture.

4. Mangrove forests during the French colonial period

4.1 The mangrove forests in Cochinchine during the colonial period

With a total forested area of 18,000 km^2, Cochinchine did not represent an important part of the overall forest resources in Indochina (Vietnam, Cambodia and Lao) with a total forested area estimated at 313,000 km^2 during the early part of the colonial period (prior to the 20th century). Cambodia, Annam or Tonkin territories were more oriented toward forestry, while plans for Cochinchine development were geared toward expanding agriculture and intensifying rice culture.

For the period before 1860, there is not much information on the forests in Cochinchine. Only a few general descriptions are available: "*De ces temps héroïques antérieurs a l'époque coloniale, on ne sait a peu près qu'une chose: c'est que le pays était recouvert au trois quart de son étendue d'une foret dense que l'on prétendait vierge dans les régions montagneuses et plus ou moins exploitées dans la plaine.*"[30]. The first maps of the area do not show forest cover (Figure 6). With the development of the French Administration, more information became available on forest resources, with the first maps including vegetation cover appearing in 1889, followed by several updated maps during the 20th century (Figures 4, 4, 5, 7, 8, 9 and other maps referred to in chapter 6).

Initially the Administration tried to describe and classify forest resources in order to manage their exploitation. Since the early period of colonisation, the government of Indochina understood the importance of protecting forests for long-term exploitation. But mangrove forests were not of a prime interest for the Administration, who were more interested in high-value wood for construction and export. However, during the French Administration, the forests in Cochinine were classified into different types according to ecological criteria. Mangrove forests were classified as "*inundated forests*", which included fresh water and brackish water forests[31]. In 1891, Henri[32] estimated the surface area of the different inundated forest types in Cochinchine at 2,484,000 ha, which included:

- Brackish water forests: 1,034,000 ha
- Fresh water forests: 300,000 ha
- Swamp: 1,150,000 ha

Inundated forests were found near Saigon in the provinces Gia Dinh and Baria in the eastern part of Cochinchina, but the main forested area was in the Mekong Delta and included Bac Lieu, Rach Gia, Ha Tien, Soc Trang and Chau Doc provinces (Figure 8). Depending on the level of water salinity and the duration of the brackish water period, the inundated forest varied from *Tram* (*Melaleuca sp*.) in the fresh water area to *Rhizophoracee* in the mangrove forest. Those forests in the western part of the Mekong Delta were "pure" forests, composed of one single species, which differed from forests of the eastern part of the delta[33], where forest composition was more diversified. In 1938, the mangroves of Cochinchine covered 329,000 ha, which included 140,000 ha in Ca Mau, 30,000 ha in Baria, 20,000 ha in Rach Gia, and 139,000 ha in Tra Vinh, My Tho and Ben Tre and Ha Tien[34] (Figure 5).

Mangrove forests, designated "*foret de paletuviers*" during the French Administration, were found along the coast and at river mouths, where saline water can enter. At a conference in 1905 at the Ecole Coloniale, the *Captain Jacquet de l' Artillerie Coloniale*[35] described the coast in the Ca Mau peninsula as a dense inundated forest, with almost no roads or any transportation means which would impede any

[30] Nguyen C. 1959. La forets vietnamienne et la politique forestière nationale. Causeries sur le Développement des Ressources Naturelles au Vietnam. 15-31: "from this heroic time before the colonial period, we know almost only one thing: three quarters of the country's territory was covered by a dense forest that we assumed to be a primary forest in the mountainous areas and more or less exploited in the plains" (translation by O. Joffre).

[31] Couffinhal. 1918. La Situation des Forets en Cochinchine. 30p. Rapport du Chef du Service Forestier de la Cochinchine.

[32] Henry Y. Projet de mise en valeur du domaine forestier de la colonie. 1891. Saigon.

[33] Les Forets Indochinoises, extrait du Numero Special "L'Indochine". La Vie Technique et Industrielle eds. Paris.

[34] Maurand P. L'Indochine Forestière. 1938. Rapport du VII congres International d'agriculture tropicale et subtropicale, Paris 1937. Institut des recherches agronomiques et forestières de l'Indochine. Hanoi.

[35] Capitaine Capitaine Jacquet. Artillerie Coloniale. Saigon-Cap Saint-Jacques. Point d'Appuie de la flotte. Conférences Publiques sur l'Indochine faites à l'Ecole Coloniale. 1905-1906. Paris.

landing of foreign invaders. In *Les Forets Indochinoise* (1921), the authors describe a forest with large and tall trees where the salinity is high and smaller trees with a more mixed species composition where salinity was lower[36].

Based on the classification of Couffinhal (1918), the mangroves in Cochinchine included 3 main types of trees: *Paletuvier vrai*, *non paletuvier* and *palm trees*. For some species the scientific name has changed since 1918, in these cases the current name is added in brackets.

Table 1: List of the main species found in the mangroves in Cochinchine. Based on Couffinhal (1918)[37]. Local and scientific names according to Couffinhal; if current names are different they are added in bracket. Scientific name follow IUCN (1993)[38]. Additional information on the characteristics and use of the forest species added from other sources.

Local name	Scientific name	Use and quality
Paletuvier vrai		
Cây đước sành & Viet: Đước (Đước đôi)	*Rhizophora conjuguta* (new name *R. apiculata*)	Common tree in Cochinchine, with a value of $20,000 by m^3. Used for construction (poles), fuel wood and tannin. The tree can be tall and resistant to humidity
Cây đước đưng	*Rhizophora mucronata*	
Cây dá do	*Ceriops sp* (*Rhizophoracee*)	Used for construction (poles), fuel wood and dye
Cây dá nuóc (Dà vôi)	*Ceriops candolleana* (new name *C. tagal*)	Used for wood construction and in fisheries, and tinctures of the bark with red brownish (or dark green, according to sources) colours sold for $4/100 kg of bark[39]
Cây vet đen (Vẹt dù)	*Bruguiera gymnorhiza*	Used as fire wood and later introduced on the market for tannin and charcoal[40]
Cay vet tach (Vẹt khang)	*Bruguiera eriopetala* (new name *B. Sexangula*)	
Non Paletuvier		
Cây mấm (Mấm đen)	*Avicennia officinalis (Verbenacees)*	Fuel wood
Cây Bần đắng (Bần chua)	*Sonneratia acida* (new name *S. caseolaris*) *(Lythrariees)*	Soft wood, fruits
Cây bần ổi (Bần đắng)	*Sonneratia alba*	Soft wood
Cây su (Xu ổi)	*Carapa obovata (Meliacees)* (new name *Xylocarpus granatum*)	Fuel wood, construction wood tannin bark, oil seeds
Cây gía (Giá)	*Excoecaria agallocha (Euphorbiacees)*	Latex (caustic), fuel wood
Cây rau vùng	*Barringtonia sp (Myrtacees)*	Indian oak
Cây cui (Cui biển)	*Heritiera littoralis (Sterculiaces)*	Hard wood for poles
Ô rô	*Acanthus volubilis (Acanthacees)*	Shrub
Palm trees		
Chà là	*Phoenix paludosa*	
Dùa nuóc	*Nypa fructicans*	Palm tree used for roof tops, wild and cultivated, and fruit used to feed pigs

[36] Forest tree species have been identified and described by M. Chevalier, Inspector in Chief of the "Mission Permanente d'Inspection de l'Agriculture et des Forets".

[37] List based on Couffinhal. 1918. La Situation des Forets en Cochinchine. 30 pp. Rapport du Chef du Service Forestier de la Cochinchine.

[38] Mangroves of Vietnam. 1993. IUCN The World Conservation Union, Bangkok, Thailand, 173 pp.

[39] Maurand P. L'Indochine Forestière. 1938. Rapport du VII congres International d'agriculture tropicale et subtropicale, Paris 1937. Institut des recherches agronomiques et forestières de l'Indochine. Hanoi.

4.2 The mangrove forest, a hostile environment or an economic resource?

4.2.1 Perception of the mangrove resource

The perception of mangrove forests and inundated forests in general varies among authors. Some regard it as a hostile and useless environment, while others see it as a protective belt against erosion or note its importance for the economic growth of the region.

In 1899, in "*Rapport sur l'Etat, le régime et le reboisement des Forets*"[41] Mr. Lacote (Administrateur 1er classe) explained that soil that can support forests could be found only in the 4 provinces of eastern Cochinchine. In the western part of Cochinchine, in Bac Lieu and Rach Gia provinces, *"[…] les terrains bas et alluvionnaires sont presque toujours inondés et sur lesquels on rencontre les forets de Tram. Ces bois poussant dans l'eau sont destinés fatalement à disparaître au fur et à mesure de l'exhaussement du sol qui entraînera le développement de l'agriculture, car ces terrains très fertiles seront bientôt transformés graduellement en rizières. D'ailleurs, ces bois ne font l'objet d'aucun commerce, ils sont d'assez médiocre qualité et ne sont pour ainsi dire employés qu'a la consommation locale."*[42]. Even if the author was referring to *Melaleuca* forest behind the mangrove belt, such an approach shows that western Cochinchine was considered of very low value for forest resources. The report predicted a rapid transformation of those plains into rice fields, presenting the economic orientation of the government toward intensive rice culture for this area of the Delta (Biggs 2004[43]).

Mangrove forests and specifically those the Ca Mau peninsula were considered a hostile environment where disease lurked and life was difficult. Henri described the mangrove forests as "*Cet arbre envahisseur dresse sur les bords des rivières d'impénétrables murailles d'une verdeur grisâtres, d'autant plus tristes que rien ne vient rompre sa fatigante monotonie […]. Toute cette vaste nappe de vase va dégager des gaz sulfurique qui étaient retenus dans son intérieur […] en répandant son odeur pestilentielle"*[44]. The forests, and particularly *Rhizophora sp.* with its unique roots systems, were described as difficult to cross and without much economic interest.

On the other hand, some authors presented the mangroves as an important part of the ecosystem that protected the coast and river embankments, such as Sylvain (1911): "*Il est nécessaire ici d'entrer dans quelques détails pour montrer que le palétuvier est une essence admirablement adaptée au milieu dans lequel elle vit et la plus apte à maintenir les sables mouvants sur le bord de la mer, à consolider les berges des fleuves dans la partie terminale de leurs cours ou elles sont inondées à mare haute, enfin à fixer et permettre la mise en valeur des alluvions que les eaux dispersaient définitivement dans la mer*"[45]. Moreover, mangroves were already seen in 1918 by engineers of the *Service Forestier* as a way to protect the coastal zone and enable accretion[46].

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[41] Lacote 1899. Rapport sur l'Etat, le régime et le reboisement des Forets.

[42] "The alluvial low lands are almost always flooded, and where you find forest of Tram. These forest that grow in the water with disappear inevitably with the progressive elevation of the ground which will result in the development of agriculture, such fertile soil will be gradually transformed into rice field. Besides, these woods are not the subject of any trade, they are fairly poor and are used only for local consumption" (translation O. Joffre).

[43] Biggs D. 2004. Between rivers and tides: a hydraulic history of the Mekong delta, 1820-1975. PhD Thesis. University of Washington. 422 p.

[44] Henry Y. 1926. Massifs de palétuviers de la région de Ca Mau, correspondance de l'Inspecteur Général de l'Agriculture, de l'Elevage et des Forets au Gouverneur Général de l'Indochine, Hanoi, 2 pp. "These trees standing on river bank, creating impenetrable gray walls, even more sad that nothing stops its tiresome monotony […] All this vast area of mud will generate sulfuric gases which were trapped inside, spreading the stink" (translation O. Joffre).

[45] Sylvain B. 1911. L'utilité du Service Forestier en Indochine: la disparition du palétuvier et l'ensablement de la rivière Saigon, in La Depeche de Saigon, 7 pp. "It is necessary to go into some detail to show that the mangrove trees are a species admirably adapted to the environment in which they live and better able to maintain the sands on the seashore, to stabilise the river bank at the river mouth where they are flooded at high tide and finally to fix the development of the alluvium that the water will have finally dispersed into the sea". (translation O. Joffre).

[46] Couffinhal. 1918. La Situation des Forets en Cochinchine. 30 pp. Rapport du Chef du Service Forestier de la Cochinchine.

In 1891, Henri in "*Projet de Mise en Valeur du Domaine Forestier de la Colonie*"[47] stated that brackish water inundated forests should be protected and conserved as a source of fuel wood for the colony. According to the author, the forests affected inland climate and other inland forested areas and so required careful management.

By 1911, Ducamp had already explained the importance of mangrove forests for protection against tidal wave: *"[….] de faire par le palétuvier, à peu de frais, comme glacis de matière vivante et agissante capable de protéger les digues maritimes et leurs populations, non pas peut-être contre l'invasion des eaux, mais contre l'énorme coup de bélier qu'est un raz de mare se ruant sur une plage découverte"*[48]. In 1918, Couffinhal described the root system of mangrove trees as a web or a tight net useful in protecting and fixing soils and sediments, with trees shielding river embankments and mangroves producing land while the forest progressed toward the sea. The author mentioned that this land could be converted into farm land later. The mangrove forests were perceived later as a potential source of revenue for the Administration with the rising need for fuel wood and charcoal.

4.2.2 Exploitation of the mangroves in Ca Mau

Mangroves in the Ca Mau region progressively became a more important resource, with increasing production of fuel wood and charcoal to feed the cities and the economic growth of Cochinchine.

In 1916, fuel wood production in Cochinchine was recorded at 549,478 m^3 [49], with 1,322 and 15,403 m^3 estimated for Soc Trang and Bac Lieu provinces respectively. However, according to the authors a large part of the production was not taken in account because it could not be controlled by the *Service Forestier*. The *Service Forestier* estimated real production at around 700,000 m^3. Later, as shown in Table 2, production increased drastically with production peaking in 1940 with 334,000 m^3 of fuel wood and 70,000 tonnes of charcoal around Ca Mau only (Bac Lieu Province).

Table 2: Forest production and revenue from forest taxes in Ca Mau from 1931 to 1941 (cited by Tran 2006).

Forest products	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
Fuel wood ('000 m^3)	134	117	189	180	175	257	284	240	334	251
Charcoal ('000 tonnes)						52.6	60.8	61.0	70.0	58.0
Construction wood ('000 m^3)	2.6	4.0	4.7	5.7	7.7	11.6	10.3	10.4	10.2	7.4
Bark ('000 m^3)	1.3	1.1	1.2	1.2	1.6	1.8	1.6	1.2	7.1	7.1
Nypa palms ('000 leaf)	5.0	8.6	7.7	9.4	14.6	17.1	11.9	10.0	14.5	10.5
Total income ($'000)	126	117	185	156	153	215	297	364	465	435

Fuel wood extraction from the forest increased from 1932 to 1941. Exploitation of additional resources such as construction wood or *Nypa* palm also increased during this time. Bark production for tannin and dye remained stable from 1932 to 1939, after which it jumped from 1,200 m^3 to more than 7,000 m^3.

Besides fuel wood production, charcoal production became an important part of the economy, with exportation to Hong Kong, Siam (Thailand) and Cambodia, in addition to the local market needs. Charcoal production taxed by the *Service Forestier* in Cochinchine increased from 36,8433 tonnes in 1925[50], to 56,000 tonnes in 1936[51], and 70,000 tonnes in 1940, with export to China raising up to 14,000 tonnes in 1939. The demand in Cochinchine was estimated between 50 and 70,000 tonnes[52], with a local

[47] Henry Y. 1891. Projet de mise en valeur du domaine forestier de la colonie. Saigon.

[48] "...using mangrove trees, with a minimum cost, like glaze of living matter capable of protecting dykes on the sea shore and the local population, probably not against water intrusion but against the massive hit of a tidal wave rushing onto an uncovered beach" (translation O. Joffre).

[49] Rapport sur la Situation Forestière en Indochine, 1917.

[50] Les bois et principaux sous produit de la foret, 1931.

[51] La mise en valeur du domaine forestier. L'Opinion 16 Mai 1939.

[52] Billet d'Indochine n°32 the 27th September 1945.

selling price of $3.5/100 kg in Saigon and $5 in Hanoi[53]. The "*réserves*" in Damdoi, Tanan and Nam Can west in the Ca Mau Peninsula were the main producers of wood for charcoal in the region.

In 1937, Dugros explained that not only had all of Cochinchine become dependent on the mangrove forests of Ca Mau for charcoal production, but also neighbouring countries like Thailand and Hong Kong had as well[54]. We can see that production and revenue from the forests increased from 1932 to 1941.

However, the exploitation of the forest was not seen as sustainable. Not only was the increasing extraction of fuel wood and charcoal a threat for the sector, but the expansion of rice culture through conversion of forest land into rice fields[55] was also highlighted by economic reports in 1939 as the main limiting factor for small scale enterprises producing fuel wood.

4.2.3 Over-exploitation of the resources, reports from the Service Forestier

From the beginning of colonisation, scientists and agronomists understood the ecological role of mangrove forests and their importance for coastal protection, and they became increasingly concerned about their over-exploitation.

Henri, in 1891[56], explained that inundated forests under saline water influence were already exploited. Already in 1899, a report mentioned that fuel wood production had shifted from mangrove trees to smaller trees and that the use of large trees for fire wood was due to the absence of other forest resources[57].

During the first period of colonisation, mangrove exploitation was forbidden within 150 m of river banks to protect forests and limit erosion. According to Sylvain (1911), this was an important regulation to limit deforestation if consistently applied[58]. According to Couffinhal (1918), one of the factors leading the deforestation of the inundated forests in Baria, Bienhoa and Gia Dinh was the modification of this rule[59].

The development of a local economy for charcoal production also contributed to the non-sustainable exploitation of mangrove forests. In Ca Mau forest, mangroves were also exploited illegally by foreign boats from Singapore. Export of charcoal to Thailand, Hong Kong, and Singapore as well as tannin for the domestic market in Cholon were often cited as economic factors influencing deforestation and over-exploitation of mangroves (Couffinhal 1918; Les Forets Indochinoises 1921 [60]). Reports strongly advocated the development of regulations for fuel wood exploitation to protect the forests on Ca Mau Peninsula. The economic argument used in these reports was that sustainable forest management would generate more income for local governments[61]. Engineers in charge of forest management based their

[53] The price of fire wood was $0.10/m^3 in 1907 and sold on the market at $1.5 to $1.8 /m^3. In 1951, the all inclusive price for fire wood was $10/m^3 and $30/m^3 for the bark of "paletuvier". The all inclusive price for fire wood exploited without permit in classified forests or under verification of post guards was $35 for "duoc" (*Rhizophora sp*.) and $10 for other mangrove trees. (translation O. Joffre).

[54] "[…] *de 500 en 1924, le nombre d e fours installes dans le Cantonnement de Ca Mau est passe a 850 en 1934, tandis que le volume de bois extrait des foret de palétuviers de ce Cantonnement et livre a la carbonisation passait dans le même temps, de 60,000 a 180,000 stères et le rendement de charbon de 200,000 a 500,000 quintaux. Et ce n'est point seulement la Cochinchine toute entière qui devint tributaire de nos forets de palétuviers en utilisant le charbon incomparable qu'elles lui fournissaient, mais les pays voisins, comme le Siam, Hong Kong qui surent apprécier ce combustible de choix"*. In Dugros M. 1937. Le domaine forestier inonde de la Cochinchine. Bulletin Economique de l'Indochine, Nouvelle Série, Gouvernement General de l'Indochine, Hanoi : 238-315.

[55] Principe Généraux économique d'Indochine. 1939.

[56] Henri Y. 1891. Projet de mise en valeur du domaine forestier.

[57] Lacote 1899. Rapport sur l'Etat, le régime et le reboisement des Forets : "*Pour les bois a brûler, on a exploite d'abord les cay duoc, cay vet, les palétuviers, puis les arbrisseaux, les arbustes, les lianes, la brousse en un mot. Actuellement on s'en prend à des arbres assez gros"*.

[58] Sylvain B. 1911. L'utilité du Service Forestier en Indochine: la disparition du palétuvier et l'ensablement de la rivière Saigon, in La Dépêche de Saigon, 7 pp. "*Si l'on avait continuer a appliquer cette mesure, il n y aurait pas lieu aujourd'hui de supporter les inconvénients du déboisement".*

[59] Couffinhal. 1918. La Situation des Forets en Cochinchine. 30 pp. Rapport du Chef du Service Forestier de la Cochinchine.

[60] Les Forets Indochinoises, extrait du Numéro Spécial "L'Indochine". La Vie Technique et Industrielle eds. Paris.

[61] Rapport sur la Situation Forestière en Indochine, 1917.

predictions on recent history, with the earlier disappearance of mangrove forests in Baria and Bien Hoa provinces in 1919[62].

However, for local governments, protection of the mangrove forest was not a priority. As the Chief of *Service Forestier* mentioned to the Governeur of Cochinchine in a letter on December 6th, 1920, even though the mangrove forest needed to be exploited in a sustainable way, it was not a priority of the service because of its distance and the difficulty of guarding it[63].

Besides the lack of human resources to guard the forests, even in the "*réserves*", technical aspects also contributed to over-exploitation of the resource. The *Inspecteur General de l'Agriculture, de l'Elevage et des Forets* estimated losing 60% of production due to inefficient harvest techniques[64]. Couffinal described a similar problem in 1918 with a loss of 50% of the tannin due to the sun drying technique[65]. In order to control fuel wood exploitation, the Colonial Administration issued permits for small-scale fuel wood exploitation after 1934 (*Arrêté du 30 Octobre 1935*). But the Administration realised that guarding and enforcement of small-scale fuel wood exploitation was not possible[66].

To maximise exploitation of forest resources, the Administration proposed developing "clusters" of forest exploitation in order to concentrate human resources in certain areas and facilitate the protection of the forest. In "*réserve*" areas, the *Service Forestier* managed the mangrove forest with a turnover of 60 years and a rotation of 20 years[67]. *Rhizophora conjugata* (new name *R. apiculata*) was the main species regenerated because of its economic value, with reforestation programmes after exploitation. However, these programmes were limited, with the annual reforested area in Cochinchine varying from 0.01 km^2 to 3.52 km^2 per year between 1931 and 1941[68]. To facilitate exploitation and regeneration of the forest, the *Service Forestier* also developed a network of canals within the mangrove forests of Ca Mau[69]. To exploit mangrove forests effectively, the distance for wood transport should not exceed 125 m, with canals every 250 m (80 cm deep and 1.50 m wide). This policy was also a way for the Administration to access and control remote areas[70]. For example, in the Ca Mau Peninsula, the soil extracted from the canal dug in Nam Cam ended up being the road between Nam Cam and Ca Mau. In Ca Mau, 8,000 km of canals were planned but only 2,200 were dug before the wars (first Indochina and later Vietnam War)[71].

Later during the war of independence, forest exploitation was less controlled. In 1947, Decree n° 5055-MI/DAA stipulated that forest exploitation was not allowed in areas where the security of forest department agents was not guaranteed[72]. Mangrove forests assumed strategic importance during the Vietnam War, giving shelter to the guerrillas. Therefore, these areas were not exploited, and the US Army targeted them with herbicides in order to clear the forest. The forests in Ca Mau, as well as in Vinh Chau and Cu Lao Dung in Soc Trang Province, were affected by herbicides during the war. After 1975, the Vietnamese Government implemented reforestation programmes in some of these herbicide affected areas.

The status of mangrove forests changed during the 20th Century, from a hostile and not valuable environment to the development of an industry with management plans and infrastructure development.

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[62] Les Forets Indochinoises, extrait du Numéro Spécial "L'Indochine". La Vie Technique et Industrielle eds. Paris.

[63] Note pour Mr. le Gouverneur de Cochinchine. Contrat a passé avec la Société Forestière de l'Ouest de Can Tho. 6 Decembre 1920.

[64] Foresters removed the bark for tannin and left the wood for charcoal. Only the trunk of the tree was collected.

[65] Couffinhal. 1918. La Situation des Forets en Cochinchine. 30 pp. Rapport du Chef du Service Forestier de la Cochinchine.

[66] Délivrance de permis réduit pour l'exploitation des bois de feux. 1937.

[67] Maurand P. 1938. L'Indochine Forestière. Rapport du VII congres International d'agriculture tropicale et subtropicale, Paris 1937. Institut des recherches agronomiques et forestières de l'Indochine. Hanoi.

[68] Maurand P. 1943. L'Indochine forestière, Hanoi, IDEO, 252 pp.

[69] Maurand P. 1938. L'Indochine Forestière. Rapport du VII congres International d'agriculture tropicale et subtropicale, Paris 1937. Institut des recherches agronomiques et forestières de l'Indochine. Hanoi.

[70] Foret d'Indochine. 1er Trimestre 1947. Bois et Foret des Tropiques, 1. 25 pp.

[71] Thao Tran 2006. Les perturbations anthropiques contemporaines dans les mangroves du Sud Viet-Nam entre nature, civilizations et histories. PhD Thesis. Universite de Paris IV. 609 pp.

[72] Arrete 1736-Cab/DAA du 1er Août 1950. Interdiction d'exploitation forestière dans les zones d'insécurité. In addition, the origin of charcoal had to be proven. Otherwise, it would be considered derived from trees over 1 meter and of a diameter lower than the minimum and the owner of this charcoal would be punished.

Over exploitation of the mangrove forests happened already in the early years of the 20th Century. However, the French Administration and its *Service Forestier* did try to control and limit mangrove forest clearing, trying to prevent what had happened in the Eastern part of Cochinchine.

This happened mainly in Ca Mau forest, were the the *Service Forestier* was more active. In the following sections we will focus on the changes in mangrove forest cover and species composition in Soc Trang Province.

5. Land use dichotomy: rice in Soc Trang and forests in Bac Lieu

5.1 Soc Trang land use in the early 20th century

According to French administrators, the name Soc Trang came from a "mistake" related to the pronunciation of the province's Khmer name: "*Srok Khleang*" (*Treasure Country*)[73]. Originally, this name probably referred to the finance department of Bassac Province (Soc Trang and Bac Lieu) during the Khmer Kingdom in Soc Trang[74].

During the French colonial period, Soc Trang Province did not include the present Vinh Chau District. Vinh Chau was part of Bac Lieu Province. The coastal area of Soc Trang included the districts of Tran De and Cu Lao Dung. At that time, Cu Lao Dung was divided into 3 islands as we can see on the map of Cochinchine Française (1868) (Figure 6).

Soc Trang Province was one of the poorest provinces of Cochinchine in terms of wood resources. According to the French Administration, there was no need to re-forest the province. With its low lands, the province would be transformed entirely into rice production[75]. Developing forest farms would create an unrealistic utopia according to the French Administration[76], while Bac Lieu Province was a forest-oriented province, but also an area with productive fisheries and salt production.

In 1904, Soc Trang included 140,000 ha of rice fields, which was the province's main resource. Soc Trang's economy depended on its rice fields and only its rice fields[77]. Soc Trang was part of an intense rice production area with more than 75% of the total province area dedicated to rice production in 1931 (85% in 1929) with rice fields that had already been irrigated. In Bac Lieu (including Vinh Chau District), the percentage of the total area dedicated to rice was between 35 and 50% in 1931 (46% 1929) and rice fields were rain fed.

Documented descriptions of the natural environment along the coast are few. Some indication can be found in Couffinal (1918)[78], where the author describes the coast between the mouth of the Bassac and the My Thanh River being covered by unpopulated mangrove forest. People settled more inland in the plain of Soc Trang Province, famous for its rice production, and in Vinh Chau District along the dunes (locally named "*giong*"). The coast from the My Thanh River to Ca Mau was not well mapped until 1889 (Figure 9), as access by boat was difficult due to sand banks and mapping complicated by the dense mangrove forest of Bac Lieu Province.

Vinh Chau District, along the South China Sea from Gan Hao (south of Bac Lieu Town) and the My Thanh River mouth, was described as a series of dunes where salt pans (727 ha) and vegetable production were developed. Rice culture was present, including the oldest rice field in the province[79]. The district was described in 1916 as: *"[...] la partie de la province dans la région comprise entre Bac Lieu, la mer et le My thanh est peuplée et cultivée, c'est la que se trouve dans un grand 'giong' la délégation de Vinh Chau[80]".* The rest of Bac Lieu Province (present Ca Mau Province) was described as a swamp and inundated area with mangrove trees. It was a "*pioneer area*" where new settlers had to clear forest to cultivate rice or exploit mangrove trees: "*La partie centrale […] est en plein défrichement. C'est la*

[73] The Mekong Delta was part of the Khmer Kingdom until the 17th Century. In 1623 the Khmer king allowed refugees from the Annam region to settle in the region of Prey Nokor, the area of present-day Ho Chi Minh City. Since then increasing waves of Vietnamese settlers colonised the Mekong Delta until 1845, when the Vietnamese Kingdom signed a treaty with the Khmer King for the annexation of the Mekong Delta. In 1859 the French started to colonise the region and in 1867 the French colony of Cochinchine was created. (A. Dauphin-Meunier – Histoire du Cambodge, PUF, 1961).

[74] Monographie de la province de Soc Trang. 1904. Géographie Physique, économique et historique de la Cochinchine. XI fascicule. Société des études Indo-Chinoises. Saigon.

[75] The author called it: "*la Beauce de la Cochinchine*". *La Beauce* is a French province famous for its intensive cereal production.

[76] Monographie de la province de Soc Trang. 1904. Géographie Physique, économique et historique de la Cochinchine. XI fascicule. Société des études Indo-Chinoises. Saigon.

[77] Monographie de la province de Soc Trang. 1904. Géographie Physique, économique et historique de la Cochinchine. XI fascicule. Société des études Indo-Chinoises. Saigon.

[78] Couffinhal. 1918. La Situation des Forets en Cochinchine. 30 pp. Rapport du Chef du Service Forestier de la Cochinchine.

[79] Louis Girerd. 1925. Monographie de la Province de Bac Lieu. 38 pp. Saigon.

[80] Rapport d'Inspection de la Province de Bac Lieu 4 avril 1916, Mr Tourres administrateur de 2eme classe. *"[…]* the part of the Province located between Bac Lieu, the sea and the My Thanh River is populated and cultivated; it is there that you can find the delegation of Vinh Chau, on a large 'giong*'"* (translation O. Joffre).

qu'affluent les concessions. Tout le reste de la province comprenant la Pointe, sur la mer de Chine et le golfe du Siam est surtout habité par des villages de pécheurs et de gens qui viennent exploiter les forets de palétuviers. […] Dans toute la pointe Sud il n'y a aucune autorité indigène[81]*"*. In those lands, a large and dense mangrove forest was present: "*Toute l'extrémité de la presque île de Ca Mau est couverte de forets de palétuviers que pour préserver de la destruction rapide on a convertie en réserves*[82]."

At the opposite extreme, there were almost no forest resources in Soc Trang. In the "*Rapport d'Inspection de la Province de Soc Trang*" (1905), the author explains that there is no forest in the province except the mangrove forest in Cu Lao Dung Island. There was no forest guard at that period in Cu Lao Dung and the forest was already a source of conflict between villagers and the concessions owner[83]. In 1904, the Monographie of Soc Trang Province indicates that in Dinh My District (present Tran De District), the village of Hoi Binh (with a population of 1,232 inhabitants) was named "*Bai Gia*" due to the mangrove forest on the coastal area composed of "*cay-gia*" trees (*Excoecaria agallocha)*, "*Bai*" meaning seashore (or beach). But the author mentions that the forest was partially degraded. This mangrove forest in Tran De District is represented in the forest maps of 1914 and 1925. On those maps Tran De District has a continuous layer of mangroves, while Vinh Chau District has no forest (Figures 7 and 8).

5.2 Forest production and forest "*réserve*", differences between Soc Trang and Bac Lieu provinces

The differences between the forestry sector in Bac Lieu and Soc Trang are illustrated by historical provincial statistics. In 1916, 1,322 m^3 of fuel wood was produced in Soc Trang Province with a value of $2,514, while in Bac Lieu Province (which included a large part of Ca Mau Peninsula) the volume was 4,946 m^3 and 15,403 m^3 for construction and fuel wood respectively with a total value of $53,218[84].

In Soc Trang Province, the only exploited tree was the "*Tram*" (*Melaleuca sp.*) which was not really abundant and was small in size after forests in the province were cleared for rice culture[85]. Besides *Melaleuca sp.*, the other valuable trees included mangrove species such as *Ceriops sp., Rhizophora sp., Sonneratia sp*. and *Bruguiera sp.,* which were exploited for their bark for tannin and dye. *Rhizophora sp.,* mainly found in Cu Lao Dung, was used to make rice production machineries[86]. Other species were used for fuel wood (*Bruguiera sp.* and *Excoecaria agallocha*) while larger trees of *Sonneratia sp.* were used for boat construction. Forest management was not of prime interest in Soc Trang. The only mentioning of forest protection in the province was cited in the Monograph of Soc Trang Province (1904). The authors had already noted that trees should not be cut along rivers and canals to protect against weed seeds (transported by the wind), sustain embankments, and to produce fuel wood (the province was already importing construction wood from other provinces).

No indication was found about mangrove forests along the Vinh Chau coast. No document was found about forests in Vinh Hai at the mouths of the Bassac and My Thanh rivers. Most documents concern Bac Lieu Province, with the forested area around Ca Mau. In 1924, a natural forest of *Rhizophora apiculata* was discovered, containing individuals 20 meters tall, 80 cm in diameter, and more than 100 years old[87]. In this area, mangrove trees were abundant and the local administration tried to develop new management plans to exploit these resources.

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[81] "The central area is under ongoing forest clearing. This is where concessions flock. The rest of the province, from the top end, the China seashore and the Gulf of Siam is mainly populated by fishing villages and people who migrate here to exploit mangroves forests. […] In the entire South, there are no indigenous authorities". (translation by O. Joffre). In Louis Girerd. 1925. Monographie de la Province de Bac Lieu. 38 pp. Saigon.

[82] *"*The entire Ca Mau peninsula is covered by mangrove forest that in order to preserve, we converted into 'réserves'*".* (translation by O. Joffre). In Louis Girerd. 1925. Monographie de la Province de Bac Lieu. 38 pp. Saigon.

[83] Rapport d'Inspection de la Province de Soc Trang 31 mai au 5 juin 1916, Mr Bon administrateur de 2eme classe. "*Il n'y a pas de forets, sauf une partie en palétuviers dans le sud de l'île de Cu Lao Dung. Cette foret se trouve sur un terrain domanial conteste que la commission de bornage au lieu d accorder aux concessionnaires proposa de réserver pour le village. Il n'y a pas de garde forestier".*

[84] Couffinhal. 1918. La Situation des Forets en Cochinchine. 30 pp. Rapport du Chef du Service Forestier de la Cochinchine.

[85] Monographie de la province de Soc Trang. 1904. Géographie Physique, économique et historique de la Cochinchine. XI fascicule. Société des études Indo-Chinoises. Saigon.

[86] Couffinhal. 1918. La Situation des Forets en Cochinchine. 30 pp. Rapport du Chef du Service Forestier de la Cochinchine. *Rhizophora* sp. was probably not very abundant in Cu La Dung. According to villagers interviewed in 2010 the forest was mainly composed of *Avicennia* and *Sonneratia* sp.

[87] Ducamp R. 1909. L'arbre et l'eau en Indochine. In Revue Indochinoise: 18-24.

6. Coastal zone in Soc Trang Province from 1889 to 1965 and comparison with the present situation

6.1 Soc Trang mangrove forest representation during the 19th and 20th centuries

The map of Cochinchine from 1868 (Figure 6) only shows salt pans but no other forms of land-use or land cover such as forest[88]. The first maps showing vegetation cover were produced in 1889 and updated later in 1901 (Figure 10). On this map, Cu La Dung Island is not a single island, but divided into 3 smaller forest covered islands, Cu Lao Tron on the west part, Cu Lao Dung in the middle and Cu Chang Coc on the eastern side of the Bassac River mouth. Accretion areas (sand banks) are shown on these maps for both Cu Lao Tron and Cu Lao Dung. The Bassac River had 3 branches at that period, namely Cua Tran De, Cua Bassac and Cua Dinh-An.

Forest cover is continuous from the mouth of My Thanh River to Tran De, probably representing the *Excoecaria agallocha* forest described in the Soc Trang Province Monograph (1904). The My Thanh riverbank is also covered with forest and only some forest is represented in the eastern part of Vinh Chau District, at the present location of Vinh Hai Commune. The South China Sea coastline is bordered with dunes and no forest appears on the coast line. On the 1904 map, some forest is shown in the western part of Vinh Chau, between the sand dunes and the coastline (Figure 10). While no forest cover is mentioned in Vinh Chau District in 1952, forest cover appears in the western part of the coast, in Bac Lieu Province (Figure 11). The difference between Vinh Chau District and Bac Lieu Province shown on the map was confirmed during interviews with old people in the area. They said the difference was due to land level, with higher land in Bac Lieu creating a favourable environment for forest growth.

In less than 100 years, several changes can be seen on maps of the study area. We will analyse the evolution of specific areas in Vinh Chau District (west and east part of the district and the My Thanh River mouth), Tran De District and Cu La Dung District. Data presented in the following paragraphs are based on maps from 1904 to 1965[89], aerial photos from the 1950s and interviews with key informants in the study areas. We also present satellite images from 2006 and 2007 in order to briefly analyse the changes over a period of more than a century.

6.2 Vinh Chau District

6.2.1 West Vinh Chau

- In Lai Hoa commune, where Nopol Hamlet is located, the 1904 map shows the presence of mangroves between the sand dunes and the coastline (Figure 10a). According to local villagers, the vegetal cover was mainly composed of small *Avicennia sp*., *Thespesia populnea* and herbaceous species such as *Acanthus sp.* The forest layer was not wide according local villagers. The 1952 map shows no forest cover along all of the Vinh Chau coastline (Figure 11 and 11a). The change in forest cover was due to mangrove clearance to support local fuel wood consumption and the use of the mudflats to trap fish and shrimp.
- The local administration had been renting out plots on the mudflats by auction since before the 1950s. These plots, usually rented by merchants from Vinh Chau Town, Bac Lieu Town or better-off households from Vinh Phuoc, were used to trap fish and shrimp at spring tide when the mudflats were submerged. In the 1953 aerial photo from the same area (Figure 12), we can clearly see the canals and dykes on the mudflats used to trap fish and shrimp. Local people were employed to dig canals and dykes around the plots and to operate sluice gates. This practice stopped after 1975.
- Within this system, the mudflats were not part of an open access system and local villagers could only collect sesarmid crabs, mud crabs and other low-value crustaceans. The renters of those areas trapped fish such as mullets or goby and shrimp (*Penaeus* and *Metapenaeus sp*.) and sold them in the town of Bac Lieu or Vinh Chau.
- On the 1953 aerial photo, we can distinguish cleared mudflats near the seashore and some vegetal cover, made of *Acanthus sp.* Darker spots are remaining *Avicennia sp.* showing that in 1953 the forest layer was not continuous. According to local fishers, areas with forest were more productive for crabs while mudflats were used to trap goby type fish.
- A comparison of the two maps (1904 and 1952) shows that the western part of the district was an accretion site during this period. If we compare the distance from the Vinh Chau canal to the

[88] On a 1874 map, the China Sea coast is labeled as not well know: *" Cote mal reconnue*".

seashore in 1904 (Figure 10) and 1952 (Figure 11b), there is an increase of 83%, which represents approximately 1.7 km in 48 years (about 35 m per year). The accretion area started at the western side Vinh Chau Town and continued up to Bac Lieu Province. This is illustrated by the dashed red line on figure 10. In the 1950s, according to local people, the waves were less destructive than now, even if the area was regularly flooded up to the road from October to April. Later, the accretion at the same location stopped, with a distance of about 3.4 km measured using the same abovementioned transect on the 1965 map (Figure 13). Measurements are not precise, but this comparison shows that the same dynamics that existed between 1904 and 1953 did not exist between 1953 and 1965. According to recent studies, this same area is now an erosion zone (Soc Trang CZM project 2010[90]). This change in erosion and accretion patterns over a 100 year period is an example of the dynamics of the coastal zone.

- The map of the west part of Vinh Chau District in 1965 does not show any mangroves, but only swamps and mudflats, and intermittent ponds near Vinh Chau Town.
- In 2006, the satellite image shows that the mudflats were converted into shrimp and artemia ponds following the development of a protecting dyke (in the 1990s) on the sea shore (Figure 14). On the seaside of the dyke *Rhizophora sp.* were planted, but they have been partially degraded due to strong erosion.

West Vinh Chau

- Original vegetation cover was composed of *Avicennia sp.* and progressively disappeared until the 1950s.
- The present forest cover of *Rhizophora apiculata* is the result of a reforestation programme.
- Western Vinh Chau was an accretion area until the mid-sixties, while now the same area is an erosion area under the influence of the longshore current.
- Before 1975, mudflats were rented out by the local administration and used to trap fish and shrimp. It was not an open access resource area but an extensively farmed area with canals, dykes and specific access rules.
- Main products extracted from the area were fuel wood (*Avicennia sp.*), fish (mullets, goby), shrimp, mud crabs, and sesarmid crabs.
- Sections of mudflats were converted into shrimp and artemia ponds after the dyke was constructed.

6.2.2 East Vinh Chau

- No mangrove belt was present from Vinh Chau Town to Vinh Hai Commune on the 1904, 1952 or 1965 maps (Figures 10, 11 and 16), or in aerial photos from 1953 (Figure 15). On the 1904, 1952 and 1965 maps, the coastline is characterised by sand dunes. The fact that there were no mangroves between Au Tho B Hamlet and Vinh Chau Town before the reforestation programme in the 1990s was confirmed by villagers.
- A comparison of the 1904, 1952 and 1965 maps shows the accretion of the sand bank between Tra Set and O'Be Hamlets (Figure 10, 11c and 16a). This sand bank was covered with palm trees such as *Phoenix paludosa* as we can see in the aerial photo (Figure 15). Natural canals with *Nypa* palms (*Nypa fructican*) cut through the sand dunes (Figure 11d) and local people from Au Tho Hamlet collected fuel wood (*Avicennia sp.* and *Sonneratia sp.*) and natural resources (goby, seasarmid crab, and other crustaceans) on the higher land at the edge of Vinh Hai forest. On the 1965 map, a part of this area is shown as swamp (Figure 16a) and a part of the sand bank is now covered with mangrove trees. The forest is progressing toward the west (Figure 16b). In the 1950s and until the end of the Vietnam War in 1975, Vinh Hai forest was not accessible by most of villagers due to the presence of guerrillas.
- After the war, swamp, forest and the sand bank between Tra Set and O'Be hamlets were progressively colonised for agriculture and aquaculture (Figure 17).

[90] Current and Erosion Modeling Survey in the Coastal Zone of Soc Trang. Fact Sheet. Management of Natural Resources in the Coastal Zone of Soc Trang Province 2010. Technische Universität Hamburg Harburg.

- Au Tho Hamlet now has a mangrove belt of *Avicennia sp*., due to reforestation programme in the late 1990s (Figure 17). The coast from Au Tho Hamlet to Vinh Chau Town is now an accretion site. According to villagers, since dyke development (in 1994 in this part of the district) and reforestation with *Avicennia sp*. In 1997, the profile of the coastline has changed, with a more gentle slope due to higher sedimentation, a change in texture, and more mud compared to the sandy soil before the 1990s.

East Vinh Chau

- No mangrove belt from Au Tho Hamlet and Vinh Chau Town, only sand dunes before the 1990s. Presence of forest (*Avicennia sp.*) only after reforestation programme in the late 1990s.
- The eastern part of Vinh Chau is now an accretion area with different soil texture.
- In the 1950s, the sand dune and sand bank between Tra Set and O'Be hamlets was covered with sparse palm trees and *Nypa* palms along natural canals and waterways. Between the 1950s and 1965, the mangrove forest progressed toward the west. *Sonneratia sp.* and *Avicennia sp.* trees at the edge of the forest were exploited by locals.

6.2.3 Vinh Hai forest and My Thanh River mouth

The 1889 map shows some vegetation, but not a dense forest in Vinh Hai Commune (eastern part of Vinh Chau) (Figure 9). The 1904 and 1952 maps (Figure 10 and 11) show the forest cover in more detail. In 1952, some forested areas have been converted into settlements and rice fields compare with 1904 situation. The 1952 map clearly shows a sand bank covering the eastern side of Vinh Hai, almost from north to south (Figure 11d). This can also be seen on the aerial picture of 1953, along with forest composed of scattered trees, *Nypa* palms and some agricultural plots at the My Thanh River mouth (Figure 18). At this time, the forest was mainly composed of *Sonneratia sp.* and *Avicennia sp.* though species such as *Ceriops sp.*, *Bruguiera sp.*, *Excoecaria agallocha* and *Lumnitzera racemosa* could also be found. In 1965, Vinh Hai forest had expended to the south west (compared to 1953), but settlements and swamps covered the northern part adjacent to the My Thanh River mouth (Figure 16b and 19). In 1965, the shape of the coast was still comparable to 1953 and it was only later that the accretion modified the coastline, leading to the disappearance of the sand bank surrounding the forest (Figure 20).

With the presence of permanent settlements of guerrillas during the Vietnam War, Vinh Hai forest suffered from the use of herbicides by the American Army between 1965 and 1971[91]. After the war, the Vietnamese Government started reforestation programmes, using *Rhizophora apiculata*. The choice of this species during the reforestation programme, explains the change in species composition after the war, with the forest now composed mainly of dense *Rhizophora sp*.

Vinh Hai forest and My Thanh River mouth

- Change in mangrove tree species, from *Sonneratia sp.* and *Avicennia sp.* to *Rhizophora apiculata* after the use of herbicides (1965-1973) during the Vietnam War and subsequent reforestation programme.
- Important accretion in the eastern part and disappearance of the sand bank between 1965 and 2006.

6.3 Tran De and Cu Lao Dung districts

As we already noticed, the present Cu La Dung Island is shown as 3 islands on the 1889 map (Figure 6). All islands were covered by forest and Tra De District contained a continuous layer of forest. Maps of 1904 and 1933 (Figures 21, 22, 23, 24a, 24b, 25a and 25b), show the accretion site in both districts. Tran De District gained land towards the east, with an accretion both north and south of Bai Gia port (Figures 24a and 24b). In 1904, only a strip of land 0.7 km wide (maximum width) and 3.7 km long (north to south)

[91] Thao Tran. 2006. Les perturbations anthropiques contemporaines dans les mangroves du Sud Viet-Nam entre nature, civilisations et histoire. PhD Thesis. Universite de Paris IV. 609 pp.

was located east of the longitude 115º40 E[92]. In 1933, the same strip of land was 7.8 km long (north to south) and 1 km at its maximum width. The difference in land area represents the accretion between the 1904 and 1933. In 1965, the same strip of land was estimated (based on 1965 map) to be around 11 km long with a maximum width of more than 2 km.

Using latitude and longitude we can observe that Cu Lao Dung and Cu Loa Tron islands both increased towards the south west (Figures 25a and 25b). The most southern point of Cu Lao Dung Island was located 1.6 km north of the latitude 10º60N in 1904 (Hanoi system, correspond to 9º32'24''), while in 1933, the island had already "crossed" this latitude. Cu Lao Tron Island Island had also crossed this latitude in 1933, whereas in 1904 it was located 3 km further north. The shape of the islands also changed, with Cu Lao Dung Island in 1904 having a width of 3.2 km, while in 1933 it was about 5.4 km at its maximum width.

- The 1953 aerial pictures show that Tran De District contained a southern part without any mangroves, while north of Bai Gia port mangroves were still present (Figure 26). According to locals, in the southern part, the forest of *Nypa* palm, *Sonneratia sp*. and *Excoecaria agallocha* suffered from exploitation by villagers (for home consumption mainly fuel wood, palm roofing) and also from erosion. During the Vietnam War, inhabitants from Mo'O and the My Thanh River mouth were re-located for security reasons ("Strategic hamlet" policy) to near Bai Gia port, increasing the need for fuel wood in this area. The 1965 map does not show mangroves north to Bai Gia port, but "clear forest" refer to the absence of *Rhizophora sp.* in this area. Surprisingly, on the 1965 maps, mangrove forest is shown, while no forest cover can be seen on 1953 aerial photos. According to a key informant, later in the 1970s this area suffered from strong erosion, forcing households to be relocated near Kinh Ba port. It was only in the late 1970s and 1980s that the Government started reforestation with *Sonneratia sp*.
- The present mangrove belt in Tran De District comes from reforestation programmes (Figure 26). Reforestation was not successful in the first attempt because of strong erosion. According to local people, the growth of Cu Lao Dung Island modified the long-shore current, protecting the Tran De coast and allowing successful reforestation later in the 1980s.
- In the northern part of Tran De District, the pattern of deforestation was different, with a thin mangrove belt of *Nypa* palm and *Sonneratia sp.* present as shown on aerial photos of 1953 and 1965 map. Later the mangroves disappeared, with agriculture expansion along the coastline and aquaculture development (Figure 26).
- Aerial photos of Cu Lao Dung and Cu Lao Tron in 1953 (Figure 27) show that the islands were clearly separated (Cu Lao Tron is called Cu Lao Khong on the 1889 map). On both islands a mangrove belt was present, but on Cu Lao Tron Island the mangroves were dense, particularly on the eastern shore of the island. On Cu Lao Dung Island, the mangrove belt was continuous along the southern part of the island facing the South China Sea. It is interesting to note that based on the 1951 map, the width of the mangrove forest was approximately 2.3 km (Figure 28). The forest was composed mainly of *Avicennia sp.* and *Sonneratia sp.* and the land was flooded as far as Rach Trang Village located in the middle of the island. According to villagers, agriculture expansion started from there, with rice fields and orchards around the village. Behind the mangrove belt, the forest was more open, and in 1953 agriculture expansion had already encroached on the forest. On another map (Figure 29) created from similar aerial photos, agriculture in the mangroves is clearly represented.
- On the 1965 maps (Figure 23 and 30), we can observe the emergence of new land covered with mangroves, between Cu La Dung and Cu Lao Tron Islands. During that period the gap between the two islands narrowed due to continuous accretion. This area, covered with mangroves in 1965, was later converted into farmland (Figure 31). In 1965, the mangrove belt on Cu Lao Dung Island had a similar shape and width as the belt in 1951.

[92] During the French Administration, the Service Geographique d'Indochine was using a georeference system different from the sexadecimal (degree, minutes and seconds). During that period, the « Système de référence géodésique de Hanoï » was used. The coordinates are expressed in "grades" and 90° decimal is equivalent to 100 "grade" and decimal degree need to be converted into sexagesimal degree. In addition, longitudes are referring to the Paris Meridien (need to add 2°20'13.95'' to convert to Greenwich Meridien). In this case the longitude of 115°40 E in Hanoi system correspond to: 106°11'50'' E in sexagesimal degree.

- After the 1960s and 1970s, deforestation started, with people from Tra Vinh Province specialising in forest clearing for agriculture, while inhabitants from Tran De used the forests mainly for fuel wood. Later during the Vietnam War, the forests were affected by herbicides and according to villagers the *Sonneratia sp*. population suffered the most. However, villagers acknowledge that the main impact on mangrove forests was not the herbicides sprayed during the war but intensive deforestation in the south west part of the island for fuel wood and land reclamation. Deforestation continued at a high rate on Cu La Dung Island until the development of the State Forest Farm in 1986.
- On 2006 satellites images (Figure 31), the shape of the island is different compared with 1953. Accretion in the south west part is important. Villagers explained that new islands progressively emerged and were reclaimed during the 1970s and 1980s for agriculture by the Forest State Farm. In addition, the sand bank in front of Cu Lao Dung Island also expanded towards the south. According to local fishermen, in the 1950s it was possible to go by boat from Bai Gia to Ca Coi hamlet in Tra Vinh Province following a straight line. Due to the rapid accretion expansion of the island, this journey now requires a detour towards the south to avoid the sand bank. In 2010 the edge of Cu Lao Dung Island had almost reached latitude 9º29'24, 4.96 km[93] south, whereas in 1933 it was at latitude 9º32'24 N. Growth of the island can clearly be seen in 1965, with the edge of the island estimated to be 2.1 km south from this latitude. In Tran De District, the accretion during the same time period is also significant, a strip of land (located east of the longitude 106º11.50 E) that was 0.7 km wide and 3.7 km long in 1904, is now 2.9 km wide and 11.3 km long (including mangrove belt). From 1904 to 2006, the average accretion of the island was 64.3 m per year.

Tran De and Cu Lao Dung districts

- The Tran De coastal zone was covered by a continuous layer of mangroves until 1933. Later, the southern part of the district suffered from fuel wood exploitation and erosion, leading to deforestation, while in the north, mangrove clearing occurred between 1953 and 2006 due to the expansion of agriculture and shrimp farming.
- The current mangrove belt in Tran De was created by reforestation programmes after 1975. Reforestation programmes were probably effective due to the modification of the long-shore current with the protection provided by the expansion of Cu Lao Dung Island.
- The Cu La Dung Island mangrove belt suffered mainly from intensive deforestation for fuel wood and land reclamation after the Vietnam War until the establishment of the State Farm. Defoliant used during the war was not the main factor in destruction of this mangrove forest.
- Accretion on Cu Lao Dung Island is fast and concentrated towards the south west, with a new island emerging between Cu Lao Dung and Cu Lao Tron Islands between 1953 and 1965. In Tran De District, accretion is towards the east which reduced the distance between Tran De and Cu Lao Dung Island.

[93] Distances estimated using Google Earth (2010).

7. Conclusion

Information on mangrove forests and developments in the Mekong Delta before the 20th century is limited. We have seen that this area was colonised only recently and that forests were one of the drivers of economic activity, with the Colonial Administration developing a legal framework and management plan for its exploitation.

Mangrove forests were traditionally exploited during the 19th and 20th centuries for charcoal and fuel wood, but also dye, pigment and tannin. These industries became progressively more organised, with legislation, taxes and management plans to limit over-exploitation of mangrove forests and to avoid rapid deforestation similar to what had happened to the mangroves surrounding Saigon. Ca Mau Peninsula became the most important source of fuel wood and charcoal for the colony. The French Administration developed tools for its management with a reforestation programme of *Rhizophora sp.* and the creation of protected areas ("*réserve*"). The peninsula was perceived as the main source for fuel wood and charcoal needed for the economic growth of Cochinchine. However, in Soc Trang Province and Vinh Chau District, mangroves were not included in any reforestation programme or protected during that period, even though some forest resources had been mapped by the *Service Forestier* since 1904. Therefore, little information was available about mangroves forest for those areas.

A comparison of maps from 1889 to 1965, aerial photos (1953) and satellite images (2006, 2007) shows rapid changes in the coastal area of Soc Trang. The mangrove belt in the province was not continuous, with areas of sand banks in Vinh Chau District and areas with a thin layer of *Avicennia sp.* and grassland on mudflats. The mudflats in Vinh Chau District were traditionally used by local people until 1975 to trap fish and shrimp in plots delimited by dykes and canals which were rented annually from the local administration. In Vinh Chau, the main forest area in the eastern part of the district changed over the century due to deforestation from herbicides used during the Vietnam War and later reforestation programmes driven by the Government. These programmes in the 1980s modified the species composition of the forest with a shift from *Sonneratia sp.* and *Avicennia sp.* towards *Rhizophora sp.* In Tran De District mangroves changed rapidly through a succession of deforestation and then reforestation programmes, with deforestation induced both by erosion and man-made exploitation. In Cu Lao Dung, the mangrove belt grew in parallel with the accretion of the islands affected only by man-made exploitation of the wood during the 1980s.

Accretion and erosion patterns changed during the 20th century, especially in Vinh Chau District. Areas that previously underwent accretion are now subject to severe erosion. One hypothesis is that those changes along the South China Sea coast and Tran De District are related to the modification of the longshore current. A change in current direction might be due to the growth of Cu La Dung Island toward the south.

Mangrove forest cover changes in Soc Trang were not well documented in the early period of the French Administration. Later with the expansion of technology, such as aerial photos and updated maps, more precise information became available. However, even with limited information, we can already document some major changes, related both to natural and anthropogenic factors. This historical approach allows us to have a better understanding of the original ecosystem and the changes in mangrove forest species and cover to develop and implement strategies for future adaptation such as selection of sites for reforestation programmes or selection of mangrove species. Data and material collected during this study must be analysed further with geo-referencing and forest cover analysis for a detailed understanding of the dynamics of the mangrove forests.

Figures

Figure 3: Réserves Forestières en Indochine. 1904. Edition de Mars 1904. Publiée par le Service Géographique de l'Indo-Chine. Scale 1:3,000,000. Cochinchine counts 58 "réserves". Surface de l'Indochine (including Tonkin, Amman and Cochinchine) 82,000,000 ha. Forets à protéger: 8,000,000; Forets à réserver 5,000,000 (scale on the map added by O. Joffre).

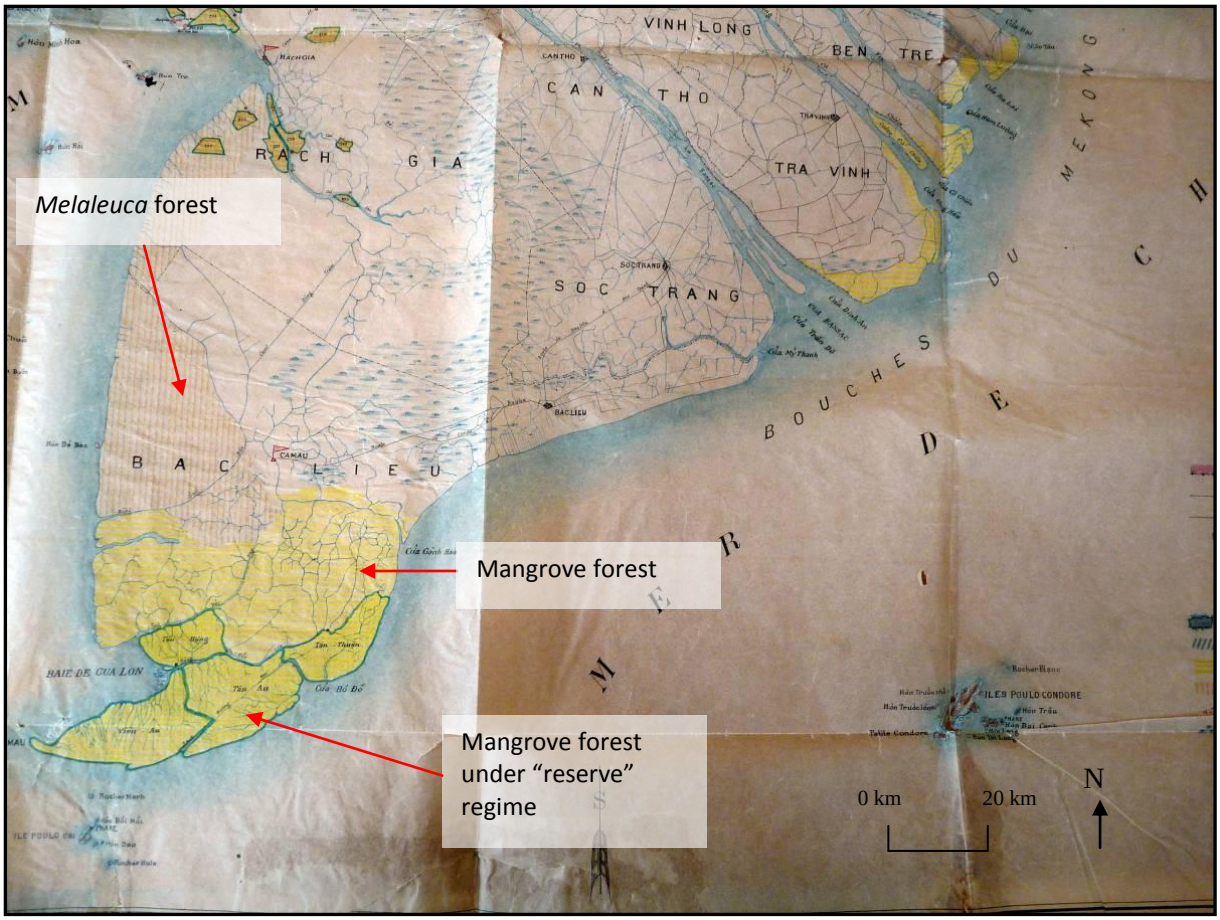

Figure 4: Forest map of Cochinchine (Carte Forestière de la Cochinchine). 1917. Scale: 1:500,000. (scale on the map added by O. Joffre). Found in "*Rapport sur la Situation Forestiere, 1917*".

Figure 5: Detail of Carte Forestiere de l'Indochine. 1938 in "*L'Indochine Forestiere*". Carte établie par P. Maurand. Scale 1:2,000,000. Dashed area represent «*réserves*», light green dense forest (poor), dark green dense forest (rich) and yellow colour: open forest. Red dots represent wood market and red flags centres of Forest Divisions. Mangroves are represented in Tran De and Vinh Chau districts (scale on the map added by O. Joffre).

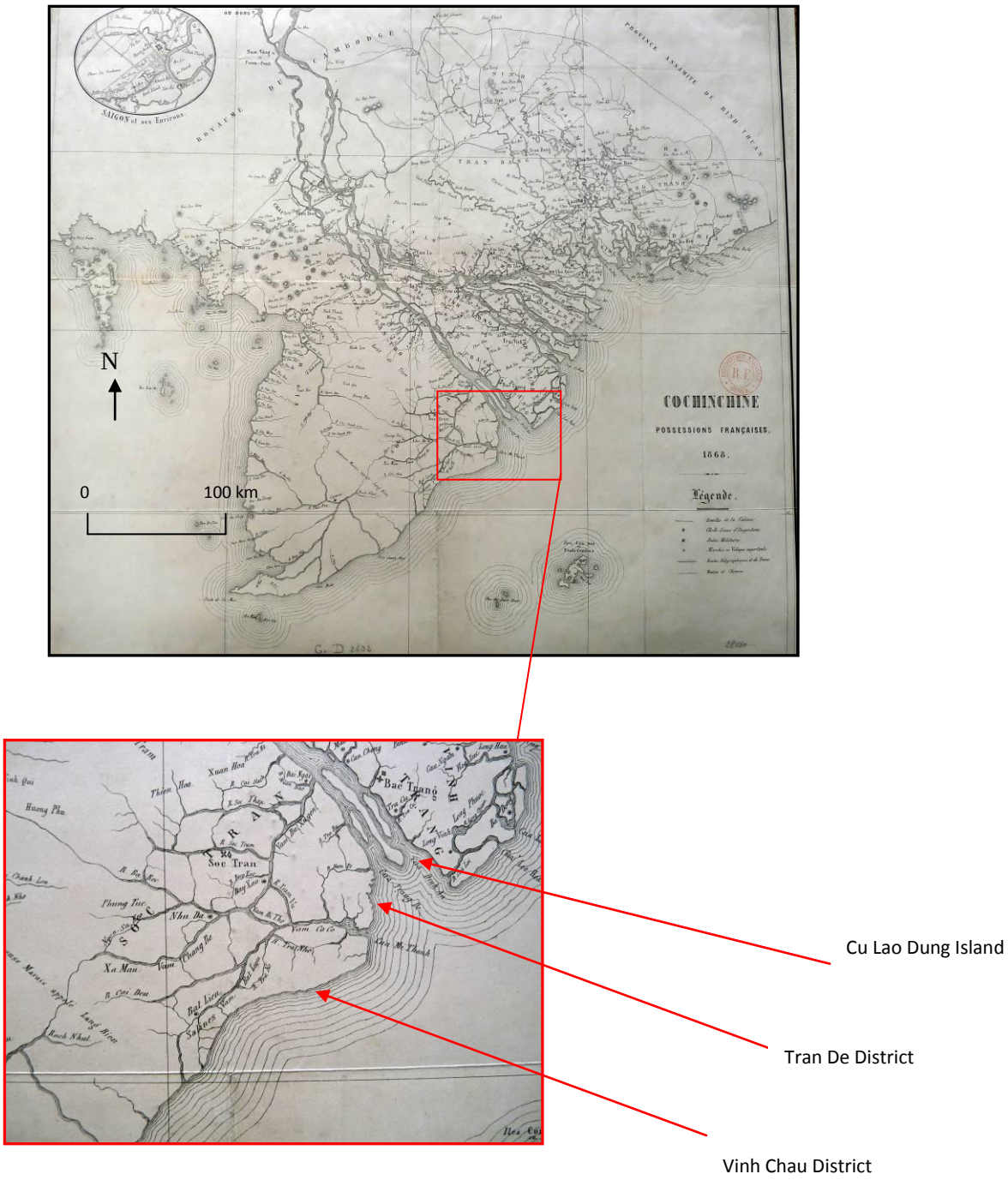

Figure 6: Cochinchine, French territories (Possession Française). 1868. Map of the Cochinchine (scale on the map added by O. Joffre).

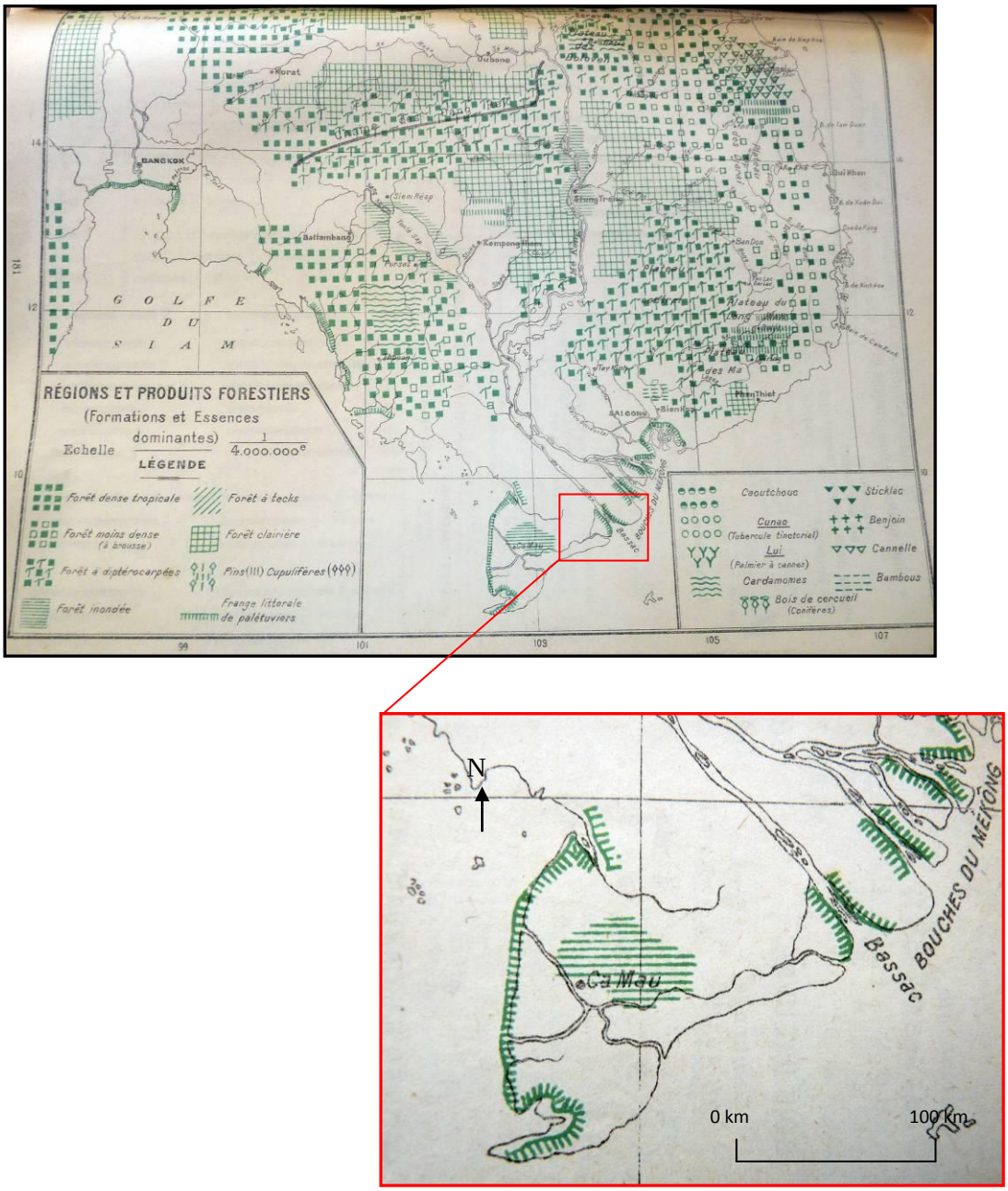

Figure 7: Forest map (Carte Forestière). 1914. Atlas Statistique de l'Indochine Française. Henry Brenier. Hanoi. Legend indicates inundated forest (horizontal lines) and mangrove forest along the coast. The latter includes Tran De District (scale on the map added by O. Joffre).

Figure 8: Forest map of Indochina (Carte Forestière de l'Indochine). 1925. Henri Guibier, Inspecteur des Eaux et Foret. Scale: 1:5,000,000. Mangroves are represented in plain green, *Melaleuca* forest in green dots.

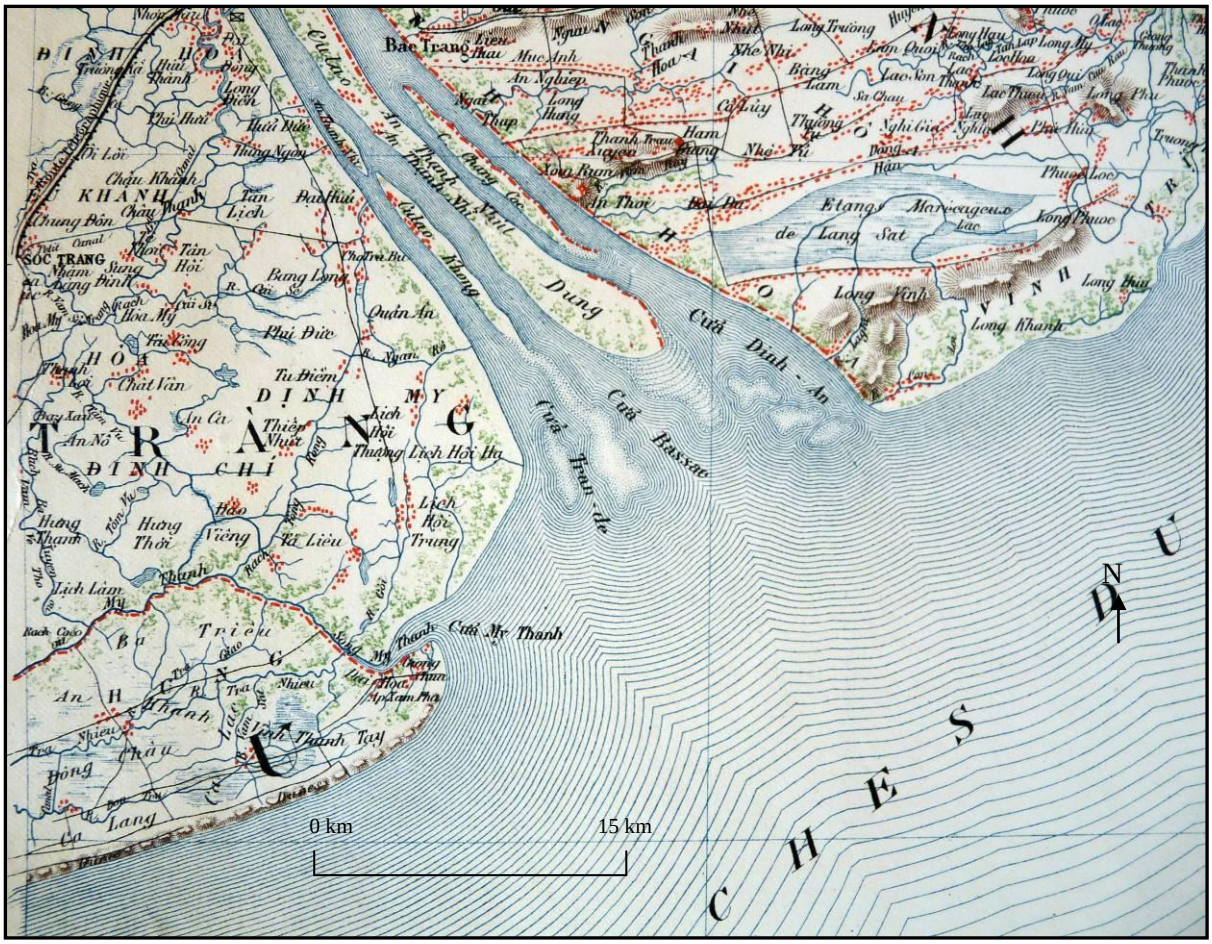

Figure 9: Details of map of Cochinchine Française. 1889. Pour la Cochinchine: MM les Géomètres du Services Topographique de Cochinchine, la carte du Commandant Bigrel, les cartes et Observation Astronomiques du Dépôt de la Marine. Publiée sous les auspices de Mr Etienne, Sous secrétaire d'Etat aux Colonies. Paris Challamel et Cie Editeurs. Scale 1:400,000. Data available: forest cover in coastal zone, dunes and swamps. Canals and rivers annotated. Mangroves are shown along Tran De and Cu Lao Dung,while the coast of Vinh Chau is dominated by sand dunes. Cu la Dung Island clearly divided into 3 islands (scale on the map added by O. Joffre).

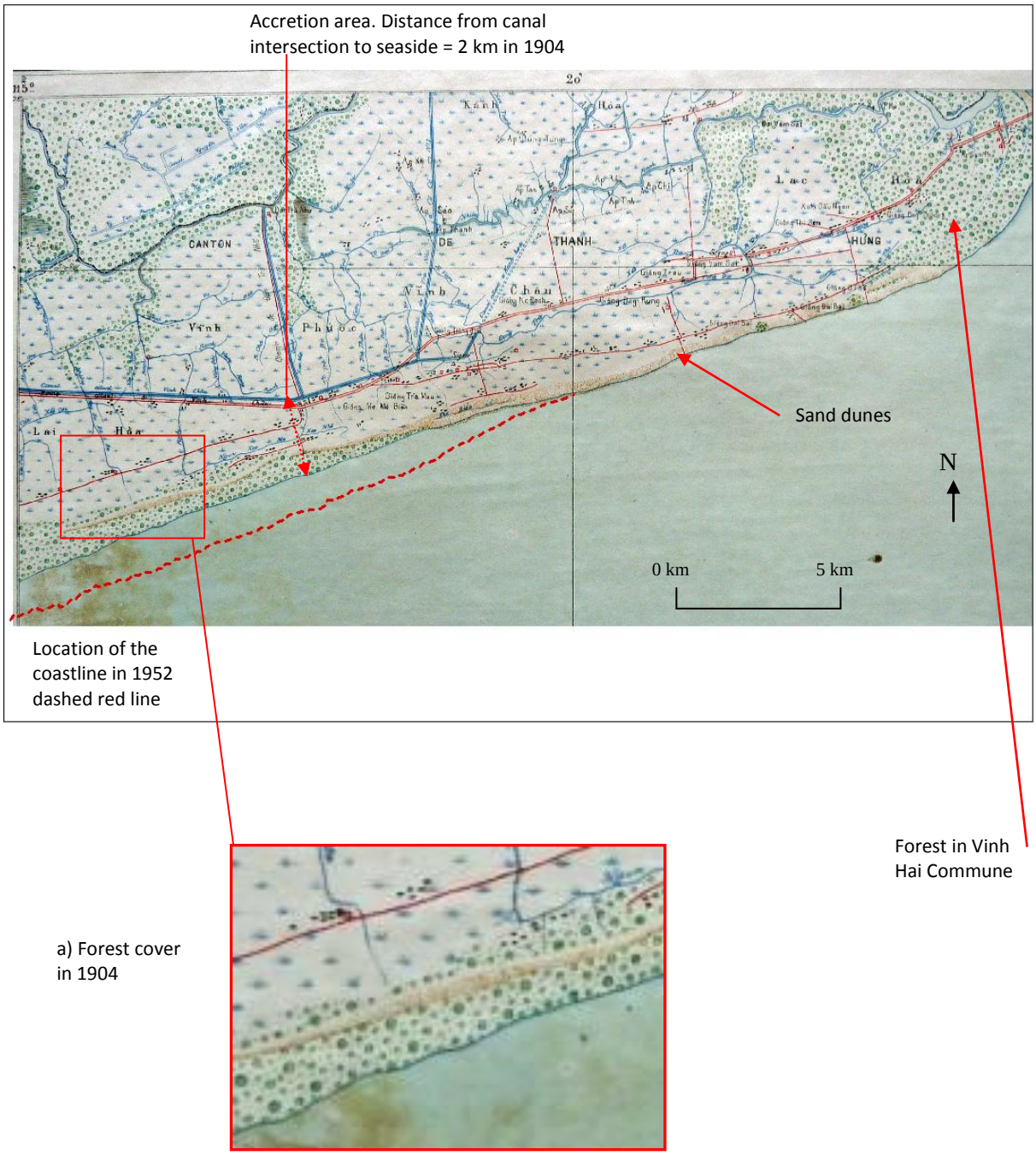

Figure 10: Map of Bac Lieu (Carte Bac Lieu Est). 1904. Dresse par le soldat Michaud du Service Géographique d'après les travaux du Service du Cadastre et de la Topographie de la Cochinchine. Edited in December 1904. Scale 1:100,000. Green dots on the coast represent mangrove according to the original legend. The location of the coastline in 1952 is represented the red dashed line, showing the accretion in this part of the district between 1904 and 1952 (scale on the map added by O. Joffre).

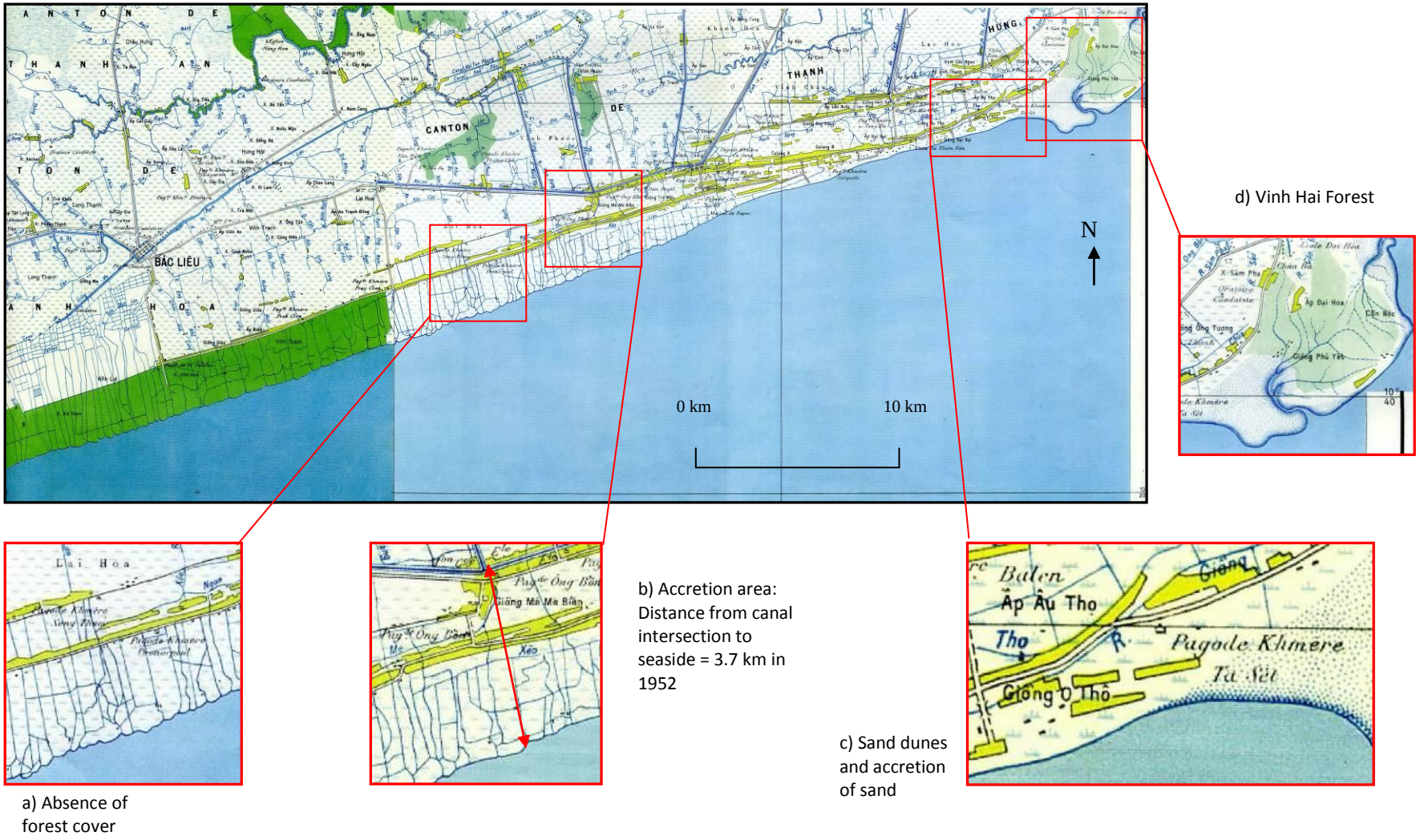

Figure 11: Map of Vinh Chau and Bac Lieu. 1952. D'apres les Document du Cadastre. Updated with aerial photo of 1952. Edited by Service Geographique d'Indochine 1928 and updated in 1952. Feuille 243 (Vinh Chau) and 242 (Bac Lieu Est). Scale 1:100,000. Green area in Bac Lieu Province coastal area represent "Open Forest" where it is possible to walk through (scale on the map added by O. Joffre).

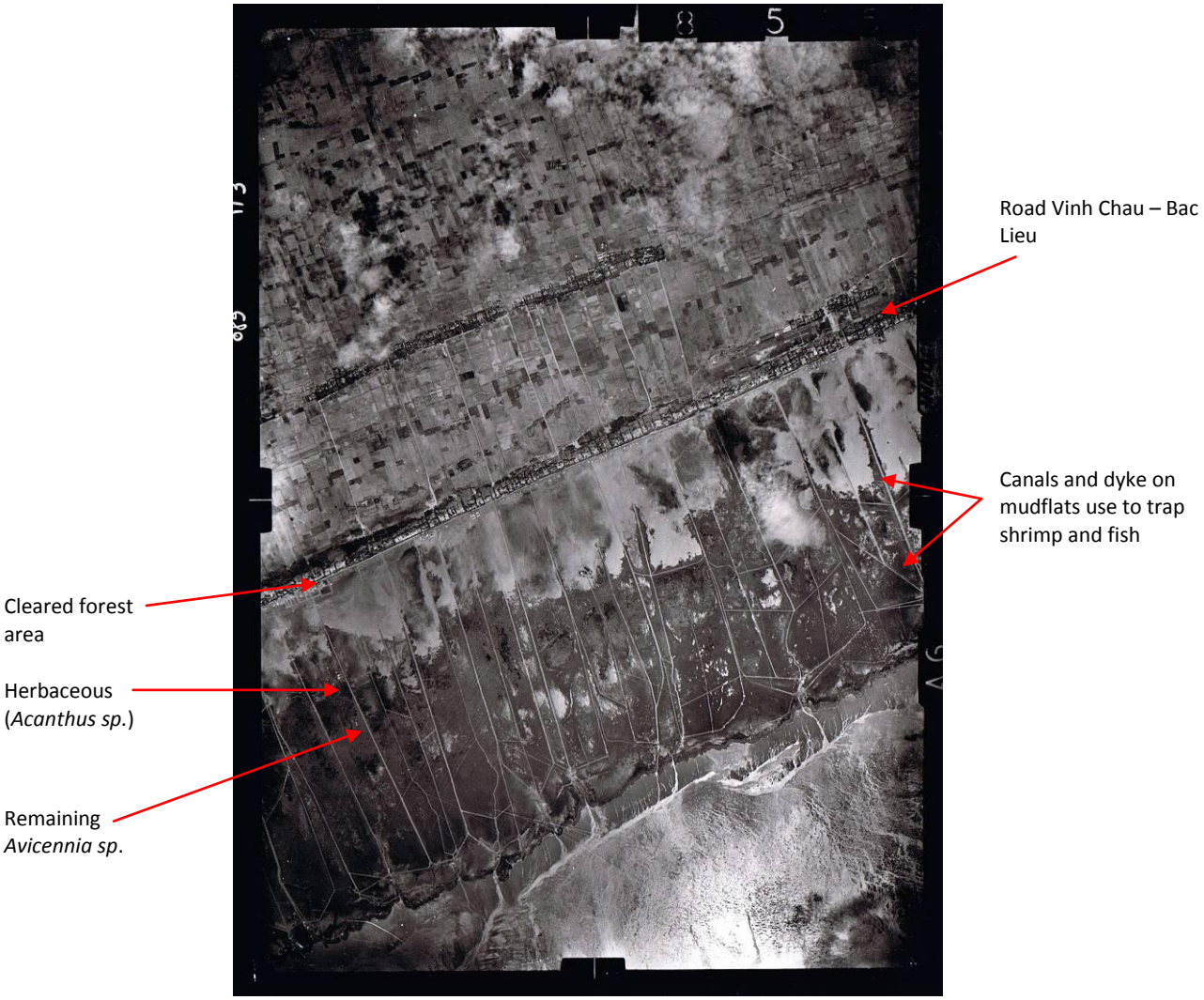

Figure 12: Aerial photo 1953 of Nopol hamlet. Institut National Géographique, Mission 89. Focale 125 mm. Altitude 5,200 m. Scale 1:42,000. The photo corresponds to the zones in Figures 10a and 11a.

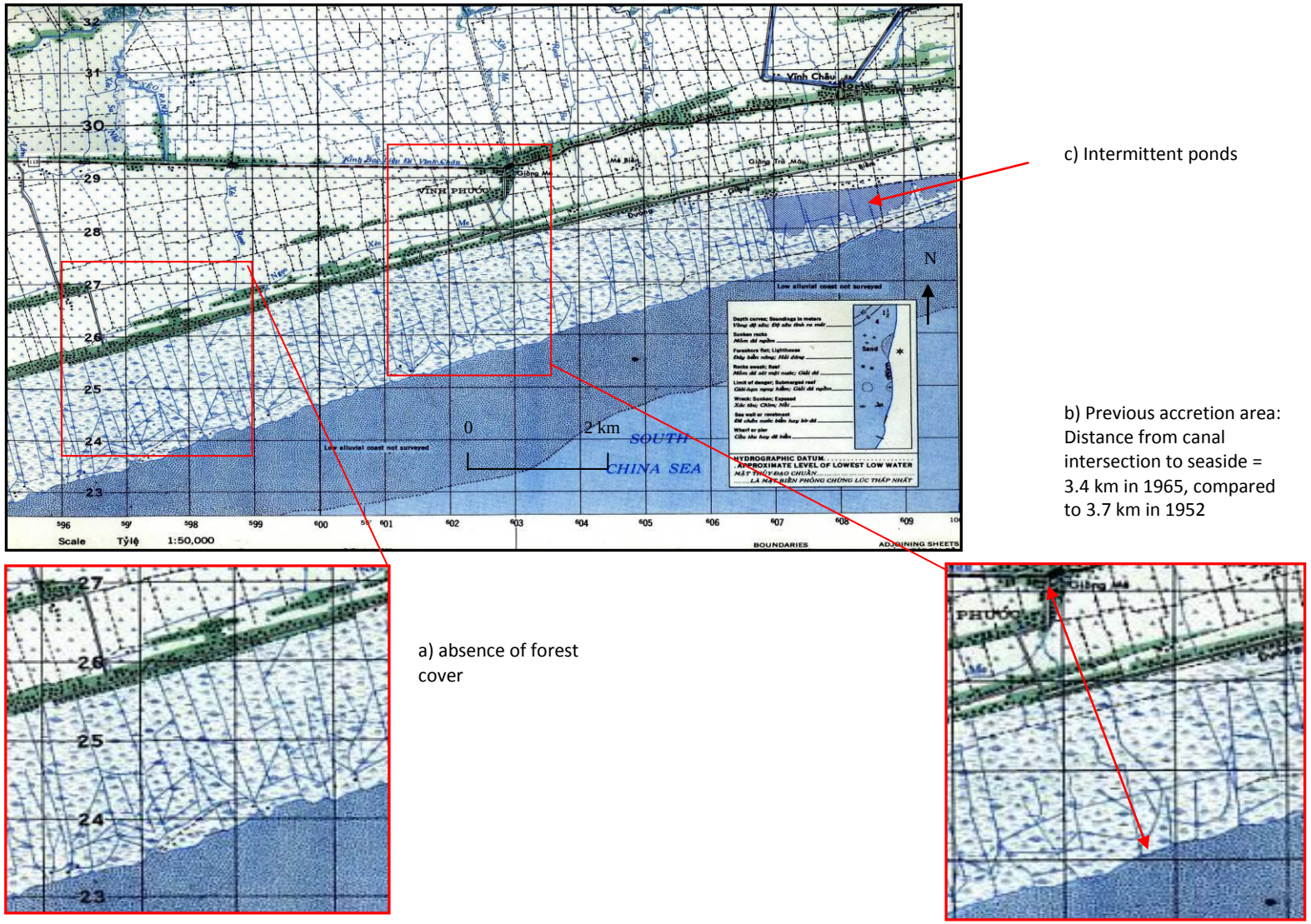

Figure 13: Map of Vinh Chau. 1965. (Scale 1:50,000). Map information as of 1965. Prepared by the US Army in 1966. Absence of mangrove forest in west Vinh Chau. Presence of intermittent ponds in Vinh Chau Town. Dashed blue area along the coast represents swamps. The grid represents 1,000 m^2 (scale on the map added by O. Joffre).

Figure 14: Satellite image of west part of Vinh Chau (Same area as Figures 10a, 11a, 12 and 13a) (QuickBird image 04/12/2006).

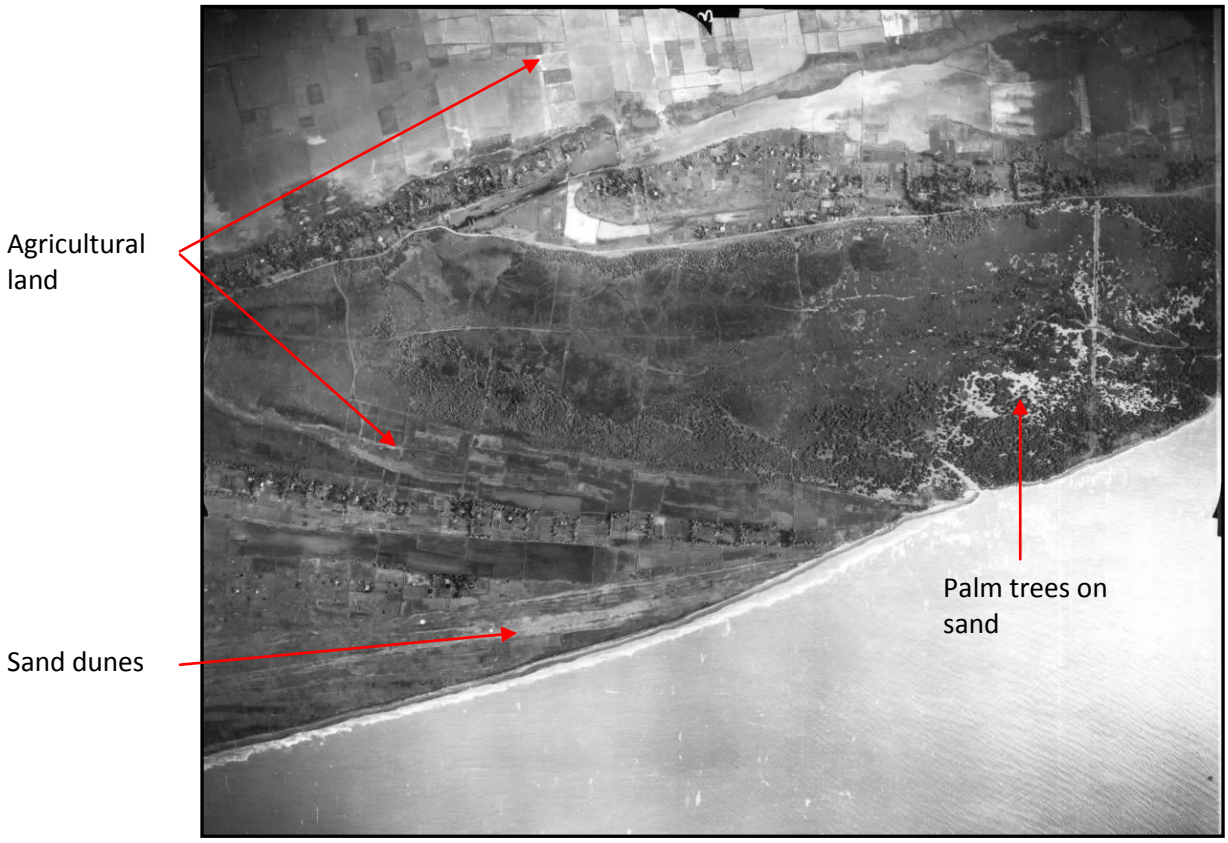

Figure 15: Aerial photo of Au Tho hamlet. 1953. Armée de l'Air Française. Mission RV 245. Focale 5 mm. Altitude 1,500 m. Scale1:10,000. The photo corresponds to Figures 11c and 16a areas.

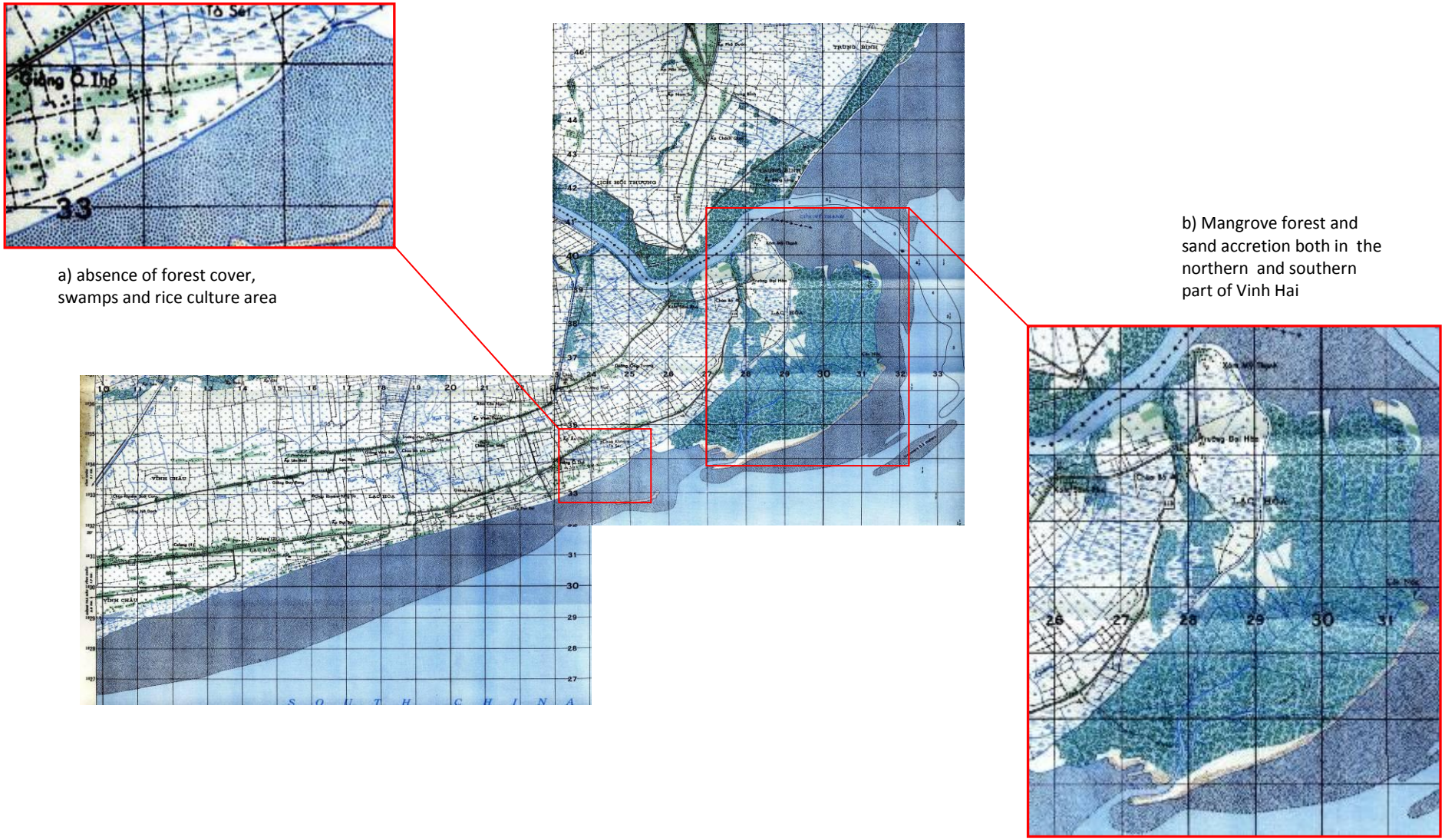

Figure 16: Map of east Vinh Chau and Vinh Hai commune. 1965 (Scale 1:50,000). Map information as of 1965. Prepared by the US Army in 1966. Absence of mangrove along Vinh Chau coast. Mangrove in Vinh Hai Commune (scale on the map added by O. Joffre).

Figure 17: Satellite image of east part of Vinh Chau (Same area as Figures 11c and 16a). QuickBird image 06/02/2006.

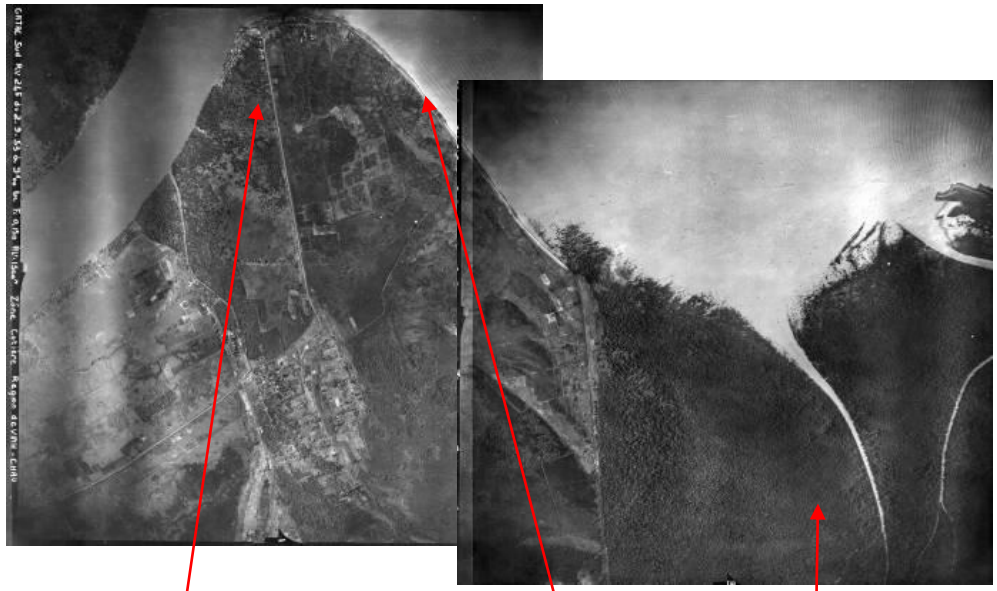

Figure 18: Aerial photo of Vinh Hai forest and My Thanh river mouth. 1953
Armée de l'Air Française. Mission RV 245 Focale 5 mm. Altitude 1,500 m. Scale 1:10,000.

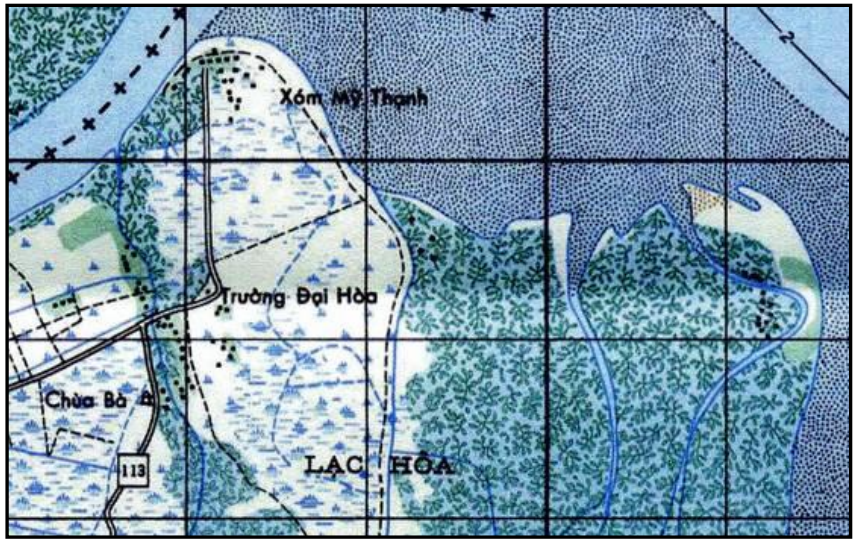

Figure 19: Details of Vinh Hai map. 1965. Army 1966.
Scale 1:50,000. Sand bank along the coast and areas of swamps in Truong Dai Hoa.

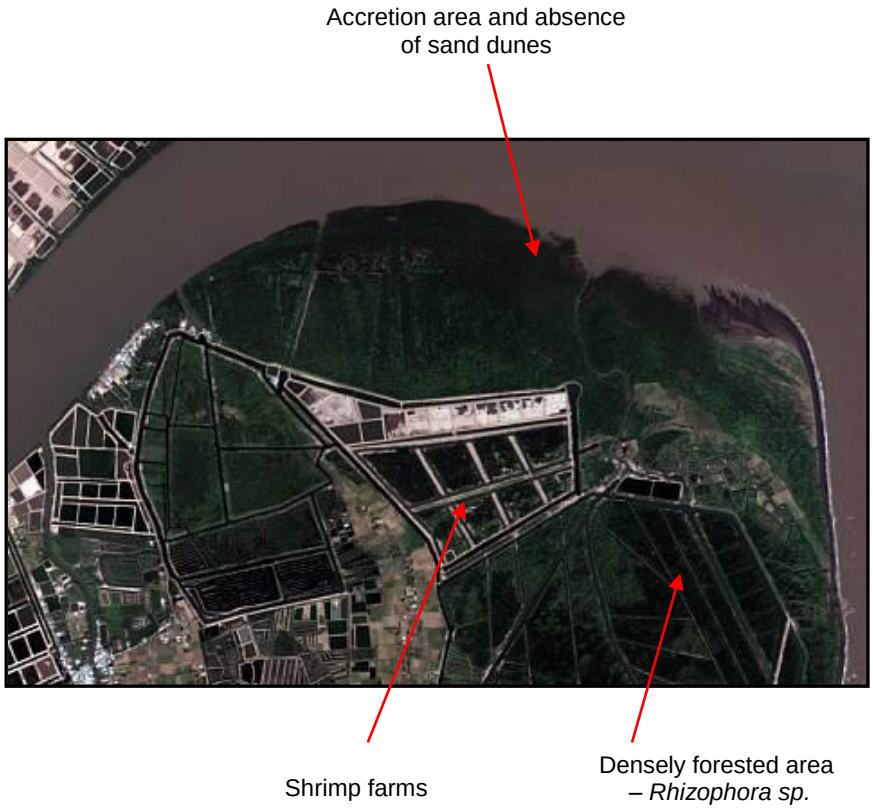

Figure 20: **Satellite image of Vinh Hai forest** (covering similar area as Figures 18 and 19) (QuickBird image 06/02/2006).

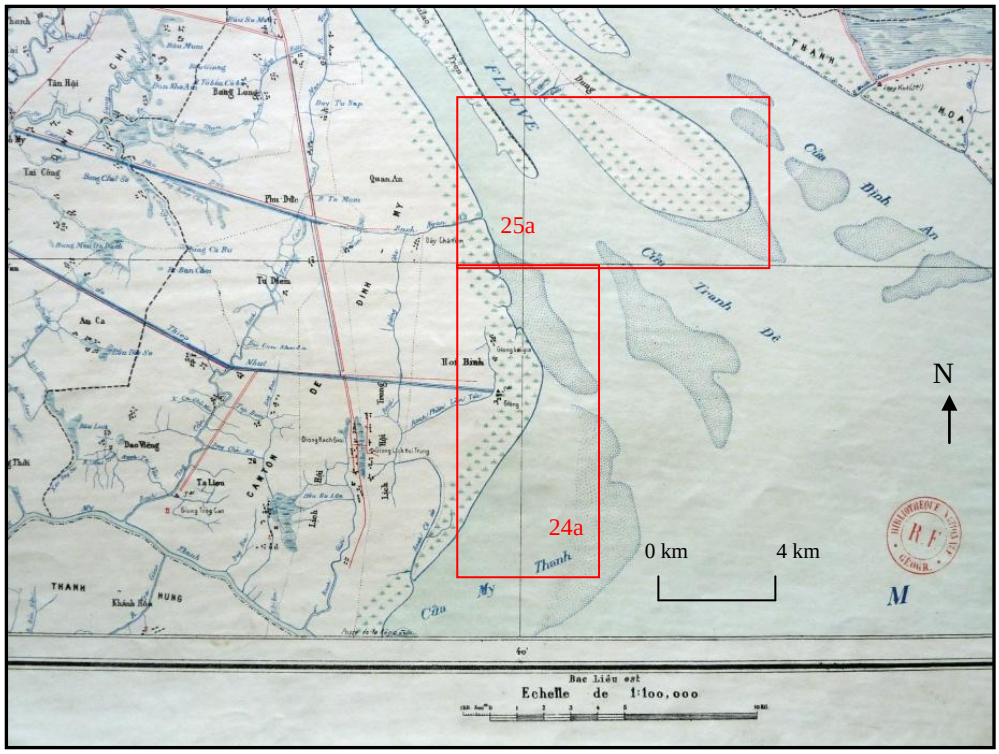

Figure 21: Map of Soc Trang (Carte de Soc Trang). 1904. Dresse par le soldat Lootens du Service Géographique d'après les travaux du Service du Cadastre et de la Topographie de la Cochinchine. Edited in December 1904. Scale 1:100,000. Green dots on the coast represent mangrove according to the original legend. Red squares represent the area displayed in Figures 24a and 25a added by O. Joffre (scale on the map added by O. Joffre).

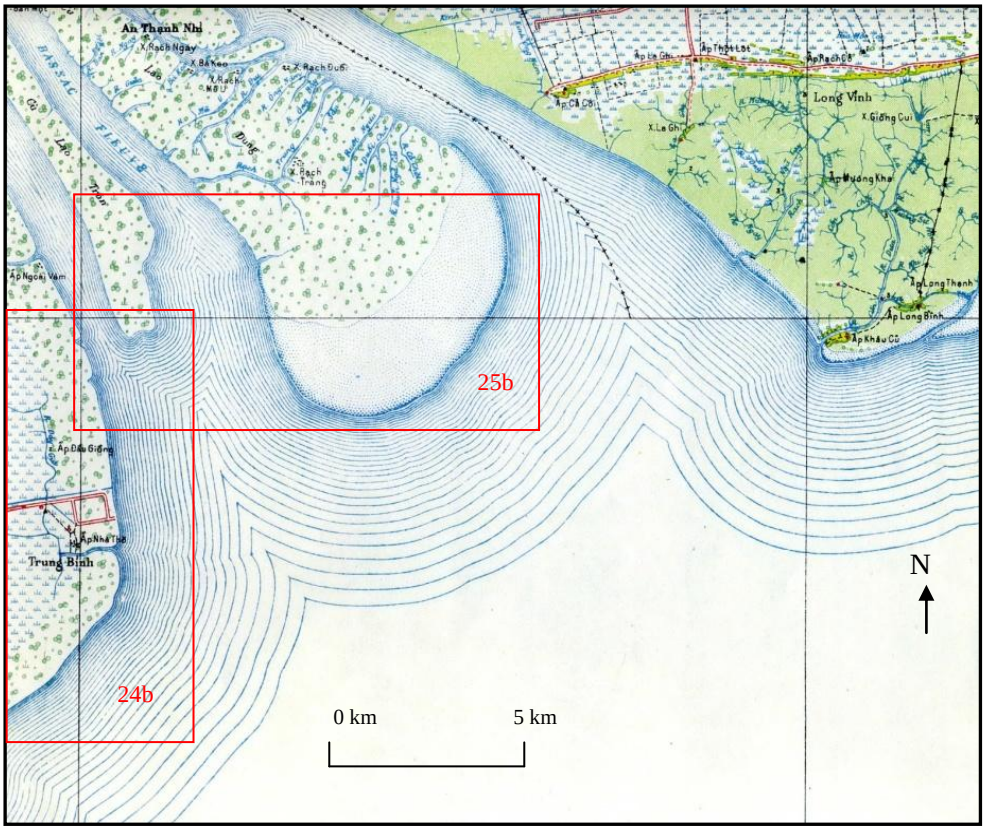

Figure 22: Map of Soc Trang (Carte de Soc Trang Est) 1933. D'apres les Document du Cadastre. 1933 Feuille 239 E. Scale 1:100,000. Cu Lao Dung and Tran De based on 1933 information. Red squares represent the area displayed in Figures 24b and 25b added by O. Joffre (scale on the map added by O. Joffre).

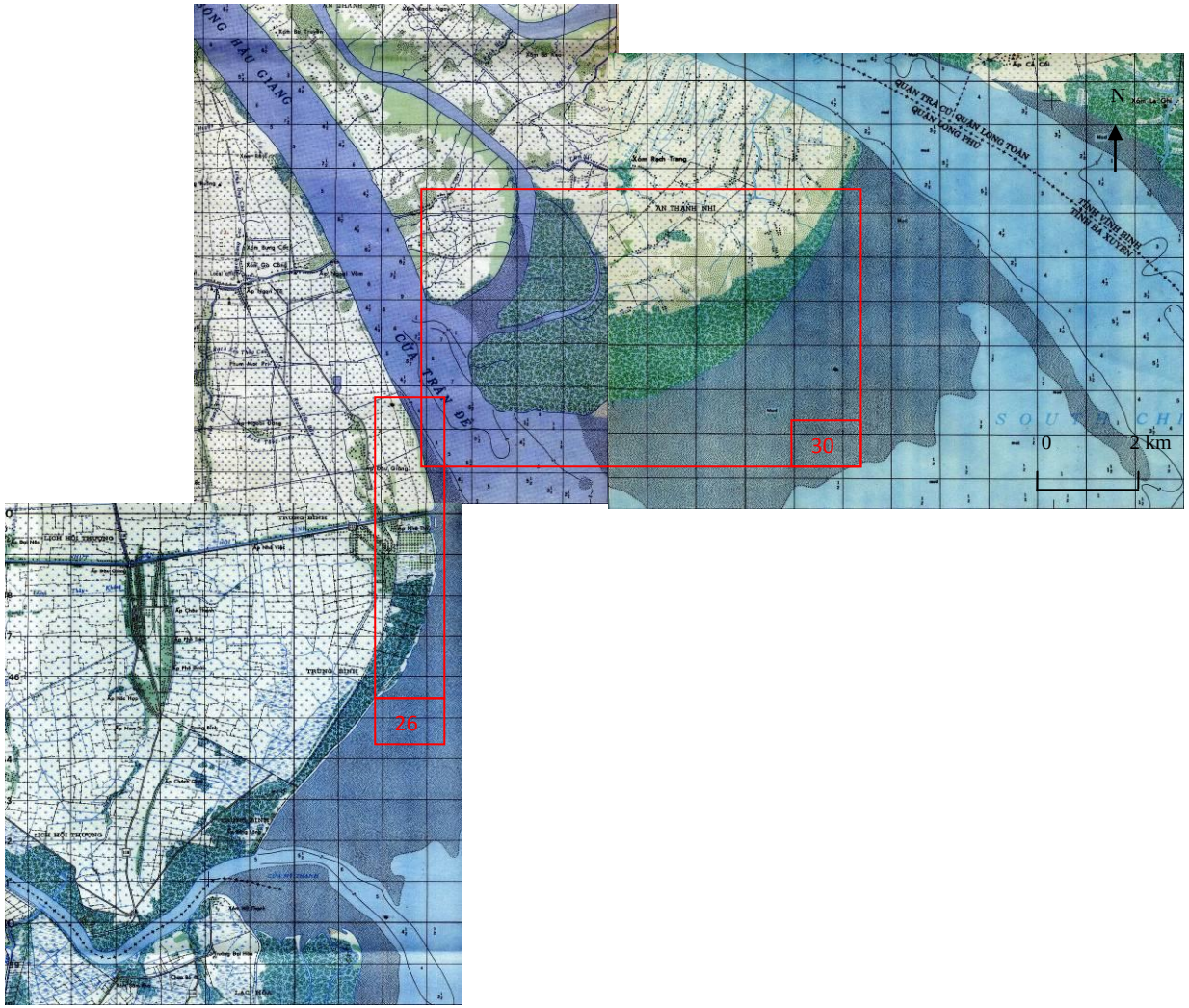

Figure 23: Map of Soc Trang, representing Tran De and Cu Lao Dung districts. 1965. US Army 1966. Scale 1:50,000. Red square is the detailed area represented in Figures 26 and 30.

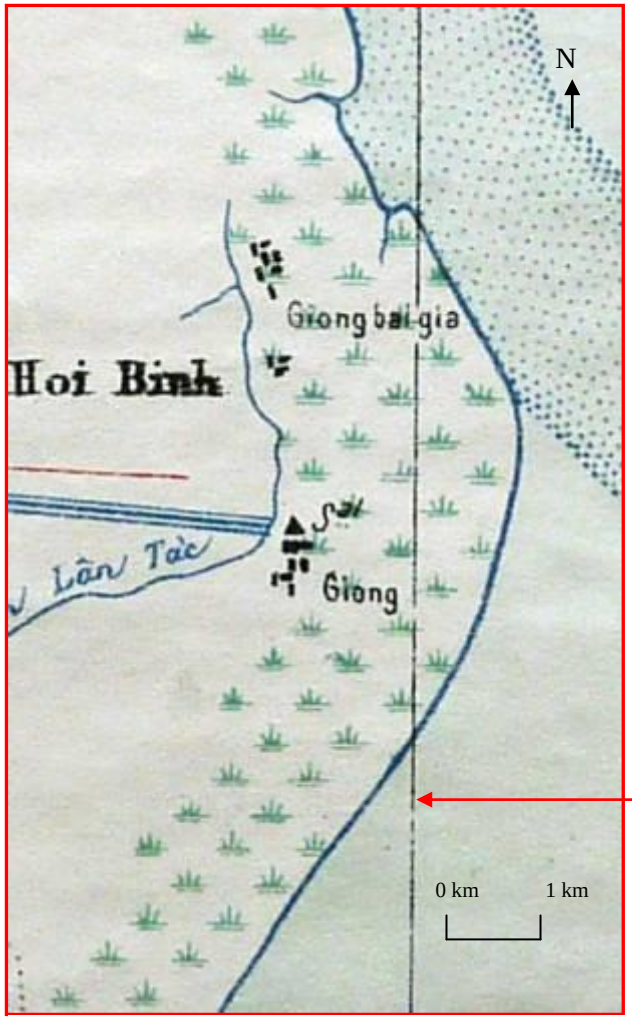

Figure 24a: detail of map of Soc Trang 1904.

115°40 E longitude
(Hanoi System) or
106°11'50'' E
(sexagesimal system)

Figure 24b: detail of map of Soc Trang Est 1933.

Figure 24: Details of map of Soc Trang 1904 and Soc Trang Est 1933. The details show the accretion toward the east in Tran De coast between 1904 and 1933. The accretion can be estimated using the latitude shown on both maps (scale on the map added by O. Joffre).

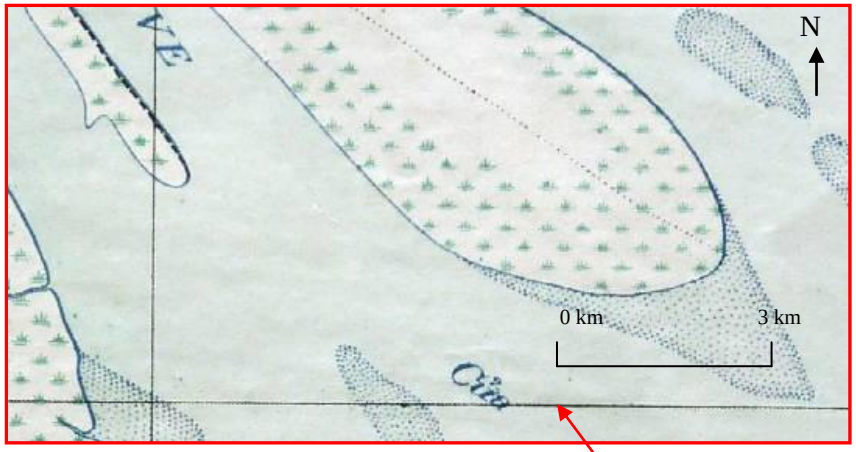

Figure 25a: detail of map of Soc Trang 1904

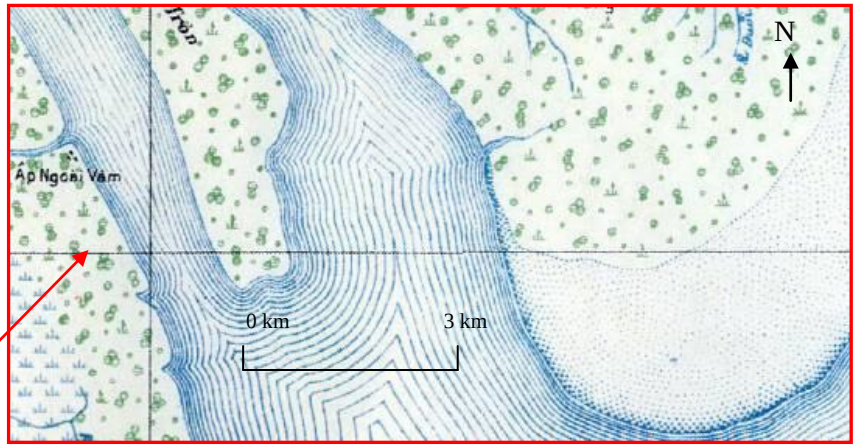

Figure 25b: detail of map of Soc Trang 1933

$10^{o}60$ N latitude (Hanoi System) or $9^{o}32'24''$ N (sexagesimal system)

Figure 25: Details of map of Soc Trang 1904 and Soc Trang Est 1933. The details show the accretion towards the south west of Cu Lao Dung and Cu Lao Khong Island between 1904 and 1933. The accretion can be estimated using the latitude shown on both maps as reference (scale on the map added by O. Joffre).

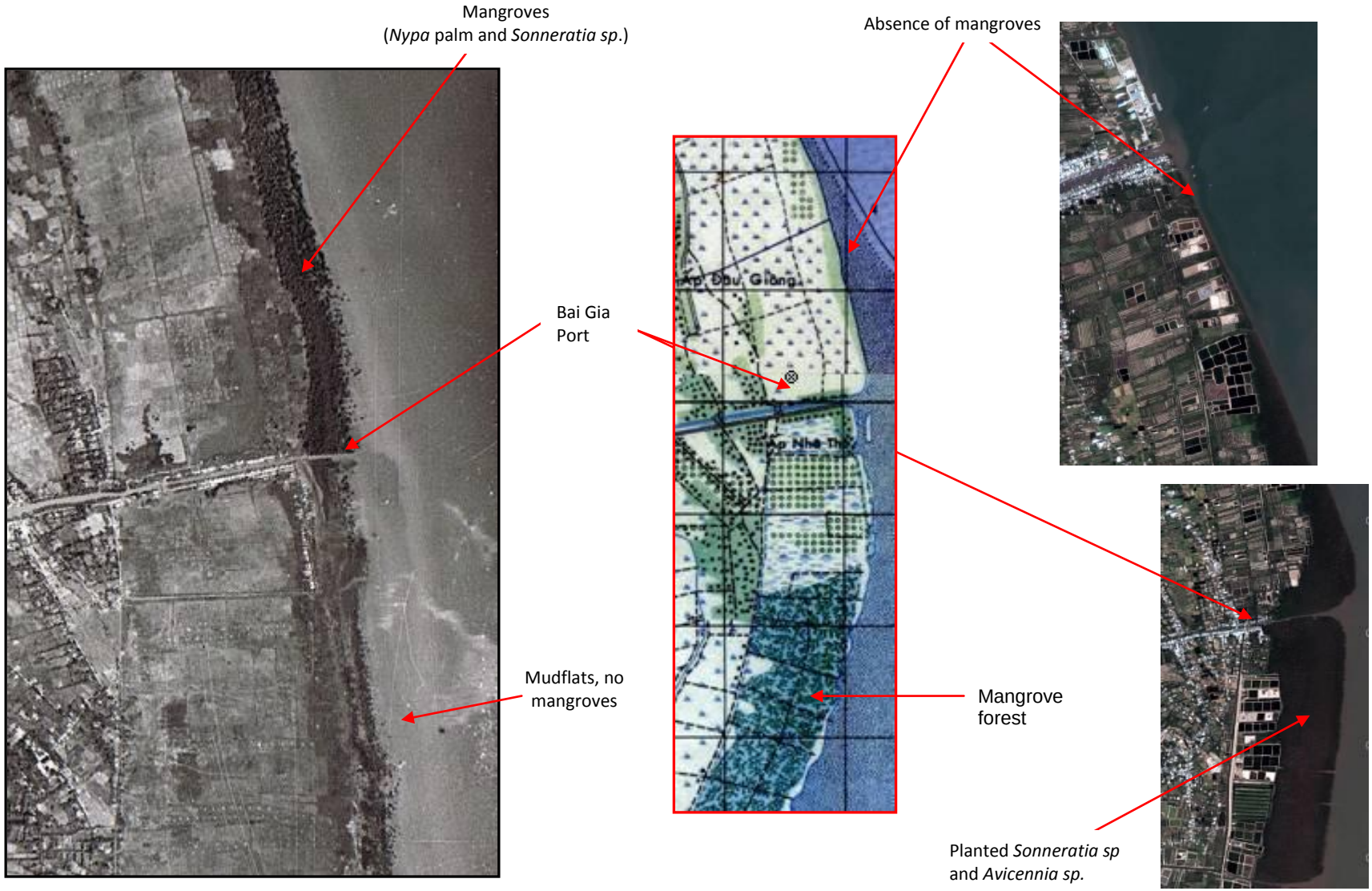

Figure 26: Aerial Photo 1953 of Tran De District. (Institut National Géographique, Mission 89. Focale 125 mm. Altitude 5,200 m. Scale 1:42,000.), **Detail of 1965 map of Tran De coast** (US Army, Scale 1:50,000) and **Satellite image of Tran De forest** (QuickBird image 06/02/2006).

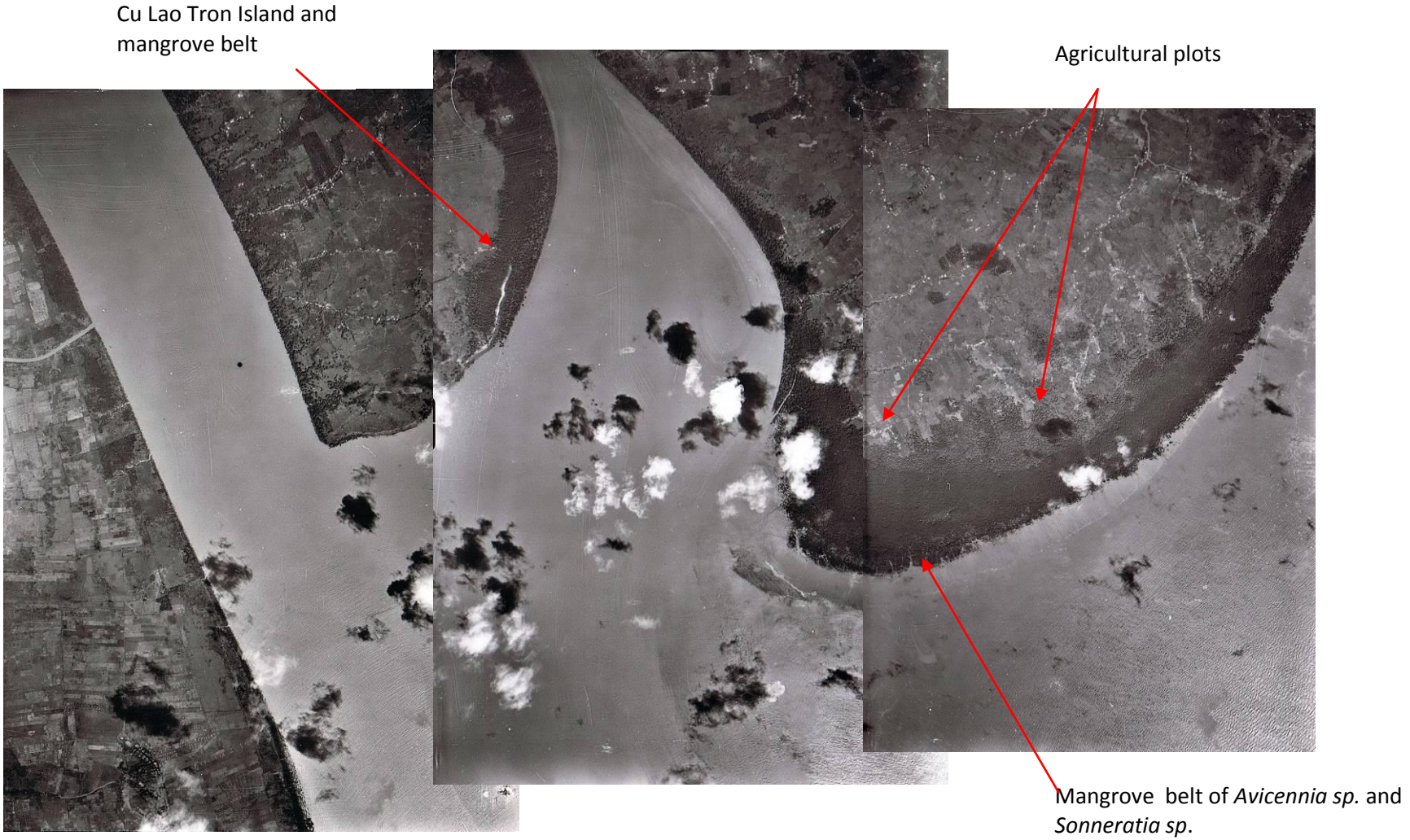

Figure 27: **Aerial Photo 1953 of Cu Lao Dung and Cu Lao Tron Island.** (Institut National Géographique, Mission 89. Focale 125 mm. Altitude 5,200 m. Scale 1:42,000.)

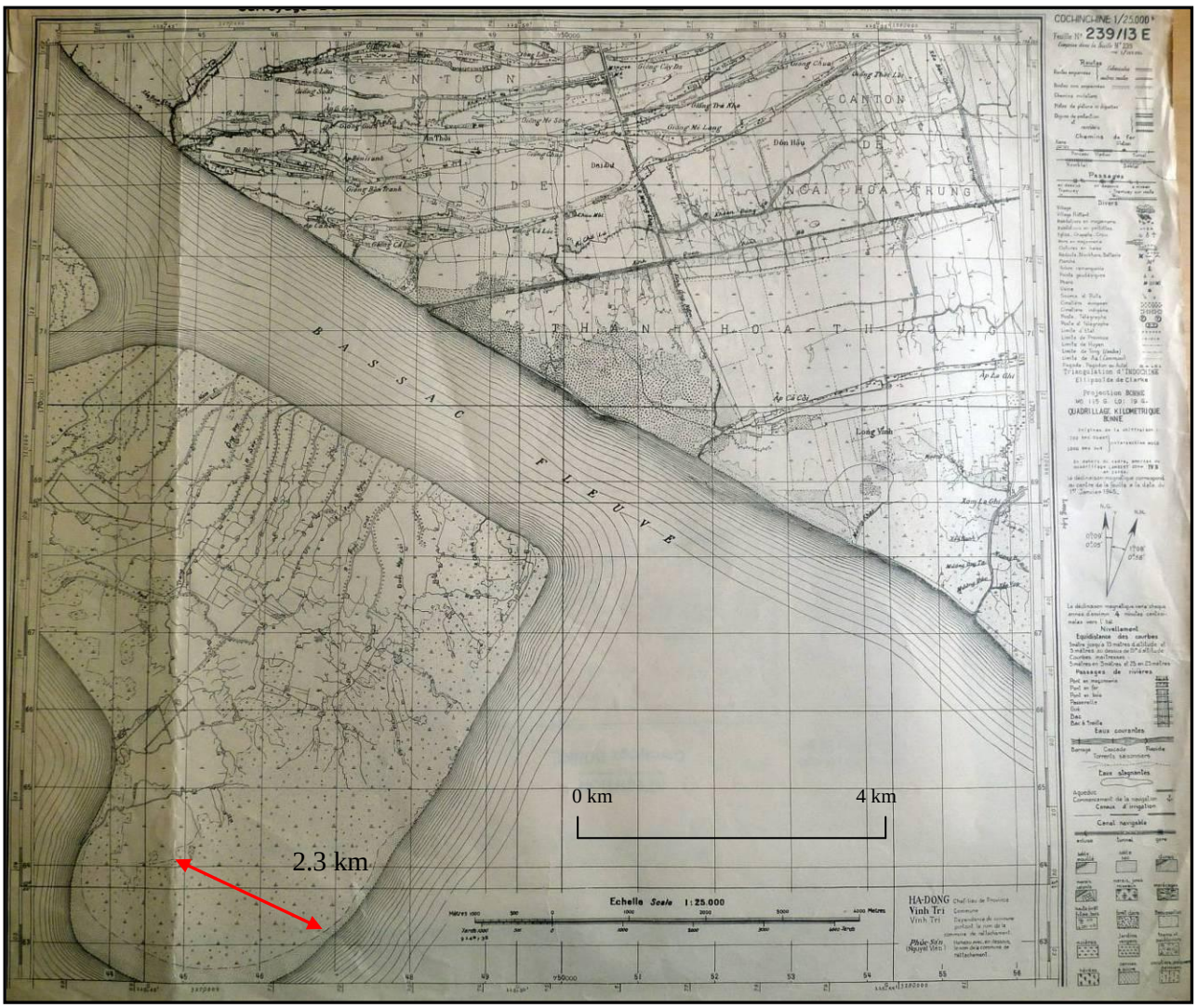

Figure 28: Carte de Long Vinh. 1951. First edition in 1927, updated by aerial photo of 1949 and 1950, Scale 1:25,000. Armée Française (scale on the map added by O. Joffre).

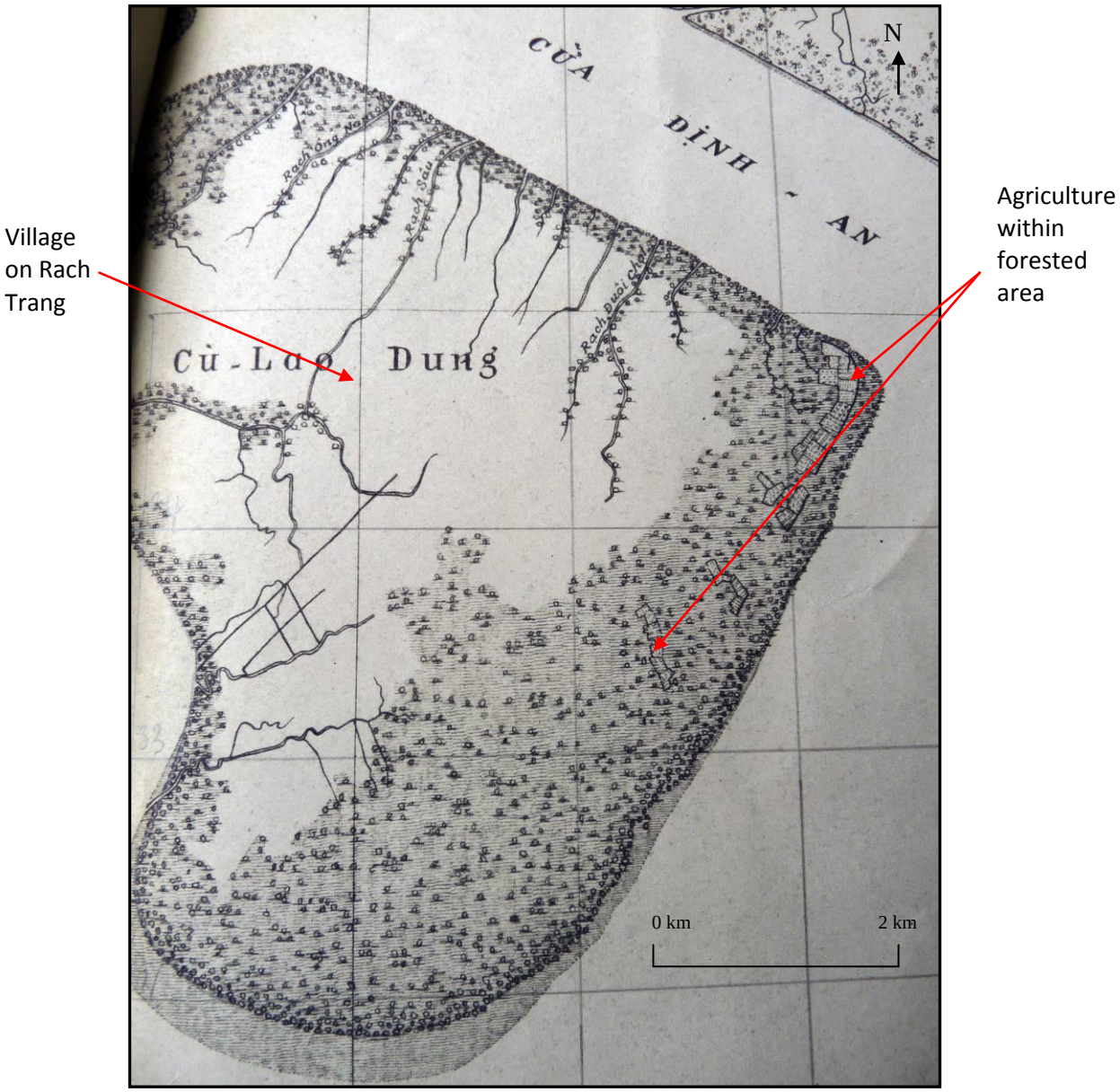

Figure 29: Cu Lao Dung Island in 1949-50. Detail of map Embouchure du Bassac. Service hydrographique du Vietnam. Mission hydrographique Française au Vietnam. Scale 1:50,000. Maps were updated with aerial photo of 1949-1950 (scale on the map added by O. Joffre).

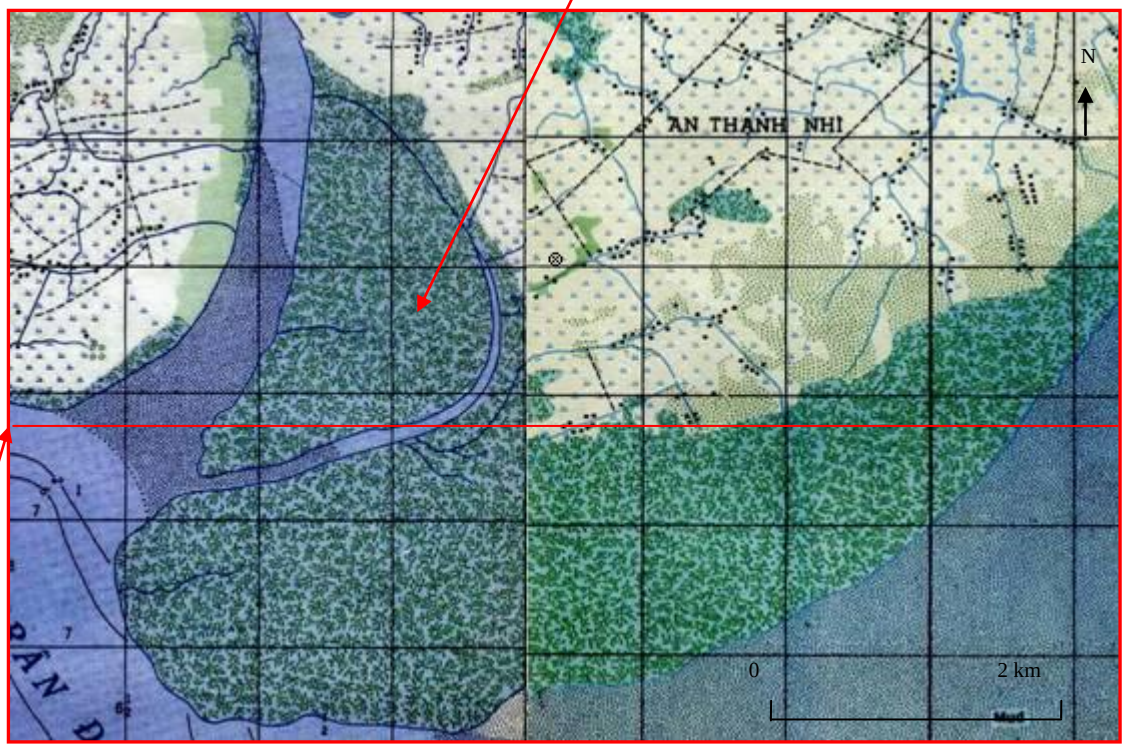

Figure 30: Details of map 1965, representing the south part of Cu Lao Dung Island. (see Figure 23 for the entire map). US Army 1966. Scale 1:50,000. (scale latitude 9°32'24'' N on the map added by O. Joffre).

Figure 31: Cu Lao Dung Island in 2006. Details of Satellite image (QuickBird image 06/02/2006).

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