

HISTORICAL GEOGRAPHY OF THE CANAL SYSTEM IN THE CHAO PHRAYA RIVER DELTA

From the Ayutthaya period to the fourth reign of the Ratanakosin dynasty

by

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A. Introduction

The large, complex delta stretching from Chainat Province to the Gulf of Thailand, customarily called the Chao Phraya delta, consists of flat, open land watered by the lower reaches of the Chao Phraya, Tha Chin, MaeKlong and Bang Pakong rivers. Throughout the Ayutthaya and Ratanakosin periods of Siamese history, the delta was the center of geographical living-space on which the society's agricultural production depended. This article aims at analyzing historical change in the Chao Phraya delta by investigating the formative process of the canal system, before the introduction of the irrigation/transportation system operated by the Krom Khlong ("Department of Canals") during the Ratanakosin period.

Both the agricultural production, characterized by wet-rice cultivation, and the transportation facilities on which the Siamese government traditionally depended, seem to have been determined largely by the physiographical conditions of the delta. Traditional wet-rice cultivation generally depended on water supply from natural inundation of river channels. Because shortages of water may result from the unstable

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monsoon rainfall pattern, rice cultivation needs supplemental irrigation from the annual floods¹. And to use the floodwaters effectively, systems of canals have been developed in addition to the watercourses of the natural drainage system. At the same time, the natural watercourses have been important to the traditional government economy, as well as to rural society for its daily communication and economic activities². The traditional economy was based primarily on control and mobilization of *corvée* labor, taxation, and foreign and domestic commerce. The development of the economy was accomplished by facilitation of inland navigation through construction of canal systems.

In the mid-nineteenth century A.D., the conclusion of the Bowring Treaty in 1855 had an important effect on the national economy in Thailand, involving it in international economic networks. The development of canal systems was also closely related with this economic development, since in order to meet the foreign demand for rice, rice production had to be expanded.

In his analysis of economic change since the latter half of the nineteenth century, J.C. Ingram described the development of irrigation projects which resulted in expansion of rice production³. In particular, he discussed the role of modern irrigation and drainage systems operated from the latter part of the fifth reign (A.D. 1890-1910). Without doubt the modern systematic projects that are based on the project submitted by Homan van der Heide were fundamentally significant in agricultural development in this period. Government efforts to carry out these projects led to the establishment of Krom Khlung, later Krom Thotnam ("Royal Irrigation Department").

Ingram also pointed out that the government had done comparatively little towards provision of public works for irrigation and reclamation of land before the introduction of these systematic projects⁴. This view of pre-modern agricultural development seems to result from the

1. Credner, 1935: p. 212; Dobby, 1958: p. 272; Pendleton, 1963: p. 138.

2. Credner, 1935: pp. 304-305.

3. Ingram, 1971: pp. 79-85.

4. *Ibid.*: pp. 80-81.

stress placed on the remarkable development in the following periods. In the pre-modern period, however, there were formative processes important for future development. These were indigenous, and closely related to the geographical and historical conditions of the Chao Phraya delta.

In addition to Ingram's economic historical analysis, there are many studies of the hydraulic works and irrigation projects in this delta, based on various disciplines. With few exceptions, however, most recent works in the field of geography and socio-economic history have tended to overlook the earlier indigenous and traditional processes⁵. The changes brought by large-scale public works in this region cannot be allotted their proper place in the development of the national economy without consideration of earlier canal construction and its aims. Useful discussions of this subject may be found in Tomosugi, Hubbard, Small and Johnston, who have investigated Thai historical materials; through their exhaustive description of hydraulic works, they have to a certain extent succeeded in indicating the effects which these projects have had on the course of Thai history⁶. However, more detailed examination is necessary to clarify the types of irrigation works undertaken and their aims, particularly for the very important latter part of the nineteenth century.

In this article, I describe the formative process of the canal systems which provided the foundations for later agricultural development, and analyze the development of two main functions of traditional canals, transportation and distribution of floodwater to adjacent ricelands, through investigation of Thai historical sources. In addition, I draw attention to the type of reclamation and land tenure brought about by a series of new canal excavations in the latter half of the nineteenth century⁷.

5. Credner, 1935: pp. 215-217; Pendleton, 1962: p. 141.

6. Tomosugi, 1966: pp. 165-176; Hubbard, 1967; Small, 1973: pp. 1-24; Johnston, 1974.

7. As for the changing process of land tenure of this period, see Lingat, 1940: pp. 37-41; Tomosugi, 1967: pp. 96-105; Kitahara, 1973: pp. 11-48.

A brief but useful description of canal excavation may be found in *Rüang Prawat Krasuang Kasettrathikan* ("A History of the Ministry of Agriculture") by Čhao Phraya Wongsanupraphat, first published in 1910 A.D.⁸ The description consists of short documents concerning canal excavation from Ayutthaya times until van der Heide's resignation from the directorship of Krom Khlóng, most of which are cited from royal chronicles and royal decrees issued in the fourth and fifth reigns⁹. In that description, however, there are some mistakes in dates, dimensions of the canals and reclaimed land, and other details of canal construction. Thus researchers must return to the primary sources.

I have closely examined the details of canal construction in the appropriate editions of royal chronicles of the Ayutthaya and Ratanakosin periods¹⁰. In addition, I have also examined royal decrees and proclamations after the fourth reign concerning construction and maintenance of canals and reclamation of land adjacent to canals, which were compiled in *Prachum Kotmai Pračham Sok* ("Collected Laws, Arranged Chronologically")¹¹. Other Thai sources and important documents written by contemporary Europeans have also been used. A series of topographical maps (scale 1:50,000), surveyed mostly in the 1910s and revised in the 1950s by the Division of Maps, Royal Thai Army, have also provided useful information¹².

8. Hereafter abbreviated as *PKK*.

9. *PKK*: pp. 125-161.

10. For the royal chronicles of Ayutthaya, the Luang Prasoet version (*PPKA 1*), the Krom Phra Pramanuchit version (*PPKA 2*), the Phan Čhanthanumat version (*PPKA 3*) and the Somdet Phra Phanarat version (*PPKA 4*) are used. For the royal chronicles of the Ratanakosin period, the National Library editions for each reign published by the Khlóng Witthaya Press (*PPKR I, II* and *PPKR III, IV*) are used. In addition, for the fourth reign, useful information on canal excavation is found in *Rüang sathanthi lae watthu süng sang nai Ratchakan Thisi* ("Public works constructed in the fourth reign") in *Prachum Phongsawadan, phak thi 25* ("Collected Chronicles, vol. 25") abbreviated as *PP 25*.

11. Hereafter abbreviated as *PKPS*.

12. These maps are held by the Institute of Developing Economies, Tokyo, Japan.

B. Physiographical conditions of the Chao Phraya delta

1. *The upper part of the delta*

The upper part of the delta comprises alluvial plains that developed along the main channel of the Chao Phraya river and its distributary channels, the Suphan Buri (Tha Chin), Noi and Lop Buri, between the provinces of Chainat and Ayutthaya. According to the physiographical classification of Takaya¹³, this region corresponds to the old delta area, which has a distorted, fan-shaped configuration with the apex at Chainat. The elevation is between 20 meters (m) and 5m above sea level, with the general slope in a north-south direction. The repeated bifurcation of river channels forms a network of spreading distributaries with well-developed natural levees.

Ricefields can be found along the watercourses which spread into the backswamps between natural levees. The distribution of ricefields, however, was restricted to depressional plots until the introduction of modern irrigation schemes in the early part of the twentieth century¹⁴. Small artificial channels that clearly were excavated can be distinguished from natural watercourses (figure 2). These small canals, which run across natural levees to backswamps, sometimes use natural watercourses or marshes. Although the date of excavation is not clear, they seem to have been excavated in order to expand ricefields that were restricted by the topography of the backswamps. On the well-developed natural levees along rivers, a continuous pattern of "ribbon settlement" predominates¹⁵. This is a typical component of the landscape of the old delta area. The historical towns, such as Ayutthaya, Suphan Buri, Sing Buri, Phrom Buri, Inthaburi (In Buri), and Ang Thong are also situated on natural levees along main river channels. These important towns were included in the category of "fourth-class town" (*huamüang çhattawa*), which was directly administered by the central government from the time of the Ayutthaya kings¹⁶.

13. Takaya, 1971: pp. 375-397.

14. *Ibid.*: pp. 384-386.

15. Sternstein, 1965: pp. 30-31.

16. Tanabe, 1972: pp. 247-251.

2. *The lower part of the delta*

The lower part of the delta, which comprises Takaya's "deltaic high" and "delta flat" areas, is low-lying, flat terrain of elevation less than 5m above sea level, and stretches from around Ayutthaya to the Gulf of Thailand (figure 1). This region is considered the youngest plain geomorphologically, and is thought to have risen from the Gulf of Thailand during the past few thousand years¹⁷. The deltaic high has an average elevation of 3m, occasionally reaching 5m, and extends to Nakhon Chaisi on the west, to the area north of Nonthaburi along the Chao Phraya main channel on the north, to the southern boundary of the Rangsit canal system and the west bank of the Bang Pakong river on the east, and centers on the site of Bangkok. Takaya suggests that this elevated land may have formed on old beach ridges or on a complex of natural levees. This area has about 1m higher elevation and a higher stream density than the surrounding delta flat area. Because of these topographical conditions, which give adequate flood depth for rice cultivation and quick drainage, cultivation in this area was much more widespread than in the delta flat¹⁸.

The delta flat is mostly low-lying land of elevation less than 2m, and almost no local relief. This recent delta is dominated by brackish environments and unstable lowland with numerous wandering marshes and swamps. Takaya describes it as an "amphibious terrain": it is neither land nor water. It covers the area between the old delta and the deltaic high including the Rangsit canal region and the coastal area¹⁹. Until the early part of this century, a considerable area adjacent to the coast was subject to the influence of the tide, and is still covered by hypersaline plants such as mangrove and nipa.

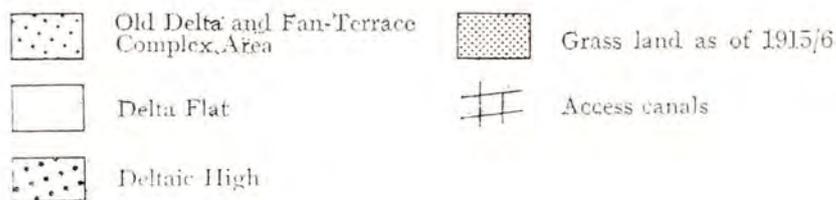
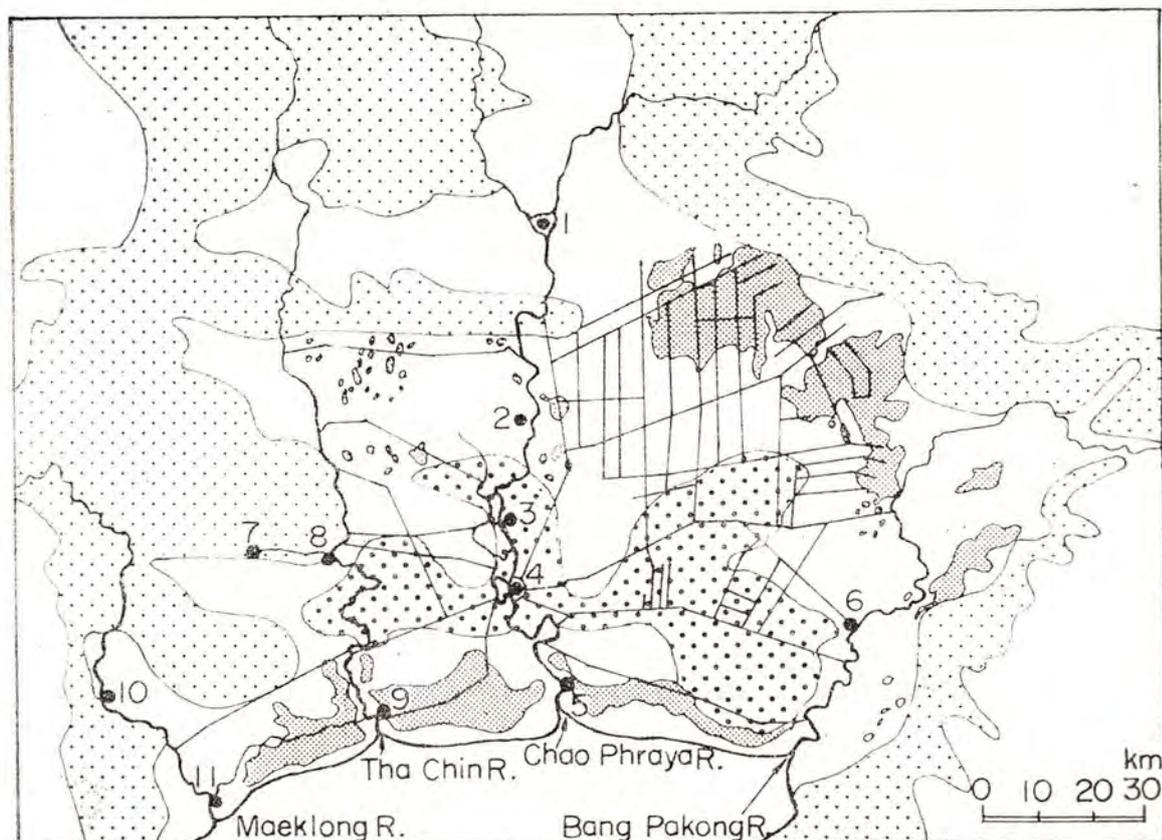
Settlement of the lower part of the delta is considered to be very recent. The remarkable development and expansion of Siamese settlement since the latter half of the nineteenth century were achieved through the social demand for expanded rice production, brought by the liberali-

17. Smyth, 1898: vol. 1, pp. 54-55; Takaya, 1969: p. 24; Credner, 1935: p. 37.

18. Takaya, 1971: pp. 390-391.

19. *Ibid.*: pp. 387-388.

Figure 1. Physiographic regions and trunk canals in the lower part of the Chao Phraya delta



Notes: Modified from Takaya, 1971: p. 390.

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|------------------|----------------------|
| 1 : Ayutthaya | 7 : Nakhon Pathom |
| 2 : Pathum Thani | 8 : Nakhon Chaisi |
| 3 : Nonthaburi | 9 : Samut Sakhon |
| 4 : Bangkok | 10 : Ratchaburi |
| 5 : Samut Prakan | 11 : Samut Songkhram |
| 6 : Chachoengsao | |

zation of trade and a series of domestic reforms. Before that, from Ayutthaya times to the early part of the Ratanakosin dynasty, though the main towns were mostly situated at the mouths of river channels or at water-traffic centers, they were primarily ports. Vast tracts of land behind them were left uncultivated, because there were hardly any perennial means of access to the land behind towns other than the main river channels. At the same time, lack of artificial watercourses for water supply and drainage of ricefields made rice cultivation impossible²⁰.

In the mid-nineteenth century, canal excavation projects were started in what corresponds to Takaya's deltaic high area. The inland navigation system was gradually completed through the excavation of trunk canals, which linked the main river channels with the capital. In the delta flat area, which was largely uncultivated, canal construction was begun at the end of the nineteenth century. Thus the process of canal construction in the delta was strictly determined by physiographical conditions.

In the following sections I discuss the historical process of canal construction through detailed examination of the relevant historical sources.

C. Canal construction in the Ayutthaya and early Ratanakosin periods

1. Ayutthaya period (A.D. 1350-1767)

Throughout the Ayutthaya period, the center of agricultural production seems to have been the upper part of the delta. Although there is scant documentation of canal excavation for irrigation in this region, a large number of small, artificial watercourses which seem to have been used for irrigation can be found throughout the old delta area on topographical maps. But editions of the *Royal Chronicle of Ayutthaya*, which give information on the achievements of the central government, hardly mention irrigation canal projects. Assuming that most of those watercourses were not dug in later periods, it seems likely that excavations were carried out not as government projects but as

20. Bowring, 1857: vol. 1, p. 8.

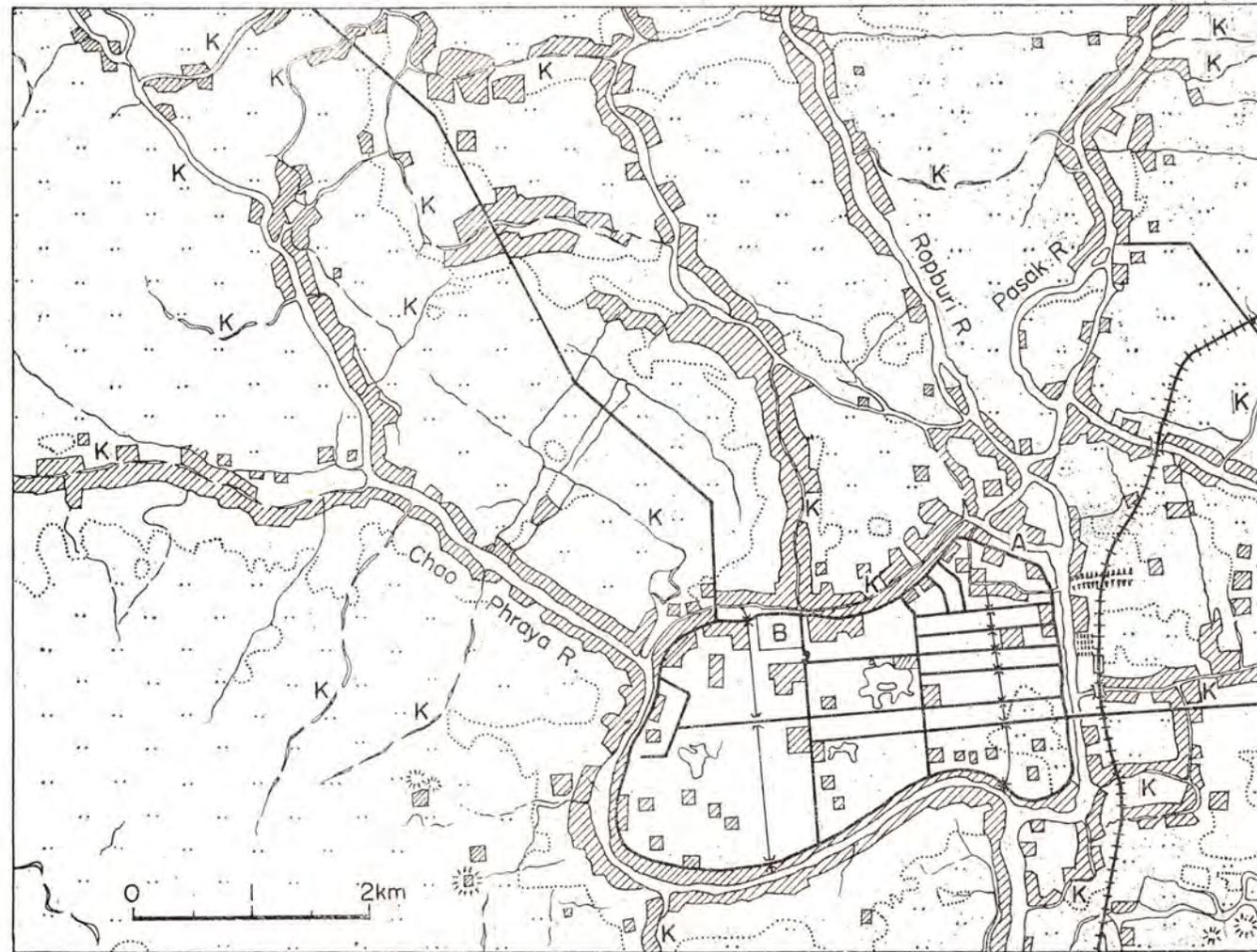
community or individual works by peasants, probably during or since the Ayutthaya period²¹. Credner has also indicated the existence of networks of small, winding canals excavated by peasants in this area, in his morphogenetical analysis of plans of canals and watercourses in this delta²². Even if peasants in rural communities wished to dig watercourses, they could not do so without government permission. Thus *Phra Thammanun* ("Law of Procedure"; A.D. 1743) in *Kotmai Tra Sam Duang* ("The Law of Three Seals") provides as follows:

The seal of Phra Phirun ["Rain God"] standing on the back of a king *naga* should be used in cases of scooping up water for irrigation of ricefields and for the digging of small ponds²³ [*bïng bang*] or irrigation canals from which to draw water.²⁴

This was one of the seals of the Krom Na ("Ministry of Agriculture") of this period. Thus, in the Ayutthaya period, the government seems to have made a limited effort to control irrigation works operated by peasants in rural communities. Government control over irrigation, however, was not as rigid as in the Lannathai kingdom which had a well-developed irrigation system, constructed and maintained by both government and peasants²⁵. Rice cultivation in the backswamps of the old delta region did not require large-scale irrigation. Using the water supply from annual floods, peasants could get sufficient water for rice cultivation merely by digging small watercourses and ponds. Thus the government concentrated on public works for transportation of products and for military affairs, rather than for irrigation, throughout the

21. According to a personal communication from Dr. Takaya, a large number of small watercourses are the result of small-scale repairs and dredging of existing natural watercourses.
22. Credner, 1935: p. 217.
23. *Bïng* seems to mean artificial pond, as well as marsh or swamp, in the depression area of the delta. Bradley explains that *bïng* means a large *khlong* without streams in barren land, while *bïng bang* means a smaller one. (Bradley, 1873: p. 360.)
24. *Kotmai Tra Sam Duang* ("The Law of Three Seals") is abbreviated to *KTS*: vol. 1, pp. 147-148.
25. Kraisi, 1965: pp. 10-14; Tanabe, 1975: pp. 79-82.

Figure 2. Small canals and city moats of Ayutthaya



 River channel or canal
 Road
 Railway

 Village, including ruins
 Rice fields
 A The Khuna canal B Old palace
 K Channel, named Khlong on the topographical map

Note: Taken from the Ayutthaya sheet of the topographical maps surveyed in 1915 by the Division of Maps, Royal Thai Army, and revised in 1953. Scale: 1:50,000.

Ayutthaya and the early Ratanakosin periods²⁶. Apart from irrigation canals, three other types of canal may be distinguished according to function and form: the city moat, the short-cut (*khlong lat*), and the transverse canal. In addition, it is possible to argue that most of those canals were constructed as government public works under the king's orders, usually using corvée labour (*phrai*) under the supervision of a chief director (*mae kong*) who was appointed from among high-ranking noble officials. (See figure 2.)

City moat canals. When the capital was founded at Ayutthaya in A.D. 1350, a city moat and fortifications had already been constructed near the confluence of three rivers; the Chao Phraya, Lop Buri and Pasak²⁷. At least two later descriptions concerning construction of a city moat on the east, which may correspond to the Khūna canal of the end of the sixteenth century, can be found in the royal chronicles²⁸. As shown by Phraya Boranratchathanin and Sumet Jumsai's reconstruction of the old city plan, a complicated but splendid network of canals facilitated communication between political and religious centers, markets and settlements, both inside and outside the city²⁹. The city moats might have also been used for domestic water supply in the dry season. It should be noted that the remains of an old barrage to hold water in the dry season was discovered at the mouth of a canal inside the city³⁰.

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26. Čharubut, 1972: p. 564; Phonipha & Thawisin, 1975: pp. 46-47. During the Ayutthaya period, governmental control over irrigation works is hardly mentioned in historical materials. In Phra Ayakan Betset, clauses 28, 29 and 30 of *Kotmai Tra Sam Duang*, one finds only provisions for punishment, with a fine, in cases of stealing water. (*KTS*: vol. 2, p. 209.)
27. Boranratchathanin, 1963: p. 6, footnote 2; Sternstein, 1965a: pp. 88-90; 1966b: pp. 221-220.
28. In the Luang Prasoet version, L.E. 942 (A.D. 1580) is given, while L.E. 932 (A.D. 1570) is given in the Phan Čhanchanumat version. (*PPKA 1*: vol. 1, p. 151; *PPKA 3*: p. 134). Although W.A.R. Wood mentions the reconstruction of the city wall in A.D. 1550 in King Čhakraphat's reign, no information is given for the city moat. (Wood, 1926: p. 114.)
29. Sumet, 1970: pp. 301-314.
30. Boranratchathanin, 1969: pp. 43-44.

But the two primary functions of the city moats were military and transportation. Thus the moat was usually accompanied by ramparts and fortifications, as in the towns throughout the upper delta such as Suphan Buri, Lop Buri and Sara Buri³¹.

Short-cut canals. From the sixteenth century, in accordance with the development of foreign and domestic trade, the maritime ports and towns along the lower reaches of river channels became increasingly important centers of transportation. The main channel of the Chao Phraya river also assumed the important function of the trunk navigation route linking the capital with the Gulf of Thailand. In order to improve and shorten the route, the government carried out short-cut canal projects. Such projects accounted for the greater part of public works, and at least ten were carried out on a vast scale. According to the royal chronicles, the short-cut canals were largely restricted to meandering parts of the channel between Pathum Thani to the north and Phra Pradaeng (Nakhon Khüankhan) to the south.

Besides Thai historical sources, navigation charts drawn by contemporary Europeans, such as the chart held in the General State Archives at the Hague³², also show re-channelization under such projects. Table 1 lists these navigation charts. Figure 3 is a map showing the courses of short-cut canals and old transverse canals excavated during the Ayutthaya period.

Below appears the example of the Tret Noi canal from the Pramanuchit version of the royal chronicle:

In the Year of the Tiger, the fourth year, the King thought that as the meanders near the mouth of the Bang Buathong canal were very tortuous, a short-cut should be constructed. The King thus ordered Phra Thonburi, the chief director, to conscript around ten thousand corvée laborers from the southern provinces to excavate the Tret Noi canal, 6 *soē* [3m] deep, 6

31. For example, construction of city moats in Lop Buri in the reign of King Narai. (*PPKA 2*: vol. 2, p. 95.)

32. Detailed information on this chart is given in Meilink-Roelofz, 1965: pp. 167-184.

Table 1.

Navigation charts of the lower part of the Chao Phraya river

- I. "Kaat van de Rivier van Siam, van de Zee tot aan Stad Siam ofte Judea", circa 1687/8 A.D. (Loeupe No. 267, General State Archives, The Hague), a facsimile of which is in the Siam Society's map collection.
- II. de la Mare, "Carte du cours de Më-nam depuis Siam jusqu' à la mer copiée en petit d'après une fort grande faite par M. de la Mare ingénieur du Roi", no date, in Lucien Fournereau, "Le Siam ancien", *Annales du Musée Guimet*, vol. 20, Paris, 1895.
- III. La Loubère, "Carte du cours du Menam depuis Siam jusqu' à la mer, copiée en petit d'après une fort grande faite par M. de la Mare, ingénieur du Roy", in his *Du Royaume de Siam*, vol. 1, Amsterdam, 1691.
- IV. François Valentyn, "De Groote Siamse Rievier Me-Nam ofte Moeder der Wateren in haren loop met de in vallende Spruyten Verbeeld", in his *Beschryving van Oud en Nieuw Oost-Indiën*, vol. III, p. II, no. 35, Dordrecht, 1726.
- V. Engelbertus Kaempfer, "Msspps Meinam Fluvij, ad orig. Eng. Kaempfer delin I.G.S.", in his book translated by Scheuzer, *The History of Japan, together with a Description of the Kingdom of Siam*, vol. 1, London, 1727.

wa [12m] wide and 29 *sen* [1,160m] long. Then Phra Thonburi undertook the King's order, and completed excavation in about one month, within the same year³³.

The Year of the Tiger, the fourth year, corresponds to Chunlasakharat 1084 (L.E. 1084=A.D. 1722/3). But on the navigation chart of A.D. 1687/8 in The Hague, and on Kaempfer's and La Loubère's charts, this canal appears as completed. In addition, the topographical map of the 1910s and this writer's field research show that the dimensions of the Tret Noi canal correspond exactly with those given in the chronicle³⁴. So, although this description refers to the Tret Noi canal, other evidence suggests that the date of excavation is incorrect, and should be set before A.D. 1687. However, no other description concerning this project can be found in the chronicles. Prince Damrong and the author of *A History of Nakhon Khüankhan* pointed out this discrepancy, asserting that the description must relate to the Lat Pho canal located near the southern town of Phra Pradaeng³⁵. But, because the description in the chronicle does not fit the Lat Pho canal, but does fit the Tret Noi canal, the claim is not well founded. The date of excavation therefore remains obscure. The "southern provinces" may indicate the fourth-class provinces (*miang chhattawa*) situated south of the capital. Large numbers of corvée laborers living in nearby provinces were ordinarily conscripted for canal excavation.

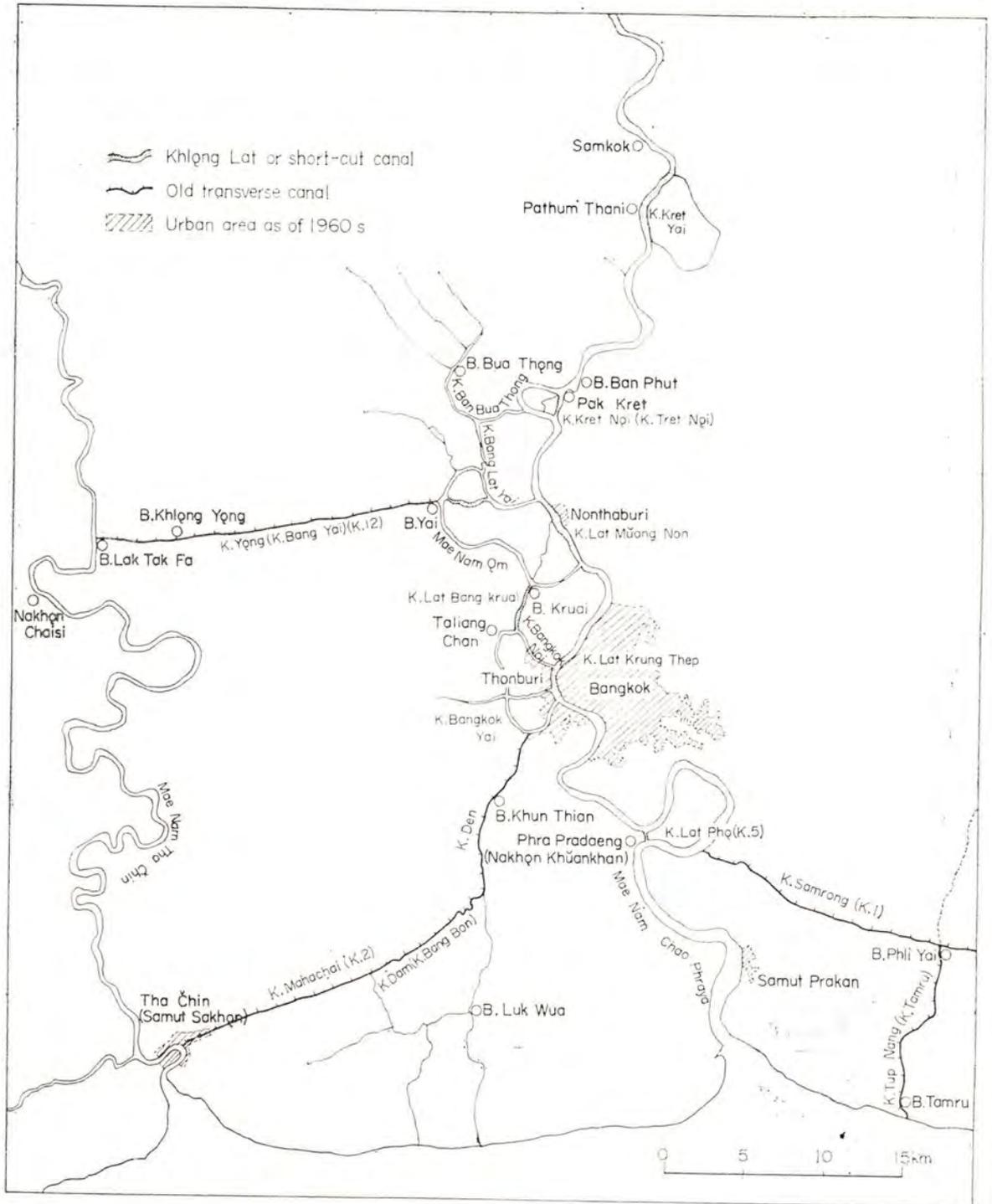
As the construction of short-cut canals frequently caused shifting of main channels, the network of the Chao Phraya between Pathum Thani and Phra Pradaeng has been largely transformed, as shown in figure 3. The network of old channels, tributaries, distributaries and artificial short-cut canals made up a comprehensive system of water transportation between the two towns. With the development of transportation in the lower delta region from the mid-nineteenth century, this canal system was important in linking the many trunk canals constructed to the east and west of the Chao Phraya with the capital, Bangkok.

33. *PPKA 2*: vol. 2, p. 219. In a recently published edition of the Somdet Phra Phanarat version, "Kret Noi" is given in place of "Tret Noi". (*PPKA 4*: p. 595.) The year L.E. 1048 given in *PKK* could be a misprint. (*PKK*: p. 130.)

34. See the Čhangwat Nonthaburi sheet, 459/4-47.

35. Sang, 1958: pp. 11-12.

Figure 3. Short-cut canals and old transverse canals of the Ayutthaya period



Transverse canals. The dynastic chronicle cites two examples of transverse canals constructed for the main purpose of water transportation. These are the Samrong canal, which runs from the east bank of the Chao Phraya toward the Bang Pakong river, and the Mahachai canal, which runs transversely from the west bank to the mouth of Tha Chin river. Both canals were built across the barren coastal area, which was sparsely populated in that period³⁶.

According to the chronicle, the Samrong and Thap Nang canals to the southeast of Bangkok were already in existence in L.E. 860 (A.D. 1498), during the reign of Ramathibodi II, that is, the early Ayutthaya period. In this year, because of the inconvenience to navigation caused by deposition of silt, the king ordered the improvement of the two canals³⁷. The pattern of channels on topographical maps suggests existing natural channels between the Chao Phraya and the Bang Pakong, and that the Samrong canal was built to link these natural channels. As there is no other information about this canal, it is not clear when it was constructed.

For the Mahachai canal in the west, information is available on its excavation and the reasons why it was built. This canal, in contrast to the Samrong canal, was constructed as a straight channel. In L.E. 1066 (A.D. 1704) the chronicle records as follows:

The King, Prabat Boromabophit Phra Phuttha Čhaoyuhua [Phra Phuttha Čhao Sĩa], thought that the Khok Kham [Mahachai] canal was so tortuous that it was troublesome for people to row their boats along it. Their route is long and circuitous. So the meandering parts should be made straight. Then the King ordered the Samuha Nayok ["Minister of Civil Affairs"] to conscript thirty thousand corvée laborers from the provinces to excavate the Khok Kham canal, to straighten it and make it 6 *sok* [3m] deep, 8 *wa* [16m] wide at the top and 5 *wa* [10m] wide at the bottom. He also appointed Phra Ratchasongkhram as chief director, in command of all provincial corvée labor, and responsible for completion of the canal excavation in accordance with the King's order³⁸.

36. La Loubère, 1691: tome 1, pp. 7-8.

37. *PPKA 2*: vol. 1, p. 48.

38. *Ibid.*: vol. 2, p. 204.

The chronicle also relates how the king told high-ranking noble officials of the glorious achievements in canal construction by former kings, from King Ramathibodi II's construction of the Samrong canal in A.D. 1498 to King Prasat Thong's Nonthaburi short-cut canal constructed in A.D. 1636³⁹. He then solemnly declared that he would complete this work. The *corvée* labor commanded by Phra Ratchasongkram was mobilized from eight provinces in the lower part of the delta, that is, Nonthaburi, Thon Buri, Nakhon Chaisi, Sakhonburi, Samut Songkhram, Phetchaburi, Ratchaburi and Samut Prakan. It appears that scientific survey methods introduced by Europeans were used for the first time in large-scale canal construction in Thailand. Phra Ratchasongkhram ordered the measurement of the projected route of 340 *sen*, or 13.6 kilometers (km), with surveying instruments, and he himself took charge of part of the excavation⁴⁰. Construction began in the next year, A.D. 1705, but remained unfinished because of the death of the king, Phra Phuttha Chao Süa. It was not until more than ten years later, in the reign of King Thai Sa (L.E. 1083, or A.D. 1721), that it reached the mouth of the Tha Chin river, by mobilizing 30,000 *corvée* laborers⁴¹.

The straight part of this long transverse canal seems to have been achieved by dextrously straightening some winding distributary channels (fig. 4). Even on a topographical map of the 1910s, it passed through spacious barren terrain with brackish vegetation⁴². As with other canals of the Ayutthaya period, this suggests that the canal was not excavated for improvement of agricultural production, but for inland navigation in the coastal provinces, and south to the Malay Peninsula.

These two transverse canals, which allowed traffic to move from the Chao Phraya trunk channel to the mouths of the two parallel main channels to the east and west, contributed to the development of communication facilities, especially to and from coastal provinces and the capital. Thus the government of Ayutthaya seems to have primarily

39. *Ibid.*: vol. 2, p. 205.

40. *Ibid.*: vol. 2, pp. 204-206.

41. *Ibid.*: vol. 2, pp. 218-219.

42. See the Samut Sakhon sheet, 530/4-47 and the Ban Hua Krabu sheet, 531/4-47.

intended to secure transportation facilities for movement of corvée labor and, through expansion of the canal system south of the capital, to encourage foreign trade, which is important in explaining the vigor of the Ayutthaya administration.

2. *The early Ratanakosin period (A.D. 1782-1851)*

There was no marked development of canal construction in the early Ratanakosin period, especially during the reign of Rama I and Rama II. City moats which contributed to the defence of the capital, and some short-cut canals for navigation, were constructed continuously. In the early Ratanakosin period, canal construction consistently followed the Ayutthaya tradition.

City moat canals. The excavation of the Rop Krung canal as an eastern city moat by conscripted Cambodian captives in L.E. 1145 (A.D. 1783), and the construction of a moat-fortified city similar in form and function to Ayutthaya, are mentioned in *The Dynastic Chronicle of the Ratanakosin Era, Rama I*⁴³. The city plan of the new capital seems to have been significantly influenced by the old capital of Ayutthaya. The chronicle records that:

The King ordered the excavation of a large canal to the north of Wat Saket, named the Mahanak canal. This canal was excavated so that the city people could assemble, in boats, to perform music and to recite poetry as in the rainy season ceremony of the old capital, Ayutthaya⁴⁴.

Although generally considered as a route for traffic to and from the eastern region from the fortified city area, it is noteworthy that the Ratanakosin dynasty's desire to restore the glory of old Ayutthaya was reflected in plans for canal construction in this period.

Short-cut canals. The removal of the core of the kingdom to a more maritime location, with the establishment of the new capital at the lower part of the delta, meant that the short-cut canals dug in the Ayutthaya period were greatly utilized. But unexpected problems were also encountered because of those canals. For instance, the Lat Pho canal which was excavated to avoid a large meander south of Bangkok,

43. *PPKR I, II*: p. 68.

44. *Ibid.*: p. 68.

had been gradually widened by high tides, allowing seawater to penetrate farther inland and causing widespread damage to ricefields near the capital at times of flooding. Rama I therefore ordered that bricks brought from the ruins of Ayutthaya be used to construct a barrage to hold back the tidal water, in L.E. 1146 (A.D. 1784)⁴⁵.

Changes in canal development. It seems to have been during the reign of Rama III that changes took place in canal construction, which had previously been the same as that of the Ayutthaya period. Firstly, canal construction became more closely related to military affairs. Secondly, with the proliferation of taxation of farming, and the pervasion of payment in specie instead of performing corvée, a change was effected in the labor used in canal construction. Chinese wage labor, which was cheap and reliable, was widely used as a substitute for unreliable Thai corvée labor under the disorganized process of traditional conscription⁴⁶.

The military role of river channels and canals in moving troops and supplies needs to be stressed⁴⁷. In this period, with conflicts with Burma, and later with the British in the Malay Peninsula, with Annam over Cambodia, and the problem of establishing sovereignty over the Laotian principalities of the Khorat Plateau and the middle reaches of the Maekhong river, rapid conveyance of troops and supplies was the main consideration. At the same time, in order to meet this heavy military expenditure, the securing of transportation facilities for collection of various taxes and the requisition of goods was also necessary⁴⁸. Because of these military and revenue requirements, the reinforcement of the defense of the mouths of rivers or the existing main canals near the capital, and the maintenance and construction of transverse canals linking the main parallel channels, were regarded as important during this period.

Maritime ports, called *huamiuang pak nam* ("fortified rivermouth town"), which occupied strategic points at the mouths of the rivers Chao Phraya, Tha Chin and Maeklong, had performed an important function

45. *Ibid.*: pp. 79-80.

46. Ishii, 1968: pp. 51-52.

47. Wales, 1965: pp. 229-230.

48. Vella, 1957: p. 24.

as centers of trade under the jurisdiction of the Krom Tba ("Harbor Department") since the Ayutthaya period. These towns also functioned as fortified towns with garrison troops. Phra Pradaeng was typical of such a fortified town at the beginning of the Ayutthaya period. Later, in the reign of King Songtham at the beginning of the seventeenth century, Phra Pradaeng was abandoned because of regress of the shore-line caused by deposition of sediment at the mouth of the Chao Phraya river, and Samut Prakan was established farther south on the east bank.

From L.E. 1176 to 1178 (A.D. 1814-1816), Rama II ordered the establishment of a new fortified town, Nakhon Khüankhan, on the opposite bank to old Phra Pradaeng, between Samut Prakan and the capital, where 300 Mon conscripts from the old Mon settlement of Pathum Thani were settled as garrison troops⁴⁹. There is a description of fort construction at Samut Prakan in L.E. 1181 (A.D. 1819)⁵⁰.

Although these forts were located at strategic points along the Chao Phraya main channel for the defense of the capital, they were also gradually established at the junction of the existing canals. In B.E. 2372 (A.D. 1829) immediately after the rebellion of Čhao Anu was crushed, the chronicle of the reign of Rama III reads as follows:

The King ordered Phraya Chodükrachasetthi (Thong Čhin) to erect a fort, later named the Wichian Chodük fort, at the junction of the Mahachai canal at Sakhonburi. The wages of the Chinese for brickwork were 47 *chang*, 15 *tamliang*, 3 *baht*, 2 *saliang*, 1 *fiang* [3,823.625 baht]. Then the King ordered the Mon clan under the command of Čhao Phraya Mahayotha to live in the town of Sakhonburi.⁵¹

Sakhonburi functioned as a traffic junction for the Tha Chin river and the Mahachai canal. It is important to note that the chief director of construction seems to have been descended from a Chinese noble, and that many Chinese wage laborers were hired. This appears to be the first example of Chinese wage labor being hired for large-scale public

49. *PPKR I, II*: p. 505.

50. *Ibid.*: p. 692.

51. *PPKR III, IV*: p. 92.

works in the dynastic chronicles⁵². Thereafter construction or improvement of canals was mostly carried out by Chinese wage labor rather than corvée labor.

The chronicle next relates the construction of the Sunak Hon canal (fig. 4), a long transverse canal, running through the coastal delta-flat region to the mouth of the Maeklong river, and linked with the Mahachai canal at Sakhonburi:

The King named Čhao Phraya Phra Khlang ["Minister of Finance"] chief director of excavations for the Sunak Hon canal. Čhao Phraya Khlang discovered that the currents which met at the straight section made it shallow, and considered that if a lateral canal were dug flowing into the point where the currents met, it would remain at the required depth. He hired Chinese wage labor to excavate a lateral canal from the Sunak Hon canal to the meadow at Pho Hak village. And then he conscripted water buffaloes and peasants to wade through the canal. So the water flows swiftly and the canal keeps its depth to this day. The wages of the Chinese for excavation were 102 *chang*, 4 *tamliang*, 1 *saluang*, 1 *fiuang* [8,176.375 baht]⁵³.

The Sunak Hon canal seems to have consisted of two natural distributary channels parallel to the coastline. The description suggests that tidal currents, which came upstream from both the Tha Chin and the Maeklong rivers at high tide, met at the center of this canal and deposited thick silt sediments⁵⁴. The deposition of silt sediments often occurred in canals in the lower part of the delta, even in later periods, and it was necessary for the government to carry out frequent repairs. In the Sunak Hon canal, the construction of a drainage canal to take the

52. As an early example of public works carried out by Chinese wage labor, Skinner mentions the funeral ceremony of King Rama II in A.D. 1824. (Skinner, 1957: p. 114.) The royal chronicle of the fourth reign mentions excavation of a short-cut canal behind the town of Nakhon Khüankhan by Chinese wage labor during the second reign. But we cannot find any evidence of this in Prince Damrong's edition of the royal chronicle of the second reign. *PPKR III, IV*: p. 436; *PPKR I, II*: p. 693.

53. *PPKR III, IV*: pp. 92-93.

54. Mgr. Pallegoix who travelled this canal from the Mahachai canal via Sakhonburi in A.D. 1843, describes its channel as running tortuously to the west and its water as brackish. (Pallegoix, 1854: tome 1, p. 98.)

tidal current at high tide was carried out, and the silt sediment on the bottom of the canal was stirred up by water buffaloes and washed out.

Besides the technical importance of this canal improvement, it has a wider significance because the Sunak Hon canal, together with the Mahachai canal, opened artificial navigation routes between the three main river channels, the Chao Phraya, Tha Chin and MaeKlong. The *huamüang pak nam*, such as Sakhonburi and Samut Songkhram, stood at the junctions of rivers, running from north to south, and the transverse canal routes. At this period, after the British victory in the first Anglo-Burmese War, and with tension about sovereignty over the Malay sultanates, this westward canal route seems to have been of special significance in military affairs.

Conflict with Annam over Cambodia encouraged canal construction eastward from the capital. Thus the famous transverse Saen Saep canal, the eastern part of which is called the Bang Khanak canal, and which extended to the Prachin Buri river, the middle part of the Bang Pakong river, was excavated in L.E. 1199 (A.D. 1837)⁵⁵. Construction of this canal aimed at hastening the movement of troops and military supplies to Cambodian territory, and took three years for a distance of 1,337 *sen 19 wa 2 sok* (53.519 km)⁵⁶. This canal, running in a straight line on the deltaic high region to the east of the capital, facilitated exploitation of the lower part of the delta region and functioned as a main trunk canal in the following period⁵⁷.

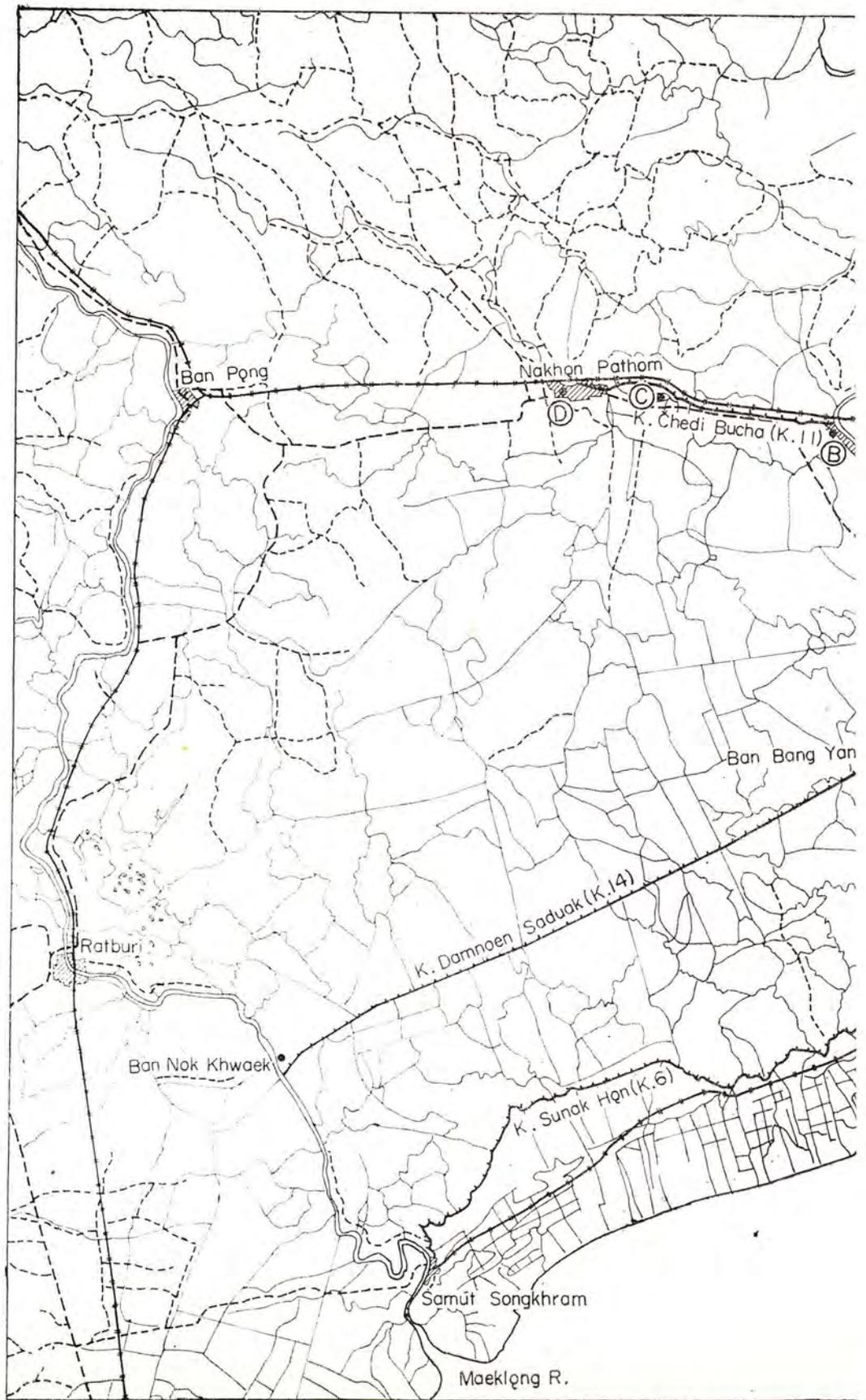
Most canal construction undertaken to secure the flow of revenue and to facilitate military affairs in the early Ratanakosin period, is of little consequence to either the development of agricultural production or the expansion of a commercial economy. Although they had little direct connection with agricultural development when constructed, these transverse canals, which connected with the parallel river channels in the lower delta region, provided a basic network of canals for agricultural development in the following period.

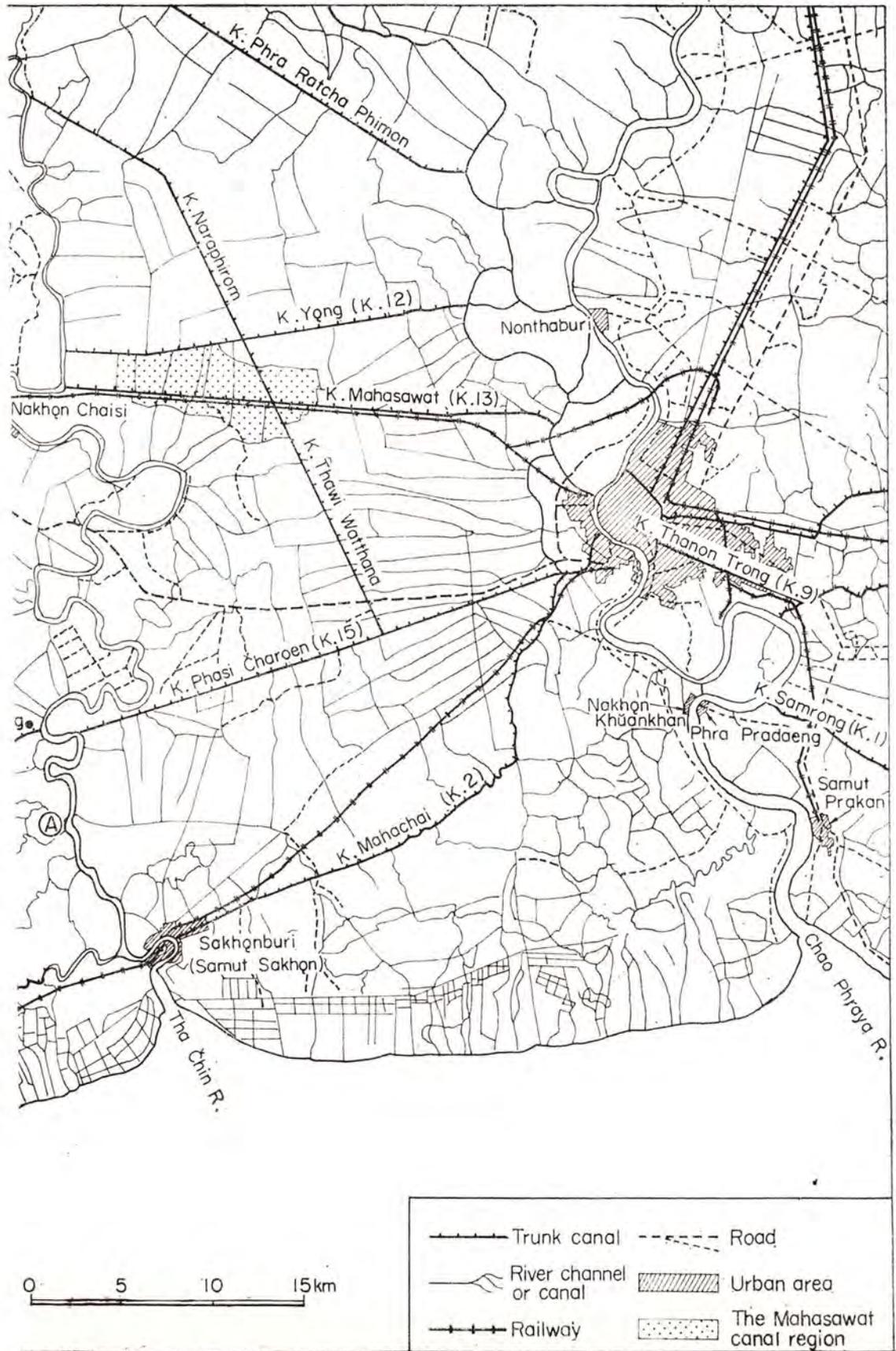
55. *PPKR III, IV*: p. 179.

56. *PKK*: p. 133.

57. Muslim Malay immigrants or *Khaek Malayu* from Müang Sai (Kedah) began to settle along this canal after the military expedition during the third reign. (Chunlachomklao, 1933: p. 8.)

Figure 4. Tru





D. Canal development in the mid-nineteenth century

1. Changes in Bangkok

The liberalization of trade under the terms of the Bowring Treaty, A.D. 1855, afforded an opportunity for the development of the Thai national economy in the following period. The landscape of Bangkok changed rapidly, from a military, moat-fortified city with the palace as its center, to a commercial city, interested in foreign trade with the Western colonial powers as liberal trade, rather than the former royal monopoly. The plan of Bangkok, however, had developed before the political and economic impact of Western colonial powers was felt. In canal development, the expansion of city area through the excavation of an outer city moat under population pressure in the mid-nineteenth century should be noted.

In B.E. 2394 (A.D. 1851) soon after his accession, Rama IV reflected on the achievement of the kings of the Ratanakosin era as follows :

The previous three kings ordered canals to be excavated for the people's benefit. In these days, as the nation has attained prosperity and the population of the capital has increased greatly, the city area should be expanded⁵⁸. The population of common people has become much larger. Houses and residences of officials and common people are mostly outside the city area⁵⁹.

The Phadung Krung Kasem canal as an outer city moat, 137 *sen* 10 *wa* (5.5 km) long, was excavated over three years. The city area was doubled, although the pattern remained the same. It is generally considered that the concentration of population in the city was chiefly caused by Chinese immigration. Table 2 shows the Chinese population of Bangkok from the beginning to the middle of the nineteenth century. The Chinese population comprised about half the total, and reached 62 per cent in 1822. In the 1850s it was more than 50 per cent of a total population of more than 300,000. The Chinese population was in a

58. *PPKR III, IV*: p. 437.

59. *Ibid.*: p. 453.

Table 2.
The Chinese population of Bangkok

Year	Chinese population	Total population	Percentage
1822	31,000	50,000	62
1826	60,700	134,000	45
1839	60,000	100,000	60
1843	70,000	350,000	20
1849	81,000	160,154	50.6
1854	200,000	404,000	49.5
1855	200,000	300,000	66.6

Sources :

1. J. Crawford, *Journal of an Embassy from the Governor-General of India to the Courts of Siam and Cochin-China* (London, 1828), p. 450.
2. D.E. Malloch, *Siam: Some General Remarks on its Productions* (Calcutta, 1852), p. 70.
3. H. Malcom, *Travels in South-Eastern Asia, Embracing Hindustan, Malaya, Siam and China, with Notice of Numerous Missionary Stations, and a Full Account of the Burman Empire*, vol. 1 (London, 1839), p. 139.
4. F.A. Neal, *Narrative of a Residence in Siam* (London, 1852), p. 29.
5. D.E. Malloch, *Siam: Some General Remarks*, p. 70.
6. Mgr. Pallegoix, *Description du Royaume Thai ou Siam*, vol. 1 (Paris, 1854), p. 60.
7. Sir John Bowring, *The Kingdom and People of Siam*, vol. 1 (London, 1857), pp. 85, 394.

majority of 5:3 according to Mgr. Pallegoix, in 1854⁶⁰. Malloch's figures for 1826 and 1849 may be regarded as an approximate estimate of population within the old urban area surrounded by the Rop Krung canal. The Chinese population increased by 33 per cent from 60,700 to 81,000, while the Siamese population increased by only 4 per cent from 48,000 to 50,000, in 23 years⁶¹.

These Chinese, in the majority in the urban area, operated rice mills, shops and manufacturing industries, and not only developed a commercial economy in place of the Siamese corvée peasants, who were prohibited from moving under the traditional client-patron relationship, but also met the heavy demand for labor for the government's public works⁶². The liberalization of trade made this tendency more pronounced.

The liberalization of trade and political pressure from Western colonial powers caused a sudden change in the landscape of Bangkok. It also had an effect on canal construction in the city proper and the suburbs. For the period immediately after the conclusion of the Bowring Treaty, the chronicle reads as follows:

In the Year of the Small Snake, consuls and business executives of foreign countries submitted a joint letter as follows. Merchant vessels must go enormous distances to reach Bangkok. In the rainy season, because of the strong current, a ship must waste many days before reaching Bangkok. Let our commercial establishments move to the south of the mouth of the Phra Khanong canal in Bang Na District. And we ask that a short-cut canal be excavated from Bang Na District to the Phadung Krung Kasem canal⁶³.

Accepting this request of the Western trading companies that occupied the east bank of the Chao Phraya river to move far to the south, on the grounds that conflict with foreigners should be avoided, the king ordered the excavation of the Thanon Trong canal, 207 *sen* (8.28

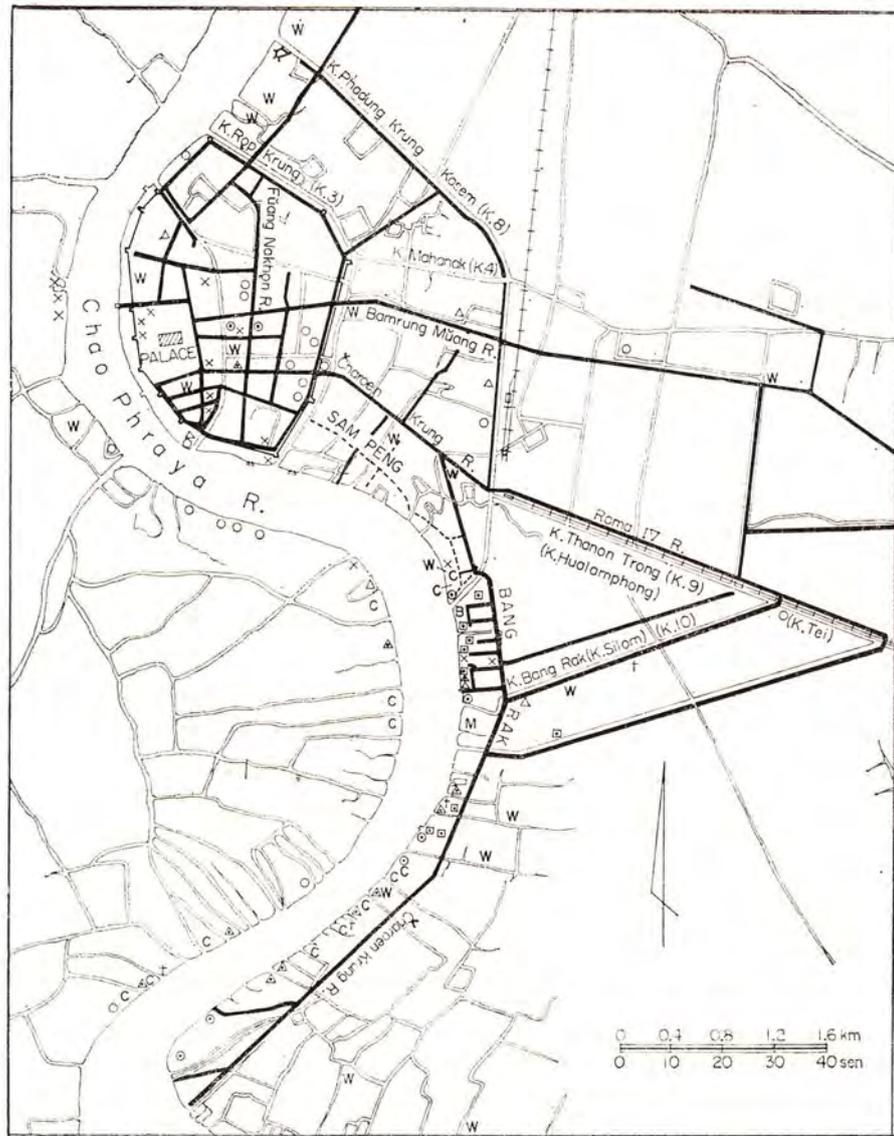
60. Pallegoix estimates the population as follows: Chinese who pay poll tax (200,000), Siamese (120,000), Cochinese and Annamese (12,000), Cambodian (10,000), Peguan [Mon] (15,000), Laotian (25,000), Burmese (3,000), Malayan (15,000), foreign Christian (4,000); total=404,000. (Pallegoix, 1854: tome 1, pp. 60-61.)

61. Malloch, 1852: p. 70.

62. Skinner, 1957: pp. 115-118.

63. *PPKR III, IV*: pp. 533-534; Thepchu, 1975: p. 68.

Figure 5. Plan of Bangkok, around A.D. 1900



- | | |
|--|------------------------|
| — : River channel or canal | □ : Consulate |
| — : Road | C : Chinese residence |
| ○ : Residence of royal family or noble | W : Wat or temple |
| × : Government office | † : Church or Cemetery |
| △ : Public institution | B : Bank |
| ⊙ : Foreign residence | M : Market |
| ▲ : Company, Warehouse, Ricemill, Saw mill, etc. | |

This map is modified from the original by J. McCarthy (A.D. 1900), and therefore does not necessarily reflect the city as it was at the middle of the nineteenth century. In particular, the railway and many of the businesses, warehouses, etc. developed along the Chao Phraya from the Bang Rak area, and date from the fifth reign, or the close of the nineteenth century. However, the city skeleton of canals, river channels and roads developed from the middle of the nineteenth century.

km) long, and also the construction of a road along its north bank. This was the first case of large-scale road construction in response to foreign wishes. The canal corresponds to the Hualamphong or Toei canal, and the road on the north bank later became the Phra Rama IV Road. Nevertheless it seems that the foreigners did not move to the south but remained where they were⁶⁴. A few years later, in B.E. 2404 (A.D. 1861) the Western consuls complained of ill health because there were no roads for their horse-drawn coaches, and put pressure on the government to construct a road system in the capital⁶⁵. Under this pressure the king decided to initiate road construction on a large scale. A road system, including Charoen Krung Road was constructed, also called "New Road", which extends from the inner city area through Bang Rak District where foreign consulates, trading companies and residences were mostly located, as the main road. Road construction was usually undertaken in parallel with canal excavation. For example, in the case of the Bang Rak (Silom) canal, the mud which was dug out from the canal trench was used for the road. At the same time, bridges were built over many canals, and a city plan based on a road system was gradually consolidated⁶⁶. In particular Bang Rak District, south of the Phadung Krung Kasem canal, where Charoen Krung Road is parallel and close to the Chao Phraya channel, had both water and road transport facilities. In this district, the consulates and residences of foreigners, a harbor, docks, rice mills, sawmills, warehouses and churches were located in the narrow area between the river channel and the road. Thus the traditional city plan of Bangkok, which had consisted of city moats and a complicated network of canals, underwent a marked change, its landscape being colored by colonial buildings⁶⁷. (See figure 5.)

64. *PPKR III, IV*: p. 534.

65. *Ibid.*: pp. 601-603; *PP 25*: p. 287; Thepchu, 1975: pp. 69-78.

66. Bamrung Muang Road, Füng Nakhon Road, and part of Charoen Krung Road constructed inside the Phadung Krung Kasem canal, complemented existing canals and were important to commercial communication. (Phlainoi, 1960: p. 163.)

67. McGee, 1967: pp. 72-74.

2. Construction of trunk canals in the lower part of the delta

It is generally thought that in order to meet the demand for rice with the development of foreign trade, the government tried to increase rice production by expanding rice-growing to uncultivated wasteland in the lower delta region. However, it is not always clear where such agricultural development was undertaken, and how it was attained. Canal construction in this period is closely related to the expansion of ricelands.

In general, the government undertook canal construction to secure transportation facilities for the circulation of products, and also to expand irrigated riceland and to promote reclamation by peasants. A series of policies for encouragement of reclamation, including a policy of low land taxes for newly cultivated land, seems to have contributed to the expansion of riceland along newly excavated canals in this region⁶⁸. Although the above suggests the basic course of agricultural development during Rama IV's reign, the regional development of canal construction in modern Thai history deserves more than passing consideration. In this section, I discuss the formation of the canal system by investigation of some examples of canal excavation.

Since the conclusion of the Bowring Treaty, which led to a steady increase in rice exports, cultivation of rice as a cash crop has gradually extended to the lower delta. Canals in this region had to irrigate the land, although they merely functioned as inundation canals which were able to send floodwater to riceland only during the rainy season. In the 1850s and 1860s, canal construction in some regions seems to have been closely related to the transportation of cash crops such as sugarcane. Sugarcane, as a dry-season crop, was cultivated only in comparatively dry areas, from Nakhon Chaisi to Nakhon Pathom in the west and Chachoengsao Province in the east⁶⁹. This area corresponds with the deltaic high, the old delta and the fan-terrace complex area.

68. Ingram, 1971: pp. 75-83.

69. Sugarcane is not cultivated under extended inundation, but grows well in somewhat drier areas, such as the margins of the delta. (van der Heide, 1903: pp. 52-53; Credner, 1935: pp. 239-240.)

Although it is usually thought that the cultivation of sugarcane was introduced to Thailand in the 1810s by overseas Chinese from Taechew⁷⁰, sugar plantations and factories with 200 to 300 Chinese laborers were already established in Nakhon Chaisi Province in the reign of Rama III⁷¹. Of the exports listed by Malloch⁷², sugar and sugar products were the largest, amounting in value to about 708,000 baht around 1850, and throughout the 1850s and 1860s they were among the principal exports of Thailand⁷³. Floods and water shortages in Nakhon Chaisi Province in the 1870s, and the decline in the market price caused by the production of cheaper sugar in Java, brought about a rapid decline in sugarcane cultivation in those provinces⁷⁴.

A small-scale, short-cut canal construction project for transporting sugarcane is found in the chronicle as follows:

There is a small canal at Lat Krut, which was first excavated, in order to transport sugarcane, by Chinese people in the reign of Phrabat Somdet Phra Nang Klao Chaoyuhua [Rama III]. These days the current has eroded it until it is as wide as the main channel [the Tha Chin river]⁷⁵.

This canal, point A on the topographical map (fig. 4), was intended to shorten the route from sugarcane plantations along the Tha Chin river by way of Sakhonburi to the capital. This route (Nakhon Chaisi–Tha

70. Crawford suggests that introduction of sugarcane cultivation by Chinese does not date back more than 12 years from his visit to Siam (A.D. 1822). The cultivated areas in that period, he indicates, were Nakhon Chaisi and Chachoengsao Province along the Bang Pakong river. (Crawford, 1828: p. 112; Skinner, 1957: p. 112.)
71. Pallegoix, 1854: tome 1, pp. 101-102; Neal, 1852: pp. 68-69.
72. Malloch, 1852: pp. 46-47.
73. According to Finlayson, sugar products in A.D. 1821 amounted to 30,000 *picul* (1 *picul* = 60 kg). Neal also states that 20 vessels loaded with more than 4,000 tons of sugar sailed for Singapore and Bombay in 1841. (Neal, 1852: pp. 68-69.) Ingram mentions that by 1859 exports amounted to 204,000 *picul*, a rise from 107,000 *picul* in 1849. (Ingram, 1971: p. 123.)
74. Ministry of Commerce and Communications, 1930: pp. 220-221; Credner, 1935: p. 241.
75. *PPKR III, IV*: p. 713.

Chin river—Sakhonburi—the Mahachai canal) to the capital was too long. The route between the sugar production area and the capital had to be reduced.

The Chedi Bucha canal (k.11, fig. 4). Rama IV, who had carried out large-scale repairs of the Mon relics of the Phra Pathom Chedi and constructed his own palace nearby, ordered the excavation of a canal between Nakhon Chaisi and the Chedi. The chronicle states that this canal was dug from Tha Na, through the palace, to Wat Phangam, a length of 448 *sen* (17.92 km)⁷⁶. It was continued westward from a ferry at Tha Na, Nakhon Chaisi, which is found at a marketplace called Talat Tha Na at point B on the topographical map (k. 11, fig. 4)⁷⁷. The chronicle also states that for a royal visit of the king in the dry season, a road 150 *sen* (6 km) long was constructed between Chao Sadao and the palace. The village name Chao Sadao is at point C⁷⁸. This region is not part of the delta, but is first part of the deltaic high, then of the fan-terrace complex area, so a road would be necessary in the dry season. According to *A History of the Ministry of Agriculture*, although the canal was excavated primarily for the benefit of people making their pilgrimages to the Phra Pathom Chedi⁷⁹, sugarcane transportation was also a specific aim⁸⁰.

For navigation between Nakhon Chaisi and the capital, it is highly probable that, other than the long route through the Mahachai canal, boats also used the Yong or Bang Yai canal (k. 12) running eastward from Nakhon Chaisi, though the date of its excavation is uncertain. Using this canal, they could either go via Nonthaburi or directly to the capital through the meandering Mae Nam Om, an old channel of the Chao Phraya river. The Yong canal, however, was shallow at this

76. *Ibid.*, pp. 804-805.

77. See the Nakhon Chaisi sheet, 494/4-47.

78. See the Nakhon Pathom sheet, 493/4-47.

79. *PKK*: pp. 133-134.

80. Although Prince Damrong mentions that in the latter part of the fifth reign, there were still 17 sugar factories, and sugar factory tax for one year was 100 *chang* in Phra Pathom Chedi District. (Damrong, 1968: pp. 15-16.)

period; so boats had to be towed in the dry season⁸¹. Thus, as a consequence of the opening of the Chedi Bucha canal, the region specializing in sugarcane cultivation was connected with the capital and chief port.

The decline of sugarcane cultivation and the steady rise of rice prices gradually brought about canal construction with the principal object of reclamation of riceland in the lower delta region. Most of this canal construction took place in the part of the deltaic high lying between the Chao Phraya and the Tha Chin rivers, to the west of the capital, in the 1860s. This region provided easier access for rice cultivation and dwellings than the delta flat area. Within only slightly more than ten years, an integrated framework of inland navigation was built up connecting these main channels and the Maeklong river, which the transverse Damnoen Saduak canal joined. Existing main canals such as the Mahachai canal of the Ayutthaya period and the Chedi Bucha canal also complemented this system, and functioned as trunk canals in the lower delta region.

Although most of these canals, built for both water transportation and irrigation of adjacent land, provided to a certain extent for expansion of riceland, such vast tracts of uncultivated land were not always rapidly transformed into riceland by peasant reclamation. It was the outstanding characteristic of canal development in this period that, although large-scale land-holdings by the royal family and high-ranking officials developed along the newly excavated canals, large tracts of land were left uncultivated. The government was compelled to invest heavily in these canal projects because of the shortage of royal finance⁸², and therefore had to adopt some effective means of raising the necessary capital. High-ranking noble officials and wealthy Chinese thus came to play an important part in these projects. Here I discuss the construction of the later trunk canals, using the Mahasawat, Damnoen Saduak and Phasi Charoen canals as examples.

81. *Akkharanukrom Phumisat Thai* ("Geographical Dictionary of Thailand") is abbreviated to *APT*: vol. 2, pp. 171.

82. Shortage of royal finance of this period was mainly caused by the abolition of royal trading monopolies, unstable tax conditions under the farm system, and a considerable increase in government expenditure. (Ingram, 1971: pp. 176-177; Wira, 1961: pp. 104-106.)

The Mahasawat canal (k. 13, figs. 4, 6, 7). According to the chronicle, the king ordered the Minister of Finance, Čhao Phraya Rawiwong Maha Kosathibodi, and Phra Sisombat to excavate a canal westward from near the Bang Kruai short-cut canal northeast of Bangkok to the Tha Chin river northeast of Nakhon Chaisi, 676 *sen* (27.04 km) in length, 7 *wa* (14m) wide and 6 *sok* (3m) deep, beginning in L.E. 1219 (A.D. 1857)⁸³. However, there is slight confusion over this starting date, because *Collected Chronicles*, volume 25, reports that work started in B.E. 2403 (A.D. 1860) and was completed within that year⁸⁴. According to the chronicles, the wages of the Chinese laborers, which amounted to 1,101 *chang*, 10 *tamlüng* (88,120 baht), were appropriated from a forfeited bequest of about 1,000 *chang* (80,000 baht), which Thao Thep Akon Čhao Talat had accumulated, and the deficiency was covered by 100 *chang* from the Ministry of Finance and 1 *chang*, 10 *tamlüng* from the Minister as chief director. If one compares this figure with the revenue of the Ministry of Finance at this period, it appears that a considerable amount of money was invested in one canal project. Pallegoix's and Malloch's figures⁸⁵ of around 20 million baht appear to be over-estimates, so if one accepts that the amount of revenue was 1,947,369 baht in 1857 and 2,197,121 baht in 1860⁸⁶, wages of 88,120 baht equal 4.4 per cent of the national budget.

This canal, to the south of the existing Yong canal, was intended as the shortest route for transportation of native products, such as rice and sugarcane, between Nakhon Chaisi and the capital, as well as to bring adjacent land under cultivation. The Royal Draft of the Proclamation for the Royal Grant of Land to Princes and Princesses, B.E. 2404 (A.D. 1861), in *Collected Laws* states :

83. *PPKR III, IV*: pp. 530-531.

84. *PP 25*: p. 295.

85. Pallegoix's estimate comes to 26,964,100 baht and Malloch's to 33,372,000 baht. In particular, the figures of 12,000,000 baht (Pallegoix) and 22,380,000 baht (Malloch) for money payments in lieu of corvée seem incredibly exaggerated. (Pallegoix, 1854: tome 1, pp. 309-311; Malloch, 1852: p. 64).

86. *Wira*, 1961: p. 74.

A plain extending over both Nonthaburi and Nakhon Chaisi Provinces along the newly excavated canal which runs between Bang Khwang and Ban Ngiorai had been left uncultivated, so there had been no one to hold it. When the canal was excavated, the King ordered Chao Phraya Rawiwong Maha Kosathibodi, Minister of Finance and chief director of canal excavation, to make it into royal riceland. There are 1,620 *rai* [259.2 hectares (ha)] on the north bank in Nonthaburi Province, and 9,396 *rai* [1,503.36 ha] on the north bank and 5,184 *rai* [829.44 ha] on the south bank in Nakhon Chaisi Province; 16,200 *rai* in all. This land is divided into 50 plots; one plot is 324 *rai* [51.84 ha], being 60 *sen* [2.4 km] long and 5 *sen*, 8 *wa* [216 m] wide. As there is no landowner, the King is in full possession of this land and will grant some plots to princes and princesses, so that some will get one plot and some will get two. They should be cultivated by *corvée* peasants or leased to other people . . . This newly reclaimed riceland is exempt from land tax under the terms of the previous proclamation. But this kind of riceland cannot be sold to others. . . Hereafter, the holder of this riceland is exempt from land tax until the *tradaeng* deed now issued requires renewal.⁸⁷

Areas with convenient access, bordering Nonthaburi and Bangkok and the Tha Chin river, might have been already occupied at the time of canal excavation or even before. Rama IV intended to divide the unoccupied wasteland along the central part of the canal into rectangular plots, 2.4 km by 216 m, among his princes and princesses. In addition, he encouraged cultivation by issuing a *tradaeng* deed which gave exemption from land tax for two years. In other words, a landlord-tenant system, with large-scale land-holding by royalty, was planned.

How was this large-scale estate farming, derived from canal construction, to be operated? Prince Damrong's report concerning the riceland along this canal submitted to the throne in R.E. 122 (A.D. 1903), which includes a land register map and a list of royal landowners, provides much useful information on this subject⁸⁸. Figure 6 shows the register map itself, while figure 7 shows the Mahasawat canal region as of 1913 or 1914. In figure 6, the canal crossing the rectangular plots

87. "Prakat rang phraratchahatlekha phraratchathan na phrachaolukthoe" (PKPS: vol. 6, pp. 273-274.)

88. Damrong, 1903: "Rüang thina nai khlong mahasawat" (manuscript).

diagonally is the Naraphirom and Thawi Watthana canal, which was excavated between 1878 and 1880⁸⁹. From the shape of the plots on the register map, there are considerable deviations from the originally prescribed 60 *sen* by 5 *sen* 8 *wa* (324 *rai*). Prince Damrong writes:

The reason for this seems to be that these plots were not previously accurately surveyed. When the time came to stake out their borders with peasants' riceland, much of the riceland granted by the king on the south bank had to be staked out wider than the provisions. Even though most of the plots on the north bank could be staked out almost as in the provisions, their northernmost sides are not equal. The plots in the east are wider than those in the west, because the Yong canal [A-B, k. 12] which borders the plots, slopes in a southwesterly direction. So most of these plots are not 60 *sen* [2.4 km] long. And so the area of these plots along the Mahasawat, which the owners received as a royal grant, do not conform to the specifications of the proclamation, and were not equal from the beginning.⁹⁰

The irregular border of the southern plots, bounded by "peasants' ricelands", suggests that reclamation by peasants began to develop at the close of the nineteenth century⁹¹. Small, irregular channels running toward the Mahasawat canal from the Tha Chin river might have been used for irrigation of these reclaimed ricelands. This southern border and the northern F-G line composed of dikes separating ricelands indicated landownership, as well as, from the end of the nineteenth century, the administrative boundaries of districts (*amphoe*) or provinces (*changwat*).

Although some plots are more than 500 *rai* in area, most plots thus granted are around 300 *rai* (48 ha). Even the plots granted to Rama V, including those added later that formerly belonged to other members of royalty, only total 1,896.66 *rai* (303.47 ha). Dilock states that around A.D. 1900 one household cultivated about 80 to 100 *rai* on average, and in well-irrigated areas would be able to cultivate up to about 200 *rai* in central Thailand⁹². Such plots granted by the king

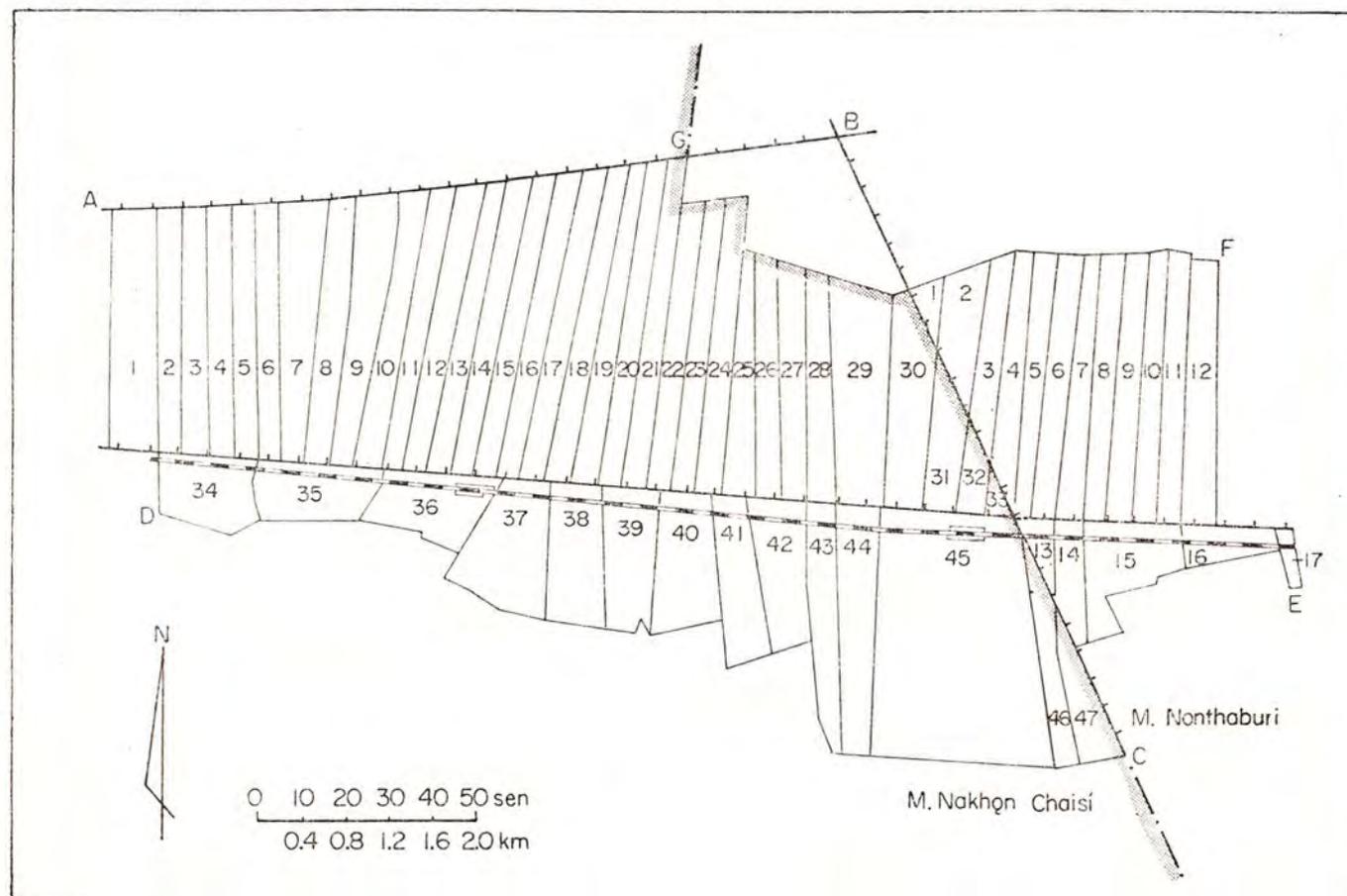
89. *PKK*: pp. 142-145.

90. Damrong, 1903: (manuscript).

91. For the conditions of rural society in that period, see the results of field research conducted by Suthon. (Suthon, 1975: pp. 60-76.)

92. Dilock, 1908: p. 98.

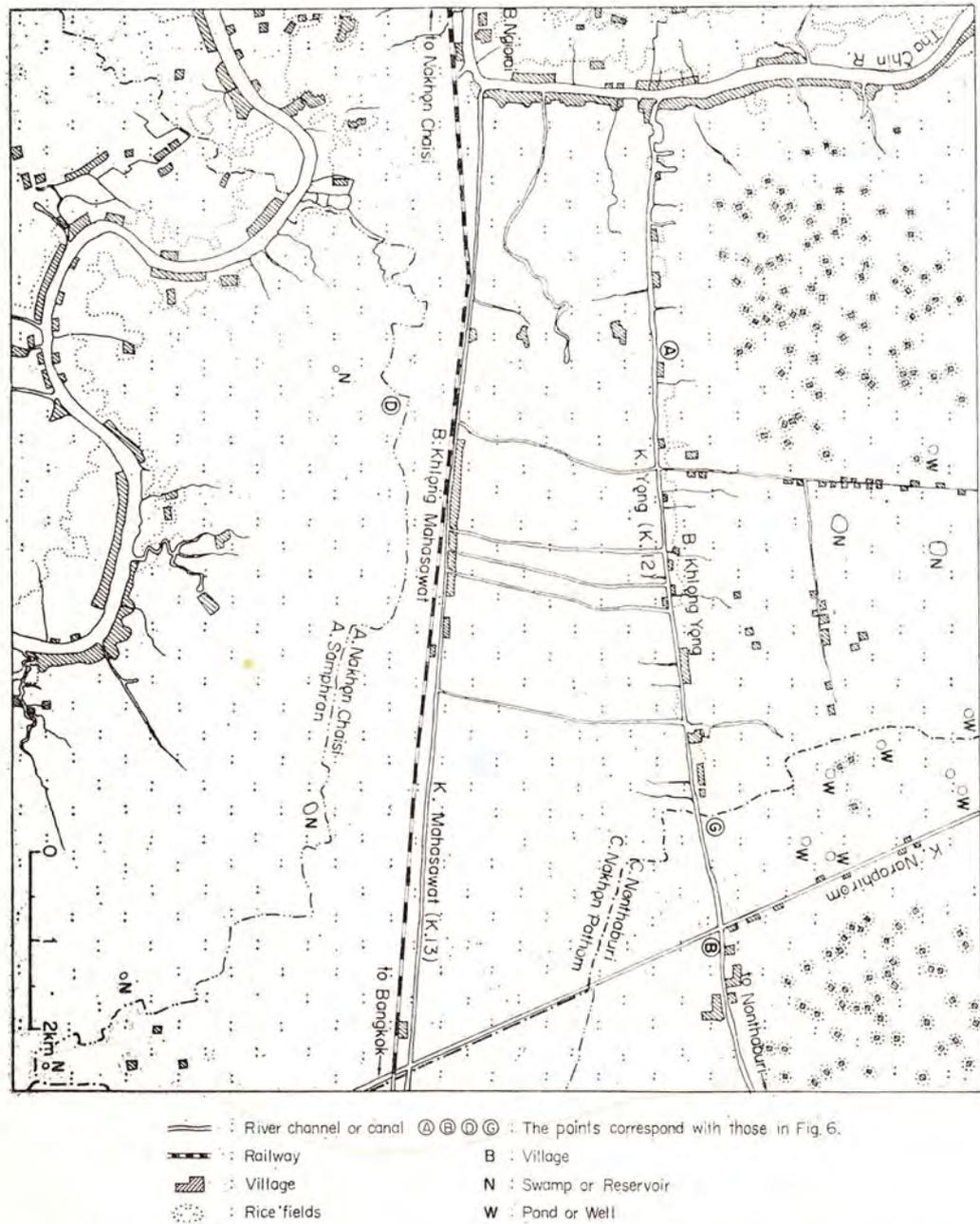
Figure 6. Land register map of the Mahasawat area, R.S. 122 (A.D. 1903)



From Damrong, 1908

- Notes: 1. N.C. 30 (Nakhon Chaisi 30) and N. 1 (Nonthaburi 1), N.C. 31 and N. 2, N.C. 32 and N. 3, N.C. 33 and N. 4, N.C. 46 and N. 13, N.C. 47 and N. 14, were each granted to one individual.
2. Only N.C. 25 and N.C. 29 were held by people other than the sons and daughters of Rama IV. N.C. 25 was granted to a high official by Rama IV, and N.C. 29 was held by an official himself who was engaged in division of the land by order of the Minister of Finance. The largest plot of land, N.C. 45, belonged to the prince who later became Rama V, and, together with the land granted to the other sons of Rama IV, its area was 1,896.66 rai (303.47 hectares).

Figure 7. The Mahasawat canal region



Notes: Based on the 1:50,000 topographical maps surveyed by the Division of Maps, Royal Thai Army, in 1913: the Ban Bangrakam sheet (published 1956), and the Nakhon Chaisi sheet (published 1914).

Neither sheet was revised in the 1950s. North of the Yong canal there seem to be isolated dwellings, scattered among the paddy fields, but the details are not clear. This suggests that the morphogenesis of these settlements can be explained by their location, as these scattered dwellings are on the delta flat, while most other dwellings are on the deltaic high.

were not too large to cultivate by the broadcast method, under which the fields are flooded during the rainy season and labor productivity is high. These plots were, however, not always fully cultivated by *corvée* peasants or tenants under the traditional client-patron relationship. The following description clearly suggests that.

In that time there were only a few cultivators, and there were vast amounts of wasteland. Although there were a few people who went to cultivate them, there was not enough labor for the granted area. At first, then, these lands were in good order, and there was no mutual infringement of land. When prospects for these lands became better after R.E. 115 [A.D. 1896] with the good price for rice, the area filled with peasants to cultivate it. Then mutual infringements frequently occurred at the edges of plots. Thus it came to be necessary to send me to stake out these plots at this time.⁹³

From this description it is obvious that, in spite of the establishment of large-scale land-holdings by royalty, concomitant with a large canal project in Rama IV's reign and the first half of Rama V's reign, still a large estate or a landlord-tenant system could not be operated unless *corvée* peasant or 'debt-slave' labor was employed under the traditional relationship⁹⁴. A large estate of over 1,000 *rai* (160 ha) operated by an eminent noble official and employing debt slaves was also reported by a foreigner in 1884 as lying along this canal⁹⁵. Debt slaves were probably often used by royalty or noble officials at the turn of the century, because the newly acquired large-scale lands suffered a perpetual shortage of labor, although slavery was soon abolished and gradually transformed into a landlord-tenant system⁹⁶. It took many years for free peasants to appear, through the disintegration of the traditional client-patron relationship and the increase in foreign demand for rice, and to transform these semi-wastelands into cultivated riceland. The period since A.D. 1896 roughly corresponds to the period of disintegration of *corvée* conscription⁹⁷. From that time, with increasing disputes over riceland, the government was faced with the necessity of land registration in the newly occupied lands of the lower delta region.

93. Damrong, 1903: (manuscript).

94. Dilock, 1908: pp. 96-97.

95. Hardouin, 1884: p. 192.

96. For economic conditions in this transitional period, see Ammar's discussion. (Ammar, 1972: p. 23.)

97. Ishii, 1966: pp. 43-45.

The Damnoen Saduak canal (k. 14, fig. 4). The chronicle reads:

On Monday, the fourth day of the waxing moon of the seventh month [25 May 1868 A.D.], the Minister of Military Affairs went to the opening of the newly excavated canal at Bang Nokkhwaek. Excavation of this canal was started at the end of the Year of the Tiger, eight of the decade [A.D. 1866/7], westward from the east bank of the Bang Yang river in Nakhon Chaisi Province to the Bang Nokkhwaek canal in Ratchaburi Province. It is 840 *sen* [33.6 km] long, 6 *wa* [12 m] wide and 6 *sok* [3 m] deep. Wages for excavation and removing tree stumps amounted to 1,400 *chang* [112,000 baht], of which 1,000 *chang* [80,000 baht] was appropriated from the Minister of Military Affairs and 400 *chang* [32,000 baht] granted by the King.⁹⁸

The project was carried out under direction of Somdet Čhao Phraya Sisuriyawong (Chuang Bunnag), who had held the high official position of Minister of Military Affairs. A source mentions that he acquired large areas of unclaimed land along the canal as collateral for his heavy investment⁹⁹. In fact, this heavy investment by Sisuriyawong, as Rama V wrote in a later letter, was appropriated from the balance of the sugar tax revenue which had been put in Sisuriyawong's charge for construction of a palace at Phetchaburi¹⁰⁰. Sisuriyawong took full advantage of the project, distributing lands along the canal to his wives, relatives and dependants, and selling it to others for cultivation. Large-scale landholding was thus established here as along the Mahasawat canal.

The Damnoen Saduak canal, linking fortified towns at the river mouths in place of the existing Sunak Hon channel, was intended to develop water transportation between the Tha Chin and Maeklong rivers. Rice produced in the Ratchaburi area, and fruit and vegetables from the Chinese plantations on the natural levees of the Maeklong river, could reach Tha Chin river by this new straight canal rather than by the existing coastal channels, which were winding and troublesome to navigate¹⁰¹. For transport to the capital, this canal must be considered in conjunction with the Phasi Charoen canal.

98. *PPKR III, IV*: p. 711.

99. *PP 25*: pp. 297-298.

100. Čhunlachomklao, 1927: p. 3.

101. Smyth, 1898: vol. 1, pp. 277-278; Bacon, 1892: pp. 217-218.

The Phasi Charoen canal (k. 15, fig. 4). The famous Phasi Charoen canal had a somewhat curious beginning in a Chinese appeal for its construction in L.E. 1227 (A.D. 1865). A Chinese opium and sugarcane tax farmer, Phra Phasi Sombatboribun (Pho Jim), later referred to by Rama V, who had extended his commercial operations in sugarcane at Don Kradi on the east bank of the Tha Chin river, proposed the construction of a canal to facilitate transportation between his commercial base and the capital¹⁰². According to his proposal, widely known as Prakat Khut Khlong Phasi Charoen¹⁰³, the government could not provide sufficient finance for the project because of shortage of revenue, chiefly caused by abolition of the orchard tax (*akon suan yai*) and the shortfall in rice export tax (*phasi khao*) in that year¹⁰⁴. So, citing the foreign example of public subscription for works, he suggested two methods of financing: the first was the collection of a toll, according to the size of boat, for the next ten years, and the second was the establishment of gambling houses (*rong huai*) at Nakhon Chaisi and Tha Chin (Samut Sakhon), for three years¹⁰⁵. Although it is not clear whether his proposals were approved, ultimately his revenue from a contract for opium-tax farming, 1,400 *chang* (112,000 baht), seems to have been expended on the project. This suggests that Chinese financial power, mostly obtained from various kinds of tax farming, began to establish control over canal projects, which had been traditionally regarded as the type of public works undertaken by government.

Certainly this canal, although frequently mentioned as planned with the sole object of transportation, seems to have also been intended to open unclaimed lands to some extent. In his proposal, Phra Phasi Sombatboribun referred, briefly but clearly, to the levying of land tax on people who reclaim and hold lands which extend up to 15 *sen* (600 m) from each bank¹⁰⁶. Judging from his expectation of a land tax in the

102. Čhunlachomklao, 1927: p. 2.

103. PKPS: vol. 7, p. 154.

104. For the orchard tax and the rice export tax, which seem to have been collected by Chinese tax farmers, see Damrong, 1923: pp. 22-33; Dilock, 1908: pp. 85-88.

105. PKPS: vol. 7, pp. 155-156.

west bank region along this canal, intensive farming had been developed by Chinese in the western outskirts of Bangkok, especially in the old Bangkok Yai canal area¹⁰⁷. That canal, connecting with the Damnoen Saduak canal, was most important for water transportation in the west bank region. In the 1880s, a royal decree for the repair of the latter canal refers to the improvement of transport facilities between provincial towns along the Nakhon Chaisi river and the Chao Phraya main channel since the construction of the Phasi Charoen canal, planned and built in the reign of Rama IV¹⁰⁸.

Besides the excavation of such trunk canals, some canal projects chiefly financed by eminent noble officials such as Somdet Chao Phraya Sisuriyawong and the Minister of Harbors, Chao Phraya Thipphakorawong, are mentioned in the *Dynastic Chronicle*. Those include excavation and repair projects carried out in Samut Songkhram Province (the Bang Li canal and the Yi San short-cut canal), and Samut Sakhon Province (the Khun short-cut canal and the Krut short-cut canal), coastal areas of the west bank¹⁰⁹.

V. Conclusion

The canal system constructed prior to the fifth reign on the east and west banks of the lower part of the Chao Phraya delta is shown in figure 8. The entire water-transportation network of this part of the delta region evolved through the historical development of two canal networks. (a) The network of numerous channels, including old river channels and short-cut canals mainly constructed in the Ayutthaya period, made up a system of water transportation for the markets and harbors of the capital, which can be termed the Greater Bangkok canal system, stretching from Pathum Thani in the north to Nakhon Khüankhan or Phra Pradaeng in the south, with Bangkok as the center. Water transportation in the kingdom's core or *Wong Ratchathani*, which extended from

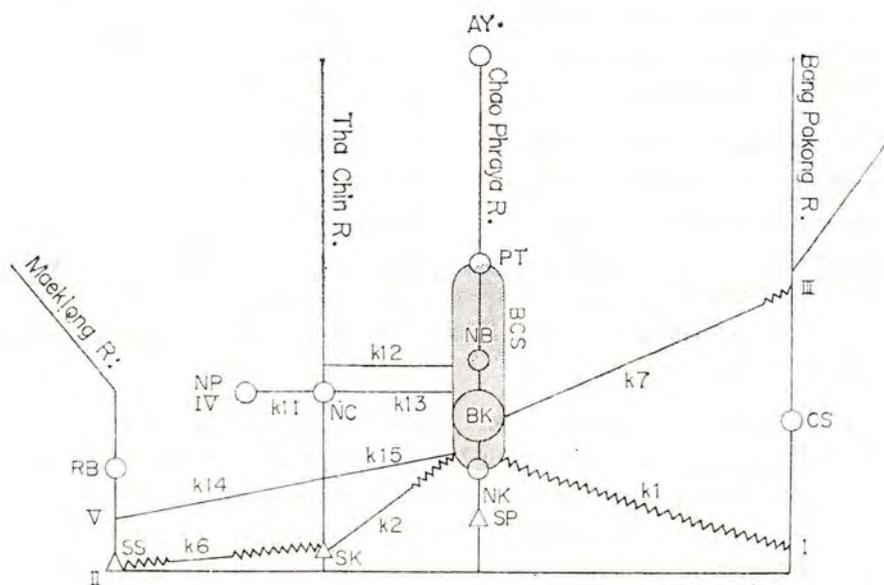
106. *Ibid.*: p. 156.

107. Skinner, 1957: p. 113; Sternstein, 1966a: p. 58. In particular, see Bradley's map for A.D. 1870, cited in Sternstein's article.

108. Prakat Khut Khlong Phasi Charoen, C.S. 1247-1248, *PKPS*: vol. 11, p. 7.

109. *PPKR III, IV*: 712-713.

Figure 8. The canal system of the lower part of the Chao Phraya delta, in the mid-nineteenth century



BCS : Greater Bangkok canal system
 AY : Ayutthaya
 PT : Pathum Thani
 NB : Nonthaburi
 BK : Bangkok
 NK : Nakhon Khüankhan (Phra Pradaeng)
 SP : Samut Prakan
 CS : Chachoengsao
 NC : Nakhon Chaisi
 NP : Nakhon Pathom
 SK : Sakhonburi (Samut Sakhon)
 RB : Ratchaburi
 SS : Samut Songkhram

k1 : K. Samrong
 k2 : K. Mahachai
 k6 : K. Sunak Hon
 k7 : K. Saen Saep
 k11 : K. Chedi Bucha
 k12 : K. Yong
 k13 : K. Mahasawat
 k14 : K. Damnoen Saduak
 k15 : K. Phasi Charoen
 ○ : *krung* ("capital")
 ◦ : *huamüang* ("provincial town")
 △ : *huamüang pak nam* ("fortified rivermouth town")

the capital city area, always consisted of this canal system, even when Ayutthaya was the capital¹¹⁰. (b) Long-distance canals, linked to provincial towns on other rivers and constructed for military affairs, movement of goods, and expansion of cultivated land through irrigation, form a supplementary trunk canal system connecting with the Greater Bangkok canal system.

Within the trunk canal system, routes I and II, running east-west with meandering parts on the coastal delta flat, were transverse channels constructed in early times. At the junctions of channels and at such *hua müang pak nam* ("fortified rivermouth towns") as Samut Prakan and Nakhon Khüankhan, military bases were situated. Those two routes, and the Saen Saep canal, route III, of a later period, played an important part in military affairs.

In the mid-nineteenth century, during the fourth reign, construction of trunk canals was begun with the improvement of route IV for the transportation of truck-farm produce, especially sugarcane. This was followed by the excavation of the Mahasawat canal, which completed route IV, and of the Damnoen Saduak and Phasi Charoen canals, route V, which were intended for the transportation of rice, fruit and vegetables as well as the expansion of riceland in the deltaic high region. Although a water transportation system composed of old and new canal systems on the west bank was developed, vast areas of land stretching toward the Bang Pakong river on the east were left uncultivated. New trunk canal construction projects to the east might have been expected, to facilitate transportation from the Chachoengsao region where rice cultivation had been fully developed by this period, and to reclaim wasteland, but that did not occur until the fifth reign.

Establishment of the trunk canal system on the west bank was, in part, intended to encourage reclamation of wasteland, and it led to the appearance of large-scale land-holding under the traditional client-patron

110. *Wong Ratchathani* in the latter part of the nineteenth century seems to have been reduced to a few provinces near the capital, such as Pathum Thani, Nonthaburi, Phra Pradaeng and Samut Prakan, which fully correspond with the Greater Bangkok canal system. (Tej, 1968: p. 34.)

relationship. Vast amounts of this land were left uncultivated, although such lands held by royalty and eminent noble officials seem to have been cultivated by *corvée* peasants and debt slaves still bound by the client-patron relationship. The landlord-tenant system of the Mahasawat canal area was also founded on the traditional social relationships of Thai society¹¹¹. Thus it appears that the expansion of riceland through the construction of canals in the mid-nineteenth century took place only within the very rigid limits of traditional society.

111. The landlord-tenant system developed in the traditional society does not have the same character as the modern landlord-tenant system that is based on payment of rent. (Dilock, 1908: pp. 96-99; Tomosugi, 1967: pp. 102-103.)

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