System of Ancient Canals in Long Xuyen Quadrangle in Period of Oc Eo Culture

Nguyen Quang Mien[1], Nguyen Quang Bac[2], Vo Hong Son[3], Nguyen Huu Tuan[4] et al.

[1] Institute of Archeology, Vietnam Academy of Social Sciences.
[2] VINASA Science and Technology Institute.
[3] National Remote Sensing Center.
[4] Institute of Information Technology, Ministry of National Defence.
Email:nqmien1962@gmail.com

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Abstract: Based on an analysis of remote sensing data, including aerial photographs and satellite images, as well as ancient maps, locations of ancient rivers, which were waterways connecting areas in Chau Doc and Oc Eo - Ba The to the bay of Rach Gia - Ha Tien, have been identified. Some ancient canals in the area of Oc Eo have been also specified as essential transport routes connecting the centre of Oc Eo - Ba The to other residential areas in Long Xuyen Quadrangle. Having exploited and improved available natural streams, in the period of Oc Eo culture, local people created a system of canals, which contributed significantly to socio-economic and cultural activities in the kingdom of Funan. In addition, the research findings have also identified ancient coastal estuaries in the archaeological site of Nen Chua, proving the existence of an important seaport on the coastal trade route in Southeast Asia.

Keywords: Geo-archaeology, Mekong Delta, Oc Eo culture, Long Xuyen Quadrangle.

Subject classification: Archaeology

1. Introduction

Long Xuyen Quadrangle is a lowland area in the lower plain of Mekong River. It is also where a large number of archaeological sites dating back to the period of Oc Eo culture, especially systems of ancient waterways, were found.

The system of ancient waterways is very important to the research on socio-economic and cultural activities in the period of Oc Eo culture and the kingdom of Funan. During the period from 1930 to 1950, Pierre Paris and Louis Malleret carried out analyses of aerial photographs of the southwestern part of Vietnam and identified a system of 28 ancient canals, which played a role as transport routes connecting archaeological sites in the region [8]. It was convincing evidence of an ancient civilisation with an

advanced irrigation system that showed the development of a kingdom in the current lower plain of Mekong River. However, it still remains very difficult to identify the locations of those ancient canals, due to not only the devastation made by nature and human beings but also the difference, which is very great, between the coordinate reference system titled Bonne, used by L. Malleret, and the national coordinate reference system used in Vietnam at present.

The surface observations carried out at present cannot enable us to recognise the ancient canals. It is, therefore, necessary to do inter-disciplinary research from various perspectives such as archaeology, remote sensing, geographic information system (GIS), and geo-physics etc., aimed to identify field locations of the canals discovered by P. Paris and L. Malleret in the past as well as locations of the ancient waterways in the region, which will demonstrate more clearly the role of Nen Chua - Oc Eo seaport on the coastal trade route in Southeast Asia at that time. Based on the remote sensing and GIS data, this paper focuses on the system of canals in Long Xuyen Quadrangle in the period of Oc Eo culture.

2. Initial studies carried out by Pierre Paris and Louis Malleret

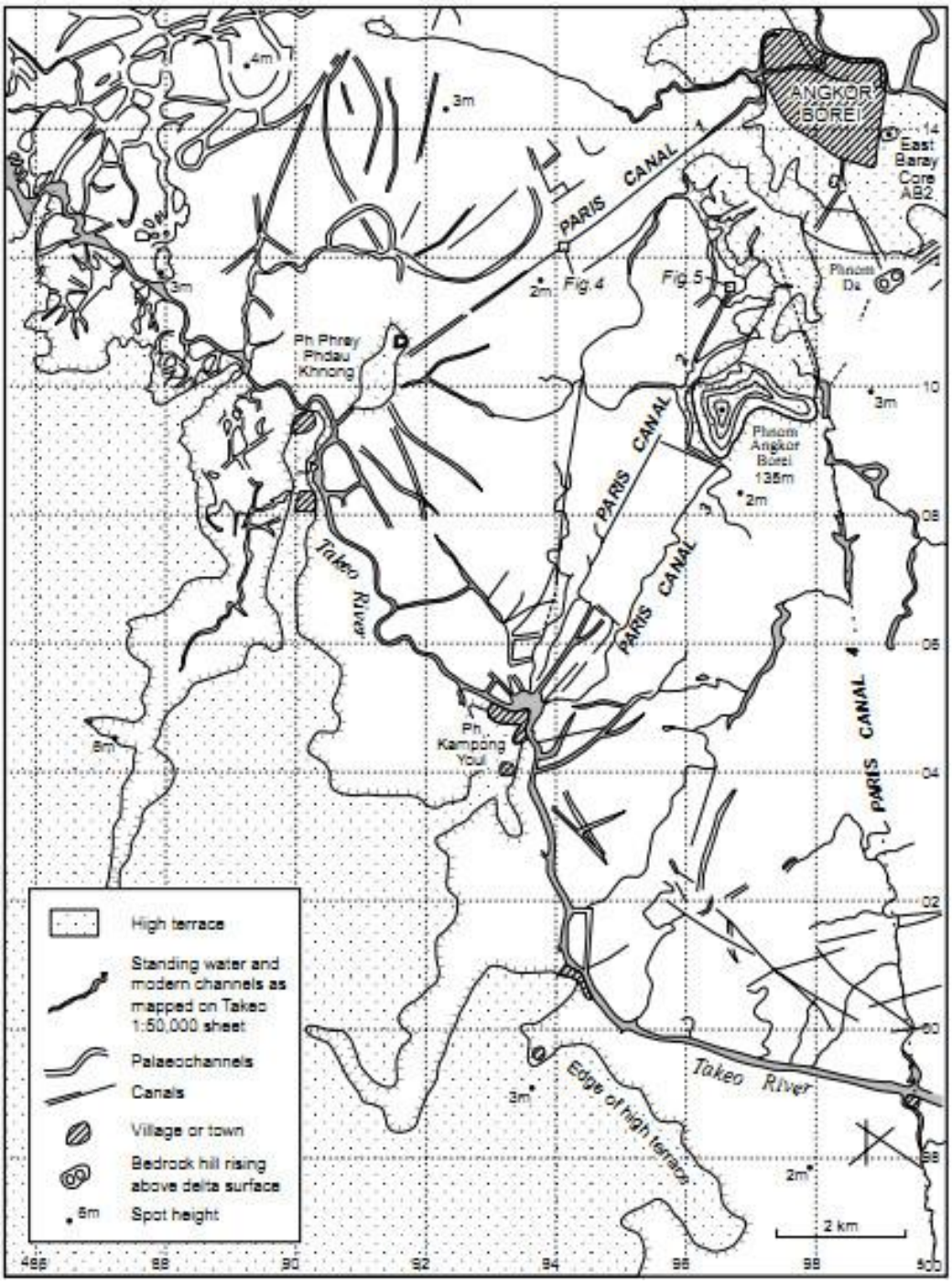
2.1. Information on the system of ancient canals

While dealing with the aerial photographs of Long Xuyen - Chau Doc region in the 1930s, Pierre Paris, a French geographer, made an announcement of an ancient canal, which used to run from Angkor Borei District (Takeo Province, Cambodia) to Ba The Mountain (An Giang Province, Vietnam). However, it had been almost fully filled with sand without any traces left [9]. In 1942, P. Paris identified five more canals, which were numbered 1, 2, 3, 4, and 5, in the area of Angkor Borei District (Cambodia) near the border with Chau Doc District (An Giang Province, Vietnam). Of those canals, Canal No. 4 (K4) ran towards Ba The Mountain (Figure 1).

The studies of P. Paris were followed in 1946 by L. Malleret, a French archaeologist, who continued to search for traces of the canals. He supposed that Canal No. 4 ran from Angkor Borei across the border with Chau Doc to Ba The Mountain; after flowing around the northeast side of Oc Eo City, it continued to run further south-eastwards. The length of the canal was determined to be around 110km. Another branch of the canal ran southwards to Takev (also named Nen Chua), which was located 12km far from the bay of Rach Gia. According to L. Malleret, Nen Chua played a role as a seaport during the period. He also assumed that Canal No. 4 continued to run further to somewhere in Ca Mau peninsula [8]. In addition, L. Malleret identified 23 more canals, which were numbered continuously after the canals discovered earlier by P. Paris (Figures 1, 2, and 3).

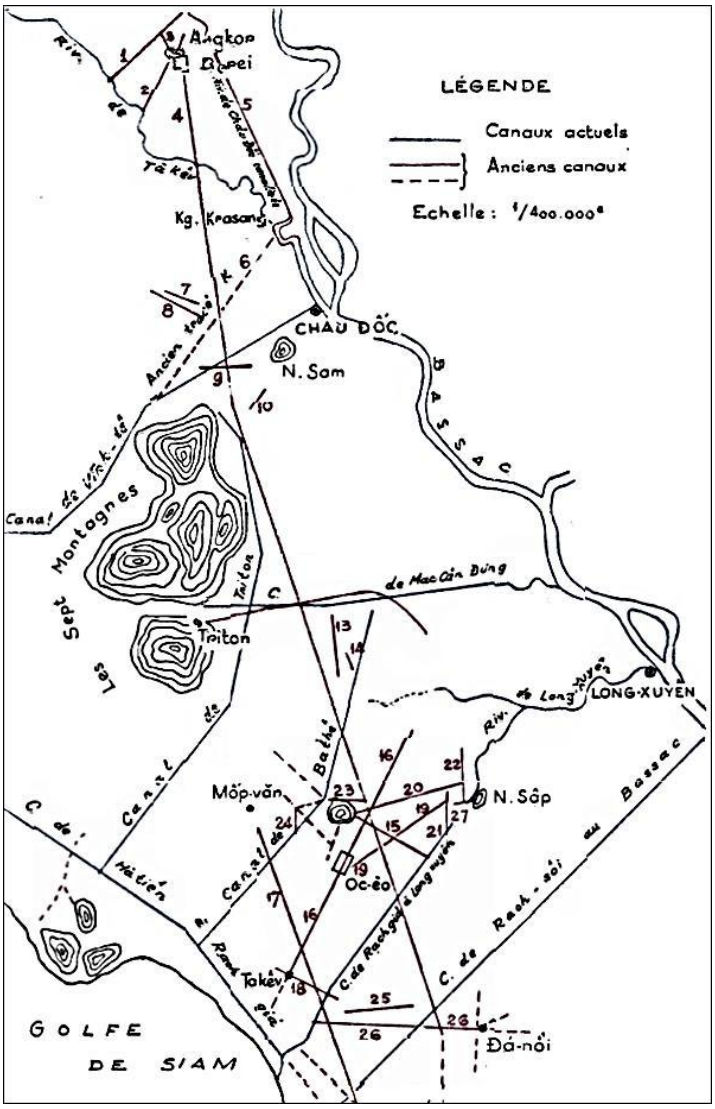
In the publication titled "Archaeology of Mekong Delta" (*L'Archéologie du Delta du Mékong*, 1959-1962), L. Malleret paid particular attention to the system of ancient canals in the plain area of Oc Eo - Ba The and mapped it at a scale of 1:100,000. He also made notices of the less obvious canals, which were shown by dashed lines (Figure 3).

Figure 1: Ancient Canals in the Area of Angkor Borei (Cambodia)



Source: Pierre Paris (1931), "I. Anciens canaux reconnus sur photographies aériennes dans les provinces de Takeo, Châu Đốc, Long Xuyên et Rạch Giá (Complémentà la note parue dans *Bulletin de l'École française d'Extrême-Orient*, 1931, p.221 et suivantes)", *Bulletin de l'École françaised'Extrême-Orient*, Tom 41, 1941.

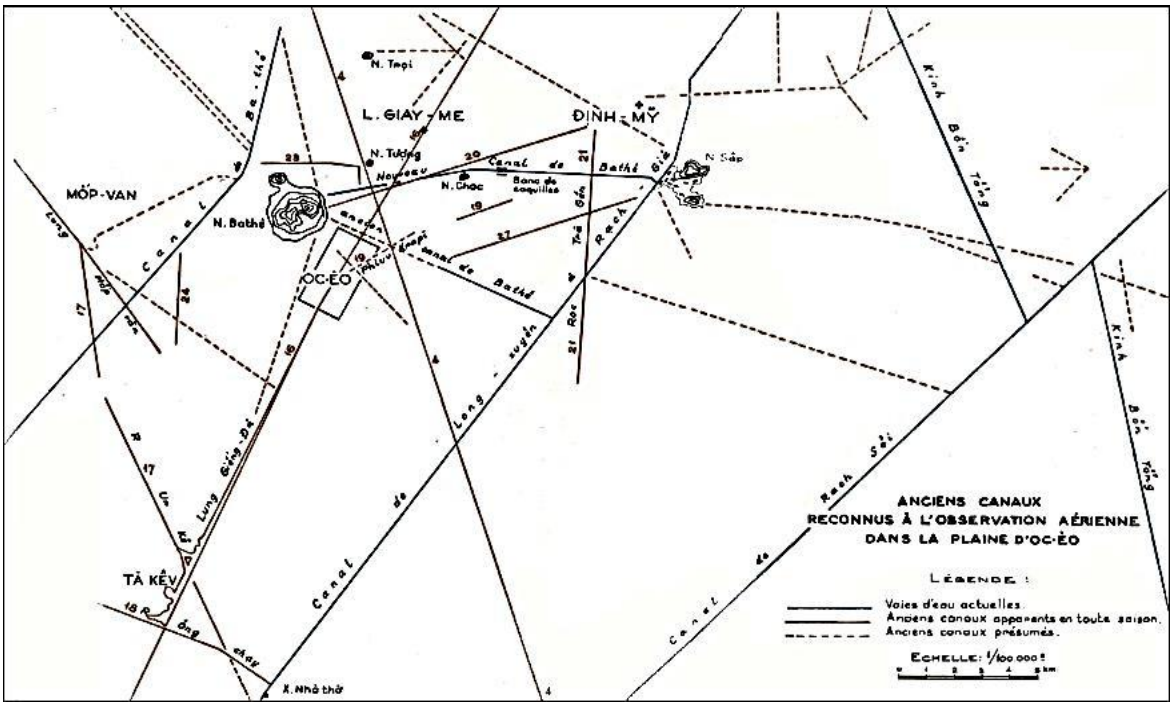
Figure 2: Map of the System of Ancient Canals in the Southwestern Part of Vietnam at a Scale of 1:400,000



Source: Louis Malleret (1959), "L'Archéologie du Delta du Mékong", Tome Premier, *L'Exploration Archéologique et les fouilles d'Oc-Èo*, École Française d'Extrême-Orient, Paris.

Of those 23 canals, L. Malleret argued that at least three ones, including Mac Can Dung, Vinh Te, and Rach Gia - Long Xuyen canals, were re-dug under the Nguyen dynasty along the entire or at least most of the previous canals. Meanwhile, Tri Ton Canal, which ran along the eastern edge of the range of Bay Nui, was dug under the French colonial government later on. Nevertheless, he assumed that it was dug mainly along the beds of the previous canals as well [6].

Figure 3: Map of the system of Ancient Canals in the Period of Oc Eo Culture at a Scale of 1:100,000



Source: L. Malleret (1959), *L'Archéologie du Delta du Mékong*, Tome Premier, *L'Exploration Archéologique et les fouilles d'Oc-Èo*, École Française d'Extrême-Orient, Paris.

2.2. A Number of issues relating to the research on the system of ancient canals in Long Xuyen Quadrangle

The discovery of the system of ancient canals made by P. Paris and L. Malleret in Long Xuyen Quadrangle provided us with significant understanding of the socio-economic development of the ancient residential community in Mekong Delta in the southwestern part of Vietnam (the kingdom of Funan) specifically and the whole region of the lower Mekong Basin generally during the period of Oc Eo culture. Together with cultivation activities in the past, Oc Eo residents gradually exploited natural streams by making them become useful irrigation canals for agricultural production, flexible inland waterways, and even effective lines of defence against the intrusion of "uninvited guests". Based on the local natural conditions, furthermore, we can affirm that all the canals, including both the older and the newer, in Long Xuyen Quadrangle were mainly built along the beds of available natural streams.

Due to the devastation caused by wars and activities for agricultural soil improvement, almost all traces of the ancient canals have been wiped out. In fact, the present field observations cannot enable us to recognise the system of canals identified by P. Paris and L. Malleret in the past [2], [4]. Another

point that should be mentioned is that both P. Paris and L. Malleret did not have favourable conditions to carry out fieldwork due to the war. At the same time, the maps used by them were made with low precision due to the contemporary technology. As a result, the coordinates of the archaeological sites identified by L. Malleret do not agree with those in the present national coordinate reference system of Vietnam.

It is, therefore, necessary to carry out in-depth research, aimed to verify the research findings of P. Paris and L. Malleret on the system of ancient canals in the plain area of Long Xuyen Quadrangle and identify the beds of other ancient rivers in the region. In reality, we have done a research project titled "*Application of Remote Sensing and Geographic Information System Technologies to Archaeological Studies in Southwestern Vietnam (Focusing on Sites of Oc Eo Culture)*" since 2017. After analysing remote sensing and GIS data in combination with fieldwork investigations, we have come to a number of remarks on the system of ancient waterways in the plain area of Oc Eo, as described in the following part.

3. Traces of ancient rivers, based on the remote sensing and GIS data

3.1. Traces of an ancient river in the area of Chau Doc - Bay Nui

The remote sensing data of the plain area in the southwestern part of Vietnam have revealed traces of an ancient river, which are mainly found along the west side of the Bassac, or *Hậu*, River, from Angkor Borei (Cambodia) to Rach Gia (Kien Giang Province, Vietnam). It was the bed of an ancient river, which is easily recognised, especially in Cambodia, where topographical characteristics have not been greatly impacted by human activities. After being processed with geometrical corrections and clutter filtering, satellite images have enabled us to recognise traces of some parts of the ancient river, specifically as follows:

The image of Chau Doc captured by VNREDSat-1 shows traces of an ancient river section in the area located 5.5km due southwest of Nui Sam, which started to run from Vinh Te Canal southwards to the melaleuca forest of Tra Su (Figure 4). This section was a continuation of the ancient river running from Cambodia into Vietnam. It had a winding shape and ran mainly from northwest to southeast. The width of the section did not vary much, ranging from 0.4 to 0.5km (in the figure, it is annotated as "Sam Mountain Western Ancient River). On the local geological map, traces of the ancient river section correspond to a strip of swamp sediment spreading towards the plain area of Mop Van and Rach Gia-Kien Giang. It is, therefore, possible to argue that the ancient river ran across the field in Mop Van into the sea in Rach Gia - Ha Tien (Figure 7).

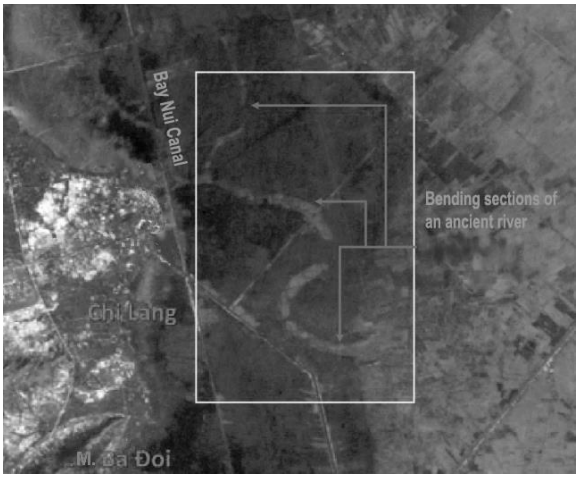
After going 20km southwards, we can find traces of an ancient river running in a winding direction across the field that lies to the east of Bay Nui, from Chi Lang to Ba Doi Mountain. In the satellite image (Figure 5), they were named "the ancient river bending sections to the northeast of Ba Doi Mountain". There are two parts, which are about 10km in length and averagely 0.2km in width; the radius of the arc of the

bending sections is around 0.8km (Figure 5). They were sections of an ancient river named "the Ancient River to the East of Bay Nui". In reality, it was a continuation of the ancient river named "the Ancient River to the West of Sam Mountain". The total length of the ancient river was around 41km, of which the section located to the west of Sam Mountain was around 8km in length with a width ranging from 0.4 to 0.5km. It started to run south-eastwards from Vinh Te Canal and then joined the ancient river section running to the melaleuca forest of Tra Su. In the remote sensing images which have been captured since 1984 up to now, however, it is very difficult to see the ancient river section located to the east of Bay Nui, which ran from the northeast of Ba Doi Mountain to the east of Co To Mountain (Figure 5). Based on the geological and geomorphological maps at a scale of 1:250,000, we have also found some branches of another ancient river running across the paddy field of Ta Danh and Vinh An Communes located to the east of Co To Mountain (Figure 14).

Figure 4: An Ancient River Section to the West of Sam Mountain, Which Visibly Ran Southwards from Vinh Te Canal to the Melaleuca Forest of Tra Su

Source: Landsat satellite photo of 1988.

Figure 5: Two Bending Sections of an Ancient River, Which Were about 10km in Length to the Northeast of Ba Doi Mountain



Source: Landsat satellite photo of 1988.

3.2. Traces of an ancient river in the area of Mop Van - Rach Gia

According to the satellite image, due south of the Ancient River to the East of Bay Nui, there are traces of an ancient river section running across the field of Mop Van (Kien Giang Province), which was located to the west of Ba The Mountain (Figures 6 and 10). In Figures 6 and 7, the river was annotated as "Chau Doc - Rach Gia River", which meant that it had been an ancient river connecting Chau Doc with Rach Gia.

Figure 6: Traces of the Bed of an Ancient River and an Ancient Canal Running from Oc Eo and Joining Chau Doc - Rach Gia River

Source: Landsat satellite photo of 1988.

Figure 7: Traces of a Network of Ancient Estuaries in the Coastal Area of Rach Gia

Source: Landsat satellite photo of 1988.

In the satellite images of Rach Gia (Figures 5 and 7), we can see traces of a network of ancient estuaries of a river in the coastal area of Rach Gia. The river section was 36km long in total and got gradually wider towards the bay of Rach Gia. It was 5.5km wide at the largest point. It demonstrates that the coastline of Rach Gia used to lie further inland. This has been proven by a number of satellite images captured in various periods. The traces of ancient rivers in the region can be seen in the Landsat images in 1973, 1979, 1984, 1988, and 1994....

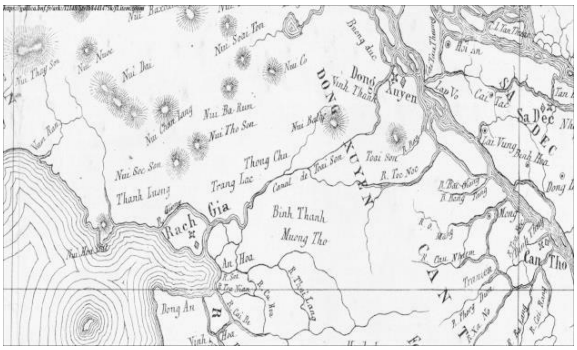
In addition, on a number of ancient maps, such as "*An Nam đại quốc họa đồ"* (Map of Vietnam under the Nguyen Dynasty; *1838), "Burmah, Siam, Cochinchina" (1832); "Base Cochinchiné et Cambodge" (1863);* and, *"Map of Vinh Long" (1899)...,* we can see traces of estuaries and realise a significant role played by the rivers running from Hau Giang into the sea in the area of Rach Gia - Ha Tien (Figure 8).

Based on the analysis of remote sensing images, we have come to two important points about the river section as follows: *Firstly*, there was a canal of 6.5 km in length, running from the area of Mop Van to the archaeological site of Oc Eo - Ba The (Figure 6); and, *secondly*, there was a network of river branches shown by estuaries in the coastal area of Rach Gia (Figures 7 and 8).

Furthermore, processing and combining corresponding physical indicators from the satellite images, researchers have also identified a system of ancient canals in the field of Oc Eo (Thoai Son District, An Giang Province) and the coastal area of Rach Gia. Remarkably, there are traces of an ancient river, which was quite large (it was estimated to be 5.5km wide at the

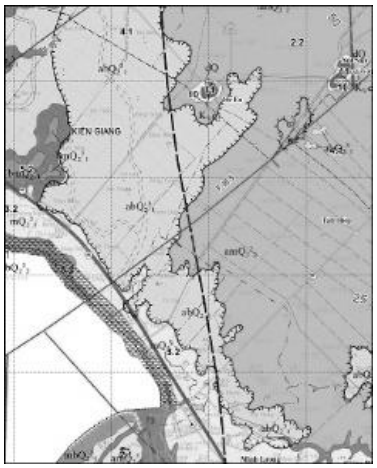
largest point), near the archaeological site of Nen Chua. The document demonstrates that the estuaries of the river contributed significantly to the development of the seaport town of Nen Chua - Oc Eo, making it become one of the most influential seaports in Southeast Asia during the prosperous period of Oc Eo culture.

Figure 8: Traces of Ancient Estuaries in the Area of Rach Gia - Nen Chua on the Map of Cochinchina in 1868



Source: Map of Cochinchina (Southern Vietnam) of 1868.

Figure 9: Geomorphological Map of Thoai Son



Source: Mekong Delta Geomorphic Map at a Scale of 1:250,000.

3.3. Traces of an ancient river in the area of Thoai Son - Long Xuyen

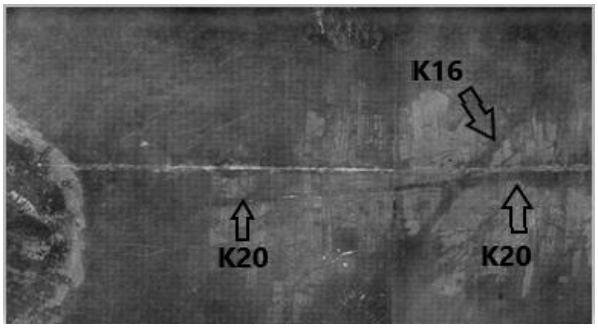
On the geological map released in 2017 at a scale of 1:250,000, traces of ancient rivers are also found, based on the recognition of a strip of river and swamp sediment dating back to the Holocene (Figure 9). Moreover, some traces of the ancient rivers are also shown in the past aerial photographs (Figures 10a and 10b).

In addition, while carrying out research on the paleo-geographical environment in the region, we realised that the geological and geomorphological maps at a scale of 1:250,000 did not show traces of the bed of the ancient river in the location of Rach Gia - Long Xuyen Canal, but we found that the canal had almost the same direction with that of a nearby geological fault coded F.III.5 (Figure 9). As we know, geological faults often result in secondary small-sized streams that have almost the same direction with the faults [5], [6]. Thus, we have agreed with the point of view of L. Malleret, who supposed that Rach Gia - Long Xuyen Canal (Canal No. 12) was created by re-digging available streams. It is, however, necessary to identify which parts of the canal were created by re-digging available

streams and which ones were not. In-depth studies should be carried out on this issue with specific archaeological, geological, and geomorphological analyses...

Figure 10a: Traces of Intersections of Canals in the Area of Long Xuyen on the Aerial Photograph Captured by B.P. Groslier in 1950

Figure 10b: An Aerial Picture Taken by French Army in April 1928 (at a height of 4,160 m), in which the intersection of ancient Canal No. 16 and ancient Canal No. 20 to the east of Ba The Mountain can



Source: Project Coded VT-UD.10/17-20.

3.4. Traces of an ancient river to the southwest of Bay Nui

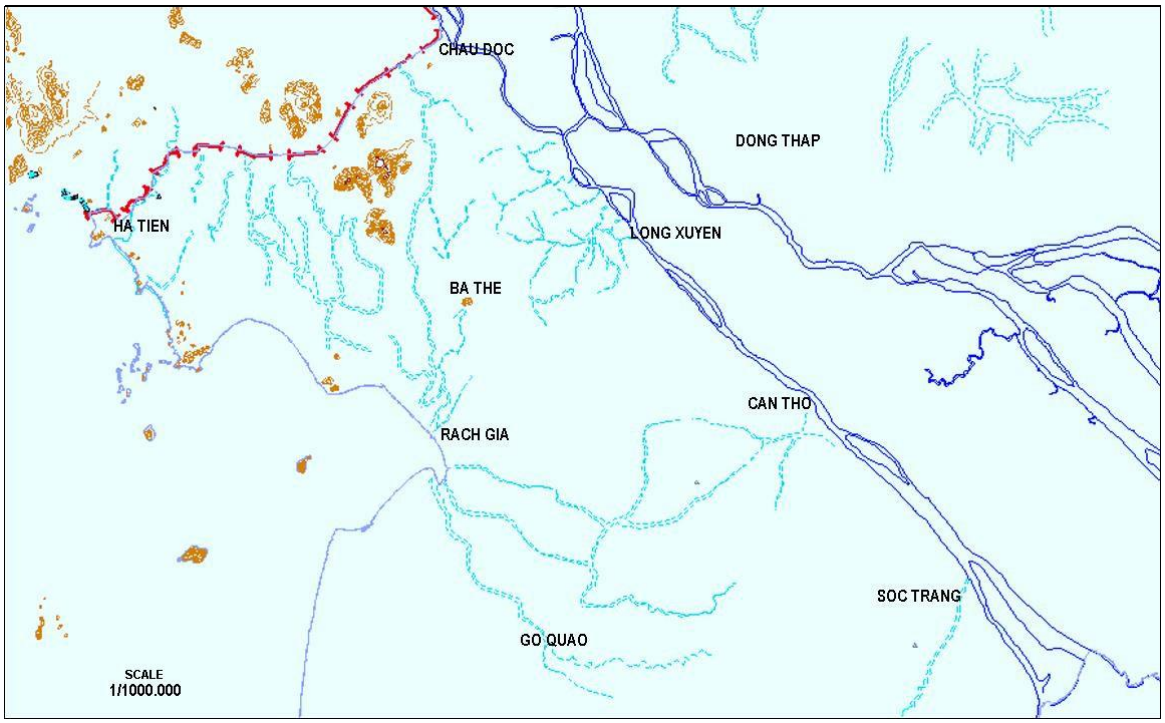
The analysis of traces of ancient rivers in the southwestern area of Bay Nui in the satellite images has revealed a network of ancient river beds, which have the same pattern as those in the aerial photograph coded AF-68-15 taken by the United States Armed Forces. They mainly ran from the north to the south (Figures 11 and 12). Moreover, there were rivers running in the north - south direction from Cambodia and eventually joined a main river running from the northwest to the southeast at the sharply bending section (Box a in Figure 11).

The research findings on ancient rivers are shown generally in Figure 12, in which an ancient river running across the triangular area of Rach Gia, Go Quao and Can Tho is also identified. There were two networks of ancient rivers connecting the bay of Rach Gia - Ha Tien with the Bassac River. In regard to the network in the triangular area of Rach Gia, Go Quao, and Can Tho, it consisted of Cai Lon and Cai Be rivers in the area of Rach Gia and O Mon and Can Tho canals in the area of Can Tho. In the past, the river section was filled up due to the accretion. In the late 19th century, the French colonial government ordered people to dig some canals to be used as irrigation channels for agricultural production and transport lines for local control.

Figure11: Outline Map of Traces of the Ancient River Beds in the Area of An Giang and Kien Giang, Based on the Remote Sensing Data

Source: Authors.

Figure 12: Outline Map of Ancient Rivers (dashed lines) in Long Xuyen Quadrangle, Based on the Remote Sensing, Geological, and Geomorphological Materials and Ancient Maps



Source: Authors.

4. Traces of some ancient canals

4.1. Traces of canals No. 1, 2, 3, 4, and 5

Canals No. 1, 2, and 3 were located within the area of Angkor Borei. In a research work, P. Paris supposed that the three canals spread south-westwards and he therefore made marks along them from the north to the south ends. He also noticed that Canal No. 4, in which there were two gaps and two sections that strayed from the main direction, ran from Angkor Borei to the surrounding area of Ba The [8].

As a section of Chau Doc River, Canal No. 5 ran from the mountainous area in Angkor Borei to a bending section annotated as Mat Jruk (i.e. Pig's Mouth), where the first settlement of Chau Doc residents was established in Vietnam (Figures 1 and 2).

Canal No. 4 ran south-southeastwards from Angkor Borei and joined Vinh Te Canal in the field located between Sam Mountain and Tinh Bien District. On the Universal Transverse Mercator (UTM) map released in 1962 at a scale of 1:250,000, we can see traces of the canal (Figure 13a). At present, however, there are only traces left in the territory of Cambodia. For the section of the canal in the territory of Vietnam, we can find a blur in the remote sensing images captured in the past. The reason is that after

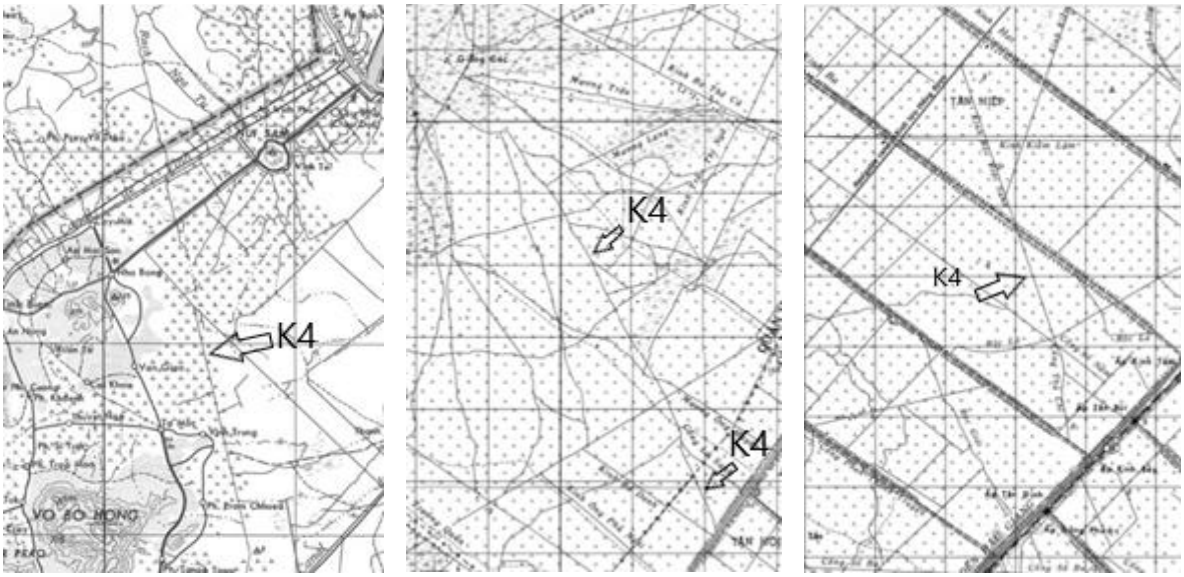
Vinh Te Canal was built under the Nguyen dynasty, most of water running from Cambodia flew southwards along the canal and then joined Giang Thanh River to run into the bay of Ha Tien - Rach Gia.

Canal No. 4 was built along the bed of a natural ancient stream, according to L. Malleret. In the early rainy season, it appeared as a greenish strip of trees and pools. It is interesting that the canal did not stop in Ba The, but bent along the northeast corner of the Oc Eo City and then ran straight south-eastwards. After being intersected by Rach Gia - Long Xuyen Canal in Tan Hoi Commune, it disappeared without any traces left (Figure 9).

Figure 13a: Traces of Canal No. 4 (K4) in the Section from Angkor Borei (Cambodia) to the Intersection with Vinh Te Canal

Figure 13b: Traces of Canal No. 4 (K4) in the Section, Which Bent along the Northeast Corner of the Oc Eo Citadel and then Ran South-eastwards

Figure 13c: Traces of Canal No. 4 (K4) in the Sections Named "Roc Troi Sanh Canal" and "Thu Chi Sluice"



Source: Universal Transverse Mercator Map of 1962.

As described by L. Malleret, it continued running towards the canal that connected Rach Soi with the Bassac River (Hau Giang Province). On the UTM map released in 1965 at a scale of 1:50,000, Canal No. 4 ran quite straight in the area, according to almost all the traces of the canal, and was named Roc Troi Sanh Canal. It then joined a canal named Thu Chi Sluice (Figure 13c). Before reaching Rach Soi - Hau Giang Canal, it ran slightly eastwards at an angle of several degrees. After cutting across Rach Soi - Hau Giang Canal in the area of Kenh Bay Hamlet, which was about 3km due southwest of Tan

Tho Tu archaeological site, it ran directly eastwards to the archaeological site of Giong Da (Da Noi, Kien Giang Province) numbered 103 by L. Malleret [8].

Thus, Canal No. 4 was the longest among the canals discovered by L. Malleret. It ran to densely-populated areas in the period of Oc Eo culture. The canal was mainly built along the beds of natural streams by Oc Eo residents.

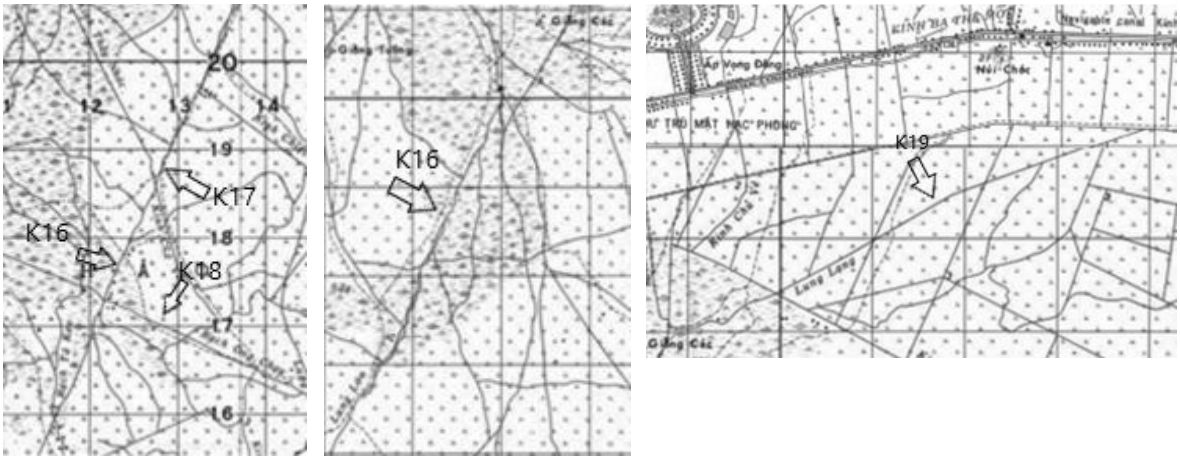
4.2. Traces of Canals No. 15, 16, 17, 18, and 19

According to P. Paris, the canal numbered 15 ran southeast-eastwards from the area of Ba The Mountain to Rach Gia - Long Xuyen Canal. It did not change much and is currently named Ba The Old (*Ba Thê Cũ,* "old" as opposite to "new") Canal (Figure 2).

Figure 14a: Three Intersections of Canal No. 16 (K16), Canal No.17 (K17), and Canal No.18 (K18) in Area of Nen Chua

Figure 14b: A Section of Canal No. 16 (K16) Named Lung Lon Running towards Oc Eo City

Figure 14c: Canal No. 19 Named Lung Lang Running from Giong Cat Archaeological Site towards Sap Mountain

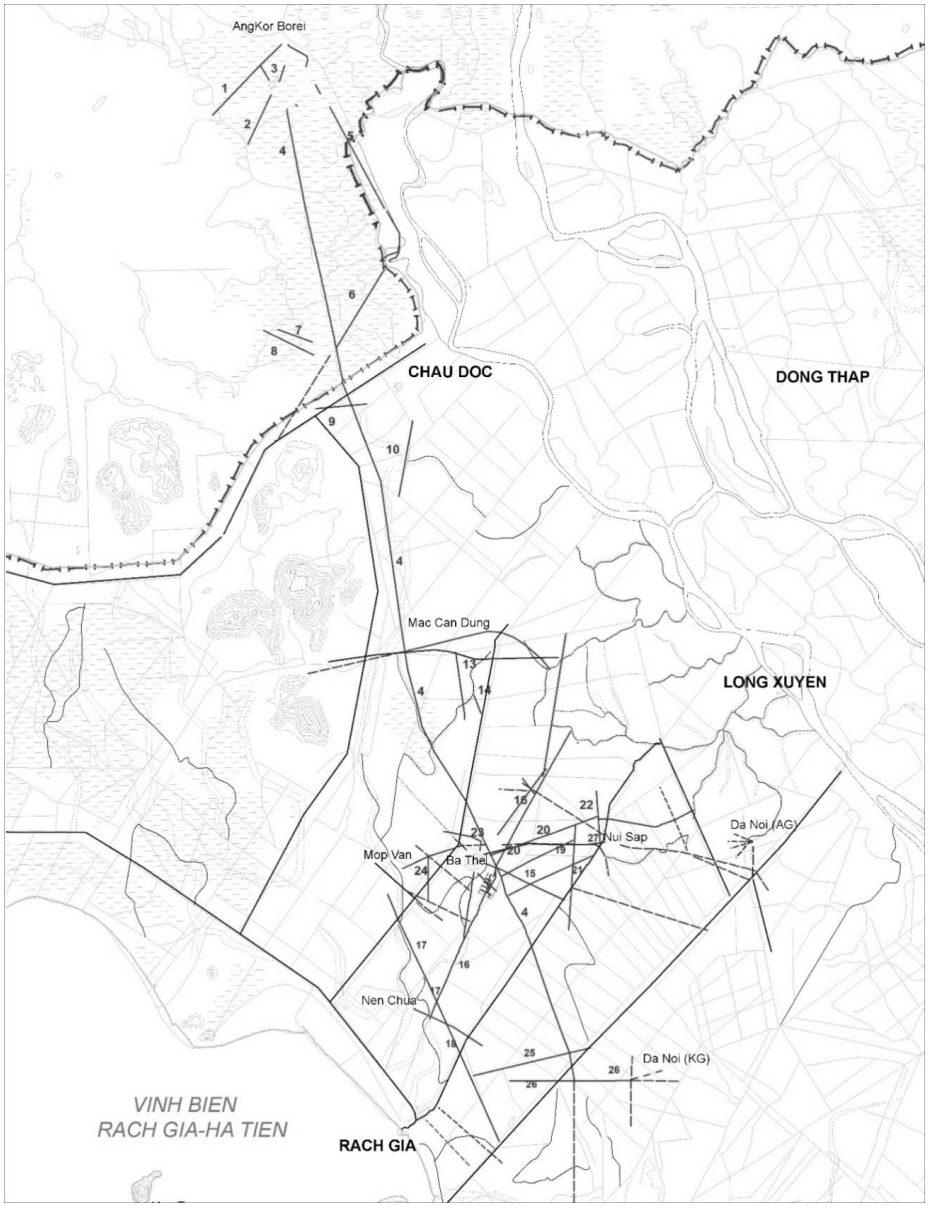


Source: See Figures 13a-13b.

Canal No. 16 was one of the most important canals in the system of ancient canals discovered by L. Malleret. He supposed that the canal played a role as the central axis of ancient Oc Eo City. It ran across the city. Residential communities were found on both sides of the canal, where production and religious activities took place. A section of the canal can be seen on the UTM map released in 1965. It came inland from the sea in Rach Gia. After being intersected with a new canal named Ong Chay (*Rạch Ông Chạy*) at almost right angles, which ran parallel to the coastline, Canal No. 16 ran across the area of the ancient residential community in Nen Chua towards Oc Eo City. At a point, which was 1.6km far from Nen Chua archaeological site, it

was intersected with a canal named Cha Va, which was numbered 17 (Figure 14a). The section of Canal No. 16 outside Oc Eo City was named Lung Lon (Figure 14b). After flowing into Oc Eo City, the canal ran along the southern edge of Oc Eo Mound and was seen as the central axis of the city. After coming out of Oc Eo City, it ran northwards and a new branch was built. The branch, which was named Lung Lang or Phlw Krapi (i.e. Buffalo Path) and numbered 19, ran north-eastwards (Figure 14c).

Figure 15: Map of Ancient Rivers and Canals in Long Xuyen Quadrangle[2]



Source: Project VT-UD.10/17-20.

After flowing out of Oc Eo City for one kilometre, Canal No. 16 was intersected with Canal No. 15 and then ran north-northeastwards to the residential area of Giay Me (Archaeological Site No. 103), which was about 20km far from Oc Eo City. Afterwards, it flew straight up to Trap Da (Archaeological Site No. 101), where it joined the eastern section of Mac Can Dung Canal in Vinh Loi Hamlet to run into the Bassac River. Thus, we can suppose that Canal No. 16 was one of the canals that played a significant role in socio-economic development in the southwestern part of Vietnam at that time.

Starting in Mop Van (Archaeological Site No. 100), Canal No. 17 ran from the northwest to the southeast. It cut across Canal No. 16 in the location of Cha Va Canal and was intersected with Canal No. 18 in the area of Ong Chay Canal. It ran across Rach Gia - Long Xuyen Canal in the area of Nha Tho Hamlet and then continued running to Lung Lach Gia and O Ke Ditch (*Rộc Ơ Kê*). The entire length of Canal No. 17 was around 30km.

Canal No. 18 was an extension to Ong Chay Canal, which was numbered 18 by L. Malleret. As shown on the map, Ong Chay Canal ran across the nearby extension of O Ke Ditch and then joined Long Xuyen - Rach Gia Canal in the area of Nha Tho Hamlet (Figure 13c).

Canal No. 19 started from the intersection with Canal No. 16 in the area of Giong Cat, where it was named Lung Lang (Figure 14c). It ran toward the southeast of Choc Mountain, as marked with a dotted line and numbered 19 by L. Malleret. It was used as a transport route between Oc Eo City and the residential area of Dinh My (Archaeological Site No. 102).

5. Remarks and assessments

Based on the initial research findings, we have come to the following remarks:

1. The system of ancient canals outlined by L. Malleret and P. Paris played an important role in socio-economic development in Mekong Delta in southwestern Vietnam during the period of Oc Eo culture and the kingdom of Funan. The system of canals was built by human beings for some major goals as follows:

- It was an irrigation system built to serve agricultural production (wet rice cultivation and aquaculture), aimed to ensure food security for a large population in the region;

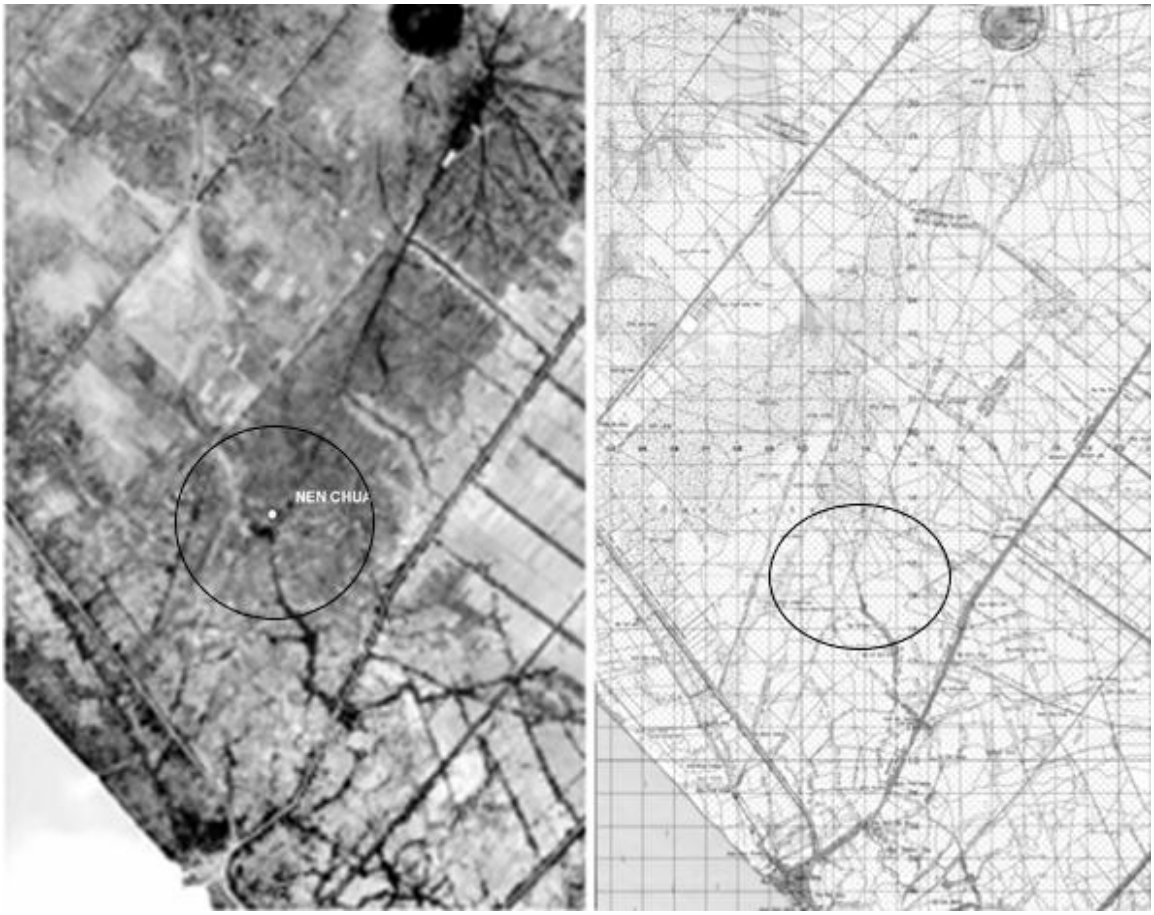
- The canals were used as waterways (for transportation of goods and people) among areas in the region, contributing to making Oc Eo City become an important trade centre in Southeast Asia and an entrepôt, where merchants from various countries such as the Mediterranean nations, India, Champa, and China came to do business;

- It was also seen as a defence work to prevent attacks and intrusion of "uninvited guests".

2. The system of ancient canals was built mainly by taking advantage of the available natural streams. It took years to carry out that work. People from many generations continually improved natural streams to create such long and straight canals that can be seen in the satellite photographs captured recently. The traces of the ancient canals show the local people's capacity to do

irrigation in the flooding environment in the past. The supply of enough fresh water for agricultural cultivation and domestic demand of local residents demonstrates the advanced development of production techniques and social management in the kingdom of Funan, as it is even considered to be a tough job for us at present.

Figure 16: Satellite Images Processed with Appropriate Physical Indicators Show that the Archaeological Site of Nen Chua Was Located in the Area of an Estuary in the Past



Source: Landsat satellite photo of 1994; and Universal Transverse Mercator Map of 1962.

3. In regard to the section at the southern end of Canal No. 16, some researchers argued that it was a section of Nam Lieu Canal on the UTM map released in 1965 at a scale of 1:50,000 (Figure 16). The data of the remote sensing images processed with physical indicators (Annexes 2, 3, and 4) have proven a system of ancient rivers running from the area of Chau Doc across Mop Van to the bay of Rach Gia; particularly, there were ancient estuaries located along an area of several kilometres in Nen Chua. This

demonstrates that the archaeological site of Nen Chua used to be located on the area of a large river mouth not far from the sea; it was an appropriate place for the anchorage of boats and ships coming from the sea. This has also helped wipe out the doubt that Allan Charles Thorburn had about Nen Chua's role as a port (2016), when he thought that it was not located by any estuaries [7], [5]. The identification of traces of the ancient rivers in the remote sensing images of Nen Chua has contributed to our belief in the fact that Nen Chua used to be a port for Oc Eo City on the coastal trade route in Southeast Asia (Figure 16).

6. Conclusion

The system of ancient canals discovered by L. Malleret in the plain area of Vietnam's southwestern part was mainly built by improving available natural streams in the period of Oc Eo culture. It took years for people from generation to generation to accomplish the work.

There was a system of ancient rivers running from the area of Angkor Borei across Chau Doc and then Mop Van to reach the sea in the bay of Rach Gia. The archaeological site of Nen Chua used to be located by a large river mouth, which was seen as a place of convenient anchorage for ships and boats coming from the sea. This helped to affirm the role played by the archaeological site as a port in the period of the kingdom of Funan.

It is necessary to pay more attention to the advantage and the role of remote sensing and Geographic Information System (GIS) data, while doing research on archaeological sites of Oc Eo culture, especially Oc Eo City, ancient rivers, canals, and coastal areas of estuaries.

Notes

[1] This paper was published in Vietnamese in: *Khoa học xã hội Việt Nam*, số 9, 2020, then developed into this English version. Translator: Nguyen Tuan Sinh. Language editor: Ta Quang Dong. The co-authors are Nguyen Xuan Lam from Department of National Remote Sensing, and Le Ngoc Thanh from Ho Chi Minh City's Institute of Geography and Resources.

[2] Map of ancient rivers and canals in Long Xuyen Quadrangle, which has been revised according to the UTM map at a scale of 1:50,000 (in which, light dashed curvy lines represent ancient rivers; thick straight lines represent the present canals; straight lines represent the ancient canals that have been verified; dashed straight lines represents conjectural ancient canals; and, light straight lines represent the canals on the present map at a scale of 1:250,000).

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